Essays on Selected Issues of Post-Crisis Banking Regulation, Profitability, and Risk

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Chapter 1

Introduction

Over a decade has passed since the last grand financial crisis 2008 and banking regulation has changed significantly. Since then, the Basel 3 framework provides in particular new and more restrictive capital and liquidity requirements for banks. The core of the reforms was the attempt to increase the stability of banks and the banking system. This was a consequence of the crisis showing that banks were individually not resistant enough and their interdependencies led to systemic effects destabilising even solid institutions. With regard to capital requirements, both quality and quantity of eligible means have been increased, in particular for so-called "systemic" institutions. Strict capital requirements might lead to more resilience in times of financial distress. However, aside from times of financial distress, they are associated with higher costs of capital for the institutions, making banks less profitable. Indeed, ever since the crisis, banking sectors in developed countries around the world are struggling with extraordinarily low profitability (Detragiache et al. (2018), Deutsche Bank (2019)). Low profitability of banks, however, increases again their vulnerability and leads to higher default risks. Another consequence of the financial crisis was the criticism of banks' risk governance mechanisms. Myopic remuneration practices and insufficient risk control mechanisms were manifold deemed inadequate (see Peni & Vähämaa (2012) among many others). Since then, corporate social responsibility became increasingly relevant to banks. Throughout the last years, the debate on responsibility focused in particular on a co-responsibility for fighting climate change. The term "climate risks" evolved as a new type of risk relevant for financial institutions, which had not been on the agenda before. Quantifying these risks is, however, difficult, which complicates the evaluation whether responsible business policies lead to a risk-reduction.

The central aim of this cumulative dissertation is to shed light on issues of post-crisis banking regulation and bank management studying their effects on bank risk and profitability. Common to all three essays is the approach to evaluate specific policy measures concerning their effect on the banking sector based on empirical data. In this way, all three studies are conducted with econometric methodology and bank specific panel datasets. The intention is to study the consequences of selected measures on bank risk and profitability, in order to provide guidance to bank regulators and bank management based on reliable data.

The first two essays of this cumulative dissertation concern the empirical evaluation of one particular type of hybrid capital which was proposed after the financial crisis 2008, the so-called "contingent convertible bonds" or "CoCo-bonds". CoCo-bonds were developed to provide loss absorbing going concern capital to financial institutions if and only if the capital is needed. They promise to combine the best of equity and debt, the quality to absorb losses, without the necessity of issuing supposedly costly equity. Though the idea of CoCo-bonds dates back to well before the crisis (Raviv (2004), Flannery (2005)), their relevance for the banking industry grew particularly after Basel 3 came into force in 2013–2014. Basel 3 allows the eligibility of CoCo-bonds as either additional tier 1-capital or as tier 2-capital, depending on their specific design. Predestined, however, is the eligibility as additional tier 1, because CoCo-bonds are the only remaining hybrid capital instrument other than common equity which remains eligible as tier 1-capital. The reason for the introduction of CoCo-bonds as additional tier 1-instruments was the aim to increase the resilience of banks (Squam-Lake-Working-Group (2009)) compared to hybrid capital instruments used before the crisis, without requiring banks to issue additional equity. After some years of experience with these new instruments, in principal there is now sufficient data to evaluate the effects on risk and profitability of this aspect of capital regulation. The quality of existing data on CoCo-bonds and their features as reported by data providers is, however, suboptimal. Therefore, for the preparation of the first two studies, extensive hand-collection of data was necessary.

Chapter 2 comprises my first and single authored essay entitled “Increasing Profitability through Contingent Convertible Capital. Empirical Evidence from European Banks” (Petras (2018)). This study investigates the consequences of the usage of CoCo-bonds on bank profitability. It is motivated by the fact that the usage of CoCo-bonds instead of equity offers a tax-shield and positive risk-taking incentives. I empirically analyse a panel dataset of 231 banks from EEA-countries as well as Switzerland from 2014 to 2018 as provided by Thomson Reuters’ Eikon. The analysis is focussed on those CoCo-bonds which are eligible as additional tier 1-capital, because only for these there is an obvious substitution relationship with equity. My analysis is conducted in two consecutive steps. The first part of the study analyses the determinants of the usage of CoCo-bonds. It shows, among others, that the potential tax-shield of CoCo-bonds is a relevant determinant. Subsequently, I analyse the implications for profitability of using CoCo-bonds as a substitute for common equity tier 1-capital. I find that the usage of CoCo-bonds instead of equity as additional tier 1-capital has significant and positive effects on bank profitability.

Chapter 3 comprises an essay entitled “Can CoCo-bonds Mitigate Systemic Risk? Evidence for the SRISK Measure”, which is based on a collaborative study with Arndt-Gerrit Kund (Kund & Petras (2019)). This essay is also concerned with the usage of CoCo-bonds, studying their implications for the vulnerability of banks towards systemic risk. After the 2008 financial crises, the idea of contingent convertible capital was manifold proposed as a means to stabilise individual banks, and hence the entire banking system. The purpose of this study is to empirically test whether CoCo-bonds indeed improve the stability of the banking system and reduce systemic risk. Our panel dataset comprises the entire universe of banks using CoCo-bonds as provided by Thomson Reuters’ Eikon and covers the years from 2012 to 2018. Using the broadly applied SRISK metric, we obtain contradicting results, based on the classification of the CoCo-bond as debt or equity. We remedy this short-coming by proposing an adjustment to the original SRISK formula that correctly accounts for CoCo-bonds. Using empirical tests, we show that the undue disparity has been solved by our adjustment, and that CoCo-bonds reduce systemic risk. As part of this cooperative work with Arndt-Gerrit Kund, I was involved in all parts of the work, in particular the conceptualisation, design, implementation, calculation, interpretation of the results, and writing. The work was particularly fruitful because Arndt-Gerrit Kund shared his expertise on systemic risk measures, while I contributed mine on hybrid capital instruments.

Aside from the capital resources to cope with materialised risk, a bank's riskiness is determined by the exposure on the asset side. While the management of conventional types of risk is already highly regulated, new risk dimensions like climate change induced risks have recently come to the fore. The management of climate risks can be seen as part of the social responsibility of banks as well as as forward looking risk governance in the interest of the bank. The term "sustainable banking" is used to capture the responsibility towards environmental, social, and governance aspects. Sustainable banking, be it voluntary or in compliance with regulatory requirements, affects the aggregated risk structure of banks. Therefore, my third essay in chapter 4 considers the implications of corporate social and in particular environmental responsibility for the idiosyncratic bank risk.

Chapter 4 comprises the essay entitled "Corporate Social Responsibility and Bank Risk", which is the result of a collaborative study with Florian Neitzert (Neitzert & Petras (2019)). Extant literature on sustainability finds that corporate social responsibility does not necessarily decrease profitability but reduces idiosyncratic firm risk. However, it remains unclear whether the risk-reduction stems from the environmental, social, or governance pillar. We investigate the origins and effect drivers, by analysing a sample of 2,452 banks from 115 countries over the period from 2002 to 2018. The worldwide dataset provided by Thomson Reuters comprises bank characteristics and, in particular, data on their environmental, social, and governance performance. As a result, we identify the environmental pillar and its sub-components as the significant determinants. Our analysis yields that the three dimensions of corporate social responsibility do not affect bank risk to the same degree. Instead, the environmental dimension, i.e. sustainability in a narrow sense, is identified as the most relevant aspect of responsibility for bank risk. As part of this cooperative work with Florian Neitzert, I was involved in all parts of the work, in particular the conceptualisation, implementation, interpretation of the results, and writing. I am responsible for the empirical design and the calculations. On the theoretical level, I contributed my expertise on empirical banking and idiosyncratic risk.

The studies included in this dissertation all provide insights into the effects of regulated bank policies on risk and profitability. In this way, I give guidance on the implications of bank management decisions and bank regulation requiring or enabling these actions. I provide evidence that the usage of CoCo-bonds increases bank profitability and decreases banks' systemic vulnerability. These are good reasons for bank management to make use of these instruments. For regulators, the increase in profitability and the reduction of systemic risk associated with these instruments additionally confirm that these instruments do indeed strengthen the banking sector. Finding that corporate social responsibility in the form of environmental engagement reduces idiosyncratic bank risk serves as additional motivation for bank managers to commit to sustainable banking. For regulators, it provides insights into the roots of the risk-reduction associated with corporate social responsibility, as well as justification for requirements to sustainable banking in the environmental sense.

The results presented in the three studies of this dissertation contribute and enhance the state of scientific banking research. However, the perspective on bank risk and profitability based on empirical data is always past-oriented. The results illustrate some of the consequences of policies adopted and proposed after the last grand crisis, consequences of lessons supposedly learned after the financial crisis in 2008. However, banks are already faced with new risks like climate risks, cyber risks, or the risk of public health crises, new types of risks that share a high degree of unpredictability and severe systemic consequences. The future will eventually show if the lessons learned from the last crisis serve as a good preparation for future times of financial distress.

Chapter 2

Increasing Profitability through Contingent Convertible Capital. Empirical Evidence from European Banks[1]

[1]This paper received a best paper award at the 17th International Finance and Banking Conference (Bucharest, 2019) and a best paper award at the 26th Annual Global Finance Conference (Zagreb, 2019). For helpful comments on this particular study, I thank the discussants at the 17th International Finance and Banking Conference (Bucharest, 2019), the Annual Conference of the British Accounting & Finance Association (Birmingham, 2019), the 26th Annual Global Finance Conference (Zagreb, 2019), the Infiniti Conference on International Finance (Glasgow, 2019), the 23rd European Conference of the Financial Management Association (Glasgow, 2019), the 36th Annual Conference of the French Finance Association (Québec City, 2019), and the 27th Annual Meeting of the Spanish Finance Association (Madrid, 2019).

2.1 Introduction

Since Basel III, the requirements for the eligibility of capital instruments as regulatory capital have been tightened. Aside from common equity tier 1 (CET1) which necessarily has to be equity capital, only additional tier 1-capital (AT1) – in the form of contingent convertible (CoCo) capital – will henceforth be eligible as tier 1-capital. Tier 1-capital is the relevant amount with regard to the calculation of the risk-sensitive tier 1-ratio as well as the risk-insensitive regulatory leverage ratio. In order to allow banks to adopt smoothly to the new tightened capital requirements, European regulation grants a phase-in period until 2021, during which the eligible amounts of old AT1-instruments – those which do not fulfil the new requirements – are gradually reduced, respectively phased-out. After the regulatory phase-in period, merely CRR-compliant[2] CoCo-bonds will be eligible as AT1-capital (AT1CoCos). Legally, AT1CoCos are debt obligations with a contractual quasi-automatic conversion mechanism. In case of a breach of a pre-defined trigger threshold, the instrument is either converted into CET1-instruments (C2E) or the principal amount is written down (PWD). The trigger must be based on regulatory CET1-capital and amount to at least 5.125 %. Other design features concerning the conversion price or ratio, permanent or temporary write down, or the possibility of a write up of the principal amount are left to contractual freedom. The idea of AT1-capital is to provide additional going concern capital exactly if the bank is in a state of financial distress. On the one hand, AT1CoCos provide loss absorbing capital and reduce costs of bankruptcy, similar to CET1-capital. On the other hand, AT1-capital instruments have several advantages as compared to CET1-capital. In particular, the use of AT1CoCos has the potential to mitigate adverse incentives for value reducing risk-shifting and to improve efficiency. Moreover, depending on the specific design, these capital instruments can yield a tax-shield, due to the deductibility of coupon payments. Hence, AT1CoCos combine the best of two worlds, on the one hand the loss absorption qualities of equity, and on the other hand the tax deductibility of debt. Particularly to the extent of regulatory eligibility, European capital regulation offers the discretion to use AT1CoCos as a substitute for CET1-equity for capitalisation purposes. From a theoretical point of view, such a substitution should be beneficial and promise regulatory arbitrage.

Until now, literature has predominantly been focussed on design features of CoCo-bonds, pricing methods, financial stability implications, and potential risk-shifting incentives as such. Empirical literature on CoCo-bonds, their usage, and their financial implications, on the other hand, is still rare. So far, Goncharenko & Rauf (2016), Avdjiev et al. (2017), and B. Williams et al. (2018) study determinants of the issuance of CoCo-bonds. They do, however, not study AT1CoCos as a capital component subject to a substitution relationship with CET1-capital. To the best of my knowledge, there is no literature on the determinants of the extent to which

[2]CRR-compliant relates to those instruments fulfilling the requirements of Art. 52 of the Capital Requirements Regulation (i.e. Regulation 575/2013(EU)). Such instruments necessarily must be characterised by in essence equity features like perpetual duration, cancellation of distribution does not constitute an event of default, distributions only out of distributable items.

banks make use of AT1CoCos, compared to other components of regulatory capital. Building on that, financial implications and interdependencies of the usage of AT1CoCos are for the most part still undiscovered. As one of very few, Avdjiev et al. (2015) and Avdjiev et al. (2017) study the implications of issues of CoCo-bonds for the costs of capital, focussing on their impact on CDS-spreads of subordinated debt.

This study aims to close some parts of the gap in the empirical literature. The purpose of the study is twofold. First, the study aims to analyse the use of AT1CoCos as a source of tier 1-capital and to identify the main determinants explaining the use of AT1CoCos by European banks. Second, I study the impact of the usage of AT1CoCos instead of CET1-capital on the profitability of banks. To the best of my knowledge, I am the first to examine the impact of bank specific CoCo-AT1-ratios on bank profitability.

As results of the study, I conclude that banks make increasingly use of AT1CoCos, while still a substantial part of the banking industry does not exploit its potential benefits. I find that the average earnings intensity is a significant determinant of the use of AT1CoCos, implying that banks exploit the associated tax-shield potential. Though, the tax rate does not significantly determine their use. Moreover, I conclude that the use of AT1CoCos instead of CET1-capital increases the profitability of banks significantly. This result is valid for profitability after taxes as well as before taxes, indicating that the tax-shield of CoCo-bonds is not the only reason to explain the increase in profitability.

2.2 Literature on CoCo-Bonds

The intellectual foundation of CoCo-bonds as going concern capital can be attributed to the proposal of a “reverse convertible debenture” by Flannery (2005). These bonds automatically convert into common stock if a bank violates a pre-defined capital ratio. In opposition to a capital ratio trigger, Raviv (2004) proposes ”debt-for-equity-swaps”, which are triggered if a bank reaches a pre-specified asset value threshold. The proposal of a “capital insurance” by Kashyap et al. (2008) aims to recapitalise banks if the banking sector on aggregate reaches a situation of financial distress. In the wake of the global financial crisis, the interest by policy makers and the intensity of the theoretical debate on CoCo-bonds increased drastically. Specifically designed CoCo-bonds were designated as the only remaining source of AT1-capital by the Basel III accord. If CoCo-bonds do not fulfil these design requirements, they might still be eligible as tier 2-capital. Cahn & Kenadjian (2014) provide a general overview of the regulation of CoCo-bonds according to Basel III and the European implementation through CRR and CRD IV. Most of the existing literature is of theoretical nature and can roughly be classified as either literature on design features of CoCo-bonds, on pricing issues, on financial stability implications, or on risk-taking incentives. A comprehensive literature review is provided by Flannery (2014).

Throughout this study, I build on two clusters of literature on CoCo-capital in particular: First, theoretical literature on incentive effects and other potential benefits for banks using CoCo-bonds and, second, empirical literature on the dissemination of CoCo-capital.

Starting point and motivation of my paper is the theory that the usage of CoCo-bonds instead of CET1-capital offers potential benefits for banks, because of the inherent tax-shield and positive incentive effects. Albul et al. (2010) demonstrate that CoCo-bonds increase a bank's value by increasing the tax-shield and decreasing the bankruptcy costs, particularly as regards over-leveraged banks. Ceteris paribus, a direct consequence is an increase of after tax profits and a reduction in the cost of capital. Zeng (2014) shows that CoCo-bonds should be part of the optimal capital structure, as they improve the efficiency of banks and maximise shareholder value in face of regulatory capital requirements. Hilscher & Raviv (2014) posit that the appropriate choice of the parameters of CoCo-bonds can entirely eliminate any incentives to inefficiently shift risk, compared to alternative capital structures employing either additional equity or additional subordinated debt. The central parameter is the bond's conversion ratio. In case of conversion, shareholders benefit from the cancellation of the converting debt, but suffer from the dilution of their shares. The conversion ratio determines the extent of dilution. In particular, a high conversion ratio and the threat of large-scale dilution make an additional unit of risk in the bank's portfolio more costly. Therefore, shareholders are motivated to vote for a less risky business and to issue additional equity voluntarily before CoCo-bonds are triggered (Huertas (2010), Calomiris & Herring (2013)). At an appropriate level for the conversion ratio, the costs and benefits for shareholders cancel each other. This conversion ratio eliminates any incentives to shift risk either inefficiently high or inefficiently low and enforces profit maximising decision making. Martynova & Perotti (2018) find that the threat of conversion reduces risk-shifting incentives in particular in banks with high leverage. Incentive effects, however, might not be the same for different forms of CoCo-bonds, but rather depend on the specific design. Himmelberg & Tsyplakov (2014), Berg & Kaserer (2015), and Chan & van Wijnbergen (2017) argue that other than dilutive C2E-CoCos, PWD-CoCos and non-dilutive C2E-CoCos do not yield the described positive incentives. However, the specific incentive effects may depend on a multitude of design features, making it difficult to account for each of them. In general, literature provides the theoretical foundation to expect positive incentive effects. Because of the potential benefits through incentive effects and the tax-shield, I assume that the usage of CoCo-bonds has positive financial implications for banks and test whether these effects are measurable empirically.

Empirical literature concerning CoCo-bonds is still sparse. Avdjiev et al. (2015) and Boermans & van Wijnbergen (2018) investigate the investor base of CoCo-capital instruments. Hesse (2018) empirically extends the theoretical literature on incentives, showing that CoCo-investors require a yield premium for PWD-CoCos as compared to C2E-CoCos. He interprets that investors, thereby, anticipate elevated risk-taking incentives if PWD-CoCos are issued. Avdjiev et al. (2017) perform an analysis of determinants for European banks to issue CoCo-bonds using duration analysis. B. Williams et al. (2018) perform logit regressions to test which determinants contribute to the issuance of CoCo-bonds. Their study, however, is not restricted to AT1CoCos, reducing comparability with other studies. They find evidence that systemically risky banks are more likely to issue CoCo-bonds. Avdjiev et al. (2015) and Avdjiev et al. (2017) additionally investigate the consequences of issuances of CoCo-bonds for CDS-spreads of subordinated debt of the respective banks. They find that issuing CoCo-bonds leads to a reduction of CDS-spreads. This finding, however, must not be misinterpreted as a reduction of financing costs. The reduction is at least partially compensated by higher interest payments on the respective CoCo-bonds. Nevertheless, tax-shield and efficiency gains do promise a potential reduction of financing costs. Closest to my study comes a working paper by Goncharenko & Rauf (2016). They perform a determinant analysis as regards the use of AT1CoCos based on information from CoCo-bond issuances for banks with listed equity. As a measure, they use CoCo-bonds outstanding over assets. They find that highly levered banks, those with capital constraints, are more likely to issue CoCo-bonds and issue higher amounts. They interpret, that bank managers are optimising their return on equity (ROE) through the use of CoCo-bonds, in order to increase their salaries. This, however, is an unfounded assumption. The authors do not empirically evaluate ROE. Indeed, there might not only be incentives for managers, but also adverse incentives for shareholders to adverse risk-shifting at the expense of CoCo-investors. At the same time, ROE as a measure is, of course, problematic, because it remains unclear if the CoCo-bonds considered are accounted for as equity or as debt.

The theory on potential benefits motivates the two parts of the present empirical study. First, if CoCo-bonds yield a potential tax-shield, the contributing factors of the tax-shield - i.e. earnings and the tax rate - should be determinants of the usage of CoCo-bonds. Studying the determinants of the use of CoCo-bonds, I extend existing determinant analysis using detailed information on capital components from banks' Pillar 3 reports. I measure the use of AT1CoCos as a share of tier 1-capital in order to interpret AT1CoCos as a substitute for CET1-capital. Second, I investigate whether the potential benefits can be realised. To the best of my knowledge, there is no literature concerning the empirical implications of the usage of CoCo-capital for profits and profitability, bank value, efficiency, or total funding cost measures of European banks. The present paper intends to fill this gap, evaluating the impact on bank profitability measures.

2.3 Sample, data, and variable of interest

The sample analysed is generated from Thomson Reuters' Eikon. The initial sample consists of 291 banks from 32 EEA-countries plus Switzerland. Thereof, I select banks on a fully consolidated basis, on which the Basel Accord applies, and eliminate those banks which are consolidated as part of another bank in the sample. Further, I eliminate those banks that are not subject to a supervisory institution from the EEA or Switzerland as well as those banks for which no capital adequacy data can be found. What remains is a sample comprising 231 banks from 33 countries. The data analysed is annual fundamental and capital adequacy data from 2014 to 2018. Reason for the cut-off before 2014 is the fundamental change in the capital regulation regime from Basel II to Basel III after the implementation of the CRR in 2014. Capital adequacy data from years before 2014 cannot be considered as comparable, at least not without making unwarranted adjustments. Data concerning capital adequacy is entirely hand-collected from banks' Pillar 3 reports, because it is not available from data providers in the detail necessary. Banks in the EEA (and in Switzerland in comparable form) are required by Art. 437 CRR to provide data on capital adequacy either in a separate Pillar 3 report, risk report, or as part of the annual report.[3] ITS 1423/2013(EU) provides a standardised template to comply with the reporting requirements. The data collection is based on the structure of the standardised template. The result of the hand-collected capital adequacy data is a dataset of unique detail for the capital components. Fundamental data is provided by Thomson Reuters. Data on macroeconomic variables like inflation rate, gross domestic product (GDP), or the level of corruption is retrieved from the WorldBank-database and Transparency International.

$$COCOS = \frac{AT1CoCos}{Tier1 - capital} \; (in \ \%) \tag{2.1}$$

Table 2.1: **COCOS per FY**
The table below shows information on the dissemination of AT1CoCos over the years considered. Illustrated are the share of banks using AT1-CoCos in the respective year, the mean value of COCOS in general (in %), and the mean value of COCOS restricted to positive values of COCOS (in %).

FY	2014	2015	2016	2017	2018	Overall
Share of banks using CoCos	0.357	0.454	0.443	0.461	0.502	0.443
Mean COCOS	4.004	4.403	4.531	4.581	4.754	4.454
Mean COCOS if > 0	11.200	9.703	10.230	9.926	9.465	10.044

The variable of interest in both empirical parts of this study is the extent to which banks make use of AT1CoCos for capitalisation purposes. In this way, COCOS is measured as the share of AT1CoCos of tier 1-capital. Hence, COCOS is a relative measure, i.e. fully-loaded AT1-capital relative to tier 1-capital. The advantage of this measurement approach is that it formalises the substitution relationship of AT1-capital instruments and CET1-capital instruments in order to fulfil the capital requirements with regard to tier 1-capital. It does directly reflect the premise that the substitution of CET1 by fully-loaded AT1-capital might be beneficial. It does

[3] It should be mentioned in this context that the quality of pillar 3 reporting varies significantly between the countries considered. Moreover, the information provided is regularly unaudited.

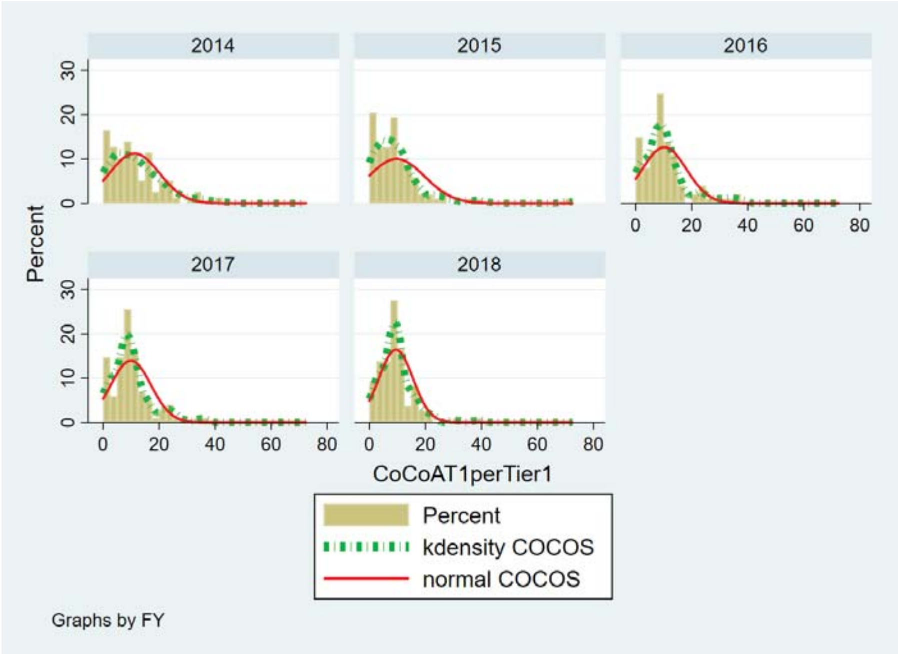

Figure 2.1: **Distribution of COCOS over the Years Considered**
The five graphs show the distributions of COCOS for the respective years. COCOS is the percentage share of AT1CoCos per tier 1-capital. Kernel density lines are painted green. Normal density lines are painted red.

not depend on the amount of risk-weighted assets and does not simply reflect higher total capital ratios. Other specifications are considered in section (2.6). Over the years 2014-2018, 44 % of the banks were characterised by positive amounts of AT1CoCos, i.e. made use of AT1CoCos for capitalisation purposes. The share of banks using AT1CoCos increased steadily since 2014 up to 50 % in 2018. The mean of COCOS amounts to 4.5 %, increasing from 4.0 % in 2014 to 4.8 % in 2018. If only strictly positive values of COCOS are considered, the mean amounts to 10.0 %. The increase in COCOS can be explained by two reasons. First, banks adopt to the new capital regulation of Basel III and issue new CRR-compliant instruments. Second, according to the phase-out rules in Art. 484 (4) and 486 (3) & (5) CRR for old AT1-instruments which are not CRR-compliant, the eligible AT1-capital decreases from year to year. Insofar, as the total tier 1-capital decreases and AT1-CoCos remain unchanged, the variable COCOS should increase. Therefore, to some extent the coefficients do not reflect management action, but simply reflect the phase-in and phase-out effects of the transition period.

In order to evaluate the values for COCOS, the question to start with is what size one may expect for COCOS. Because the absolute minimum requirement for tier 1-capital amounts to 6 %, whereof 4.5 % must be CET1, the highest possible share of eligible AT1-capital would be 25 % of tier 1. Since banks are also subject to further requirements because of buffer-requirements and SREP-requirements[4], the rate of eligible AT1-capital of tier 1-capital will be lower, possibly

[4]Based on the Supervisory Review and Evaluation Process (SREP), supervisory institutions can set i.a. additional bank-specific capital requirements. Such requirements theoretically do not necessarily need to be CET1-requirements. In practice, however, they nearly always are.

as low as 10 % or less. Consequently, it is not possible to find a universal level of eligible COCOS. Empirical ratios of AT1CoCos to tier 1-capital, though, will vary additionally to the extent that banks make use of CET1 or AT1-capital instruments for economic or practical reasons. Assuming that AT1CoCos offer going concern capital comparable to CET1, but is otherwise beneficial, it is reasonable to cover these voluntary buffers with AT1CoCos. Despite potential benefits and eligibility as tier 1-capital, about half of the banks does not yet use AT1CoCos. As a first result, I conclude that banks indeed make increasingly use of AT1CoCos – which are still a very young category of instruments. Though, a substantial part of the banking industry does not yet exploit the benefits of AT1CoCos. Another finding is that the use of AT1CoCos depends on the geographic region. While rare in Eastern Europe, about two thirds of the banks in Northern Europe make use of AT1CoCos. A series of simple two sample t-tests reveals that while banks from the north have significantly higher, banks from the east and south have significantly lower levels of COCOS. Banks from Switzerland, even though not member of the EEA, do not statistically significantly deviate from the others. Considering the Euro-zone, banks reporting in EUR have significantly less COCOS than others. The reason for that is the extraordinarily high COCOS of Scandinavian banks reporting in their local currencies. Figure (2.1) and Table (2.1) illustrate the development of COCOS from 2014 to 2018. Figures (2.3)–(2.4) and Tables (2.6)–(2.8) in the appendix provide additional results of the descriptive analysis.

Two limitations restrict the quality of the data. First, it would be interesting to evaluate the share of AT1CoCos accounted for as equity, respectively as debt. Even though banks are required to report this characteristic as part of the information of the template of Annex 4 of ITS 1423/2013(EU), this information is often neglected. The second limitation concerns a distinction between C2E- and PWD-bonds. In principle, this information is also required to be disclosed by European banks, following Annex 2 of ITS 1423/2013(EU). Because for this sample information on accounting treatment as well as on trigger mechanisms is also only available to a limited extent, I refrain from analysing these characteristics.

2.4 Determinant analysis

2.4.1 Variable selection

The first empirical part of the present study is dedicated to the analysis of the usage of CoCo-bonds eligible as AT1-capital among banks from the EEA and Switzerland. Based on the panel dataset described above, I analyse to what extent banks make use of these instruments in order to fulfil relevant capital requirements. Moreover, I use a multiple linear panel regression model to identify significant determinants of an elevated use of CoCo-AT1-instruments as part of the regulatory capital structure. The dependent variable is COCOS, as defined in section (2.3). The variables considered as determinants in the regression model are motivated as follows: I build on the insights of Goncharenko & Rauf (2016), Avdjiev et al. (2017), and B. Williams et al. (2018) about determinants of the issuance of CoCo-bonds. To some extent, one can also borrow insights from capital structure literature. Caution is, however, required, because unlike most studies on determinants of capital structure, it cannot be assumed with certainty whether AT1CoCos are accounted for as debt or as equity. AT1-CoCos are hybrid capital instruments and as such it depends essentially on the specific contractual properties as well as on the applicable accounting standards.

Bank size is a frequently tested variable in the literature on capital structure and also an intuitive possible determinant for COCOS. Goncharenko & Rauf (2016) find a significant positive effect for AT1CoCos outstanding. B. Williams et al. (2018) find that larger banks are more likely to issue CoCo-bonds and Avdjiev et al. (2017) find that larger banks are earlier adopting to CoCo-capital and are more frequently issuing CoCo-bonds. In tendency, larger banks have a more professional capital management and better access to capital markets. Issuances of CoCo-bonds regularly require a certain volume to justify the associated fixed costs. Large institutions are predestined to issue these large and cost efficient volumes, while they might be over-dimensioned for smaller banks. In this way, the argument of Titman & Wessels (1988) that small firms have higher per unit equity issue costs could just as well be transferred to the issuance of CoCo-bonds. In accordance with the literature, the present study considers size as log total assets (SIZE). Assuming that large banks are more likely to use AT1CoCos at all and, therefore, have higher AT1-capital ratios, I expect ex-ante a positive effect of SIZE on COCOS. On the other hand, if very large banks are considered "too-big-to-fail", they might benefit from lower bankruptcy risk. Hence, for the largest banks, there might be no additional increasing effect.

The equity ratio (CAR) is widely used as a measure of balance sheet capital adequacy. It is measured as the proportion of total equity to total assets. It serves as an indicator of the reliance of the bank on equity or debt financing. The expectation is that CAR has a negative impact on COCOS. The equity in the nominator of the ratio meets the requirements of CET1. Because AT1 and CET1 are substitutes for eligibility as tier 1-capital, an increase in equity should lead to a proportional increase in CET1 and decrease in the relative share of AT1CoCos to total tier 1-capital. Goncharenko & Rauf (2016) find a negative and significant effect on AT1CoCos outstanding. B. Williams et al. (2018) find a negative and significant effect on CoCo-bond issuance. Because CoCo-bonds can be accounted for as either debt or equity and it is factually impossible to eliminate the CoCo-bonds from the total amounts provided on the balance sheet, there may be a risk of reverse causality. However, the accounting treatment, wherever empirically available, does not indicate a predominance of treatment as equity or as debt. Moreover, this effect would be at any rate negligibly small, because compared to the balance sheet amounts of debt and equity the share of regulatory AT1-capital is very small.

The total capital ratio (TCR) indicates the capital adequacy ratio of total own funds over risk-weighted assets. I have no clear expectation as regards the effect of TCR because the composition of tier 1-capital should be prima facie independent of the total capital adequacy. Analogous to CAR, however, it could indicate lower bankruptcy costs. Avdjiev et al. (2017) find that higher capital ratios measured by tier 1-ratios increase the likelihood of banks issuing CoCo-bonds. This might indicate a tendency of better capitalised banks to be more likely to use CoCo-capital.

Earnings intensity (EBTAA) serves as a pre-tax measure of earnings in relation to average assets. It represents the intensity with which a bank earns taxable income. Because interest payments on AT1CoCos are tax deductible independent of their treatment as equity or debt, earnings intensive banks have enhanced incentives and potentials to materialise tax-shields by substituting CET1-capital by AT1-capital. This argument is analogous to Ooi (1999) who points out that trade-off theory shows that more profitable firms employ more debt since they are more likely to have a high tax burden and low bankruptcy risk. Therefore, I expect a positive impact of EBTAA on COCOS. On the other hand, if earnings are not paid out but accumulated, they would be eligible as CET1 and thereby reduce COCOS.

Income diversification (INDIV) refers to the share of total income which is non-interest income. It measures the extent of diversification of income sources, while high ratios indicate a higher degree of diversification through fee and commission income and lower reliance on interest income. It is not clear what effect ex-ante should be expected by this variable. If anything, it could be argued that highly diversified banks are more sophisticated and, therefore, in tendency more likely to use AT1CoCos.

Risk-density (RISK) is a measure of the amount of risk-weighted assets relative to total assets. RISK, hence, measures the riskiness of the business of banks. To properly reflect the actual riskiness, it depends on the accuracy of the risk-weights allocated to the items on the balance sheet. Because of higher agency and bankruptcy costs, banks with higher risks will be expected to rather use CET1- than AT1-capital instruments, because of the higher loss absorption quality.[5] Using asset volatility, yearly stock volatility, and probability of default as measures of risk, Goncharenko & Rauf (2016) find that less risky banks are more likely to issue CoCo-bonds.

Loan loss provisions (LLP) are adjustments of the gross loan amount made in order to account for potential losses. High amounts of loan loss reserves indicate bad loan portfolios. At the same time, loan loss provisions reduce the equity of a bank, and thereby the CET1. As a consequence, the relative share of AT1 to total tier 1 increases. Therefore, I expect a positive relationship

[5] For CRR Art. 52 compliant instruments, though, the qualitative difference is only marginal. Both serve as going concern capital.

with COCOS. B. Williams et al. (2018) find a positive effect on the issuance of CoCo-bonds for the share of loan loss reserves to gross loans.

Phase-out AT1-capital (OLDAT1) is a dummy variable indicating whether or not the bank (still) has AT1-capital instruments outstanding which will not be eligible after the expiration of the transitional period under the fully-loaded capital requirements regime. The potential effect can be twofold. On the one hand, the fact that a bank makes and made use of such hybrid capital instruments in the past could indicate a general tendency of using hybrid instruments. This would make it more likely that such a bank will also use AT1CoCos. On the other hand, old instruments subject to phase-out rules and new fully-loaded instruments are subject to a substitution relationship. The fact that a bank still has old instruments could simply indicate that it has not yet adapted to the new regulation. Therefore, the effect on COCOS could also be negative.

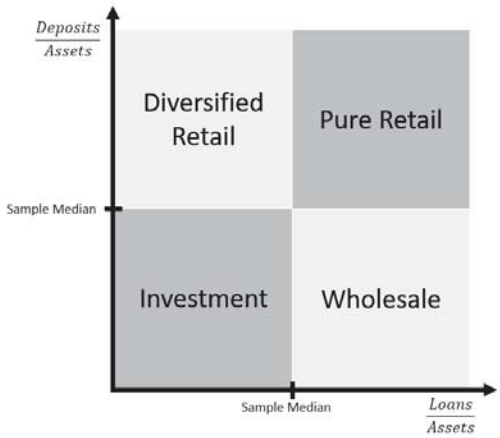

Figure 2.2: **Generic Business Models**
This figure illustrates the classification of the four generic business models used in the determinants analysis of COCOS. The relevant criteria for the classification are whether or not banks' deposits per assets, respectively their loans per assets exceed the sample median.

The business model is regarded for exploratory reasons. Similar to Ayadi et al. (2016), I distinguish four generic business models (illustrated in Figure 2.2) in dependence on the extent to which banks make use of deposits and are exposed to loans. Banks with loans per assets and deposits per assets exceeding the sample median are classified as retail banks. Banks below the respective medians are classified as investment banks. Banks with only deposits per assets exceeding the median are classified as diversified retail banks, those with loans per assets exceeding the median as wholesale banks. The classes are identified by dummies for high loans per assets (LOAN), high deposits per assets (DEPO), and their interaction (DEPxLOA). The effect of business models is generally unclear. LOAN, though, can also be interpreted as liquidity risk. B. Williams et al. (2018) find that higher loans per assets increase the likelihood for the issuance of CoCo-bonds. Goncharenko & Rauf (2016) also find a positive effect of loans on AT1CoCos outstanding. For deposits they find positive but insignificant effects.

As regards the macroeconomic variables, the average corporate tax rate (ATAX) should have a positive effect on COCOS. The higher the tax rate, the higher the potential tax-shield, which poses an incentive to use AT1CoCos. For international capital structure differences, though, Mayer (1990) states that taxes have no explanatory power.

Moreover, the following macro variables are added as control variables: Inflation (INFL), considered as the annual difference of the GDP-deflator in percent; GDP-growth (GDPG) in percent; corruption, measured by the Corruption Perception Index by Transparency International (CPI); and the rating of the countries, specified by Credit Quality Steps (CQS) as defined by the European Banking Authority. I further consider dummies for financial years (FY) to control for the general increase in COCOS (as illustrated in Table 2.1) as part of the phase-in of these instruments in the new capital framework and the simultaneous phase-out of old instruments.

Table (2.9) in the appendix provides an overview of the variables used and their expected effects. Tables (2.10) and (2.11) in the appendix provide additional information on the distributions and pairwise correlations of the variables.

2.4.2 Method and model specification

I apply a linear OLS-model with bank and time fixed effects on the above defined panel data set. The model is specified as follows:

$$COCOS_{it} = \alpha_i + \boldsymbol{\beta} * X_{it} + \boldsymbol{\gamma} * Y_{jt} + \mu_t + \epsilon_{it}, \tag{2.2}$$

while X comprises the bank specific variables and Y comprises the macroeconomic variables, the indices indicate: $i = bank$; $j = country$; $t = financial\ year$.

The regression model is specified with bank and time fixed effects, to account for unobserved heterogeneity that may be correlated with the explanatory variables. The Hausman-Test suggests that coefficient estimates in fixed and random effects model are not alike and, therefore, suggests rejection of random effects.

A modified Wald-Test for group-wise heteroscedasticity in the residuals of the regression models, following Greene (2000), rejects the homoscedasticity assumption. As a remedy, robust Huber-White-sandwich estimates of variance (following Froot (1989) and R. L. Williams (2000)) are used for the statistical analysis.

Table 2.2: **Bank Specific and External Determinants of CoCo-AT1 Usage**
The table below depicts the results of a panel regression model with bank and time fixed effects, analysing the determinants of COCOS. COCOS is the dependent variable. Model (1) illustrates the results using bank specific variables only. Model (2) adds control variables for financial years. Model (3) considers a broader set of bank specific covariates. Model (4) adds macroeconomic covariates. The variables used are described in Table (2.9). Standard errors are in parenthesis. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level.

	(1) Bank	(2) Bank+FY	(3) Bank+FY	(4) Macro
SIZE	0.3895	-0.4570	-0.5769	0.0768
	(0.82)	(0.82)	(1.05)	(1.16)
CAR	0.0069	-0.0133	-0.2199	-0.2051
	(0.03)	(0.03)	(0.15)	(0.16)
LLP	0.2414*	0.2507*	0.2658*	0.2899**
	(0.13)	(0.13)	(0.14)	(0.13)
EBTAA	0.3440**	0.3453**	0.5046**	0.5091**
	(0.16)	(0.16)	(0.23)	(0.22)
DEPO	1.7039**	1.3366**	1.5700**	1.3603*
	(0.68)	(0.66)	(0.71)	(0.75)
LOAN	1.3303	1.0907	1.7896**	1.7161**
	(0.81)	(0.79)	(0.73)	(0.76)
DEPxLOA	-2.2418**	-1.9920**	-2.8221***	-2.9103***
	(0.96)	(0.93)	(0.94)	(0.96)
INDIV			-0.0525**	-0.0560**
			(0.02)	(0.02)
RISK			0.0131	0.0311
			(0.04)	(0.04)
OLDAT1			-1.8350**	-2.0794***
			(0.71)	(0.73)
TCR			0.0232	0.0611
			(0.07)	(0.07)
ATAX				-0.0461
				(0.10)
INFL				-0.1272
				(0.13)
CPI				0.1407
				(0.09)
GDPG				0.0313
				(0.07)
CQS				-1.7502**
				(0.77)
Const.	-4.2149	9.1993	14.0648	-3.7157
	(13.40)	(13.24)	(17.35)	(20.97)
FY Dummies	No	Yes	Yes	Yes
N	1024	1024	869	848
adj. R^2	0.0926	0.1030	0.1440	0.1644

2.4.3 Evidence from determinants analysis

Table (2.2) summarises the results of four variations of the regression model. They differ by the number of regressors considered, whereas Model (1) serves as the baseline model. As regards bank specific determinants of COCOS, I find statistically significant positive coefficients in Models (1)–(4) of Table (2.2) for EBTAA, LLP, LOAN, and DEPO. The coefficients for EBTAA are in line with ex-ante expectation. EBTAA has a statistically significant and positive impact on COCOS (the share of AT1CoCos to tier 1). This implies that banks with strong earnings make use of their tax-shield potential by using tax deductible AT1CoCos, be they accounted for as equity or as debt, rather than CET1-capital. LLP also shows a significantly positive coefficient indicating that adjustments for bad loans and the associated reduction of equity increase the relative share of AT1CoCos in tier 1-capital. Interestingly, all the business model coefficients have significant coefficients. High deposits and high loans have statistically significant positive coefficients. At the same time, the combined effect impacts COCOS statistically significant negative in all four models. This implies that banks with one-sided diversification, i.e. diversified retail banks and wholesale banks make use of AT1CoCos to a larger extent, compared to investment banks. This, on the other hand, does not hold for pure retail banks which have high deposits and high loans at the same time. The combined effect of loans and deposits is negatively related to COCOS. While the result for retail banks seems intuitive, as retail banks can be assumed to be less capital market oriented, investment banks, on the other hand, are supposedly characterised by a high degree of market orientation and should be predestined to use sophisticated hybrid capital instruments like CoCo-bonds. The opposite is found, however. The coefficients for asset size and capital adequacy are both not statistically significant. This is inconsistent with ex-ante expectation. Consequently, I cannot infer that the usage of AT1CoCos of large banks differs significantly from small banks.

Model (2) additionally controls for financial year dummies. The results remain robust and nearly unchanged. Models (3) and (4) additionally consider income diversification, phaseout-AT1-capital, risk density, and regulatory total capital as additional bank specific variables. The effect of phaseout-AT1-capital is statistically significant negative. This indicates that the use of AT1-capital underscoring the phase-out rules is associated with lower COCOS. Therefore, I conclude that the negative effect from the substitution relationship with AT1CoCos overcompensates a potential tendency for all kinds of hybrid instruments of the respective banks. Income diversification is associated with lower COCOS. This result can be seen as evidence against the assumption that highly diversified banks are more sophisticated and, therefore, in tendency more likely to use AT1CoCos. Risk density and the total capital ratio have insignificant coefficients in Model (3) and (4). Therefore, the expectation that riskier banks refrain from using AT1CoCos cannot be confirmed with statistical significance. However, controlling for risk density leads to significance of LOAN, the variable for loan intensive business, which is characterised by high liquidity risk.

Adding macroeconomic variables in Model (4) slightly improves the explanatory power of the model. The inclusion does not tangibly impact the bank specific coefficients. Of the macroeconomic variables included, only CQS has a statistically significant effect. The credit ratings of the country the banks are headquartered in has a significantly negative impact. This is in line with expectation, as a higher absolute CQS indicates lower ratings and higher credit risk of the respective countries. The rating of the country is also relevant for the rating of the bank and the credit risk of the country is also related to the credit risk of the bank. Weaker banks will find it more difficult and more expensive to issue AT1CoCos. This, in effect, weakens the incentives to use AT1CoCos. Other potential determinants like GDP-growth, inflation, or corruption are not statistically significant. Even the average corporate tax rate is not significant. It was expected that higher tax rates increase the incentive to use AT1CoCos, because they increase the potential to save taxes. However, I cannot find evidence that corporate tax rates determine the extent to which banks exploit their potential to save taxes.

2.5 Impact on profitability

2.5.1 Variable selection

The second empirical part of this study is concerned with the potential impact of elevated use of AT1CoCos on the profitability of banks. I argue that theoretically those banks which make use of AT1CoCos to a higher extent should be more profitable. Reasons are at least twofold: First, the use of AT1CoCos potentially eliminates adverse risk-shifting incentives and increases efficiency (Hilscher & Raviv (2014), Zeng (2014)). Second, the use of AT1CoCos as compared to CET1-capital yields the advantage to deduct interest payments paid on CoCo-bonds from the taxable income. Thereby, a tax-shield can be materialised, which should be reflected in a comparably higher return on assets (ROA) after taxes. Therefore, I apply a multiple linear panel regression model, testing whether the use of AT1CoCos leads to significantly higher ROA after taxes.

As dependent variable, I consider different specifications of profitability measures. ROE and ROA in their multitude of possible specifications are two of the most prominent measures for profitability. ROE, though, is not a suitable profitability measure, as it is not independent from the source of capital. It can easily be inflated by increasing leverage. Further, ROE depends substantially on the classification of CoCo-bonds as equity or debt, which is by no means clear.[6] Therefore, I focus my analysis on on-assets measures. In particular, I consider

[6] Goncharenko & Rauf (2016) and B. Williams et al. (2018) assume that CoCo-bonds are always considered as debt, calculating ROE.

ROA, calculated as return on average assets, and return on risk-weighted assets (RORWA) as dependent variables. Both measures are specified both before taxes and after taxes respectively. This is crucial to identify a potential tax-shield of AT1CoCos. The on-assets calculation of profitability requires a before-interest expenses income measure. As the business of banks consists of lending and borrowing money, the calculation of earnings before interest expenses is far from trivial, because it is nearly impossible to distinguish debt financing expenses from daily business related expenses. Therefore, I use an intuitive gross measure as a proxy for earnings before and after taxes. In this way, earnings are defined as the sum of net income (before or after taxes) and gross interest expenses. In Section (2.6), I additionally test a different proxy of earnings based on standardised values for EBIT provided by Thomson Reuters for robustness.

The variable of interest of the present study is COCOS. It is measured – as before – as the share of fully-loaded AT1-capital to total tier 1-capital. I expect to find a positive impact because of the implied tax-shield and positive incentive effects. In addition, I control for several bank specific and macroeconomic determinants of bank profitability based on extant literature.[7]

OLDAT1R is the ratio of old AT1-capital subject to phase-out rules to risk-weighted assets. Unlike AT1CoCos, phaseout-AT1-capital is not as homogeneous as regards eligible instruments. It might include a variety of hybrid capital instruments and it cannot be distinguished for sure if payments on such instruments are tax deductible or not and what specific incentives might result. Because these instruments are subject to phase-out rules, they are generally less interesting. If anything a positive effect might be expected for the same reasons as for AT1CoCos.

ASIZE represents the average *log* assets. Literature has found different results on the effect of size on profitability. Among others, Menicucci & Paolucci (2016) find a positive relationship between size and ROA or ROE, which can be explained by economies of scale e.g. due to cost efficiencies, or by implied subsidies – in particular if banks are considered "too-big-to-fail". J. H. Boyd & Runkle (1993) and Pasiouras & Kosmidou (2007) find inverse relationships, representing some kind of diseconomies of scale.

LIQR is included in line with the literature as a measure of liquidity risk and represents the fraction of net loans to total assets. Because much literature found positive effects of liquidity risk on profitability (Molyneux & Thornton (1992), Pasiouras & Kosmidou (2007)), I expect a positive relationship as well. The argument is that rather illiquid loans – regardless of the implied credit risk – produce higher revenues than more liquid assets. According to the liquidity preference theory, investors require a premium as compensation for the associated liquidity risk.

[7]Relevant studies focussing on determinants of European banks comprise, i.a, Short (1979), Molyneux & Thornton (1992), Demirgüç-Kunt & Huizinga (1999), Abreu & Mendes (2002), Staikouras & Wood (2004), Athanasoglou et al. (2006), and Pasiouras & Kosmidou (2007).

The capital adequacy ratio (CAR) represents the capital structure, respectively the accounting capital adequacy. It is specified as the percentage share of total equity to total assets. Motivated by the tax-shield, one could argue that banks with higher leverage, respectively lower capital adequacy ratios should be characterised by higher profitability. Empirical literature, however, assumes that well capitalised banks have lower insolvency risk and lower costs of financial distress, and finds that higher capital adequacy ratios lead to higher profitability (among others Molyneux & Thornton (1992), Berger (1995), Abreu & Mendes (2002), and Pasiouras & Kosmidou (2007)).

LLP represents the quality of the asset portfolio. It is the percentage share of loan loss reserves to total gross loans. Menicucci & Paolucci (2016) find significant negative relationships with profitability. This is in line with intuition, as loan loss provisions represent the materialisation of credit risk. Because loan loss provisions immediately reduce bank income, the expected effect should be negative.

RISK is included to account for the riskiness of the business. Again, it is approximated by the risk density, i.e. risk-weighted assets over total assets. According to the risk return hypothesis, higher risk should be compensated by higher returns. Therefore, a positive relationship should be expected.

INDIV measures the diversification of income. It is specified as the share of total income which is non-interest income. Non-interest income sources comprise in particular fee and commission income, fiduciary income, service charge, as well as trading income. Stiroh (2004) finds no significant relationship of non-interest income and ROE. Landi & Venturelli (2001) find a positive impact of diversification of income by an increase of fee and commission based income on profitability. Therefore, I expect a positive effect on profitability.

As macroeconomic variables, the average corporate tax rate (ATAX), inflation (INFL), GDP-growth (GDPG), corruption (CPI), and country-wise credit ratings (CQS) are considered. Further, I control for the financial period FY. I expect a negative effect of the average tax rate on the profitability measures calculated after taxes. GDP-growth might be expected to increase profitability, as Neely & Wheelock (1997) and Pasiouras & Kosmidou (2007) find that the change in per capita income has a positive effect on bank profitability. As regards inflation, literature finds mixed results (compare among others Abreu & Mendes (2002), Athanasoglou et al. (2006), Pasiouras & Kosmidou (2007)).

Table (2.12) in the appendix provides an overview of the variables used and their expected effects. Tables (2.10) and (2.13) in the appendix provide additional information on the distributions and pairwise correlations of the variables.

2.5.2 Methodology and model specification

Central hypothesis is that those banks, which make use of AT1CoCos instead of CET1 should be characterised, ceteris paribus, by a higher profitability. Due to better incentives, before taxes measures should already be elevated. In particular, though, after taxes measures for profitability should be higher, because they additionally include the implied tax-shield of AT1CoCos as opposed to CET1-capital. In order to test the impact of COCOS on profitability, I specify a linear panel data model with fixed effects. Short (1979, p. 212) concluded that "linear functions produced as good results as any other functional form". In this way, the model specified is the following:

$$Profitability_{it} = \alpha_i + \delta_1 * COCOS_{it} + \boldsymbol{\beta} * X_{it} + \boldsymbol{\gamma} * Y_{jt} + \mu_t + \epsilon_{it}, \tag{2.3}$$

while $COCOS$ is the variable of interest. X comprises the bank specific and Y the macroeconomic variables. ϵ is the residual. Again the indices indicate: $i = bank$; $j = country$; $t = financial\ year$.

The model is specified as a bank and time fixed effects model following the rejection of random effects by the Hausman-Test. A modified Wald-Test for group-wise heteroscedasticity in the residuals of the regression model, following Greene (2000, p. 598), rejects the homoscedasticity assumption. As a remedy, I account for clustered standard errors on the bank level using robust Huber-White-sandwich estimates of variance (following Froot (1989) and R. L. Williams (2000)) for the statistical analysis.

2.5.3 Results

Table (2.3) summarises the results. Models (1) and (2) illustrate the results of the regressions of ROA before taxes, while Models (3) and (4) show the results of regressions of ROA after taxes. Models (5) and (6) depict the results of RORWA after taxes, as an immediate robustness check. Prima facie, the results have a great degree of similarity. The variable of interest COCOS has positive coefficients and statistical significance at least on the 5 % level in all Models (1-4) reporting results for risk-insensitive profitability measures. For the risk-sensitive measure RORWA after taxes, Model (5) reveals weak significance on the 10 % level. If controls for macroeconomic determinants are considered in Model (6), COCOS is again significant at the 5 %-level. Hence, the results confirm the ex-ante expectation that the use of AT1CoCos significantly increases bank profitability, measured by different specifications. This insight is of particular importance for a banks' financing department, making decisions about sources of capital. It means that banks which chose AT1CoCos instead of CET1-capital benefit from higher profitability numbers. This should constitute an incentive to substitute real equity CET1-capital by AT1CoCos. The coefficients for COCOS in Table (2.3) – reporting the results

Table 2.3: **Robust FE Models Regressing ROAbt, ROAat, and RORWAat**
This table depicts the results of a panel regression model with bank and time fixed effects regressing profitability on COCOS and other covariates. Models (1-2) illustrate the results for ROA before taxes as dependent variable. Models (3-4) show the results for ROA after taxes as dependent variable. Models (5-6) depict the results for RORWA after taxes as dependent variable. The variables used are described in Table (2.12). Data is non-winsorised. The variable of interest COCOS has positive and statistically significant coefficients in Models (1-4) and weak significance in Model (6). This indicates that banks can significantly increase their profitability through the use of AT1CoCos. Standard errors are in parenthesis. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level.

	(1) ROAbt	(2) ROAbt	(3) ROAat	(4) ROAat	(5) RORWAat	(6) RORWAat
COCOS	0.0800**	0.07911**	0.0610**	0.0618**	0.0628*	0.0658**
	(0.04)	(0.04)	(0.03)	(0.02)	(0.03)	(0.03)
INDIV	0.0229**	0.0241**	0.02229**	0.0233**	0.0388*	0.0409*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
CAR	0.2811*	0.2871*	0.2057**	0.2106**	0.2626**	0.2711**
	(0.14)	(0.15)	(0.10)	(0.10)	(0.12)	(0.12)
LLP	-0.1584**	-0.1574**	-0.1212***	-0.1203***	-0.2555***	-0.2553***
	(0.07)	(0.07)	(0.05)	(0.05)	(0.06)	(0.06)
OLDAT1R	0.1389	0.2191	0.0668	0.1339	-0.0845	0.0051
	(0.28)	(0.26)	(0.20)	(0.18)	(0.28)	(0.27)
RISK	0.0132	0.0156	0.0065	0.0083		
	(0.01)	(0.01)	(0.01)	(0.01)		
LIQR	-0.0361	-0.0374	-0.0192	-0.0202	-0.0157	-0.0174
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ASIZE	-0.4659	-0.3909	-0.1897	-0.1283	-0.0370	0.0312
	(0.70)	(0.70)	(0.51)	(0.50)	(0.99)	(1.02)
2015.FY	-0.3889***	-0.4454***	-0.3246***	-0.3618***	-0.5643***	-0.6420***
	(0.11)	(0.13)	(0.08)	(0.09)	(0.15)	(0.17)
2016.FY	-0.4480***	-0.5109***	-0.5036***	-0.5550***	-0.9267***	-1.0374***
	(0.14)	(0.16)	(0.11)	(0.12)	(0.19)	(0.20)
2017.FY	-0.6266***	-0.6876***	-0.6860***	-0.7218***	-1.2226***	-1.3525***
	(0.18)	(0.20)	(0.14)	(0.15)	(0.24)	(0.29)
2018.FY	-0.6204***	-0.6652***	-0.6679***	-0.6962***	-1.2140***	-1.3072***
	(0.19)	(0.20)	(0.14)	(0.15)	(0.27)	(0.32)
TaxRate		-0.0142		-0.0110		-0.0363
		(0.03)		(0.02)		(0.05)
GDPG		0.0338		0.0160		0.0350
		(0.03)		(0.02)		(0.04)
INFL		-0.0245		-0.0235		-0.0313
		(0.03)		(0.02)		(0.04)
CPI		0.0126		0.0061		0.0075
		(0.03)		(0.02)		(0.04)
CQS		0.0883		0.0470		0.2765
		(0.31)		(0.23)		(0.40)
Const.	8.2248	6.1545	3.5170	2.1759	2.6472	1.3820
	(11.96)	(12.26)	(8.66)	(8.94)	(16.56)	(18.09)
N	872	851	872	851	872	851
adj. R^2	0.4520	0.4565	0.4592	0.4654	0.4103	0.4157

calculated without winsorising – amount to about .08 in Models (1-2), and .06 in Models (3-6). These coefficients are high. E.g. it can be interpreted that on average a 1 %-point increase in COCOS leads to a .08 %-point increase in ROA before taxes and to a .06 %-point increase in ROA after taxes. In section (2.6), I show that calculating with winsorised data yields lower but still economically very relevant and statistically significant coefficients.

Significant differences between coefficients for before and after taxes profitability (compare Models (1-2) with Models (3-4)) cannot be detected. The coefficients for ROA after taxes are of course somewhat smaller, accounting for the taxes paid. Statistical significance is slightly better with p-values of 1-2 %, compared to 3-4 % for ROA before taxes. Still, it is difficult to argue that the positive effect of COCOS on profitability can be attributed to the tax-shield of AT1CoCos. Rather, it is evident from the before taxes measure of profitability that COCOS have a significantly positive effect on profitability, irrespective of the tax-load. Apart from the tax-shield, literature motivates potential benefits of CoCo-bonds primarily by positive incentive effects. The dependence on incentives, though, might also mean that the effect on profitability depends on certain characteristics and features of the instruments. In this way, it would be an interesting undertaking to differentiate between PWD- and C2E-bonds, as the literature indicates that because of the threat of dilution the incentives of C2E-bonds might be particularly advantageous. For the time being, I refrain from such a differentiation, because of a lack of available data on these characteristics. For the average instrument, though, it can be concluded that banks can optimise their profitability by using AT1CoCos.

As regards other bank specific control variables, the expected significantly negative effect of loan loss provisions is confirmed by all depicted models. Increasing loan loss reserves decrease profitability. Also in line with expectation are the coefficients for the balance sheet capital adequacy ratio. The coefficients are positive and significant in all models depicted. Income diversification – reflecting higher shares of non-interest income – has significant and positive coefficients. Taking into account the current low-interest environment, however, this effect could be the result of the current difficulties for banks to generate earnings under these circumstances. The coefficients of liquidity risk, risk density, old AT1-capital, and size are not significant. In this way, I cannot find evidence for economies of scale.

As concerns macroeconomic control variables, I cannot find any significant relationships with profitability. Indeed surprising seems the fact that the coefficients for the corporate tax rate are not significant, not even for the after taxes measures of profitability. At the same time, significant inter-temporal differences in profitability can be detected. As compared to the base year 2014, the following years are associated with significantly lower bank profitability.

2.6 Robustness

In Section (2.5), I already tested the impact of COCOS and other covariates on different measures of profitability. While ROA serves as a holistic but risk-insensitive measure of profitability, RORWA takes into account the risk associated with the business of the bank. In a consecutive step, as an alternative proxy of earnings for the calculation of profitability, I calculate an alternative earnings before and after taxes measure based on standardised values for EBIT provided by Thomson Reuters. Because the calculation of EBIT respectively EBI for banks is not as straight forward as for non-financial firms, this measure is not as intuitive but provides an additional test for robustness. The results are depicted in Table (2.4). The effects of the bank specific variables, in particular the variable of interest COCOS, are confirmed. In particular, the impact of COCOS is statistically significant in all six models. In Model (5) and (6) – reporting results for RORWA after taxes – COCOS is now even statistically significant at the 5 % level. Hence, I conclude that the effects are not dependent on a certain measurement approach of earnings. Visible changes concern the inter-temporal dependence of profitability and the impact of GDP-growth. Evidence for time dependencies can only be found for the year 2017. At the same time, GDP growth gains a statistically significant and positive effect on profitability.

In addition, I test whether different specifications of the variable COCOS determine the effect of the coefficient and its significance. Standardising with risk-weighted assets is intuitive as it is in line with the risk-sensitive measurement of risk-weighted capital ratios. Though, it does not account for the substitution relationship between CET1 and AT1-capital. Standardising with the total capital ratio takes into account the substitution relationship, but also includes tier 2-capital which might also provide a tax-shield, but certainly different incentive effects. Therefore, this specification is not as intuitive. Consequently, COCOS was specified as AT1CoCos per tier 1-capital. However, I find, that using risk-weighted assets or the total capital ratio for standardisation of the CoCo-measure yields comparable results to those presented in the main part. Hence, the results are robust as regards different specifications of the measure.

In order to test whether the effect of COCOS on profitability is size dependent, I perform an analysis of subsamples of large versus small banks measured by asset size. In particular, it might be expected that larger banks are predestined to exploit benefits of COCOS because they are more capable to actively manage and efficiently use hybrid capital sources. The subsample analysis, though, shows the opposite. In the small bank sample, coefficients of COCOS are higher in magnitude as well as in significance. They are significant on the 1 % level for risk-insensitive measures of profitability and significant on the 5 % level for return on risk-weighted assets. Considering the coefficients of COCOS in the subsample of larger banks, magnitude and significance are lower. Here, only risk-insensitive measures have weakly significant positive effects. Coefficients for risk-sensitive measures are not significant any more. Therefore, I conclude that COCOS have positive effects on profitability for all banks, small and

Table 2.4: **Robust FE Models Regressing ROAbt, ROAat, and RORWAat, Using an Alternative Earnings Definition**

This table is equivalent to Table (2.3), except for the definition of earnings used in the calculation of profitability. It depicts the results of a panel regression model with bank and time fixed effects regressing profitability on COCOS and other covariates. Instead of the gross definition of earnings used in Table (2.3), standardised EBIT values from Thomson Reuters are used. Models (1-2) illustrate the results for ROA before taxes as dependent variable. Models (3-4) show the results for ROA after taxes as dependent variable. Models (5-6) depict the results for RORWA after taxes as dependent variable. The variables used are described in Table (2.12). Data is non-winsorised. The variable of interest COCOS has positive and statistically significant coefficients in all Models (1-6). This provides even stronger evidence that banks can significantly increase their profitability through the use of AT1CoCos. Standard errors are in parenthesis. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level.

	(1)	(2)	(3)	(4)	(5)	(6)
	ROAbt	ROAbt	ROAat	ROAat	RORWAat	RORWAat
COCOS	0.0743*	0.0744*	0.0592**	0.0589**	0.0904**	0.0919**
	(0.04)	(0.04)	(0.03)	(0.03)	(0.04)	(0.04)
INDIV	0.0286**	0.0283**	0.0287***	0.0281***	0.0598***	0.0601***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
CAR	0.2966**	0.2989**	0.2278**	0.2303**	0.3313**	0.3316**
	(0.14)	(0.15)	(0.10)	(0.10)	(0.14)	(0.14)
LLP	-0.1482**	-0.1469**	-0.1146**	-0.1133**	-0.2135***	-0.2126***
	(0.07)	(0.07)	(0.05)	(0.05)	(0.08)	(0.08)
OLDAT1R	0.3488	0.3342	0.2812	0.2561	0.4072	0.3531
	(0.29)	(0.28)	(0.21)	(0.20)	(0.31)	(0.32)
RISK	0.0167	0.0187	0.0081	0.0094		
	(0.01)	(0.01)	(0.01)	(0.01)		
LIQR	-0.0329	-0.0349	-0.0145	-0.0162	-0.0042	-0.0073
	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
ASIZE	-0.5230	-0.4990	-0.1219	-0.1022	-0.0495	-0.0781
	(0.67)	(0.66)	(0.47)	(0.47)	(0.82)	(0.83)
2015.FY	-0.1340	-0.1891	-0.0504	-0.0911	-0.0538	-0.1203
	(0.10)	(0.13)	(0.07)	(0.09)	(0.13)	(0.15)
2016.FY	-0.0386	-0.0911	-0.0932	-0.1342	-0.2147	-0.2986
	(0.14)	(0.16)	(0.10)	(0.11)	(0.18)	(0.20)
2017.FY	-0.1939	-0.2991	-0.2617*	-0.3375**	-0.5741**	-0.7857**
	(0.18)	(0.20)	(0.14)	(0.15)	(0.27)	(0.33)
2018.FY	-0.1082	-0.2146	-0.1817	-0.2647*	-0.4102	-0.6317*
	(0.19)	(0.19)	(0.14)	(0.15)	(0.30)	(0.36)
TaxRate		-0.0364		-0.0298		-0.0673
		(0.03)		(0.02)		(0.05)
GDPG		0.0503**		0.0388**		0.0522*
		(0.02)		(0.02)		(0.03)
INFL		-0.0151		-0.0176		0.0072
		(0.03)		(0.02)		(0.05)
CPI		-0.0070		-0.0125		-0.0151
		(0.03)		(0.02)		(0.04)
CQS		-0.0083		-0.0472		0.0021
		(0.30)		(0.22)		(0.39)
Const.	7.5142	8.5308	0.7093	2.1284	-1.2163	2.1533
	(11.47)	(11.63)	(8.06)	(8.32)	(14.24)	(14.80)
N	869	848	863	842	863	842
adj. R^2	0.4655	0.4670	0.4769	0.4793	0.3954	0.3988

Table 2.5: **Robust FE Models with Winsorising on the 1^{st} and the 99^{th} Percentile**
This table is equivalent to Table (2.3), except that data is winsorised on the 1^{st} and the 99^{th} percentile. Depicted are the results of a panel regression model with bank and time fixed effects regressing profitability on COCOS and other covariates. Models (1-2) illustrate the results for ROA before taxes as dependent variable. Models (3-4) show the results for ROA after taxes as dependent variable. Models (5-6) depict the results for RORWA after taxes as dependent variable. The variables used are described in Table (2.12). The variable of interest COCOS has positive and statistically significant coefficients in Models (1-4). This confirms that banks can significantly increase their profitability (defined as ROA) through the use of AT1CoCos. Coefficients for COCOS of about .03 imply that banks can increase ROA by .3 %-points through an increase in COCOS of 10 %-points. For RORWA, the effect is not significant any more. Standard errors are in parenthesis. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level.

	(1)	(2)	(3)	(4)	(5)	(6)
	ROAbt	ROAbt	ROAat	ROAat	RORWAat	RORWAat
COCOS	0.0242**	0.0297**	0.0205**	0.0241**	0.0186	0.0250
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
INDIV	0.0209*	0.0223**	0.0199**	0.0208**	0.0421**	0.0444**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
CAR	0.0421	0.0359	0.0425	0.0419	0.0701	0.0767
	(0.06)	(0.06)	(0.04)	(0.04)	(0.05)	(0.06)
LLP	-0.1760***	-0.1823***	-0.1312***	-0.1346***	-0.2694***	-0.2783***
	(0.06)	(0.07)	(0.04)	(0.04)	(0.06)	(0.06)
OLDAT1R	0.0047	0.1096	-0.0621	0.0171	-0.2111	-0.0934
	(0.19)	(0.17)	(0.15)	(0.13)	(0.24)	(0.24)
RISK	0.0066	0.0074	0.0023	0.0032		
	(0.01)	(0.01)	(0.01)	(0.01)		
LIQR	-0.0234	-0.0240	-0.0103	-0.01090	-0.0036	-0.0053
	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
ASIZE	-1.2589	-1.3291	-0.6724	-0.6902	-0.1871	-0.1864
	(1.25)	(1.26)	(0.79)	(0.80)	(1.12)	(1.13)
2015.FY	-0.3084***	-0.3042***	-0.2830***	-0.2859***	-0.4944***	-0.5368***
	(0.10)	(0.10)	(0.08)	(0.08)	(0.13)	(0.13)
2016.FY	-0.2089	-0.2229	-0.3457***	-0.3685***	-0.7777***	-0.8611***
	(0.17)	(0.17)	(0.12)	(0.11)	(0.20)	(0.20)
2017.FY	-0.3606*	-0.4127**	-0.5050***	-0.5392***	-1.044***	-1.1695***
	(0.21)	(0.18)	(0.15)	(0.14)	(0.25)	(0.28)
2018.FY	-0.4056*	-0.4310**	-0.5297***	-0.5487***	-1.1031***	-1.1761***
	(0.21)	(0.20)	(0.14)	(0.15)	(0.27)	(0.31)
TaxRate		-0.0170		-0.01244		-0.0360
		(0.03)		(0.03)		(0.05)
GDPG		0.0272		0.0145		0.0357
		(0.02)		(0.02)		(0.03)
INFL		0.0098		-0.00411		-0.0153
		(0.03)		(0.02)		(0.04)
CPI		-0.0110		-0.0081		-0.0068
		(0.02)		(0.02)		(0.03)
CQS		0.3450		0.1779		0.4706
		(0.32)		(0.22)		(0.39)
Const.	23.1672	24.9000	12.7926	13.6239	6.1254	6.6292
	(21.78)	(21.77)	(13.79)	(13.95)	(19.35)	(19.73)
N	872	851	872	851	872	851
adj. R^2	0.2103	0.2135	0.2244	0.2283	0.1987	0.2060

big, magnitude and significance, though, are higher for smaller banks. This insight is to some extent surprising and deserves further attention.

Winsorising is a frequently used method in finance to reduce the influence of potential outliers. Therefore, I re-run my analysis with winsorised data, using the widespread 1^{st} and 99^{th} percentile as thresholds for severe outliers. Results are provided in Table (2.5) and confirm the statistically significant positive impact of COCOS on the risk-insensitive measures of bank profitability, i.e. ROA before taxes and ROA after taxes. For RORWA after taxes, the positive impact is not any more statistically significant. The coefficients of COCOS are lower in Table (2.5), compared to those for non-winsorised data in Table (2.3). This indicates that the magnitude, but not the statistical significance of COCOS was to some extent driven by outliers in Table (2.3). Coefficients of .02 to .03 in Models (1-4) of Table (2.5) are, however, still not only statistically significant, but also economically very relevant. Increasing COCOS by 10 %-points, implies an increase of the respective profitability measures by .2 to .3 %-points. This is still a very substantial increase, considering mean values of 1.6 % for ROA before taxes and 1.5 % for ROA after taxes throughout the sample.

In previous analyses, I used Huber-White-sandwich estimates of variance to account for heteroscedasticity. Using bootstrapped standard errors instead, though, confirms the results. The bootstrapped standard errors do not significantly differ from the robust standard errors used before.

2.7 Conclusions

The present study contributes to the empirical literature on CoCo-bonds in two ways. First, I analyse the extent and the determinants of the use of AT1CoCos by European banks using a unique panel dataset of components of regulatory capital. The advantage of this approach is the ability to analyse the use of AT1CoCos on a level basis and its development over the years. Moreover, I study the use of AT1CoCos in relation to the amount of CET1-capital. This enables an interpretation as part of the substitution relationship with CET1-capital as tier 1-capital. Second, I am the first to analyse the implications of the usage of AT1CoCos for bank profitability. I hypothesise that due to the implied tax-shield and positive incentives to reduce inefficient risk-shifting, AT1CoCos increases the overall profitability of banks.

The descriptive analysis shows that during the first years after the adoption of Basel III through the CRD IV package in Europe, the share of banks using AT1CoCos rose steadily to up to 50 % in 2018. At the same time, a substantial share of banks does still not exploit the potential benefits of AT1CoCos. Moreover, I find significant regional differences in the usage of AT1CoCos.

While banks from the north of Europe use significantly more AT1CoCos, banks from the south and east use significantly less AT1CoCos. Banks from Switzerland do not behave significantly different as regards the use of AT1CoCos.

The determinants analysis based on a panel regression with firm and time fixed effects shows that banks with higher earnings per assets and higher loan loss provisions make significantly more use of AT1CoCos. The former implies that banks make use of their tax-shield potential, even though the tax rate itself has no significant effect. Moreover, as compared to banks with low shares of deposits and loans on the balance sheet (indicating investment banks), one sided diversified banks, i.e. banks with high shares of either loans or deposits, make significantly more use of AT1CoCos. The joined effect of high loans and high deposits (indicating pure retail banks) decreases the share of AT1CoCos used. Therefore, I conclude that the business model of banks is an important determinant of using AT1CoCos.

The analysis of the implications of AT1CoCos for bank profitability reveals that using AT1CoCos instead of CET1-capital increases bank profitability with statistical significance. This result holds for risk-insensitive measures like ROA as well as for risk-sensitive measures like RORWA. It does also hold for before taxes measures as well as for after taxes measures. Therefore, I conclude that using AT1CoCos increases bank profitability significantly. Though, I cannot undoubtedly attribute this effect to the tax-shield of CoCo-bonds alone. Apart from the tax-shield, theory motivates potential benefits of CoCo-bonds by positive incentive effects, which enforce efficient risk-taking. Even though serving as a possible explanation, the exact dependency deserves further consideration. Surprisingly, the effect on profitability is higher both in magnitude as well as in significance for smaller banks, as compared to larger banks. The significantly positive effect of AT1CoCos on bank profitability is robust to different definitions of earnings, different specifications of AT1CoCos, winsorising on the 1^{st} and 99^{th} percentile, and the application of bootstrapped standard errors.

My results have important implications for a banks' financing decision making. If banks who chose AT1CoCos instead of CET1-capital benefit from higher profitability, this should constitute an incentive to substitute real equity CET1-capital by AT1CoCos. At the same time, the potential to increase profitability is large. Results on winsorised data show that by an increase of COCOS of 10 %-points, banks can increase measures like ROA after taxes by about .2 %-points, which is equivalent to an increase of 12.5 % on average. Particularly banks which currently do not make any use of AT1CoCos must scrutinise whether these benefits should remain unexploited. To regulators and bank supervisors, my results prove that the eligibility of AT1CoCos as regulatory capital is advantageous as well. The increase in profitability stabilises the European banking system, making banks more resilient. However, regulators should be concerned with the regional disparities in terms of usage of AT1CoCos.

Building on the results of the present study, further research could focus on the following questions. First, closer attention should be paid to the channels through which AT1CoCos increase profitability. It is still not clear what share of the increase in profitability can be attributed to the tax-shield channel, respectively to the incentives channel. Second, a follow-up study should further differentiate between the impact of C2E-, compared to PWD-bonds on profitability in order to account for possible dependencies of incentive effects on bond design features. Third, analysis could further elaborate on the finding that magnitude and significance of the effect of COCOS on profitability are higher for smaller than for larger banks. This result appears surprising and might veil additional structural characteristics determining the different effects. Forth, further research could be dedicated to the regional differences in the use of AT1CoCos observed. Building on the observation that in some regions banks make significantly more use of AT1CoCos, it should be studied whether this depends on differing market structures, bank characteristics, or potential benefits of AT1CoCos. In particular incentive effects may vary between regions, bank market structures, legal systems and traditions. Therefore, it might only be natural that such effects are not uniform across a heterogeneous banking market as the European.

2.8 Appendix

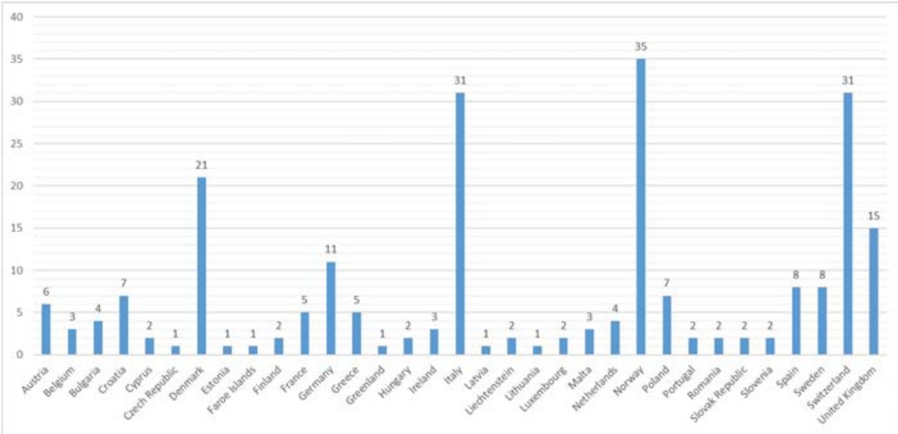

Figure 2.3: **Bank Origin**
This figure shows the absolute number of banks headquartered in the respective European countries. The total number of banks is 231.

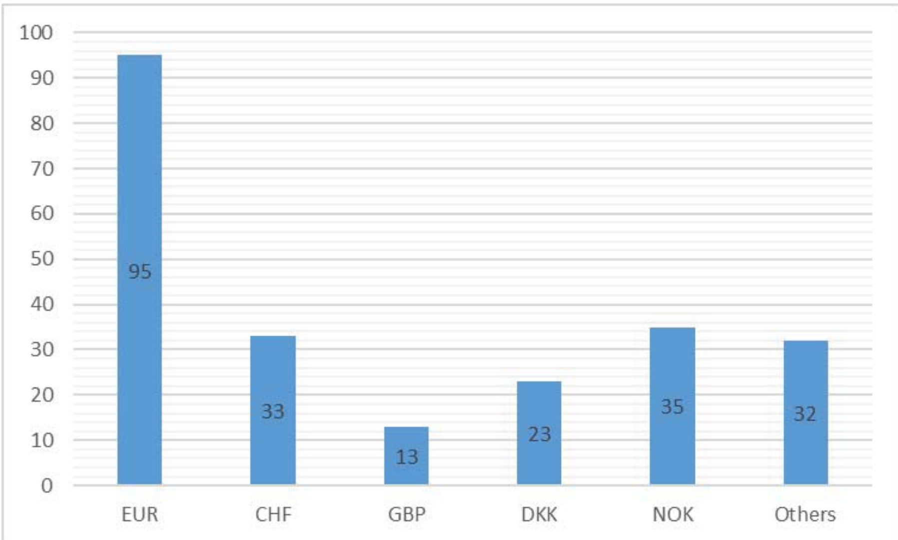

Figure 2.4: **Reporting Currencies**
This figure shows the absolute number of banks reporting in the respective currencies. The total number of banks is 231.

Table 2.6: **Definition of Regions**

The table below illustrates the definition of four generic geographical regions. It shows a break-down of the countries assigned to the regions.

Region	West	North	East	South
Countries:	Austria	Denmark	Bulgaria	Cyprus
	Belgium	Faroe Islands	Croatia	Greece
	France	Finland	Czech Republic	Italy
	Germany	Greenland	Estonia	Malta
	Ireland	Norway	Hungary	Portugal
	Liechtenstein	Sweden	Latvia	Spain
	Luxembourg		Lithuania	
	Netherlands		Poland	
	Switzerland		Romania	
	United Kingdom		Slovak Republic	
			Slovenia	

Table 2.7: **COCOS per Region**

The table below shows information on the dissemination of AT1CoCos throughout four generic regions in Europe. The regions were defined in Table (2.6). Illustrated are the share of banks using AT1-CoCos, the mean value of COCOS in general (in %), the mean value of COCOS restricted to positive values of COCOS (in %), and the number of banks headquartered in the respective regions.

Region	West	North	East	South	Overall
Share of banks using CoCos	0.400	0.674	0.037	0.425	0.443
Mean COCOS	4.789	7.382	0.762	1.988	4.454
Mean COCOS if > 0	11.957	10.957	20.410	4.677	10.044
No. of Banks	82	68	30	51	231

Table 2.8: **Two Sample t-Tests for Structural Differences in COCOS**
The table below shows the results of two sample t-tests with unequal variances for structural differences in COCOS between regions and currencies used. Each group is compared to the respective rest of the sample. West, North, South, and East relate to the regions defined in Table (2.6). Switzerland is treated separately, as it is not part of the EEA. EUR-currency identifies the 95 banks which use the Euro as reporting currency. Significant regional differences for North, East, and South can be detected. Banks from Switzerland do not differ significantly. Banks reporting in Euro have significantly less COCOS.

		simple t-test		**ranksum test**	
Group	Difference	t-value	p-value	z-value	p-value
West	0.524	1.070	0.285	-1.114	0.266
North	4.166	8.763	0.000	11.024	0.000
East	-4.197	-10.141	0.000	-9.200	0.000
South	-3.168	-8.300	0.000	-3.635	0.000
Switzerland	-1.187	-1.618	0.107	-5.093	0.000
EUR-currency	-2.558	-6.074	0.000	-3.862	0.000

Table 2.9: **Potential Determinants of COCOS and Expected Impact**
The table below summarises the dependent variable COCOS, the bank specific independent variables, and the macroeconomic independent variables used in the determinants analysis. For each variable, I provide a description, information on the measurement, and the ex-ante expected effect on COCOS.

Variable	Description	Measure	Expected Effect (+/-)
Dependent variable			
COCOS	AT1CoCos	AT1CoCos/ Tier 1-capital (in %)	
Independent variables Bank-specific:			
SIZE	Bank Size (linear)	Log Total Assets	(+)
CAR	Equity Ratio	Total Equity/ Total Assets	(-)
LLP	Loan Loss Provisions	Loan Loss Reserves/ Gross Loans (in %)	(+)
EBTAA	Earnings Intensity	Income before taxes / Av. Assets (in %)	(+)
INDIV	Income Diversification	NII/(NII + II) (in %)	(+/-)
RISK	Risk Density	Risk-weighted Assets/ Assets (in %)	(-)
OLDAT1	Phase-out AT1-capital	Dummy=1 if amount >0	(+/-)
DEPO	Deposits	Dummy=1 if >Median	(+/-)
LOAN	Loans	Dummy=1 if >Median	(+/-)
DEPxLOA	Interaction of DEPO and LOAN	Dummy=1 if DEPO & LOAN = 1	(+/-)
TCR	Total Capital Ratio	Own Funds/ Risk-weighted Assets (in %)	(+/-)
Independent variables Macroeconomic:			
ATAX	Average Statutory Corporate Tax Rate	Mean of Corporate Tax Rate over last 2 years (in %)	(+)
FY	Financial Year	Financial Reporting Period	(+)
INFL	Inflation Rate	Inflation Rate (in %)	(+/-)
CPI	Corruption Perception Index	CPI Score	(-)
GDPG	GDP Growth	Change from t-1 to t (in %)	(+/-)
CQS	Credit Quality Steps/Rating	From 1 (AA- or better) to 6 (CCC+ or worse)	(-)

Table 2.10: **Summary Statistics of Variables Included**
This table provides summary statistics on the variables considered in the determinants analysis of COCOS as well as those used in the regression of profitability on COCOS and other covariates.

Variables	N	Min	1%	50%	Mean	99%	Max	SD
COCOS	1,107	0.0000	0.0000	0.0000	4.4544	32.8340	71.5615	7.3340
SIZE	1,374	7.5820	11.7591	15.6319	15.8854	21.2590	21.5377	2.4302
CAR	1,374	-6.8428	2.7590	8.2033	9.4116	26.5222	104.2723	6.8899
LLP	1,114	0.0000	0.0000	2.4104	4.8224	26.3732	94.5094	7.1144
EBTAA	1,138	-21.9561	-3.4789	0.6580	0.7294	4.9371	24.9991	1.9222
INDIV	1,118	-2.4564	2.7517	34.0857	35.3189	95.2165	99.8594	17.7157
RISK	1,117	0.0000	17.0729	53.1373	53.1156	96.1061	189.4297	19.4006
OLDAT1	1,105	0.0000	0.0000	0.0000	0.2072	1.0000	1.0000	0.4055
OLDAT1R	1,105	0.0000	0.0000	0.0000	0.1716	2.0983	6.9691	0.5229
TCR	1,115	4.8782	10.3280	17.2427	17.8543	31.7629	68.2777	4.5763
DEPO	1,316	0.0000	0.0000	0.5000	0.5000	1.0000	1.0000	0.5002
LOAN	1,307	0.0000	0.0000	0.0000	0.4996	1.0000	1.0000	0.5002
DEPxLOA	1,304	0.0000	0.0000	0.0000	0.2132	1.0000	1.0000	0.4097
LIQR	1,307	0.9590	13.6806	65.5583	63.4130	90.0293	91.8598	17.9710
TaxRate	1,386	9.0000	10.0000	24.0000	23.4672	35.0000	35.0000	5.5737
CQS	1,374	1.0000	1.0000	1.0000	1.7576	6.0000	6.0000	1.1400
CPI	1,362	40.0000	41.0000	81.0000	72.0286	92.0000	92.0000	16.7724
INFL	1,373	-2.8218	-2.8218	0.8882	1.0084	5.4707	7.2800	1.4858
GDPG	1,369	-5.7150	-2.8608	1.0342	1.2884	6.4973	24.3765	1.8969
ROAat	1,093	-16.0303	-1.6091	1.3541	1.4997	5.5124	16.2393	1.5003
ROAbt	1,093	-21.8761	-2.3751	1.4847	1.6487	6.6066	25.0042	1.9659
RORWAat	1,071	-28.4083	-3.2234	2.6044	3.0049	12.3701	29.4359	2.9354

Table 2.11: **Correlations of Regressand and Regressors I**

The table below shows pairwise correlation coefficients of the regressors and the regressand used in Section (2.4), analysing the determinants of COCOS. Definitions of the depicted variables can be found in Table (2.9). The positive correlations of EBTAA (indicating earnings intensity) and ATAX (indicating the average tax rate) with COCOS suggest that the possible tax-shield of AT1CoCos might explain the usage of such instruments.

Variables	COCOS	SIZE	CAR	LLP	EBTAA	INDIV	ATAX	RISK	DEPO	LOAN	DEPxLOA	TCR	OLDAT2	INFL	CPI	GDPG	CQS
COCOS	1.0000																
SIZE	0.0616	1.0000															
CAR	-0.1217	-0.3569	1.0000														
LLP	-0.0025	-0.0974	0.2782	1.0000													
EBTAA	0.0384	-0.0989	0.2357	-0.2844	1.0000												
INDIV	-0.0208	0.0701	0.1647	0.0950	0.1075	1.0000											
ATAX	0.0160	0.1763	-0.0470	0.0549	-0.0463	0.0565	1.0000										
RISK	-0.1062	-0.4930	0.6493	0.3256	0.2067	-0.1597	-0.0323	1.0000									
DEPO	-0.0762	-0.3385	0.0403	0.2319	-0.0268	-0.0123	-0.1483	0.2396	1.0000								
LOAN	0.0015	-0.1836	-0.0126	-0.2104	0.0571	-0.4148	-0.0337	0.1492	-0.1426	1.0000							
DEPxLOA	-0.0176	-0.1110	-0.0224	0.0361	-0.0110	-0.2771	0.0026	0.1963	0.5237	0.5197	1.0000						
TCR	0.0382	-0.0751	0.2966	-0.2257	0.0559	0.1481	-0.1423	-0.2310	-0.1420	-0.0606	-0.1499	1.0000					
OLDAT1	0.0596	0.4650	-0.1844	0.0068	-0.1042	0.0266	0.2226	-0.2105	-0.2419	-0.1306	-0.0567	0.0014	1.0000				
INFL	0.0308	0.0004	-0.0172	-0.0610	0.1213	-0.0110	-0.0349	0.0050	-0.0064	-0.0811	-0.0383	0.0739	0.0094	1.0000			
CPI	0.2983	-0.1168	-0.0047	-0.4195	0.1904	-0.1291	-0.1709	-0.0892	-0.1531	0.2582	-0.0021	0.2997	0.0473	-0.0182	1.0000		
GDPG	-0.1007	0.0087	0.0100	0.1060	0.0064	0.0022	-0.2905	0.0305	0.2053	-0.1749	0.0306	-0.0334	-0.0381	0.2453	-0.1227	1.0000	
CQS	-0.2552	0.0694	0.0281	0.5406	-0.2322	0.0288	0.0649	0.1614	0.1861	-0.2075	0.0338	-0.2781	-0.0351	-0.1095	-0.8614	0.1098	1.0000

Table 2.12: **Potential Determinants of Profitability and Expected Impact**
The table below summarises the dependent variables, the bank specific independent variables, and the macroeconomic independent variables used in the regression of profitability. For each variable, I provide a description, information on the measurement, and the ex-ante expected effect on profitability.

Variable	Description	Measure	Expected Effect (+/-)
Dependent variables:	Proxies for profitability:		
ROA a.t.	Return on Average Assets	EBI/Average Assets (in %)	
ROA b.t.	Return on Average Assets	EBIT/Average Assets (in %)	
RORWA a.t.	Return on Risk-Weighted Assets	EBI/RWA (in %)	
Independent variables Bank-specific:			
COCOS	AT1CoCos	AT1CoCos/ Tier 1-capital (in %)	(+)
ASIZE	Av. Bank Size (linear)	Log Total Assets	(+/-)
CAR	Equity Ratio	Total Equity/ Total Assets	(+)
LLP	Loan Loss Provisions	Loan Loss Reserves/ Gross Loans (in %)	(-)
RISK	Risk Density	Risk-weighted Assets/ Assets (in %)	(+/-)
LIQR	Liquidity Risk	Net Loans/ Total Assets (in %)	(+)
INDIV	Income Diversification	NII/(NII+II) (in %)	(+)
OLDAT1R	Phase-out AT1-capital	Phase-out AT1-capital/ RWA	(+)
Independent variables Macroeconomic:			
TaxRate	Corporate Tax Rate	Statutory Tax Rate (in %)	(-)
FY	Financial Year	Financial Reporting Period	(+/-)
INFL	Inflation Rate	Inflation Rate (in %)	(+/-)
CPI	Corruption Perception Index	CPI Score	(+/-)
GDPG	GDP Growth	Change from t-1 to t (in %)	(+/-)
CQS	Credit Quality Steps/Rating	From 1 (AA- or better) to 6 (CCC+ or worse)	(-)

Table 2.13: **Correlations of Regressands and Regressors II**

The table below shows pairwise correlation coefficients of the regressors and the regressands used in Section (2.5), analysing the profitability implications of COCOS. It can be seen that the variable of interest COCOS has positive correlations with the profitability measures ROAbt, ROAat, and RORWAat.

Variables	ROAat	ROAbt	RORWAat	COCOS	INDIV	CAR	LLP	RISK	OLDAT1R	LIQR	ASIZE	TaxRate	GDPG	Inflation	CPI	CQS
ROAat	1.0000															
ROAbt	0.9814	1.0000														
RORWAat	0.6884	0.6294	1.0000													
COCOS	0.0692	0.0654	0.0765	1.0000												
INDIV	-0.1495	-0.0850	-0.1792	-0.0208	1.0000											
CAR	0.1470	0.1723	-0.1227	-0.1217	0.1647	1.0000										
LLP	-0.2639	-0.2662	-0.4462	-0.0025	0.0950	0.2782	1.0000									
RISK	0.1976	0.2005	-0.2869	-0.1062	-0.1597	0.6493	0.3256	1.0000								
OLDAT1R	-0.0553	-0.0513	0.0637	0.0916	0.0159	-0.1388	0.0309	-0.1413	1.0000							
LIQR	0.1194	0.0965	0.0341	-0.0035	-0.6117	-0.0590	-0.2172	0.1406	-0.1266	1.0000						
ASIZE	-0.0781	-0.0827	0.1865	0.0588	0.0673	-0.3612	-0.0960	-0.4906	0.2522	-0.1845	1.0000					
TaxRate	0.0462	0.0236	0.1065	0.0127	0.0413	-0.0551	0.0509	-0.0368	0.1094	-0.1032	0.1878	1.0000				
GDPG	0.0132	0.0151	0.0047	-0.1007	0.0022	0.0100	0.1060	0.0305	-0.0700	-0.1522	0.0302	-0.3299	1.0000			
Inflation	0.1079	0.1153	0.1087	0.0308	-0.0110	-0.0172	-0.0610	0.0050	-0.0032	-0.0859	0.0149	0.0186	0.2453	1.0000		
CPI	0.1373	0.1428	0.2066	0.2983	-0.1291	-0.0047	-0.4195	-0.0892	0.1452	0.2549	-0.1129	-0.1617	-0.1227	-0.0182	1.0000	
CQS	-0.1743	-0.1900	-0.2520	-0.2552	0.0288	0.0281	0.5406	0.1614	-0.1474	-0.1654	0.0556	0.0525	0.1098	-0.1095	-0.8614	1.0000

Chapter 3

Can CoCo-bonds Mitigate Systemic Risk? Evidence for the SRISK Measure[1]

[1]A special thanks to Arndt-Gerrit Kund, the co-author of the underlying paper. Moreover, I thank Alon Raviv for his valuable insights, as well as Werner Osterkamp, my discussant at the Workshop in International Economics and Finance in Bordeaux (2019), and Rainer Baule, my discussant at the 82nd Annual Business Researcher Conference of the VHB (2020) for their helpful comments. I also appreciate the work of our reviewers for the annual meeting of the Midwest Finance Association and the annual meeting of the Eastern Finance Association, providing valuable notes and accepting the underlying paper for their 2020 main conferences.

3.1 Introduction

Contingent convertible bonds (CoCo-bonds) gained particular recognition of bank regulators in the wake of the latest global financial crisis in 2008. It exposed the vulnerability of banking systems, and the need to increase their resilience by higher quality and quantity of capital (Demirgüç-Kunt et al. (2013)). CoCo-bonds as hybrid capital instruments are predestined to serve as one contribution to this end, combining the respective advantages of debt and equity. They are characterised as de jure debt obligations with a contractual or statutory feature to quasi-automatically convert into equity under certain conditions. The conversion into real equity instruments can be considered as the main advantage, compared to other hybrid instruments, which were predominantly used before the crisis. They turned out not being able to provide capital when most needed. In a joint working paper, leading academics on financial regulation, such as Douglas W. Diamond, and Nobel laureate Robert J. Shiller, proposed a hybrid security to address this short-coming (Squam-Lake-Working-Group (2009)). Just as in CoCo-bonds, they envisioned a financial instrument, which strengthens individual banks by automatically providing additional going concern capital during financial distress. Doing so increases the resilience of the weakest link, and hence makes the entire financial system more stable.

The relevance to study the effects of hybrid capital becomes evident, considering the growing relevance of hybrid capital instruments, as illustrated in Figure (3.1). It is obvious to the eye that hybrid capital has seen a steep rise in interest and dissemination across the financial sector since the advent of the global financial crisis. 2010 marked the transition from Basel II to Basel III, which only temporarily slowed the growth in hybrid capital, due to regulatory uncertainty regarding capital eligibility under the novel Basel Accord. It has continued its unprecedented growth after Basel III was finalised, and henceforth grew at an annualised rate of almost 20 %. The new Basel accord (i.e. Basel III) and the European Capital Requirements Regulation (CRR), respectively Capital Requirements Directive (CRD) allowed banks to cover parts of their core capital requirements by CoCo-bonds, and hence further fueled their growth. However, despite this stellar growth, it is not undisputed, whether CoCo-bonds actually increase the resilience of banking systems. While Coffee Jr. (2011) and Avdjiev et al. (2013) find stability enhancing effects, Maes & Schoutens (2012) and Chan & Van Wijnbergen (2014) generate opposing results.

We intend to shed new light on this discussion and to clarify, whether the usage of CoCo-bonds increases financial stability. Financial stability itself is only defined very broadly, as in the work of e.g. Gadanecz & Jayaram (2009) and Hakkio & Keeton (2009). For the purpose of this paper, we follow the definition of Brownlees & Engle (2016) and use SRISK in order to measure a banks' contribution to systemic instability. Our contribution is threefold: First, we show that the original formula for SRISK is not able to capture the stability enhancing effect of the issuance of CoCo-bonds correctly. Second, we show that the ability to capture

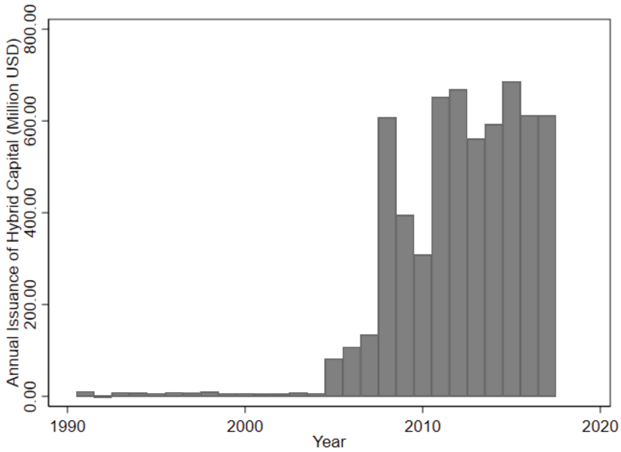

Figure 3.1: **Annual Issuance of Hybrid Capital**
The figure above shows the development of the volume of annual issuance of hybrid capital over time.

the positive contribution of CoCo-bonds to financial stability as measured by SRISK crucially depends on the treatment as debt or equity on the balance sheet. Third, we adjust the SRISK formula in order to remedy this short-coming, and to correctly account for CoCo-bonds. Using the assumption of a fictitious conversion of the CoCo-bonds directly at issuance, we eliminate the disparities induced by differences in accounting. As a result, we can draw an unbiased picture on systemic risk, and hence financial stability. Doing so allows us to make informed recommendations for policy makers and regulators alike.

Taken together, we show that SRISK needs to be adjusted in order to ensure a consistent treatment of CoCo-bonds. Doing so allows us to provide unambiguous empirical evidence that the usage of CoCo-bonds reduces systemic risk. The identified transmission channel focuses on the increased loss absorbing capacity of a bank, which originates from the issuance of CoCo-bonds.

The rest of the paper is structured as follows: Section (3.2) provides the theoretical background and the relevant literature about CoCo-bonds and systemic risk. We derive our research question and hypotheses in Section (3.3). Section (3.4) summarises our data and methodology, while Section (3.5) comprises the main results. Additional robustness tests can be found in Section (3.6), with a conclusion and an outlook given in Section (3.7).

3.2 Theoretical Background

3.2.1 CoCo-bonds

CoCo-bonds are a true subset of hybrid capital instruments. While hybrids comprise every kind of financial instrument combining features of debt and equity, not every hybrid instrument is also a CoCo-bond. Figure (3.1) illustrates the trend towards the issuance of hybrid capital instruments even before the financial crisis of 2008. Acharya et al. (2011) show that throughout the crisis a significant share of new capital issues has been in the form of hybrids, instead of common equity. Back then, Basel II allowed various different instruments to be eligible as additional Tier 1 (AT1) and Tier 2 (T2) capital, depending on the specific national regulation. Throughout these early years, hybrids comprise preferred shares, silent participations, and of course various kinds of subordinated bonds broadly summarised as “innovative” hybrid capital instruments. Retrospectively, the lacking quality of some of these types of hybrids was identified as a weak-spot of the capital regulation under Basel II. Particularly, it can be argued that non-perpetual instruments or those including call options and call incentives for the issuer, interest step-up clauses, or dividend pusher clauses cannot reasonably serve as going concern Tier 1 (T1) capital. In this way, Benczur et al. (2017) note that under Basel II the true amount of bank’s loss absorbing capital was much lower than the officially reported values. Basel III raised the required quality of the financial instruments and restricts eligibility as AT1-capital to CoCo-bonds. CoCo-bonds are those hybrids, which imply a quasi-automatic conversion feature. In contrast to simple convertible bonds, CoCo-bonds do neither imply an option for the issuer, nor the investor to convert into equity. Rather, conversion becomes mandatory if one or more contractual threshold is reached, or if the regulator considers the bank to be at the point of non-viability (PONV-trigger).

The design of CoCo-bonds varies significantly in practice with two generic types of CoCo-bonds being prevalent depending on their respective loss absorption mechanism. In case of a breach of a pre-defined trigger threshold, the principal amount is either written down (PWD) or the financial instrument is converted into equity (C2E). More specifically, the conversion yields Common Equity Tier 1 (CET1), and hence addresses previous short-comings under Basel II, which provided capital with questionable quality. In this way, they are predestined to provide going concern capital to a bank under financial distress. The conversion mechanism is of importance, but not exclusively decisive in determining whether the financial instrument is accounted for as debt or equity. Balance sheet treatment, however, depends critically on the accounting standards, and on the specific design of the instrument. Design features concerning the conversion price or ratio, permanent or temporary write down, or the possibility of a write up of the principal amount are left to contractual freedom. However, for regulatory eligibility as AT1, CoCo-bonds must fulfil several criteria regarding their quality to serve as going-concern capital determined by Basel III. Inter alia, the trigger must be based on the bank’s regulatory CET1-capital, and amount to at least 5.125 % of the total risk-weighted assets (RWA). Because under the new Basel III accord CoCo-bonds are the only remaining type of capital, which is eligible as AT1-capital, they are predestined to be designed in accordance with the requirements for AT1. However, if one or more of these criteria are not met, CoCo-bonds might still be eligible as T2-capital. Cahn & Kenadjian (2014) provide a general overview of the regulation of CoCo-bonds according to Basel III and the European implementation through CRR and CRD IV.

The existing literature on CoCo-bonds can roughly be classified as either literature on the design, pricing, or risk-taking incentives of CoCo-bonds, respectively their implications for financial stability. The conceptualisation of CoCo-bonds as going concern capital goes back to the seminal work of Flannery (2005). He calls his proposal of a CoCo-bond "reverse convertible debenture". These bonds automatically convert into common stock if a bank violates a pre-defined capital ratio, which is not based on regulatory, but book equity. In opposition to this capital ratio trigger, Raviv (2004) proposes "debt-for-equity-swaps", which are triggered if a pre-specified asset value threshold is reached. Rather than considering bank-specific trigger mechanisms, Kashyap et al. (2008) propose a "capital insurance", ensuring that banks are recapitalised if the banking sector on aggregate reaches a situation of financial distress. A comprehensive literature review on CoCo-bonds is provided by Flannery (2014).

Although the idea of CoCo-bonds precedes the subprime financial crisis, interest in it grew manifoldly from 2008 on, in a quest for tools to strengthen the stability of the banking system. CoCo-bonds provide two channels through which bank stability can be increased. First, the coupon retention, where interest payments are deferred in order to stabilise the bank capital base and ease the liquidity drain. Second, the conversion, through which the de jure debt instrument becomes equity, and increases the loss-absorbing capacity. Whether, and how such a conversion affects a banks' balance sheet equity and debt, depends on the conversion mechanism, and on the accounting treatment. Exemplary, if a C2E-CoCo accounted for as debt is triggered, it decreases debt and increases book equity. At the same time, the triggering of a PWD-CoCo accounted for as equity, decreases equity, but simultaneously yields the bank an extraordinary gain equal to the amount that was initially written down.

Considering the effects of CoCo-bonds on the financial health of individual banks, Avdjiev et al. (2015, 2017) empirically investigate the implications of CoCo-issuances on individual bank stability. They consider how the issuance of CoCo-bonds affects CDS-spreads of subordinated debt of the respective bank and find that issuing CoCo-bonds leads to a reduction of CDS-spreads. This finding implies a decrease of the risk for ordinary bond holders, and a reduction of default risk for banks in general. In contrast to this bank-individual view, our study contributes to the literature on financial stability from a systemic perspective. In this way, we investigate the implications of CoCo-bonds for systemic risk and proneness to financial distress of banking systems as a whole.

Extant theoretical literature provides multiple perspectives on the relationship between the usage of CoCo-bonds and systemic risk. Avdjiev et al. (2013) postulate that the potential of CoCo-bonds to strengthen the resilience of the banking system depends in particular on their capacity to reduce systemic risk. Coffee Jr. (2011) considers contingent capital converting into equity as an effective response to systemic risk complementing regulatory supervision. Proposing a dilutive conversion of CoCo-bonds into senior shares, however, could incentivise banks to sell-off certain illiquid assets during financial crises, which would be detrimental to financial stability. Maes & Schoutens (2012) remark that CoCo-bonds could increase systemic risk, if massive investments of insurance companies in CoCo-bonds create a contagion channel from the banking to the insurance sector. In a similar way, Chan & Van Wijnbergen (2014) argue that although the conversion of CoCo-bonds strengthens the capital base of a bank, it may increase the probability of a bank run, and hence elevate systemic risk. They reason that conversion is a negative signal to the bank's depositors as well as a negative externality on other banks with correlated asset returns (particularly if banks hold each others CoCo-bonds). Koziol & Lawrenz (2012) theoretically investigate the impact of CoCo-bonds on the risk-taking of owner-managers under incomplete contracts. They conclude that if owner-managers have discretion over the bank's business risk, CoCo-bonds bear averse risk-taking incentives, increasing the idiosyncratic risk. In this way, CoCo-bonds rather fuel systemic instability. Chan & Van Wijnbergen (2016) postulate that the wide spread use of CoCo-bonds increases systemic fragility because in particular PWD-CoCos and non-dilutive C2E-CoCos mean wealth transfers from debt holders to equity holders leading to incentives to inefficiently increase risk. Based on these ambiguous views on the effect on systemic risk, we empirically investigate this complex relationship. The following section elaborates on relevant measures for systemic risk and provides an overview of literature related to CoCo-bonds.

3.2.2 Systemic Risk

Systemic risk can be understood in many different ways, and the plurality of existing definitions highlights the still ongoing debate, about which understanding is correct. To the European Central Bank (ECB), systemic risk is "[...] the risk that financial instability becomes so widespread that it impairs the functioning of a financial system to the point where economic growth and welfare suffer materially." (ECB (2010)). Contrarily, Schwarcz (2008) understands it as the risk that a local shock results in global repercussions because of interdependencies, respectively interconnections or external effects. The number of definitions is not bound to these two exemplary given, but illustrates the necessity of a classification of the literature. Notable attempts have been made by De Bandt & Hartmann (2000), FSB et al. (2009), and Bisias et al. (2012), respectively Benoit et al. (2017) most recently.

One approach brought forward by the ECB (2010) is the systemic risk cube. It relates each dimension of the cube to an aspect of systemic risk. As such, it differentiates between the causes of systemic risk, its origin, and lastly manifestation. Regarding the causes, the systemic risk cube distinguishes exogenous and endogenous factors that trigger the systemic event, and hence lead to system-wide financial instability. They can either originate from a single bank (idiosyncratically) or from developments within the entire system (systemically). When they manifest, their impact can be sequential in the form of feedback loops, as described by Daníelsson et al. (2013), or simultaneous as prevalent in the literature on network effects (see Segoviano & Goodhart (2009), or Billio et al. (2012)).

Other definitions in the literature follow a less granular approach. Simply put, they differentiate between micro- and macro-level measures, which either assess the impact that systemic events have on individual banks, or the financial system as a whole. Notable contributions regarding the bank level assessment through microlevel measures are ΔCoVaR from Adrian & Brunnermeier (2016), respectively MES from Acharya et al. (2017), which has found its influence into SRISK by Brownlees & Engle (2016). At the other end, measures like CATFIN, as postulated by Allen et al. (2012), are noteworthy contributions to assessing the system-wide systemic risk. Irrespective of the applied definition, all systemic risk measures have individual strengths and weaknesses, depending on the dimension of systemic risk that is to be grasped. In the context of quantifying how CoCo-bonds contribute to systemic risk, these nuances make the difference in obtaining correct inference from the risk measures.

Gupta et al. (2018) use a Monte Carlo Simulation of banks' balance sheets in order to calculate ΔCoVaR in a network model in which all CoCo-bonds are issued as debt. Their results indicate a strong reduction in ΔCoVaR along with less bank failures during the stress scenarios. These observations are especially true for so called "dual" trigger CoCo-bonds, where the conversion to equity, respectively the write down of the issued debt is not only dependent on a single criterion, e.g. the share price falling below a certain threshold, but the conjunction of the share price falling below this threshold, and exemplary profits falling below a certain threshold as well. A detailed discussion of this design feature can be found in the report of the Squam-Lake-Working-Group (2009), McDonald (2013), and Allen & Tang (2016). While the findings of Gupta et al. (2018) appear desirable, they are subject to noteworthy critique. They make substantial oversimplifications, by not accounting for the different mechanics, if CoCo-bonds are issued as debt or equity. Hence, they draw a biased picture of how CoCo-bonds function. Furthermore, their argumentation that CoCo-bonds add additional liquidity is flawed, as the regulator requires CoCo-bond capital to be fully paid in at issuance. Lastly, it is difficult to theorise a transmission channel between CoCo-bonds and ΔCoVaR, which consists of seven unrelated measures, such as the weekly returns of the real estate sector. Thus, the validity of employing this measure may be questionable in the first place.

Our reservations towards ΔCoVaR in light of the aforementioned short-comings are affirmed by the literature. Kund (2018) empirically tests the predictive power of different systemic risk measures, and finds ΔCoVaR to be the worst performing of all. He generates evidence that substantiates the usage of SRISK by Brownlees & Engle (2016) for measuring systemic risk at the bank-level. We thus employ their definition of systemic risk, as an undercapitalisation in the financial sector, which hence can no longer provide credit to the real economy. In order to measure this funding gap, Brownlees and Engle have devised the systemic risk measure SRISK. Positive values indicate the presence of a funding gap, whereas negative values can be interpreted as resilience towards such adversities. The occurrence of the funding gap can be related to an extended market downturn, which is referred to as the Long Run Marginal

Expected Shortfall (LRMES). It is calculated as the expected capital shortfall of the bank conditional on the occurrence of a systemic event (c), which is equal to a decline in asset prices of 10 % over the course of a month in the original paper. As such, SRISK can be understood, as an extension of the expected shortfall, as it relates the idiosyncratic returns of the bank to the returns of the market, and hence creates a systemic risk measure. In order to address structural differences between the banks, LRMES is adjusted for individual risk through β, as well as time through $\sqrt{h}$. Formally, we can write the LRMES as:

$$LRMES_{i,t} = -\sqrt{h}\beta_i \mathbb{E}(r_{i,t+1}|r_{m,t+1} < c) \tag{3.1}$$

After obtaining the LRMES, it is incorporated in the calculation of SRISK by multiplying one minus LRMES times the adjusted equity ($E_{i,t}$) accounting for the regulatory capital fraction k. In accordance with Brownlees & Engle (2016) it was set to 8 % as approximated from the Basel accords. Pursuant, the term is deducted from the product of book valued debt ($D_{i,t}$) and the regulatory capital fraction. We thus obtain:

$$SRISK_{i,t} = kD_{i,t} - (1-k)E_{i,t}(1 - LRMES_{i,t}) \tag{3.2}$$

This original definition though is problematic, if one is to assess the impact of hybrid capital, respectively CoCo-bonds on systemic risk. As discussed in Section (3.2.1) the accounting as debt or equity is tangent to the two balance sheet variables that are necessary in order to calculate SRISK, and hence pivotal to a correct calculation. Under the current formula, hybrid capital, such as CoCo-bonds, is not taken into account, which is why we propose an extension to Equation (3.2). Using the indicator function, we will show in the following section, how our proposed extension allows for CoCo-bonds to mimic their omitted contribution to narrowing the height, respectively presence of a funding gap. From there, we derive testable hypotheses and describe and interpret their results in the subsequent sections.

3.3 Hypotheses

Throughout the existing literature on CoCo-bonds and systemic bank risk different measures for systemic risk – as described above – are used. Fajardo & Mendes (2018) make an initial attempt to study implications for SRISK. First, they estimate SRISK for banks with and without CoCo-bonds and compare the number of defaulted banks in a stress scenario. Second, they study the market reactions of the announcement and the issuance of CoCo-bonds. Their study, though, has fundamental flaws. In particular, the authors falsely assume a generalised accounting treatment of CoCo-bonds as debt. In reality a substantial amount of CoCo-bonds is accounted for as equity, as illustrated in Tables (3.6) to (3.8) in the appendix. Moreover, differentiation between C2E- and PWD-CoCos is neglected. This distinction is, however, vital, as both have very different effects on SRISK.

The starting point of our analysis is the understanding that the original SRISK formula depends on a strict classification as debt or equity and does, therefore, not properly account for hybrid capital instruments. If CoCo-bonds are not unanimously classified as debt or equity like in our sample, we expect contradicting results from their issuance. The effect of CoCo-bonds on systemic risk will crucially depend on the treatment on the balance sheet. CoCo-bonds are hybrid instruments, which can be treated very differently, depending on their specific design and the applicable accounting standards. If the CoCo-bond is accounted for as equity, SRISK decreases directly at emission. This effect stems from the immediate reduction of the potential funding gap due to the availability of additional equity. On the other hand, if CoCo-bonds are accounted for as debt, SRISK will increase at issuance. Even though CoCo-bonds are supposed to add additional loss absorbing capacity, the treatment as debt increases or even invokes potential funding gaps at emission. Only upon conversion, such CoCo-bonds are properly reflected in the SRISK formula. At conversion, debt is reduced, and at the same time equity is added to the bank. The resulting net effect after conversion is the same as the effect of the usage of a CoCo-bond accounted for as equity. If a CoCo-bond is initially accounted for as equity, there is no additional effect on equity at conversion, if it occurs at par. Figure (3.2) illustrates the different effects of CoCo-bonds on SRISK, depending on their treatment on the balance sheet.

	Equity	**Debt**
At emission	**SRISK** $\downarrow$	**SRISK** $\uparrow$
At conversion	**SRISK** $\rightarrow$	**SRISK** $\downarrow\downarrow$
Net effect	**SRISK** $\downarrow$	**SRISK** $\downarrow$

Figure 3.2: **Expected Implications of CoCo-Bonds for SRISK**
The figure above shows the ex-ante theoretically expected effects of CoCo-bonds for SRISK.

As a consequence of the differences identified, we cannot make an unambiguous or generalised statement on the effects of CoCo-bonds on SRISK. The balance sheet treatment yields the counterintuitive effect that until conversion, CoCo-bonds, which are accounted for as debt increase SRISK. Such a treatment contradicts the economic intuition, and implies an unjustified differentiation between otherwise comparable bonds, only because of their formal accounting treatment. In this way, SRISK discriminates against the usage of CoCo-bonds that are accounted for as debt. The correct treatment of CoCo-bonds in the SRISK formula is, however, relevant, as SRISK is manifold seen as a viable alternative to stress testing, and is frequently used by regulatory institutions to consider systemic stability (Pagano et al., 2014; Steffen, 2014; Constâncio, 2016). In a worst case, the regulator wrongfully acts on a sound bank, due to misleading information about its contribution to systemic risk. Building on the original SRISK formula, we therefore differentiate between debt and equity, in order to aid the regulatory triage. We hence postulate the following related hypotheses:

Lemma 1. *SRISK is highly sensitive to the accounting treatment of CoCo-bonds, and thus does not correctly measure systemic risk for issuing banks.*
Hypothesis 1a. *If CoCo-bonds are accounted for as debt, SRISK increases at emission all else being equal.*
Hypothesis 1b. *If CoCo-bonds are accounted for as equity, SRISK decreases at emission all else being equal.*

From a regulatory point of view, the treatment on the balance sheet does not have any consequences for the eligibility as regulatory AT1 or T2-capital. Therefore, from an economic and risk perspective, CoCo-bonds should not be treated differently. In particular, if we assume two otherwise identical bonds have the same capital quality, a CoCo-bond accounted for as debt should not increase SRISK, while a bond accounted for as equity reduces SRISK. Accordingly, we make the following adjustments to the original SRISK formula in order to account for the issuance of CoCo-bonds properly. First, we use the hypothetical trigger-assumption that the issued CoCo-bonds are converted instantly at issuance. In this way, CoCo-bonds either convert into real equity instruments, thereby providing equity, irrespective of their accounting treatment prior to conversion. Alternatively, for PWD-CoCos, the principle amount is written down. Doing so reduces the previous amount on the balance sheet and adds equity in the form of extraordinary earnings. Either way, CoCo-bonds are equally treated as loss absorbing equity, irrespective of their balance sheet treatment. Second, we adjust the original SRISK formula as shown in Equation (3.3) to account for the insensitivity of CoCo-capital to LRMES. CoCo-bonds offer additional loss absorbing capital in times of financial distress. Due to the trigger design, the capital is only provided in times of crisis and not ex-ante. Consequently, the distributed capital is not depleted by the LRMES factor, which is why we have added it as a dedicated summand. Only once the CoCo-bonds have been converted into non-hybrid equity, the resulting equity becomes sensitive to LRMES. Taken together, we suggest for our adjusted SRISK formula:

$$
\begin{aligned}
SRISK_{i,t} = & k\Big(D_{i,t} - DebtCoCos_{i,t}\mathbb{1}(Triggered)\Big) \\
& -(1-k)\Big(\big(E_{i,t} - EquityCoCos_{i,t}\mathbb{1}(Triggered)\big)(1 - LRMES_{i,t}) \\
& + DebtCoCos_{i,t}\mathbb{1}(Triggered) + EquityCoCos_{i,t}\mathbb{1}(Triggered)\Big)
\end{aligned}
\tag{3.3}
$$

Hypothesis 2. *If CoCo-bonds are properly incorporated in the SRISK formula, the usage of CoCo-bonds decreases SRISK, irrespective of their balance sheet treatment.*

Our study contributes to the literature on CoCo-bonds and systemic risk by investigating how the issuance of CoCo-bonds affects systemic risk. In particular, we show that the original SRISK formula fails to capture the specifics of CoCo-bonds in the context of systemic risk. As a result, we propose an adjustment to the SRISK formula to account for the differences in accounting treatment, remedying the inherent bias of the original SRISK formula. Doing so allows us to analyse the true impact of CoCo-bonds on systemic risk, irrespective of potential biases from the balance sheet treatment.

3.4 Data and Model

Our initial dataset consists of 1,514 CoCo-issuances from 2010 until 2019 and depicts the entire universe as reported by Thomson Reuters Eikon. We narrow our sample down, by restricting it to the years after 2011, because CoCo-issuance prior to that is scarce, and might be biased due to the transition from Basel II to Basel III as shown in Figure (3.1). In spite of 110 issuances in 2019, we had to drop this year, due to missing accounting information, which are required in the calculation of SRISK. After adjusting for missings, we obtain a sample of 533 CoCo-bonds, which were emitted by 126 banks from 33 countries around the world. The majority of 365 (68.48 %) CoCo-bonds are accounted for as debt, 168 (31.52 %) are accounted for as equity. Because this feature is not readily available from data providers, we hand-collected information about the balance sheet treatment of the CoCo-bonds and provide the largest overview of this characteristic available so far. Considering the relevant accounting standards, 140 (26.27 %) issuances are subject to local GAAP, while 393 (73.73 %) are in accordance with IFRS principles. The considered CoCo-bonds are equally eligible as AT1 and T2-capital. In detail, 275 (51.59 %) CoCo-bonds serve as AT1-capital, and 258 (48.41 %) as T2-capital. It is important to note that the T2-CoCo-bonds are classified exclusively as debt on the balance sheet. The general distribution between AT1 and T2 is in line with earlier research by Avdjiev et al. (2017), who analyse a sample of 731 CoCo-bonds from Bloomberg and Dealogic and find that 55 % of them are classified as AT1. Furthermore, they show that the volume weighted amount of CoCo-bond issuances was slightly dominated by PWD-bonds. In our sample, 203 (38.09 %) CoCo-bonds are designed with a C2E-mechanism, meaning that the bonds become common stock in case the bond is triggered. The majority of 330 (61.91 %) cases, is designed with a PWD-mechanism. Tables (3.6) - (3.8) in the appendix illustrate the aforementioned information. None of the CoCo-issuances has been called or triggered over the duration of our sample. Thus, we have a continuous sample free of a potential bias from converted CoCo-bonds.

Our sample contains 45,864 bank-week observations from 2012 to 2018. We use weekly LRMES in order to account for sufficient fluctuation in the stock and market returns. Doing so prevents the estimated SRISK measure from being stale. However, for the regression analysis, we only incorporate the values reported in the first calender week for two reasons. First, only then, the accounting information used for the calculation of SRISK can change. Second, due to the stationarity, the regression results would be biased by large numbers of almost identical values. As a result, our sample consists of 882 bank-year observations.

We test our hypotheses empirically by employing a panel regression model with bank and time fixed-effects as depicted by α, respectively μ in Equation (3.4). Our regressands are specifications of SRISK. Our variables of interest are the nominal amounts of debt-CoCos ($CoCo^{Debt}$) and equity-CoCos ($CoCo^{Equity}$). We subsequently control for well established bank specific and macro economic factors. On the bank level, we control for bank size using the logarithm of total assets. The capital structure is represented by the leverage ratio (LR), while profitability is measured using the return on assets (ROA). We follow Laeven & Levine (2007) in measuring the income diversification using their ROID, which relates interest and non-interest income. On the country level we control for the level of non-inflated GDP (GDP^{USD}), annual GDP-growth (GDP^{Growth}), annual inflation (CPI), and exuberant credit growth as measured by the credit to GDP ratio ($C2GDP$). We denote the coefficient for bank controls with β and the macro controls with γ to ease legibility. Subscript i refers to the individual bank, while t refers to time. An overview over the variables and their sources can be found in Table (3.10) in the appendix. Summary statistics and correlation metrics are provided in Tables (3.11) and (3.12) respectively.

$$\begin{aligned} SRISK_{i,t+1} = &\beta_1 CoCo^{Debt}_{i,t} + \beta_2 CoCo^{Equity}_{i,t} + \beta_3 ln(Assets)_{i,t} + \beta_4 LR_{i,t} \\ &+\beta_5 ROA_{i,t} + \beta_6 ROID_{i,t} + \gamma_1 GDP^{USD}_{c,t} + \gamma_2 GDP^{Growth}_{c,t} \\ &+\gamma_3 CPI_{i,t} + \gamma_4 C2GDP_{c,t} + \alpha_i + \mu_t + \epsilon_{i,t} \end{aligned} \tag{3.4}$$

We use the Wald test to generate evidence against autocorrelation. Likewise, heteroskedasticity can be rejected based on the results of the modified Wald test. Furthermore, we apply two treatments in order to address potential endogeneity. First, we address simultaneity and reverse causality concerns by using lagged values for the regressors in our analysis. Doing so reduces our sample to 756 observations from the initial 882, as 126 observations are used as lagged variables for the model calibration. A second source of endogeneity in our model might stem from the managerial leeway in structuring the CoCo-bond, such that it is either accounted for as equity or debt. This might be the case, if for example, highly leveraged or profitable banks systematically favor equity over debt CoCo-bonds. Hence, we apply the probit model from Equation (3.5) to verify the independence between the accounting of CoCo-bonds on the balance sheet and bank characteristics. The binary dependent variable y of the model assumes the value of one, when the CoCo-bond is accounted for as equity, respectively zero, if it is accounted for as debt.

Φ denotes the standard inverse Gaussian link function in the probit model.

$$\mathbb{P}(y_{i,t} = 1 | X = x_{i,t}) = \Phi\big(\beta_1 ln(Assets)_{i,t} + \beta_2 LR_{i,t} + \beta_3 ROA_{i,t} + \beta_4 ROID_{i,t} + \epsilon_{i,t}\big) \tag{3.5}$$

Table 3.1: **Probit Model with Binary Dependent Variable to Test for Accounting on the Balance Sheet**

The table below shows the coefficient and in parenthesis the p-values of probit regressions of the accounting treatment of a bond on relevant bank characteristics. The binary dependent variable assumes the value one if the bond is accounted for as equity, zero if it is presented as debt. Because we investigate whether or not a bank has issued CoCo-bonds, instead of the number of CoCo-bond issuances, the number of observations is lower compared to following tables. The bank specific variables considered are summarised in Table (3.10). Model (5) uses a dummy variable that measures profitability. It is one, when the net income is positive, and zero otherwise. Significant determinants cannot be identified from this analysis. As a consequence, endogeneity concerns regarding the balance sheet treatment of the CoCo-bonds can be dispersed. p-values: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Size	0.0493	0.0615	0.0853	0.0419	0.0620
	(0.7140)	(0.6496)	(0.6369)	(0.8006)	(0.6597)
LR	-0.0199	0.0059	-0.0076	-0.0052	-0.0071
	(0.6625)	(0.8971)	(0.8684)	(0.9107)	(0.8781)
ROID	0.0105	-0.0007	0.0303	0.0968	0.0664
	(0.9875)	(0.9992)	(0.9659)	(0.8904)	(0.9232)
ROA	-0.3604				
	(0.1373)				
ROE		-0.0206			
		(0.1945)			
EBIT			-0.0000		
			(0.8358)		
Net Income				0.0000	
				(0.8213)	
Profitability					0.0024
					(0.9985)
N	509	509	509	509	509
BIC	510.7688	511.2992	512.9126	512.9052	512.9562

We generate evidence against the theorised source of endogeneity in Table (3.1). Our results hold for different measures of profitability and hence give credit to the transmission channels we have described in Section (3.3). We thus proceed with our actual analysis in the following section.

3.5 Results

3.5.1 Hypothesis 1

Table (3.2) depicts the test results of our first hypothesis that the original SRISK formula does not correctly account for the use of CoCo-bonds. The dependent variable is SRISK as computed by the original SRISK formula. The variables of interest are the nominal amount of debt-CoCos and the nominal amount of equity-CoCos. Model (1) provides statistical evidence that the effect of CoCo-bond issuances is highly sensitive to the accounting treatment. While CoCo-bonds accounted for as equity reduce SRISK at issuance with high statistical significance, the issuance of CoCo-bonds accounted for as debt is notably insignificant, which is surprising, given the mechanics of the SRISK formula. If two otherwise comparable CoCo-bonds provide additional loss absorbing capacity and regulatory capital to banks, the original SRISK formula hence yields contradicting results, which depend exclusively on the accounting treatment. As a result, the regulator might wrongfully act on a sound bank, due to inconsistent results from the original SRISK formula. At the same time, the results confirm that the additional loss absorbing capital provided by CoCo-bonds does indeed reduce SRISK if properly treated on the balance sheet. This result is intuitive but not trivial because indirect effects between the issuance of CoCo-bonds and the LRMES factor cannot be ruled out ex-ante. Also, the absent negative significance of the debt-CoCos underlines that there is more to the effect on SRISK than just the change in leverage. Therefore, our results confirm that the relationship between the usage of hybrid capital like CoCo-bonds and SRISK is more than just a mechanical linkage and deserves closer investigation.

Model (2) adds bank specific covariates. In doing so, evidence against an omitted variable bias is generated. The previously significant intercept α becomes insignificant, as explanatory power is shifted towards the LR. It strongly contributes to explaining the riskiness of a bank from a systemic perspective. This observation is unsurprising, given that SRISK in essence is a measure of a funding gap, which occurs, if the equity cannot support the total debt and liabilities, which are used synonymously in the work of Brownlees & Engle (2016). Given that both capital types constitute the LR, our results are in line with theory.

Model (3) additionally considers macro-economic control variables, but fails to improve the model, which attests to Model (2) being the correct specification to describe the underlying mechanics. Both models reinstate the previous results. The effect of the nominal amount of equity-CoCos remains negative and highly statistically significant. The effect of the nominal amount of debt-CoCos remains ambiguous, and statistically insignificant.

Table 3.2: **SRISK: Original Formula**

The Table below shows the coefficients and p-values (in parenthesis) of regressions with bank and time fixed effects. The dependent variable is SRISK measuring systemic risk, calculated by the original formula. The variables of interest are CoCo^{Debt} and CoCo^{Equity}, indicating the nominal amounts of CoCo-bonds accounted for as debt, respectively as equity. All independent variables are one year lagged in order to disperse simultaneity concerns. p-values in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

	Model (1)	Model (2)	Model (3)
$\text{CoCo}^{\text{Debt}}$	-0.0074	0.0193	-0.0057
	(0.6664)	(0.2678)	(0.8311)
$\text{CoCo}^{\text{Equity}}$	-0.4848***	-0.3970***	-0.4157***
	(0.0000)	(0.0000)	(0.0000)
Size		984.2471	579.4413
		(0.2427)	(0.5938)
LR		793.4360***	780.2408***
		(0.0000)	(0.0000)
ROA		-161.4964	-111.7667
		(0.6378)	(0.7635)
ROID		2,777.3289	3,060.4407
		(0.1282)	(0.1251)
GDP^{USD}			-0.1011
			(0.3290)
$\text{GDP}^{\text{Growth}}$			153.9534
			(0.1436)
Inflation			17.9572
			(0.7339)
C2GDP			17.0252
			(0.2092)
Constant	6,603.8238***	-16,636.2333	-11,553.7127
	(0.0000)	(0.0815)	(0.2709)
N	756	696	637
R^2_w	0.1259	0.2471	0.2548

Table 3.3: **SRISK: Adjusted Formula**
The Table below shows the coefficients and p-values (in parenthesis) of regressions with bank and time fixed effects. The dependent variable is SRISK measuring systemic risk, calculated by the adjusted formula. The variables of interest are CoCo^{Debt} and CoCo^{Equity}, indicating the nominal amounts of CoCo-bonds accounted for as debt, respectively as equity. All independent variables are one year lagged in order to disperse simultaneity concerns. p-values in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

	Model (1)	Model (2)	Model (3)
$\text{CoCo}^{\text{Debt}}$	-1.0076***	-0.9806***	-1.0054***
	(0.0000)	(0.0000)	(0.0000)
$\text{CoCo}^{\text{Equity}}$	-0.4788***	-0.3906***	-0.4095***
	(0.0000)	(0.0000)	(0.0000)
Size		980.5157	601.8429
		(0.2408)	(0.5766)
LR		798.2166***	785.1944***
		(0.0000)	(0.0000)
ROA		-159.9226	-112.4378
		(0.6385)	(0.7603)
ROID		2,828.4129	3,107.2904
		(0.1184)	(0.1166)
GDP^{USD}			-0.1019
			(0.3213)
$\text{GDP}^{\text{Growth}}$			154.3166
			(0.1395)
Inflation			17.6509
			(0.7363)
C2GDP			16.4165
			(0.2222)
Constant	6,608.2400***	-16,689.4299	-11,769.9067
	(0.0000)	(0.0782)	(0.2583)
N	756	696	637
R_w^2	0.8518	0.8735	0.7950

3.5.2 Hypothesis 2

Table (3.3) illustrates the test results of our second hypothesis, where we suggest that after proper adjustments for the accounting treatment of the CoCo-bonds, the usage of CoCo-bonds decreases SRISK independent of the accounting treatment. The dependent variable is SRISK computed by the adjusted SRISK formula as in Equation (3.3). The variables of interest are the nominal amount of debt-CoCos and the nominal amount of equity-CoCos. Model (1) provides statistical evidence that after the adjustment, both CoCo-bonds accounted for as equity and those accounted for as debt decrease SRISK. Both coefficients of the variables of interest are negative and highly statistically significant at the 99.9 % confidence-level. Therefore, our adjustments are adequate to eliminate the perverse disparities of the original SRISK formula. Now, for two otherwise equal CoCo-bonds, whose only difference is their accounting treatment, the true economic effect is revealed. The usage of both types of CoCo-bonds reduces SRISK by providing additional loss absorbing capacity. Previous findings from Section (3.5.1) can mostly be reinstated for Models (2) and (3). The addition of bank-specific covariates in Model (2) shifts explanatory power from the intercept to the LR. At the same time, it moderates the size of the effect of the respective capital types. As before, there is no complementary influence from macro-economic control variables in Model (3). The robustness of the previous models is hence reinforced. Both variables of interest remain negative and highly statistically significant. Furthermore, we can observe significant gains in the explanatory power of the models. A possible explanation can be related to the information conveyed in Tables (3.6) to (3.8) in the appendix: the majority of CoCo-bonds (68.48 %) is accounted for as debt, which omits their stability enhancing effect in the previous regressions.

Figures (3.3) and (3.4) provide additional graphical evidence of our results, and highlight the practical implications of our findings. It can be seen in the upper row of the panel, that using the original SRISK formula leads to almost unchanged levels of SRISK, in spite of CoCo-bond issuance, which de facto increases the loss absorbing capacity of the banks. It is only under our proposed adjustments in the lower row of the panel that one observes the true effect of CoCo-issuance. In line with economic theory, we can now show that higher levels of capitalisation reduce systemic riskiness. Furthermore, we find that our adjustments indicate the absence of a funding gap, as they fall below zero from 2015 forth. This observation is of paramount importance, as it suggests that the regulator might wrongfully take action against banks, if the SRISK measure is employed in its current definition, which suggests a funding gap, where the opposite is true. Taken together, we show that the issuance of CoCo-bonds reduces systemic risk, if measured correctly.

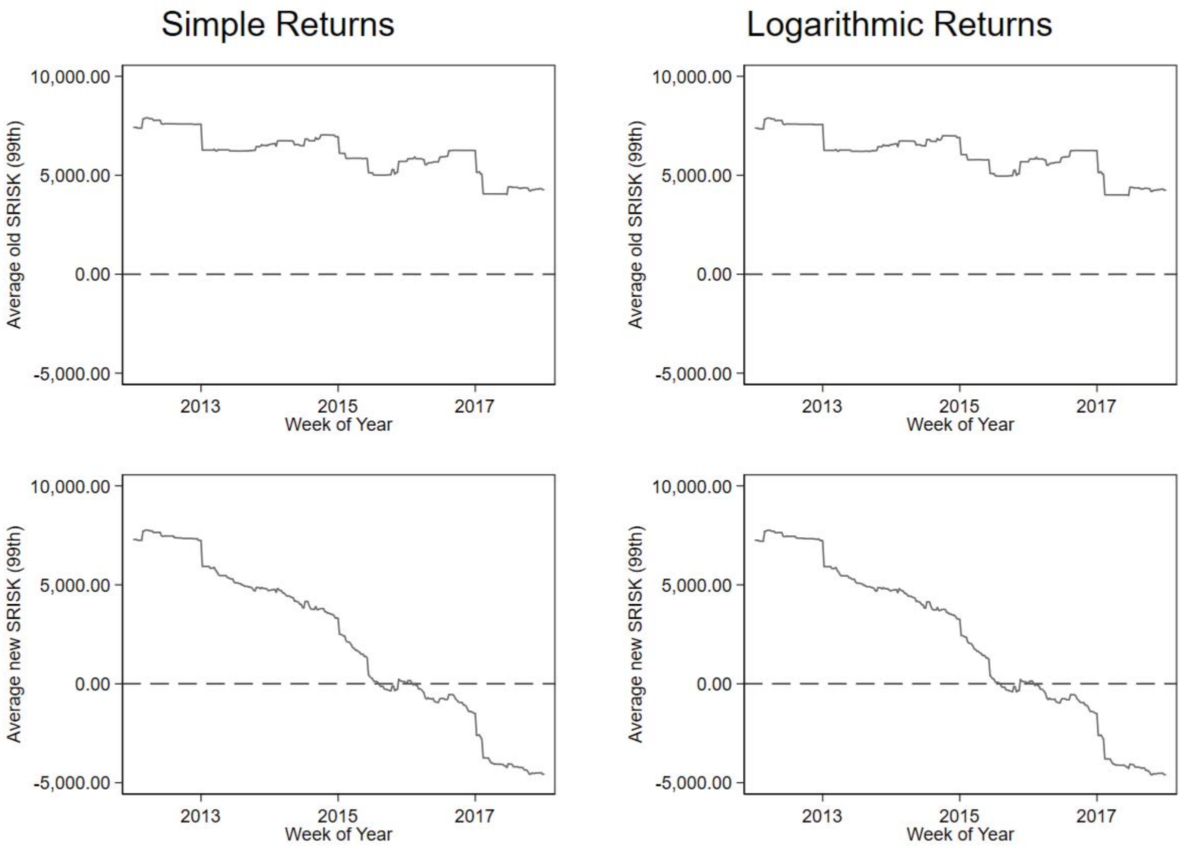

Figure 3.3: **Comparison of SRISK with Simple and Logarithmic Returns at the 99$^{\text{th}}$ Percentile**

The Figure above shows the difference between simple and logarithmic returns in a column-wise comparison. It is obvious to the eye, that the differences between the two return measures are marginal, and hence do not drive our results. The most interesting insight can be obtained from a row-wise comparison of the figure. While the top row contains the average level of SRISK under the old calculation, as depicted in Equation (3.2), the bottom row contains it with our adjustment as proposed in Equation (3.3). One directly realises the striking difference that occurs as time progresses. Crucially, the original SRISK measure remains almost static despite the on-going issuance of additional loss absorbing capital in the form of CoCo-bonds, and hence illustrates the problem this paper addresses. Our correction in the lower row clearly highlights that the issuance of CoCo-bonds, irrespective of their accounting treatment, reduces systemic risk. What is more, one can observe that under the new metric, SRISK on average becomes negative, which is especially interesting, given that it indicates the absence of a funding gap, whereas the top row indicates a capital shortfall. In light of this observation, the figure clearly illustrates the problem with the old SRISK measure, which provides a biased signal for the regulator, as it omits the loss absorbing capacity of hybrid capital. As shown in this figure, we have remedied this short-coming with our proposition.

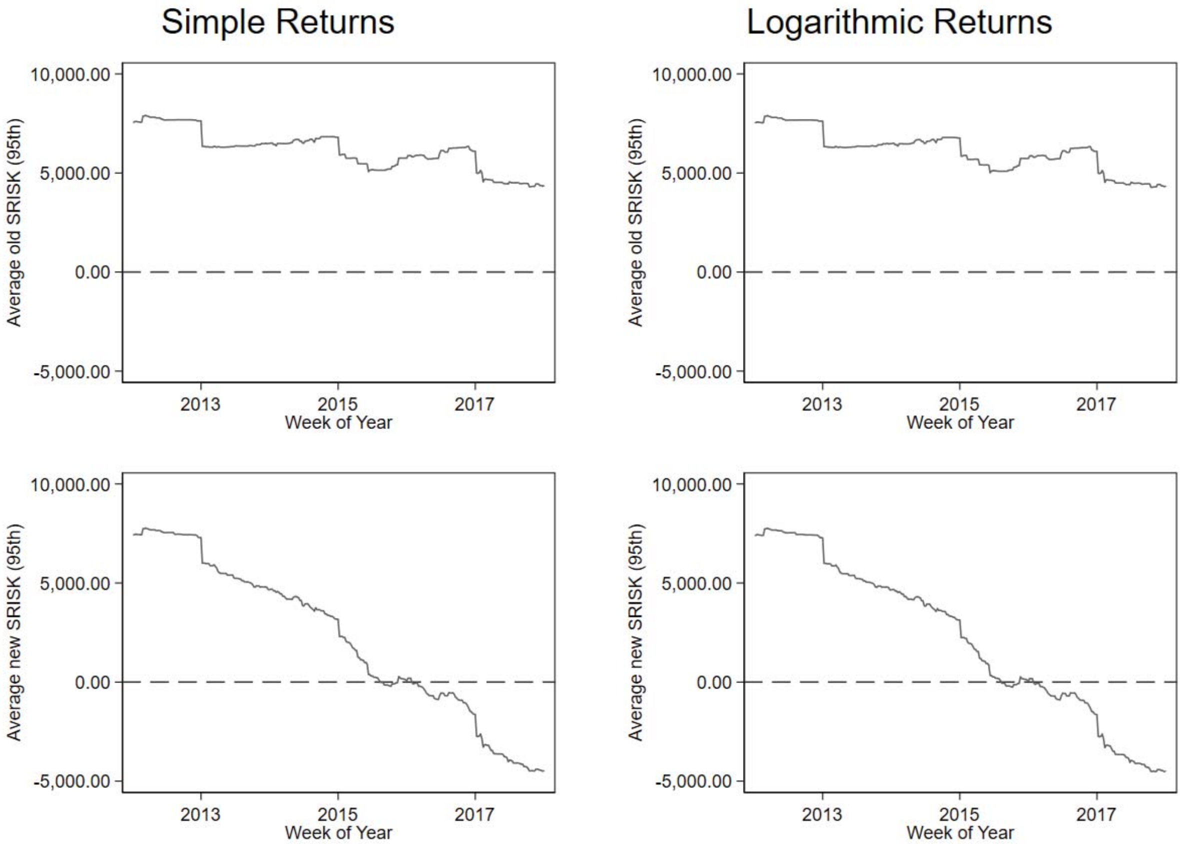

Figure 3.4: **Comparison of SRISK with Simple and Logarithmic Returns at the 95$^{\text{th}}$ Percentile**

The Figure above reinstates our findings from Figure (3.3) for a less severe market disturbance, considering the average over the worst five percent returns, instead of the worst one percent. Again, it can be seen that our adjusted SRISK formula performs significantly better at capturing systemic risk, compared to the original formula, as we correctly capture the reduction in systemic risk that can be attributed to the issuance of additional loss absorbing capacity in the form of CoCo-bonds. The difference between both formulas is substantial, as our adjustment generates evidence against a funding gap, illustrated by a negative SRISK from the end of 2015 forth. At the same time though, the original formula suggests that the systemic riskiness remains almost unchanged from its starting point in 2012.

3.6 Robustness

We assess the robustness of our results through a plurality of additional tests. The underlying principle we employ relates to the sensitivity of the parameters of the adjusted SRISK model. As such, we start by investigating the influence of different return measures on LRMES and hence SRISK. Our initial results are depicted using simple returns, and remain unchanged when using logarithmic returns, as shown in Figures (3.3). Figure (3.5) in the appendix shows both types of returns, and illustrates their similarities. Table (3.9) in the appendix corroborates this characteristic by elaborating on the descriptive statistics of both return measures. While the means appear to be reasonably comparable, we have verified this numerically, applying the Wilcoxon test statistic, which indicates no differences between the two distributions.

Another driver of our results might stem from the choice of the severity of the market downturn that is used to calculate the LRMES. We have employed the most conservative estimate in our baseline results, by investigating the impact of the 99$^{\text{th}}$ percentile of the loss distribution, and hence the most extreme values. Our results remain unchanged, when employing more broader definitions, such as the 95$^{\text{th}}$ percentile, as illustrated in Figure (3.4).

Furthermore, we winsorise the variables of our regression at the 1$^{\text{st}}$ and 99$^{\text{th}}$ percentile as a means of robustness check. Tables (3.4) and (3.5) reiterate our results, as discussed in Section (3.5), and hence disperses concerns that our results might be driven by severe outliers. While the influence of bank size becomes significant in the winsorised model, the underlying dynamics remain the same. The direction of the variables is unchanged, while their economic significance grows relative to the unrestricted models in Tables (3.2) and (3.3).

Although the results of the modified Wald test suggest homoscedasticity, we have assessed the influence of different clusters for our reported standard errors. We found no differences compared to the results in Tables (3.2) and (3.3).

The choice to set k to 8.00 % in the original SRISK formula, as used in Equation (3.2) and thenceforth, originates from the Pillar I requirements of Basel II. We have reapplied it to demonstrate the differences between the original SRISK formula and our methodology. In order to assess the robustness of our results, we have furthermore adjusted k to more accurately reflect the capital requirements in line with Basel III. In doing so, we accounted for two central short-comings, compared to the work of Brownlees & Engle (2016). First, their approach uses k to relate debt to equity. However, under the cited Basel II Accord, this threshold was used to relate equity to RWA. Second, the last financial crisis has yielded substantial changes to the regulatory framework. Generally, equity requirements have risen from the cited 8.00 % of RWA to up to 16.50 % of RWA for global systemically important banks (G-SIBs). Taking these

Table 3.4: **SRISK: Original Formula with Winsorisation**

The Table below shows the coefficients and p-values (in parenthesis) of regressions with bank and time fixed effects. The dependent variable is SRISK measuring systemic risk, calculated by the original formula. The variables of interest are CoCo^{Debt} and CoCo^{Equity}, indicating the nominal amounts of CoCo-bonds accounted for as debt, respectively as equity. All independent variables are one year lagged in order to disperse simultaneity concerns. Our regressors are winsorised at the 1^{st} and 99^{th} percentile. p-values in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

	Model (1)	Model (2)	Model (3)
$\text{CoCo}^{\text{Debt}}$	-0.0347	-0.0172	-0.0122
	(0.0807)	(0.3964)	(0.5556)
$\text{CoCo}^{\text{Equity}}$	-0.8270***	-0.7594***	-0.7533***
	(0.0000)	(0.0000)	(0.0000)
Size		1,726.4195**	2,383.6811***
		(0.0101)	(0.0016)
LR		434.4730***	407.4773***
		(0.0000)	(0.0000)
ROA		-91.9835	-95.9905
		(0.7527)	(0.7471)
ROID		2,285.1510	2,374.9800
		(0.1340)	(0.1302)
GDP^{USD}			-0.1578*
			(0.0441)
$\text{GDP}^{\text{Growth}}$			181.2602
			(0.0759)
Inflation			6.8955
			(0.8973)
C2GDP			-2.7077
			(0.6802)
Constant	6,767.5692***	-20,148.3953**	-21,356.4799**
	(0.0000)	(0.0081)	(0.0063)
N	756	756	756
R^2_w	0.1934	0.2467	0.2541

Table 3.5: **SRISK: Adjusted Formula with Winsorisation**
The Table below shows the coefficients and p-values (in parenthesis) of regressions with bank and time fixed effects. The dependent variable is SRISK measuring systemic risk, calculated by the adjusted formula. The variables of interest are $\text{CoCo}^{\text{Debt}}$ and $\text{CoCo}^{\text{Equity}}$, indicating the nominal amounts of CoCo-bonds accounted for as debt, respectively as equity. All independent variables are one year lagged in order to disperse simultaneity concerns. Our regressors are winsorised at the 1^{st} and 99^{th} percentile. p-values in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

	Model (1)	Model (2)	Model (3)
$\text{CoCo}^{\text{Debt}}$	-1.1424***	-1.1313***	-1.1295***
	(0.0000)	(0.0000)	(0.0000)
$\text{CoCo}^{\text{Equity}}$	-0.7633***	-0.7109***	-0.7038***
	(0.0000)	(0.0000)	(0.0000)
Size		1,931.0300**	2,319.1990**
		(0.0117)	(0.0070)
LR		360.9806***	343.2366***
		(0.0001)	(0.0003)
ROA		-237.0505	-214.1672
		(0.4770)	(0.5293)
ROID		1,982.3693	2,092.0286
		(0.2546)	(0.2436)
GDP^{USD}			-0.1360
			(0.1289)
$\text{GDP}^{\text{Growth}}$			171.1863
			(0.1426)
Inflation			44.3529
			(0.4680)
C2GDP			2.5344
			(0.7359)
Constant	6,808.6952***	-20,974.7265*	-21,101.8953*
	(0.0000)	(0.0138)	(0.0150)
N	756	756	756
R^2_w	0.8179	0.8261	0.8272

deliberations into account, we have re-evaluated Equations (3.2) and (3.3) using a k of 14.22 %. This number was obtained by dividing the median value of equity by the median value of RWA as observed in our sample. It constitutes a more severe scenario, as the likelihood of a funding gap to occur has now grown, due to the larger k. The results are depicted in Figures (3.6) and (3.7) in the appendix and show the same trend as described in Section (3.5). Our amended SRISK measure continues to decline with new issuances of CoCo-capital. At the same time, the old measure remains arguably static at a level of approximately 27 billion USD.

3.7 Conclusion

We start this paper by raising an important issue that has not received the attention of the regulator, as need be. Since the 2008 financial crisis, the issuance of hybrid capital, with CoCo-bonds being the most prominent source of it, has seen stellar growth. Given its rising importance, it is only prudent to investigate, how this capital type impacts systemic risk. Current measures of systemic risk, are mostly build around accounting measures, and fail to differentiate between capital types except for debt and equity. As such, the widespread SRISK measure is no exception to the rule. We believe, that this failure to acknowledge more granular characteristics leads to a biased view on the actual systemic risk. Indeed, our analysis shows that systemic risk is overestimated, when employing the SRISK measure, because the loss absorbing capacity of debt-CoCos, which are the most prevalent CoCo-bonds in our sample, is omitted. As a result, regulators might look to the wrong banks in times of crisis. Under the current calculation, certain banks may show a funding gap, which suggests them to be instable, whereas the opposite is true.

We remedy this short-coming by proposing an alternative calculation of SRISK in Equation (3.3) in order to correctly grasp the de facto systemic risk of an individual bank. By employing the trigger-assumption, we assume that all issued CoCo-bonds are converted on their issuance. In this way, we eliminate the perverse disparities in SRISK, which are solely due to a different accounting treatment. As a result, we derive a holistic framework in which both kinds of CoCo-bonds provide additional loss absorbing capacity. This equal treatment is particularly justified in light of the otherwise equal regulatory treatment of CoCo-bonds. We empirically find that both, equity-CoCos as well as debt-CoCos reduce a bank's contribution to systemic risk. Moreover, our adjustments allow us to show that banks, which rely on debt-CoCos, are less systemically risky than provided by the old calculation scheme, and do not necessarily have a funding gap. Consequently, we prevent the regulator from deriving wrong conclusions due to an inconsistent metric.

Future research should reinstate our findings for an even broader population of CoCo-bonds. Likewise, it would be desirable to look at more frequent data if available. Moreover, the generalised assumption of the SRISK formula that all liabilities will be withdrawn in times of crises might be partially unrealistic and hence should be revisited. In particular, the implicit assumption of a homogeneous reaction of deposits and other types of short-term debt is problematic. Deposit base theory motivates that even in times of financial distress a certain volume of deposits remains permanently available. The regulatory 'Net Stable Funding Ratio' accounts for these differences between various types of liabilities, considering 90 - 95 % of retail deposits to be available as means of stable funding, whereas a maximum amount of 50 % of other private short-term debt is considered stable. In this way, the SRISK formula should be adjusted to account for differences in the availability of funding sources.

3.8 Appendix

Table 3.6: **Accounting of CoCo-Bonds by Accounting Standard**

The Table below provides a breakdown of CoCo-bonds' accounting treatment by the applied accounting framework. In opposition to IFRS, GAAP denotes the multitude of local accounting standards.

	GAAP	IFRS	Percentage
Liability	134.00	231.00	68.48 %
Equity	6.00	162.00	31.52 %
Percentage	26.27 %	73.73 %	100.00 %

Table 3.7: **Accounting of CoCo-Bonds by Capital Tier**

The Table provides a breakdown of CoCo-bonds' accounting treatment by regulatory capital tier. Though, the distribution between AT1 and T2 is nearly equal, we observe visible differences for the accounting treatment. CoCo-bonds eligible as AT1 are rather classified as equity on the balance sheet. The reason for this tendency is the more equity like features of the regulatory minimum requirements to AT1-capital. On the other hand, CoCo-bonds which are only eligible as T2-capital are always classified as debt in our sample.

	AT1	T2	Percentage
Liability	107.00	258.00	68.48 %
Equity	168.00	0.00	31.52 %
Percentage	51.59 %	48.41 %	100.00 %

Table 3.8: **Accounting of CoCo-Bonds by CoCo Characteristic**

The Table provides a breakdown of CoCo-bonds' accounting treatment by their loss absorption mechanism. We find, that though both loss absorption mechanisms allow accounting classification as debt and equity, PWD-bonds have a higher tendency to be accounted for as debt.

	C2E	PWD	Percentage
Liability	124.00	241.00	68.48 %
Equity	79.00	89.00	31.52 %
Percentage	38.09 %	61.91 %	100.00 %

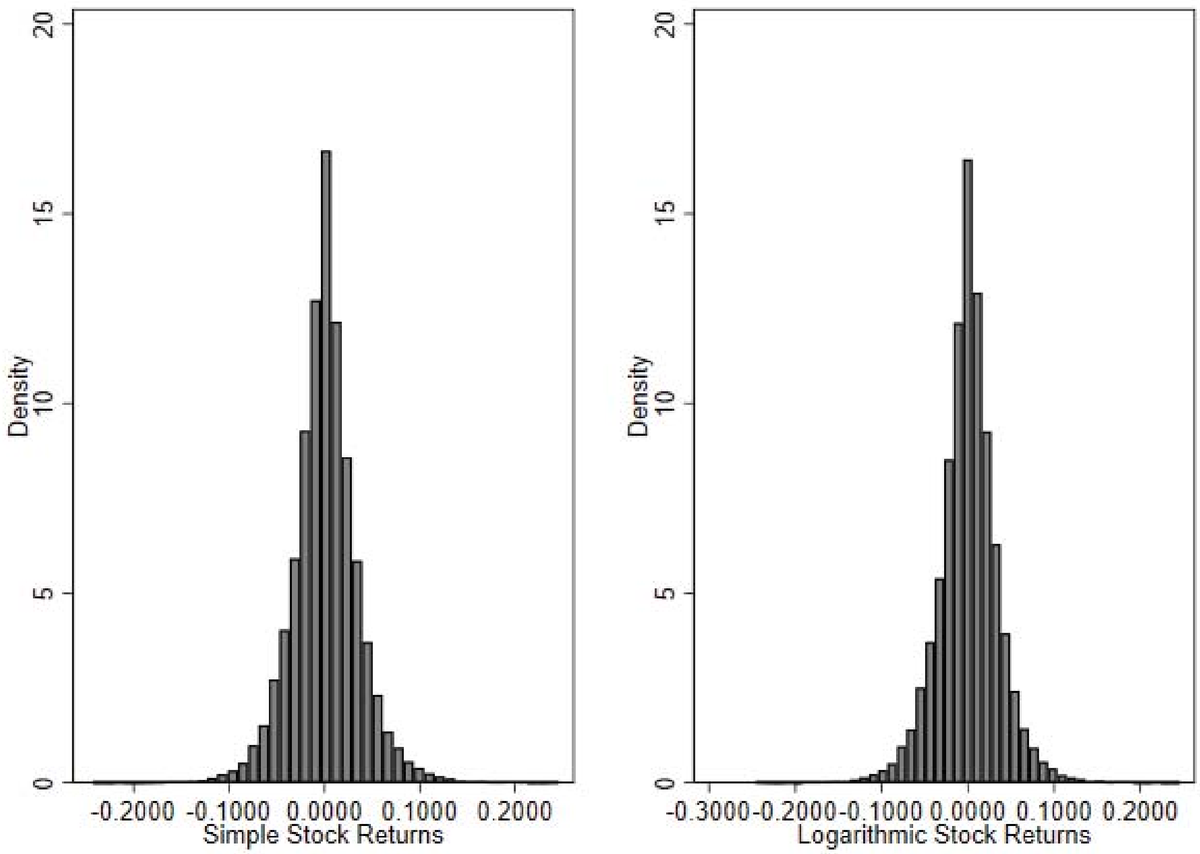

Figure 3.5: **Histograms of Different Return Definitions**
The left graph shows a histogram of the distribution of simple stock returns. The right graph illustrates the distribution of logarithmic stock returns.

Table 3.9: **Summary Statistics of Returns**
As can also be seen in Figure (3.5), simple returns yield slightly smaller negative values while positive values are notably larger, compared to logarithmic returns. Generally speaking, simple returns appears to be left-skewed, whereas the opposite is true for logarithmic returns. The standard deviations of both measures are comparable in terms of size.

	N	Min	Mean	Max	Std. Dev.
simple Returns	45,862	-0.4595	0.0013	0.9298	0.0400
logarithmic Returns	45,862	-0.6152	0.0005	0.6574	0.0398

Table 3.10: **Used Variables and Their Sources**

The Table below outlines the data source of the used variables in this paper, and details additional calculations. We have merged multiple different datasets in order to answer our research questions. The starting point was the universe of CoCo-bonds, as reported by Thomson Reuters Eikon. From there, we amended the dataset with country level macro economic control variables as reported by the Worldbank. Additional metrics have been hand-collected from the annual report, respectively computed from the Thomson Reuters Eikon data.

Variable	**Description**	**Source**
$SRISK^{old}$	SRISK as computed in Brownlees & Engle (2016)	Brownlees & Engle (2016)
$SRISK^{new}$	SRISK as computed in Equation (3.3)	Extension to the formula of Brownlees & Engle (2016)
$CoCo^{Debt}$	Nominal Amount of CoCo-bonds issued as Debt	Hand-collected from the annual report
$CoCo^{Equity}$	Nominal Amount of CoCo-bonds issued as Equity	Hand-collected from the annual report
Size	Logarithm of Total Assets	Logarithm of EIKON Item TR.TotalAssetsReported
LR	Leverage Ratio	$\frac{\text{Total Liabilities}}{\text{Total Equity}}$
ROA	Return on Assets	$\frac{\text{EBIT}}{\text{Total Assets}}$
ROID	Revenue Diversification	$1 - \left\lvert \frac{\text{Interest Income} - \text{Non Interest Income}}{\text{Interest Income} + \text{Non Interest Income}} \right\rvert$
GDP^{USD}	GDP per Capita at PPP in 2011 USD	Worldbank Indicator Code NY.GDP.PCAP.PP.KD
GDP^{Growth}	Annualised GDP Growth	Worldbank Indicator Code NY.GDP.MKTP.KD.ZG
Inflation	Annualised GDP Deflator	Worldbank Indicator Code NY.GDP.DEFL.KD.ZG
C2GDP	Credit to GDP	Worldbank Indicator Code FS.AST.DOMS.GD.ZS

Table 3.11: **Summary Statistics of Variables Included**

This Table provides summary statistics on the variables considered in the regression analysis. We display the first and ninety-ninth percentile instead of the lower and upper quartile, as we winsorise in Tables (3.4) and (3.5) in the robustness section with these percentiles.

Variables	N	Min	1 %	50 %	Mean	99 %	Max	Std. Dev.
$SRISK^{old}$	40,950	-35,549.5117	-9,721.7051	400.3422	6,172.7323	66,027.8359	115,482.8047	14,611.0927
$SRISK^{new}$	40,950	-172,098.6250	-44,070.0391	78.1388	3,245.5836	63,734.8008	115,482.8047	16,084.9918
$CoCo^{Debt}$	45,864	0.0000	0.0000	0.000	2,632.8436	56,262.7148	229,334.0156	11,566.7717
$CoCo^{Equity}$	45,864	0.0000	0.0000	0.0000	825.3359	16,530.0820	101,642.0781	4,328.9608
Size	45,864	6.5127	6.7780	11.5182	11.4008	14.6305	15.0222	1.9375
LR	45,864	3.5104	4.6905	13.2907	13.4906	27.7401	39.5339	4.9362
ROA	45,864	-2.1820	-0.0793	1.5301	1.6974	5.2637	7.4955	0.9962
ROID	42,224	0.0513	0.1272	0.6279	0.6512	1.4121	1.4950	0.3180
GDP^{USD}	45,812	4,817.1975	6,145.2946	39,700.3968	38,616.1977	9,0091.4152	120,366.2801	18,857.9595
GDP^{Growth}	45,864	-5.7993	-2.9278	2.4492	2.9339	8.4913	25.1173	2.4998
Inflation	45,864	-25.9584	-8.8625	1.5516	1.6585	13.6501	16.5544	3.5910
C2GDP	40,872	36.0167	40.7680	165.2636	163.7235	348.6077	348.6077	61.8001

Table 3.12: **Correlation Table**

This Table provides pairwise Bravais-Pearson correlation coefficients of the variables included in the regression model. The highest positive coefficient can be found for the pair of the original SRISK formula and LR. This observation is unsurprising, given that both variables are combinations of debt and equity. Hence, the high correlation is unproblematic, as different sides of the same coin are shown by the variable. The highest negative correlation can be attributed to the pair of $\text{CoCo}^{\text{Debt}}$ and $\text{SRISK}^{\text{new}}$. Again, this observation is in line with theory, as one expects SRISK to decrease, when CoCo capital is issued. Taken together, none of the correlations is excessive or in surprising instances, which is why we assess the probability of multicollinearity to be low.

Variables	$SRISK^{old}$	$SRISK^{new}$	$CoCo^{Debt}$	$CoCo^{Equity}$	Size	LR	ROA	ROID	GDP^{USD}	GDP^{Growth}	Inflation	C2GDP
$SRISK^{old}$	1.0000											
$SRISK^{new}$	0.7723	1.0000										
$CoCo^{Debt}$	0.3013	-0.3730	1.0000									
$CoCo^{Equity}$	0.1922	0.1710	0.0336	1.0000								
Size	0.5708	0.3783	0.2483	0.2491	1.0000							
LR	0.6802	0.5659	0.1164	0.0708	0.5650	1.0000						
ROA	-0.2628	-0.2025	-0.0759	-0.1115	-0.2397	-0.4277	1.0000					
ROID	0.3314	0.2667	0.0834	0.1400	0.4095	0.2830	-0.3137	1.0000				
GDP^{USD}	-0.0333	-0.0578	0.0381	0.0038	-0.0529	-0.0739	-0.2407	0.1985	1.0000			
GDP^{Growth}	-0.1491	-0.1151	-0.0413	-0.0462	-0.0615	-0.1979	0.3355	-0.3607	-0.3208	1.0000		
Inflation	-0.0755	-0.0553	-0.0318	0.0017	-0.0579	-0.1089	0.2067	-0.1223	-0.2422	0.1080	1.0000	
C2GDP	0.2751	0.2184	0.0955	0.0120	0.3514	0.4013	-0.3355	0.3050	-0.1105	-0.2686	-0.1344	1.0000

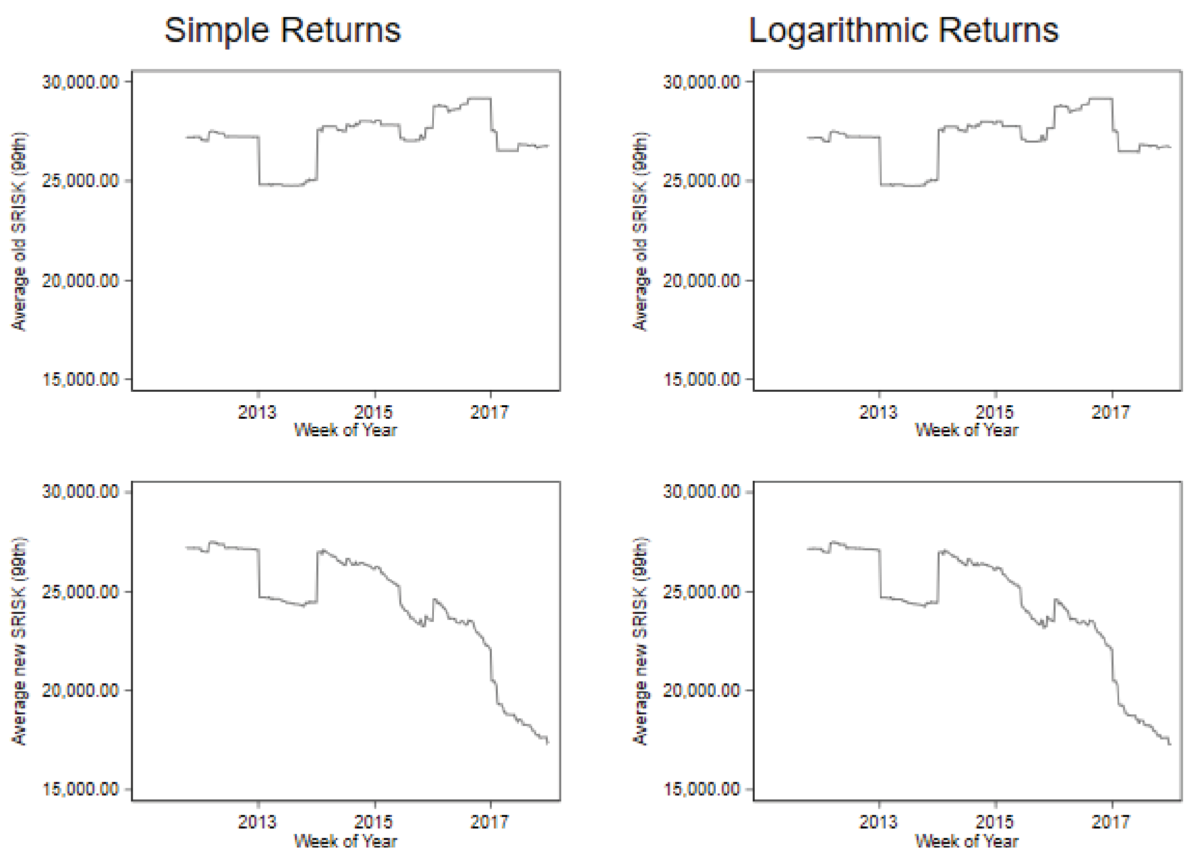

Figure 3.6: **Comparison of SRISK with Simple and Logarithmic Returns at the 99$^{\text{th}}$ Percentile Computed with an Alternative** k

The Figure above reinstates the findings made in Figure (3.3). However, we have changed the capital requirement k from 8.00 % as in the original paper to 14.22 % as we would obtain it from the data in our sample. This adjustment constitutes a more severe scenario, as a higher value of k makes the occurrence of a funding gap more likely (recall Equation (3.2)). We find that this alternation does not lead to negative values in terms of SRISK in our new formula, it nevertheless correctly grasps the reduction in systemic risk that can be attributed to the issuance of CoCo-bonds.

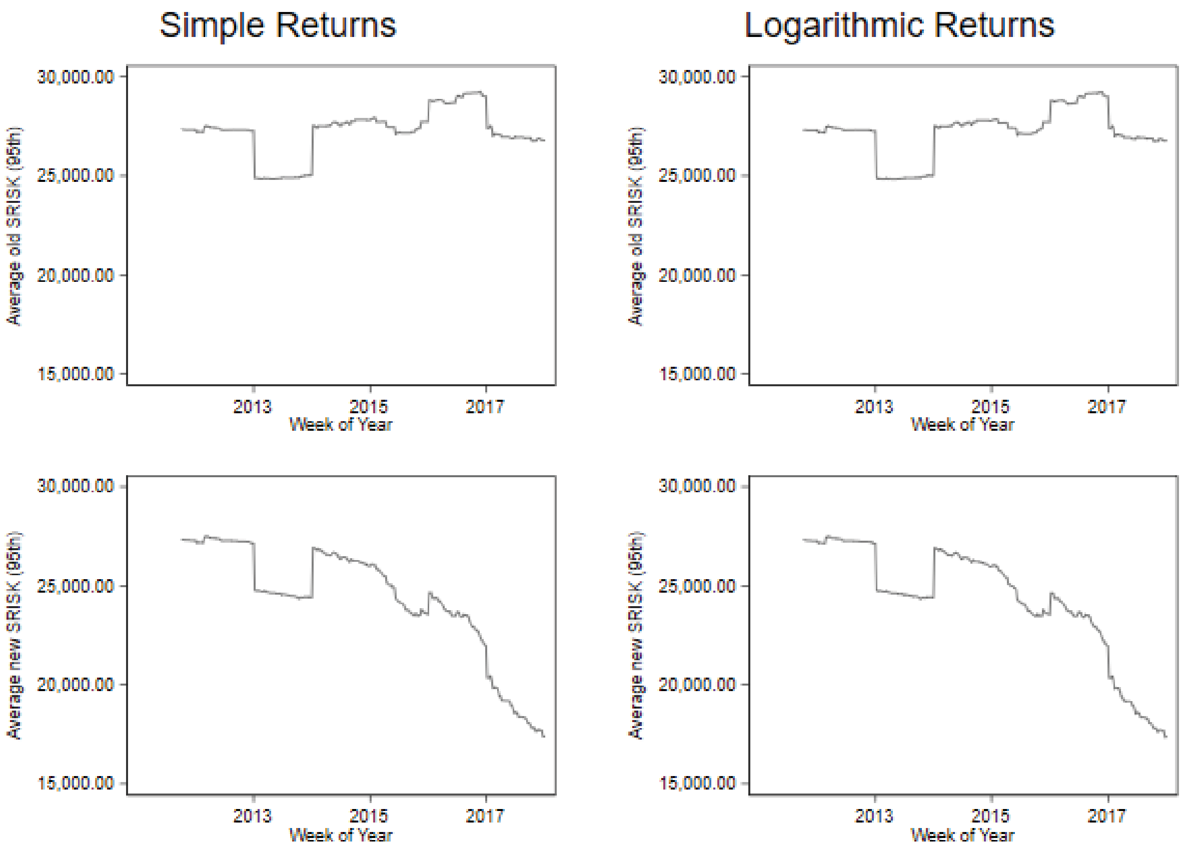

Figure 3.7: **Comparison of SRISK with Simple and Logarithmic Returns at the 95$^{\mathbf{th}}$ Percentile Computed with an Alternative k**

The Figure above reinstates the findings made in Figure (3.6). Changing the severity of the market downturn, as we have done between Figures (3.3) and (3.4) with the old k, does not drive our results, as indicated by the absence of noteworthy differences.

Chapter 4

Corporate Social Responsibility and Bank Risk[1]

[1]This study received the best paper award at the Annual Event of Finance Research Letters (Puerto Vallarta, 2020). I thank my co-author Florian Neitzert for the terrific cooperation. For helpful comments on this specific study, I thank Michael Torben Menk, and the discussants at the 7th Annual Conference on Risk Governance (Siegen, 2019) and the Annual Event of Finance Research Letters (Puerto Vallarta, 2020).

4.1 Introduction

Sustainability and mitigating climate change has become one of the most pressing issues for society. Movements such as “Fridays for Future” have recently contributed to the publicly perceived relevance of sustainability. From a business perspective, sustainability has also become increasingly relevant, being enforced by specific policies and regulations on a multinational level. By the adoption of the United Nations Sustainable Development Agenda 2030 and the signing of the Paris Agreement (2015), the international community commits itself to climate protection and sustainability (United Nations (2015)). To meet the goals set in the Paris Agreement, a transformation of the old “brown” economic system to a low-carbon circular economy is necessary. Beyond the necessity to adjust to political requirements, sustainability can also be seen as a marketing opportunity in light of increasingly conscious consumers (TCFD (2017)). The actual meaning of sustainability remains, however, often unclear in the public debate. A widely recognised definition of sustainability is a broad understanding, not only limited to ecological issues. Instead, sustainability is often used synonymously with corporate social responsibility (CSR). CSR is a well established term for a management concept which integrates environmental, social, and ethical aspects of business operations into the firm’s decision-making process (Sassen et al. (2016)). In practice, CSR is often operationalised on the basis of environmental – social – governance (ESG) scores (Chollet & Sandwidi (2018), Nofsinger et al. (2009)).

From an investors perspective, the key question of sustainable action is how it affects risk and return. Extant literature identifies a negative relationship between CSR and firm risk (Gramlich & Finster (2013)). Still, it remains unclear why risk is reduces and what determines the risk-reduction. We investigate this very question, by analysing the impact of CSR on idiosyncratic bank risk in detail. Our study is based on a data set of 2,452 banks from 115 countries in the period from 2002 to 2018. We use Thomson Reuters ESG-scores to measure banks’ CSR. This granular data enables us to analyse the effects at different levels. In this way, we contribute to the literature in two particular ways. First, we break down the risk-reducing effect into the detailed CSR-components. More precisely, we conduct an in-depth analysis of the relationship between CSR and bank risk by decomposing CSR into three pillars (environmental - social - governance) and ten sub-components. Thus, we can identify the underlying specific drivers of the risk-reduction. Second, we set a clear focus on banks, whose interdependencies of CSR and idiosyncratic risk have been sparsely investigated so far (Gangi et al. (2019)). We address banks’ specific characteristics by using different accounting-based risk measures. In detail, we quantify a bank’s default risk as well as its portfolio risk. The focus on banks is highly relevant, because the financial system plays a key role in the economic transformation process to a resource-efficient economy. Financial institutions provide the economy with capital and thus foster long-term economic growth (King & Levine (1993), Levine & Zervos (1998), Beck & Levine (2004)). In this way, financial institutions contribute to the transformation process, for example, by allocating more capital into sustainable investment projects. The consideration of banks is even more relevant in light of the current discussion about the so-called "Green Supporting Factor" to foster investments in "green" assets, a regulatory privilege of sustainable investment projects (European Commission (2018)).

Our analysis proves a significant risk-reducing effect for the overall CSR comprising all three pillars. Further, we show empirical evidence that the environmental pillar significantly determines the risk-reduction. On a sub-component level, we investigate the driving factors in detail. The social pillar and governance pillar do not show comparably significant effects. Therefore, we conclude that not all three CSR-dimensions but in particular the environmental engagement influences banks' idiosyncratic risk.

The rest of the paper is structured as follows. The subsequent section presents bank-specific CSR-literature. In this way, we highlight that the relationship between CSR and bank risk has been a blank spot on the research map so far. Based thereon, we elaborate on the relevant theory to explain the connection between CSR and idiosyncratic risk. Consequently, we develop our research hypotheses. Section (4.3) provides a summary of the sample, the dataset, and the methodology applied. Section (4.4) presents the results. The results of several robustness checks are presented in section (4.5). Finally, section (4.6) summarises the main insights and aspects of further research areas.

4.2 Literature and Hypotheses

4.2.1 Bank related literature

In times of globalisation and climate change, CSR attracts increasing public interest. However, the term CSR is not universally defined.[2] According to the United Nations, CSR is a "management concept whereby companies integrate social and environmental concerns in their business operations and interactions with their stakeholders. CSR is generally understood as being the way through which a company achieves a balance of economic, environmental and social imperatives ("Triple-Bottom-Line-Approach"), while at the same time addressing the expectations of shareholders and stakeholders." (United Nations Industrial Development Organization (2020)).

For banks, CSR is even more important, first, because of their specific business activities and, second, due to the loss of confidence in the wake of the global financial crisis in 2008 (Nandy & Lodh (2012), Marie Lauesen (2013), Hurley et al. (2014)). In contrast to the manufacturing

[2] Related concepts such as e.g. corporate sustainability, corporate social performance, or social performance are subsumed under the term CSR.

industry, banks offer primarily services, i.e. intangible products. Given the fact, that the majority of clients have no financial know-how, banks' reputation and trust are valuable assets (Soana (2011)). The grievances that emerged more than ten years ago in the wake of the financial crisis play a crucial role in this context: Governments around the world rescued local banks from bankruptcy with taxpayers' money to avert further negative effects on the financial stability, the real economy and the society (Bayazitova & Shivdasani (2012), Iannotta et al. (2013), Hryckiewicz (2014)). In this light, the business practices of banks with an intention of short-term profit maximisation were at the centre of criticism (Wu & Shen (2013)). Nevertheless, even in the post-crisis years, large capital market-oriented banks attracted attention again by scandals such as the Libor manipulation (Fouquau & Spieser (2015), Köster & Pelster (2017)). Altogether, this resulted in a historical loss of reputation and trust for the banking sector (Esteban-Sanchez et al. (2017)). For these reasons, there is a particular public interest in banks' CSR.

Also in scientific research, CSR is a "hot topic". A large number of studies examines the manifold facets and implications of CSR for non-financial companies (Orlitzky & Benjamin (2001), Margolis et al. (2007), Friede et al. (2015)). Meta- and survey studies state that research on CSR in the financial sector is comparatively rare (Goyal et al. (2013), Gramlich & Finster (2013), Wang et al. (2016)). The majority of these bank-specific CSR-studies focusses on Financial Performance (FP).[3] Wu & Shen (2013) examine the impact of CSR on banks' FP as well as the deeper motives of the underlying CSR-engagement. Based on the bank profit function, which reflects both costs and possible benefits of CSR, they find a positive influence on banks' FP. In this context, strategic motives are seen as the primary driving force behind banks' commitment to CSR, whereas CSR-activities motivated by greenwashing or altruistic motives generate costs that are not offset by additional financial benefits. In line with these findings, also Shen et al. (2016) report positive empirical evidence of CSR on FP for banks worldwide. Taking up this research, Cornett et al. (2016) analyse the CSR-effects on FP for banks around the financial crisis (2008) and report also a significant positive effect on FP. Their results are robust to different CSR-definitions and performance measures. According to Scholtens & Dam (2007), the FP of banks that apply the Equator Principles (EP)[4] does not differ significantly compared to non-adopters. Finger et al. (2018) study the EP-adoption effects on banks' FP in industrialised and developing countries. They find no significant improvement in FP for banks in developed countries in the short and medium-term, but a decline in FP in the long run for banks in developing countries. In addition, Chen et al. (2018) demonstrate that banks adopting the EP are stronger in terms of liquidity than non-applying banks. Aside from the manifold literature on FP, from a risk perspective, only Gangi et al. (2019) postulate that the bank's

[3] FP can be measured in different ways. For example, return on assets, return on equity, net interest income, and non-interest income are widely used as indicators of banks' FP.

[4] The Equator Principles are a voluntary risk management framework that establishes a commitment of banks to integrate environmental and social aspects into project finance decisions. Since the first application in 2003, almost 100 financial institutions have implemented the EP.

insolvency risk decreases as its environmental commitment increases. Obviously, the effects of CSR on risk have so far been only sparsely investigated for banks.

4.2.2 Theoretical Framework

In general, the term "risk" denotes "uncertainty about outcomes or events, especially with respect to the future." (Orlitzky & Benjamin (2001)). Based thereon, firm risk is defined as "risk inherent in a firm's operations as a result of external or internal factors that can affect a firm's profitability." (Jo & Na (2012)). Firm risk consists of systematic risk (market risk) and unsystematic risk (idiosyncratic risk). Company parameters such as profitability (Wei & Zhang (2006)), ownership structure (Xu & Malkiel (2003)), growth prospects (Cao et al. (2006)), or corporate governance (Ferreira & Laux (2007)) are identified as relevant determinants of idiosyncratic risk. CSR represents a specific company characteristic and affects, therefore, idiosyncratic firm risk (Lee & Faff (2009)). This section provides an overview of the established theories used to explain the relationship between CSR and idiosyncratic firm risk in principle.

The interaction of CSR and firm risk can be explained by risk management theory. Risk management includes the identification, measurement, control, and reduction of risks related to business activities. CSR includes the management of ecological, social, and ethical aspects and influences idiosyncratic firm risk both directly and indirectly (Bouslah et al. (2013), Vishwanathan et al. (2019)). CSR-components such as the reduction of emissions or environmental pollution, the (voluntary) adaptation of guidelines (e.g. Fair Trade, EP), the compliance with human rights or health and safety regulations directly reduce the risk of lawsuits, damages, or compensation payments (strategic risk management) (Bouslah et al. (2018)). Furthermore, CSR creates moral capital and goodwill (indirect risk-reduction). Particularly in times of crisis, moral capital acts as a protection mechanism and alleviates the negative feedback effects of external events (Godfrey et al. (2009)). Consequently, CSR reduces the vulnerability to financial, operating, environmental, and social risks, and thus reduces idiosyncratic firm risk (McGuire et al. (1988), Feldman et al. (1997), Sharfman & Fernando (2008)).

Reputation theory builds on the public opinion about the firm to explain the effect of CSR on firm risk (Lins et al. (2017)). According to Fombrun (2002), "corporate reputation is the collective representation of a company's past actions and future prospects that describes how key resource providers interpret a company's initiatives and assess its ability to deliver valued outcomes.". Within this framework, CSR is seen as an investment that can enhance a company's reputation (Jiao (2010)). Empirical evidence indicates that companies benefit in various ways from a high reputation (B. K. Boyd et al. (2010)). These firms are seen as very attractive to employees and this helps in recruiting high-quality staff (Turban & Greening (1997), Greening & Turban (2000)). Moreover, customers favour their products and are willing to pay a higher price

(Homburg et al. (2005)). The higher implied earnings are associated with lower idiosyncratic firm risk. Aside from customers, investors prefer companies with a good reputation as well (Arya & Zhang (2009), Vishwanathan et al. (2019)). Nevertheless, it is important to remember that reputation is a very fragile construct, based essentially on values, norms, and trust. Ignoring or violating these values and norms can destroy reputation permanently. This means that reputation creates a disciplining effect in terms of compliance with these norms in business operations and lowers risk appetite (Delgado-García et al. (2013)). In short, reputation theory assumes a negative impact of CSR on idiosyncratic firm risk.

Stakeholder theory represents a strategic management approach that calls for active management of the relationship with stakeholders. The idea of this theory is to integrate and balance the various stakeholder interests in the corporate management process. CSR is a relevant dimension of high-quality management and serves as a protection of the various stakeholder interests involved (Donaldson & Preston (1995), Waddock & Graves (1997), Frooman (1999), Freeman (2010)). Assuming the relevant stakeholders benefit from CSR-actions, due to "stakeholder reciprocity" the company itself profits. For example, a fair payment, qualifications, and secure working conditions enhance the motivation of employees as well as their company commitment, and finally the productivity (Jones (1995), Brammer et al. (2007), Verwijmeren & Derwall (2010), De Roeck et al. (2016)). These examples illustrate directly that CSR improves FP and, thus, reduces firm risk indirectly. CSR-reporting also reduces information asymmetries, and this can lead to more attractive financing options and conditions (Dhaliwal et al. (2011), Cui et al. (2018)). Also, CSR-companies fulfil upcoming regulations and requirements comparatively easily (Vishwanathan et al. (2019)). In the long term, the partnership between a company and its stakeholders deepens and becomes more intensive (El Akremi et al. (2018)). In short, this approach indicates a mitigating effect of CSR on idiosyncratic firm risk.

CSR is often criticised as a marketing instrument that is used for image promotion or personal benefits by the management itself (managerial opportunism theory) (Marquis & Qian (2013), Wickert et al. (2016)). For example, there is an incentive for the management to reduce CSR-investments in good times to improve FP and to benefit from performance-based remuneration. In economically weaker times, CSR-expenses are even increased to ensure shareholder support or as a justification for a lower FP (Bouslah et al. (2013)). The underlying problem here is that CSR-activity is not associated with fundamental changes within the company ("Greenwashing") and CSR-costs are not matched by any additional benefits (Preston & O'bannon (1997)). In this way, managerial opportunism theory motivates a positive relationship between CSR and idiosyncratic firm risk, which is in contrast to the theories described above.

4.2.3 Hypotheses

Central Banks, the European Commission, and supervisory authorities call for a better integration of ESG-risks by banks (European Commission (2018), Bank of England (2018), NGFS (2019), EBA (2019)). Following up, we address the issue of ESG-risks and study the relationship between CSR and idiosyncratic bank risk in detail. In this way, our study contributes to both the bank-specific CSR-literature strand (e.g. Wu & Shen (2013), Cornett et al. (2016), Finger et al. (2018)) and the literature on CSR and firm risk in general (e.g. Oikonomou et al. (2012), Albuquerque et al. (2018)).

Especially for banks, climate change creates a number of risks. These so-called "sustainability risks" can be divided into "environment-related" risks and "climate-related" risks. The former is defined as risks arising from environmental degradation such as pollution, water scarcity, or land contamination. In contrast, the latter include physical and transitory risks associated with climate change (NGFS (2019)). Physical risks are subdivided into acute risks (e.g. extreme weather events such as hurricanes) and chronic risks (i.e. long-term phenomena such as sea-level rise). Transition risks occur as part of the transition to a resource-efficient circular economy. In detail, they include "policy and legal risks", i.e. the effects of political measures to mitigate climate change (e.g. CO_2-tax) or regulatory changes. As part of the transition, technological progress is associated with an extremely disruptive potential that threatens the existence of established technologies and industries. This development is also accompanied by demand and supply changes as well as reputation risks (TCFD (2017), Mies & Menk (2019)). The influence of sustainability risks on the established bank risk types is steadily increasing (EBA (2019)).

Political requirements, technological progress, and changes in customer preferences threaten "brown" business models (e.g. replacement of the combustion engine) or, in extreme cases, investments lose their earnings-capacity before the end of their useful life ("stranded assets", e.g. nuclear power plants) (NGFS (2019)). This development jeopardises i.a. the business model of automotive manufacturers, suppliers, or energy providers. Furthermore, the ability of these companies to repay loans appears more than questionable and thus constitutes a credit risk and market price risk for the bank. For specialised banks, this can, in extreme cases, pose a threat to their business model. Additionally, natural disasters are an operational as well as a liquidity risk for banks. For example, this could be the flooding of branches or computer centres or a massive outflow of customer deposits as a result of a natural disaster (Bank of England (2018), BaFin (2020)). Apart from the environmental risk factors, banks' social as well as governance aspects are also important. Specific action to reduce social risks could be e.g. the rejection of funding for disreputable sectors such as the arms industry or companies that violate labour and human rights standards. Moreover, the guarantee of data protection, anti-corruption programs, and tax-compliance (e.g. cum-ex) contribute to the reduction of governance-specific risks in banks.

The examples above underline the interaction of ESG-risks and banks' idiosyncratic default and portfolio risk. Reputation theory assumes a restrictive and selective lending process (Nandy & Lodh (2012)). Studies point out that banks with a high reputation in comparison to banks with a low reputation are characterised by a more rigorous credit assessment (Chemmanur & Fulghieri (1994)). As a result, these banks tend to have higher profitability and high-quality and less risky assets than their competitors (Bushman & Wittenberg-Moerman (2012)). Other scientific studies confirm this relationship. For example, Billett et al. (1995) and Ross (2010) illustrate that stock returns of borrowers of banks with a high reputation showed a positive reaction at the time of a credit announcement. Consequently, the reputation theory suggests that CSR reduces idiosyncratic bank risk (Wu & Shen (2013)). Risk management theory indicates that banks anticipate such risks at an early stage, also through CSR. Concerning non-financial companies, Orlitzky & Benjamin (2001) postulate in their meta-study that higher CSR is associated with lower financial risk. Also, Luo & Bhattacharya (2009) find empirical evidence for the risk management hypothesis and confirm a negative relationship between CSR and firm risk.

Based on the empirical evidence described above, analogous to non-financial companies, as well as the theoretical concepts like risk management theory, reputation theory, and stakeholder theory, we assume that CSR and bank idiosyncratic risk are related as follows:

Hypothesis 1. *Overall CSR reduces idiosyncratic bank risk.*

Idiosyncratic risk interacts differently with each CSR-pillar (environmental – social – governance). Therefore, a more granular analysis is warranted (Bouslah et al. (2013), Girerd-Potin et al. (2014), Chollet & Sandwidi (2018)).

As previously described, environmental aspects impact idiosyncratic bank risk. The environmental pillar is determined by the usage of exhaustible resources, the release of emissions in the business process, and an innovative and sustainable product portfolio. For instance, banks can link their lending practices to environmental criteria. By adjusting the bank's portfolio early to future environmental expectations by law-makers and society, banks can anticipate future needs for adjustment and pre-empt associated costs. In line with risk management theory, we argue that investing in sustainable technologies and businesses is comparatively less risky, especially if they concern state-sponsored or highly subsidised businesses (Shane & Spicer (1983)). A lower portfolio risk also implies a lower default risk of the bank, because of more stable income streams. Moreover, reputation theory can explain higher and less volatile income streams and, hence, lower default risk. Environmental engagement is particularly predestined to improve the reputation of the bank. Stakeholder theory and reputation theory provide additional motivation for banks to engage in policies that enhance the environmental performance. Therefore, we expect sustainable banks to be less risky.

Social aspects are similarly relevant, especially to improve the image and reputation of the bank. Components of the social pillar such as working conditions or qualification measures indicate the quality of the bank's endeavours to promote and appreciate its employees and society. Because banking is a servicing business, and therefore reliant on good relationships with the workforce and customers, the social performance can have direct implications for the bank's portfolio management performance and risk. As an expression of social responsibility, banks in the United States have deferred interest and principal payments for affected borrowers in the aftermath of hurricane "Sandy"(BusinessWire (2012)). Similar to environmental engagement, reputation theory and stakeholder theory explain why banks are keen to improve their social image. As a result of a better reputation, we expect those banks with a higher social performance to have higher and more stable income streams, which lead to a lower default risk.

Besides, governance practices are seen as particularly important in the context of bank risk (John et al. (2008)). The governance pillar comprises effective management, efficient and transparent decision-making processes, and the involvement of shareholders. Management and shareholders are key actors in the implementation of a sustainability philosophy and strategy. Therefore, consistent with risk management theory and stakeholder theory, we expect banks with a good governance to be less failure-prone and behave more disciplined concerning their portfolio compositions.

In sum, this raises the following hypothesis:

Hypothesis 2. *Each single CSR-pillar (environmental – social – governance) has a reducing effect on idiosyncratic bank risk.*

Our third hypothesis is primarily motivated by reputation theory. Reputation is particularly prone to controversies, misconduct, and scandals. For instance, the manipulation of the reference interest rate Libor or the selling of supposedly sustainable financial products ("greenwashing") threatens banks' reputation and results mostly in litigation and financial penalties (Wu & Shen (2013), ECB (2016), BaFin (2020)). The majority of studies in this area analyses the effects of controversies on profitability and stock performance (Koku & Qureshi (2006), Köster & Pelster (2017)). Further studies investigate the extent to which shareholders have benefited from corporate misconduct (Bhagat et al. (1998), Haslem (2005)). Beyond that, the implications of controversies and fines for corporate policy and governance practices have been examined (Fich & Shivdasani (2007), Nguyen et al. (2016)). Following on the empirical evidence (Murphy et al. (2009)), we assess the effects of controversies on banks' risk profiles. We assume that banks with a better reputation show lower levels of idiosyncratic risk. In this way, we propose based on reputation theory, risk management theory, and stakeholder theory:

Hypothesis 3. *Controversies enhance idiosyncratic bank risk.*

4.3 Empirical Approach

4.3.1 Sample and data

We perform an empirical analysis in order to test the hypotheses stated above. Our sample consists of 2,452 banks worldwide, provided by Thomson Reuters' Eikon for the TRBC-sector "Banking Services". In total, the sample comprises banks from 115 countries around the world. Nearly a third are headquartered in the United States. From the same data source, we collect fundamental data as well as ESG-scores on an annual level. ESG-scores are used to quantify banks' CSR. The Thomson Reuters ESG-database offers data on 400 different ESG-metrics for over 7,000 companies worldwide, including banks, since 2002. On an aggregate level, differentiated scores for the three pillars (environmental – social – governance) of the total ESG-score as well as scores on each sub-component of each pillar are provided. The composition of the ESG-score is illustrated in Figure (4.1). In addition to the ESG-scores, a Controversies-score is reported.

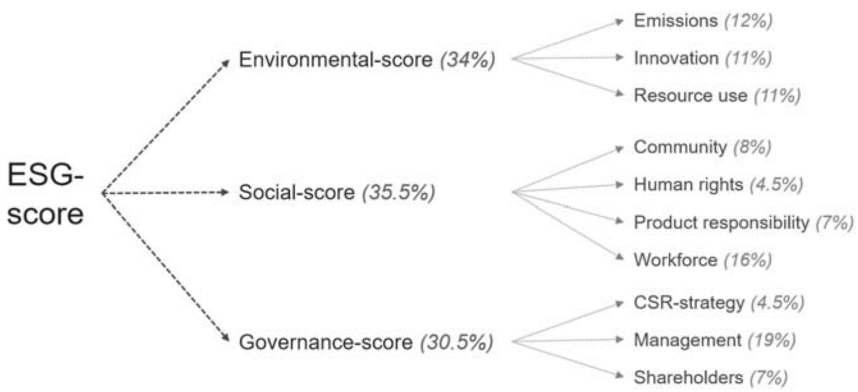

Figure 4.1: **Composition of the Thomson Reuters ESG-Score**
The graph shows the break-down of the ESG-score into its three pillars and its ten sub-components, as well as their weightings in the total score.

The availability of the ESG-scores is the restricting factor of our time series, not being available before 2002. In order to enable the calculation of metrics like the standard deviation of return on assets (ROA), we collect additional fundamental data from 1997 to 2002. To control for country-specific effects, we retrieve macroeconomic data from the WorldBank-database. Our final dataset comprises longitudinal data on 582 banks from 2002 to 2018. Figure (4.2) in the appendix provides information about the origin of the banks. To ensure that our results are not driven by severe outliers and single erroneous data points, the data is winsorised at the 1^{st} and the 99^{th} percentile. Winsorisation is not applied to dummy variables and data on ESG-scores, because they are subject to multiple checks and controls by Thomson Reuters.

4.3.2 Dependent variable and risk measures

In order to measure the impact of CSR on bank risk, we focus on accounting-based risk measures. In particular, we consider both banks' idiosyncratic default risk and portfolio risk.

We approximate default risk by different specifications of the z-score (J. H. Boyd et al. (1993), Laeven & Levine (2009)). The z-score compares a bank's ROA plus its capital adequacy ratio (CAR) with the standard deviation of ROA. CAR is defined as the ratio of equity to total assets (Houston et al. (2010)). We calculate the standard deviation of ROA for rolling windows of 5 years in our baseline scenario.[5] Thus, the z-score is defined as the number of standard deviations the ROA has to drop below its mean until equity is entirely depleted. In this way, the z-score represents a measure of the risk that a bank becomes insolvent. The higher the z-score, the more secure is the bank.

$$z\text{-}score_{i,t} = \frac{(ROA_{i,t} + CAR_{i,t})}{\boldsymbol{\sigma}(ROA_{i,t})} \tag{4.1}$$

Portfolio risk is approximated by the risk density (RD). RD is calculated as the amount of risk-weighted assets (RWA) over total assets reported on the balance sheet (Le Leslé & Avramova (2012), Baule & Tallau (2016)). RWA are reported by the banks as a key regulatory indicator necessary to compute risk-sensitive regulatory capital adequacy ratios. In order to compute RWA, banks multiply each asset with a regulatory risk-weight. RD is therefore supposed to reflect the total riskiness of a banks' assets.

$$RD_{i,t} = \frac{Risk\text{-}weighted\text{-}assets_{i,t}}{Total\text{-}assets_{i,t}} \tag{4.2}$$

Table (4.12) in the appendix summarises all the variables used in this study. Descriptive statistics on the risk measures based on non-winsorised data are provided in Panel A of Table (4.1).

4.3.3 ESG-Scores and control variables

We approximate the CSR of a bank by its Thomson Reuters ESG-scores. Thereby, we differentiate the three pillars constituting the overall score, and for each sub-component within each

[5]There is no consensus about the adequate time frame of the rolling window in the literature (Schulte & Winkler (2019)). Five years, however, is a widely recognised horizon. We apply a ten year time frame in the robustness section as well.

pillar. This enables us to perform an impact driver analysis for each of the ten sub-components, in order to identify the roots of the effect on risk. Furthermore, the Controversies-score measures a bank's involvement in ESG-controversies, scandals, or negative media coverage.

Descriptive statistics on the ESG-score and its three pillars are provided in Panel B of Table (4.1). All the scores, as well as its sub-components, are standardised between 0 and 100. A visible and important insight for the statistical analysis is that the distributions of the scores have variation and are not static. Table (4.13) in the appendix provides additional information on the correlation of the three pillars and the risk measures.

Table 4.1: **Summary Statistics of Variables Included**
This table provides summary statistics on the variables considered in the analysis. The statistics are based on the original non-winsorised data. Panel A shows the statistics of the risk measures, Panel B of the ESG-score and its pillars, and Panel C of the bank specific control variables included.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	N	min	1%	50%	mean	99%	max	sd
Panel A:								
z-score	28,448	-1,643.14	-1.15	25.03	50.95	248.58	843,312.16	767.28
RD	12,214	0.00	5.10	64.97	79.05	109.95	593,103.43	904.21
Panel B:								
ESG-score	4,189	12.30	18.22	48.02	50.78	88.95	93.53	18.93
EnvPillar	4,189	7.67	15.09	45.65	50.90	95.37	98.10	24.81
SocPillar	4,189	2.65	9.35	49.21	50.58	94.38	98.01	21.57
GovPillar	4,189	1.72	9.00	51.27	50.88	91.16	99.52	21.79
Controversies	4,189	0.08	0.88	59.00	49.47	66.67	69.05	20.66
Panel C:								
logFTE	21,624	0.00	2.30	6.88	6.91	11.91	13.13	2.09
LR	31,362	-1,470,796.00	-120.63	834.00	1,162.91	3,631.48	3,579,500.00	29,061.10
LoanRatio	23,323	-20.34	2.21	63.10	62.92	89.52	60,528.52	396.32
DepRatio	23,435	0.00	7.54	77.98	77.09	93.18	81,571.68	532.62
ROE	31,489	-278,250.00	-108.56	11.94	9.43	82.89	56,620.89	1,708.63

In order to mitigate omitted variable bias, we use several bank and country-specific control variables in the multivariate regression models. Bank specific are variables, which characterise a particular bank. In contrast, macroeconomic variables are not specific to a particular bank, but specific to a group of banks, e.g. country-specific. On the bank level, we control for size, capital structure, profitability, and the business model of banks. We approximate size by the natural logarithm of full-time employees (logFTE). We use full-time employees instead of total assets in order to reduce issues with multicollinearity.[6] The bank's capital structure is approximated by the leverage ratio (LR) calculated as liabilities over equity, profitability as return on equity (ROE). Based on the differentiation of business models by Ayadi et al. (2016), we also consider the loans to assets ratio (LoanRatio) and the deposits to assets ratio (DepRatio). On the

[6]The choice of the size proxy does not affect our results. The explanatory power of our model and the significance of the variables included does not differ substantially compared to the use of log total assets.

country level, we control for inflation, GDP-growth ($\text{GDP}^{\text{Growth}}_{\text{Cap}}$), and GDP per capita ($\text{GDP}_{\text{Cap}}$).

4.3.4 Methodology

In order to study the effect of CSR on idiosyncratic bank risk, we apply a series of univariate and multivariate linear fixed effects (FE) regression model. The model is specified as follows:

$$Risk_{i,t+1} = \alpha_i + \boldsymbol{\delta} * ESG_{i,t} + \boldsymbol{\beta} * X_{i,t} + \boldsymbol{\gamma} * Y_{j,t} + \mu_t + \epsilon_{i,t}, \tag{4.3}$$

while X comprises the bank specific variables and Y comprises the macroeconomic variables. The indices indicate: $i = bank$; $j = country$; $t = fiscalyear$.

$Risk_{i,t}$ indicates the observation of one of the risk measures used at a time t at bank i. $ESG_{i,t}$ approximates the CSR of bank i at time t, and is specified as the ESG-score, one of its three pillars, one of the ten sub-components, or the Controversies-score. The baseline models consider one year lagged independent variables in order to mitigate endogeneity by a potential reverse causality or simultaneity bias. The robustness section 4.5 considers a two-year lag as well.

The regression model is specified with bank and time fixed effects, to account for unobserved heterogeneity that may be correlated with the explanatory variables. The Hausman-Test suggests that coefficient estimates in fixed and random effects model are not alike and, therefore, suggests the rejection of random effects. Robust Huber-White-sandwich estimates of variance are used for the statistical analysis to account for group-wise heteroscedasticity in the residuals of the regression models (Froot (1989), R. L. Williams (2000)).

4.4 Results

Table (4.2) summarises the results of simple OLS-regressions of idiosyncratic bank risk on the overall ESG-score as a measure for banks' total CSR. Models (1-3) show the results for the z-score as a measure for default risk. Models (4-6) illustrate the results for RD as a measure for portfolio risk. Models (1) and (4) depict univariate regression results, without any control variables. The coefficient in Model (1) is positive and statistically significant on the 1 % level. This indicates that the ESG-score in the previous year increases the z-score and therefore lowers the default risk of the bank. Model (2) includes additionally bank specific control variables, Model (3) includes country-specific control variables as well. Both coefficients remain positive and highly statistically significant, supporting the result that the ESG-score increases the

Table 4.2: **Multivariate Robust FE Regressions of Risk on the ESG-Score**
The table shows the coefficients and standard errors (in parenthesis) of multivariate robust FE-regressions. The dependent variables are the bank risk measures z-score and RD. The independent variables are the ESG-score and bank and country specific control variables. The independent variables are 1 year lagged. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level. Data is winsorised at the 1^{st} and the 99^{th} percentile.

	(1)	(2)	(3)	(4)	(5)	(6)
	z-score	z-score	z-score	RD	RD	RD
	Coef./se	Coef./se	Coef./se	Coef./se	Coef./se	Coef./se
L.ESG-score	0.8061***	0.7749***	0.6176***	-0.1598***	-0.1368*	-0.1572**
	(0.09)	(0.09)	(0.10)	(0.05)	(0.07)	(0.07)
L.logFTE		0.1783	2.2885		-3.9859	-3.2291
		(4.19)	(4.12)		(5.57)	(5.74)
L.LR		-0.0000***	-0.0000***		0.0000	0.0000**
		(0.00)	(0.00)		(0.00)	(0.00)
L.LoanRatio		0.1448	0.1201		0.2757**	0.2782**
		(0.16)	(0.16)		(0.12)	(0.12)
L.DepRatio		0.3383***	0.2507**		-0.0977	-0.1013
		(0.11)	(0.11)		(0.13)	(0.14)
L.ROE		-0.0010***	-0.0006**		-0.0001	0.0000
		(0.00)	(0.00)		(0.00)	(0.00)
L.Inflation			-0.0277			0.0333
			(0.35)			(0.10)
L.GDP^{Growth}_{Cap}			1.2607***			0.3616*
			(0.36)			(0.19)
L.GDP_{Cap}			0.0016			0.0000
			(0.00)			(0.00)
Constant	6.3560	-24.7530	-91.1087*	70.3927***	96.1081	87.9577
	(4.75)	(39.97)	(47.32)	(2.78)	(60.31)	(61.69)
N	3,949	3,200	3,117	2,904	2,674	2,635
R^2_{adj}	0.0413	0.0450	0.0611	0.0059	0.0107	0.0119

z-score, thereby reducing banks' default risk. The coefficients in Model (4-6) for the effect on RD are all negative and statistically significant. This indicates that CSR reduces the RD, i.e. the portfolio risk of a bank. Model (4) for the univariate results implies significance on the 1 % level. The results remain negative and statistically significant if bank specific control variables are included (Model (5)) and if country-specific variables are included (Model (6)). In general, the regression results are in line with risk management theory, reputation theory, and stakeholder theory and support our first hypothesis that CSR reduces idiosyncratic bank risk.

Table 4.3: **Multivariate Robust FE Regressions of Risk on the Environmental-Score**
The table shows the coefficients and standard errors (in parenthesis) of multivariate robust FE-regressions. The dependent variables are the bank risk measures z-score and RD. The independent variables are the ESG-environmental-pillar-score (EnvPillar) and bank and country specific control variables. The independent variables are 1 year lagged. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level. Data is winsorised at the 1^{st} and the 99^{th} percentile.

	(1)	(2)	(3)	(4)	(5)	(6)
	z-score	z-score	z-score	RD	RD	RD
	Coef./se	Coef./se	Coef./se	Coef./se	Coef./se	Coef./se
L.EnvPillar	0.5589***	0.5415***	0.4393***	-0.1359***	-0.1296***	-0.1436***
	(0.07)	(0.07)	(0.08)	(0.04)	(0.04)	(0.04)
L.logFTE		0.8016	2.5585		-3.5049	-2.7782
		(4.23)	(4.13)		(5.29)	(5.43)
L.LR		-0.0000***	-0.0000***		0.0000	0.0000**
		(0.00)	(0.00)		(0.00)	(0.00)
L.LoanRatio		0.1412	0.1150		0.2854**	0.2880**
		(0.16)	(0.16)		(0.12)	(0.12)
L.DepRatio		0.3986***	0.2990***		-0.1142	-0.1204
		(0.11)	(0.11)		(0.13)	(0.13)
L.ROE		-0.0010***	-0.0006**		-0.0000	0.0000
		(0.00)	(0.00)		(0.00)	(0.00)
L.Inflation			-0.0440			0.0220
			(0.35)			(0.10)
L.GDP_{Cap}^{Growth}			1.2126***			0.3633*
			(0.36)			(0.19)
L.GDP_{Cap}			0.0016			0.0001
			(0.00)			(0.00)
Constant	18.7935***	-22.5995	-88.3094*	69.2300***	91.9350	83.2806
	(3.52)	(41.21)	(47.69)	(1.94)	(58.49)	(59.38)
N	3,949	3,200	3,117	2,904	2,674	2,635
R^2_{adj}	0.0402	0.0451	0.0622	0.0088	0.0138	0.0153

Tables (4.3–4.6) summarise the results for the breakdown analysis of the risk-reducing effect of the total ESG-score for the three pillars it consists of. Tables (4.3–4.5) provide the results of multivariate regressions for each of the three pillars. In each table, Models (1-3) depict regression results for the z-score, whereas Models (4-6) show the results for RD. In Table (4.3), we find highly significant effects for the environmental pillar in all six models. Not only for the univariate results in Model (1) and Model (4) we find highly statistically significant results in line with our expectation of hypothesis 2 that the environmental pillar should have a risk-reducing effect on a stand-alone basis. The coefficients remain statistically significant on the 1 % level and in line with expectation if bank specific control variables are included in Model (2) and Model (5) and if country-specific control variables are considered in Model (3) and Model (6).

Table 4.4: **Multivariate Robust FE Regressions of Risk on the Social-Score**
The table shows the coefficients and standard errors (in parenthesis) of multivariate robust FE-regressions. The dependent variables are the bank risk measures z-score and RD. The independent variables are the ESG-social-pillar-score (SocPillar) and bank and country specific control variables. The independent variables are 1 year lagged. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level. Data is winsorised at the 1^{st} and the 99^{th} percentile.

	(1) z-score Coef./se	(2) z-score Coef./se	(3) z-score Coef./se	(4) RD Coef./se	(5) RD Coef./se	(6) RD Coef./se
L.SocPillar	0.5181***	0.4579***	0.2958***	-0.0549	-0.0342	-0.0441
	(0.08)	(0.08)	(0.09)	(0.04)	(0.05)	(0.05)
L.logFTE		4.1909	6.2426		-5.3885	-4.7190
		(4.48)	(4.43)		(5.37)	(5.53)
L.LR		-0.0000***	-0.0000***		0.0000	0.0000**
		(0.00)	(0.00)		(0.00)	(0.00)
L.LoanRatio		0.1876	0.1566		0.2643**	0.2680**
		(0.16)	(0.17)		(0.12)	(0.12)
L.DepRatio		0.3390***	0.2475**		-0.1040	-0.1070
		(0.11)	(0.12)		(0.13)	(0.13)
L.ROE		-0.0009***	-0.0005**		-0.0001	0.0000
		(0.00)	(0.00)		(0.00)	(0.00)
L.Inflation			-0.2096			0.0802
			(0.35)			(0.11)
L.GDP^{Growth}_{Cap}			1.1619***			0.3823**
			(0.36)			(0.19)
L.GDP_{Cap}			0.0018*			-0.0000
			(0.00)			(0.00)
Constant	21.2068***	-48.0482	-119.3424**	64.8943***	104.8033*	99.2207*
	(3.81)	(43.38)	(50.89)	(1.87)	(58.73)	(59.85)
N	3,949	3,200	3,117	2,904	2,674	2,635
R^2_{adj}	0.0236	0.0278	0.0480	0.0006	0.0073	0.0079

Table (4.4) illustrates the results of the social pillar of the ESG-score. For the social pillar, the results are not as unanimous as for the environmental pillar. Instead, the results depend on the proxy of idiosyncratic risk. As for the environmental pillar, we find highly significant coefficients in Models (1-3) for the social pillar on the z-score which approximates the banks' default risk. For the coefficients for RD in Models (4-6) approximating portfolio risk, however, we cannot find statistical significance, even though the direction of the coefficients is in line with expectation.

Table (4.5) provides the results for the governance pillar of the ESG-score. Again, we find highly significant coefficients in Models (1-3) for the governance pillar of the ESG-score. For the RD, we only find statistical significance in the univariate Model (4). The results in Models (5-6) including also bank-specific, respectively country-specific control variables show no statistical significance. Therefore, the environmental pillar is the only pillar with clear and unequivocal effects.

Table 4.5: **Multivariate Robust FE Regressions of Risk on the Governance-Score**
The table shows the coefficients and standard errors (in parenthesis) of multivariate robust FE-regressions. The dependent variables are the bank risk measures z-score and RD. The independent variables are the ESG-governance-pillar-score (GovPillar) and bank and country specific control variables. The independent variables are 1 year lagged. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level. Data is winsorised at the 1^{st} and the 99^{th} percentile.

	(1)	(2)	(3)	(4)	(5)	(6)
	z-score	z-score	z-score	RD	RD	RD
	Coef./se	Coef./se	Coef./se	Coef./se	Coef./se	Coef./se
L.GovPillar	0.2886***	0.2710***	0.2264***	-0.0727*	-0.0474	-0.0502
	(0.06)	(0.06)	(0.06)	(0.04)	(0.05)	(0.05)
L.logFTE		8.9838*	8.8121**		-5.4582	-4.9101
		(4.57)	(4.40)		(5.15)	(5.30)
L.LR		-0.0000***	-0.0000**		0.0000	0.0000**
		(0.00)	(0.00)		(0.00)	(0.00)
L.LoanRatio		0.2188	0.1741		0.2614**	0.2638**
		(0.16)	(0.17)		(0.12)	(0.12)
L.DepRatio		0.3234***	0.2268*		-0.0936	-0.0959
		(0.11)	(0.12)		(0.14)	(0.14)
L.ROE		-0.0007***	-0.0004**		-0.0001	-0.0000
		(0.00)	(0.00)		(0.00)	(0.00)
L.Inflation			-0.2330			0.0768
			(0.36)			(0.11)
L.GDP_{Cap}^{Growth}			1.2033***			0.3689**
			(0.36)			(0.19)
L.GDP_{Cap}			0.0019*			-0.0000
			(0.00)			(0.00)
Constant	32.8002***	-83.2546*	-141.8616***	65.7275***	105.5128*	100.7562*
	(3.14)	(45.56)	(48.49)	(2.00)	(57.35)	(58.12)
N	3,949	3,200	3,117	2,904	2,674	2,635
R^2_{adj}	0.0098	0.0203	0.0476	0.0021	0.0079	0.0084

So far, we found that the risk-reducing effect differs between the pillars. The environmental pillar shows the strongest effects in magnitude and significance. All pillars reduce default risk measured by the z-score. In addition, the environmental pillar also affects the portfolio risk with statistical significance, in line with ex-ante expectations. In the next step, we analyse the effects of the ten sub-components of the total ESG-score. Considering the different weights of the ten sub-components, this procedure contributes to the validity of our results and provides insights about the roots of the effects of the three pillars. The findings for multivariate regressions are depicted in Table (4.6).

The environmental pillar consists the sub-components Emissions, Environmental Innovation, and Resource Use. The Emissions-score reflects a banks' commitment to emissions reduction. Also, Environmental Innovation reflects a banks' capacity to develop and support eco-friendly products and processes and thereby reduce the ecological costs for its customers. In the case of banks, this can be the integration of ecological factors into their lending policy, e.g. EP. The Resource Use measures the efficiency of a firm's resource usage. All three sub-components have highly significant effects in line with ex-ante expectations in all six models. Therefore, all three sub-components have a risk-reducing effect, considering the z-score and the RD. The results are in line with risk management theory, reputation theory, and stakeholder theory. All three variables can be interpreted as indicators of managerial sophistication to reduce operative costs, contributing to higher and more stable income. They are also related to lower operational transformation risk and reputation risk. Environmental Innovation has additionally the potential to create new value for customers. In this way, the sub-components of the environmental pillar reflect aspects of a forward-looking holistic risk management approach which also takes into account ecological aspects in a sustainable way of doing business and acknowledges its meaning for the reputation of the bank. This also confirms our superior result that the environmental pillar as a whole has a risk-reducing effect on idiosyncratic bank risk.

Table 4.6: **Multivariate Robust FE Regressions of Risk Measures on the Ten ESG-sub-components**

The table shows the coefficients and standard errors (in parenthesis) of multivariate robust FE-regressions of risk on the ten different sub-components of the ESG-score. Column (1) and (4) provide univariate results. The regression coefficients in column (2) and (5) account for bank specific control variables. Those in column (3) and (6) account for bank and country specific controls. The table shows only the coefficients of the variables of interest. Those of the control variables are not depicted. The independent variables are 1 year lagged. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level. Data is winsorised at the 1^{st} and the 99^{th} percentile.

	(1) z-score Coef./se	(2) z-score Coef./se	(3) z-score Coef./se	(4) RD Coef./se	(5) RD Coef./se	(6) RD Coef./se
L.Env. Innovation	0.3282***	0.3296***	0.2310***	-0.1302***	-0.1315***	-0.1465***
	(0.06)	(0.06)	(0.06)	(0.04)	(0.05)	(0.05)
L.Emissions	0.4007***	0.3618***	0.2880***	-0.0839***	-0.0733**	-0.0800**
	(0.05)	(0.05)	(0.06)	(0.03)	(0.03)	(0.03)
L.Resource Use	0.4639***	0.4279***	0.3644***	-0.0816***	-0.0688**	-0.0726***
	(0.06)	(0.06)	(0.07)	(0.02)	(0.03)	(0.03)
L.Community	0.0808	0.0322	-0.0391	-0.0202	-0.0131	-0.0157
	(0.05)	(0.06)	(0.05)	(0.03)	(0.03)	(0.03)
L.Human Rights	0.3037***	0.2674***	0.1602***	-0.1269***	-0.1165***	-0.1227***
	(0.05)	(0.06)	(0.06)	(0.02)	(0.03)	(0.03)
L.Product Respon.	0.1749***	0.1294**	0.0385	0.0360	0.0509**	0.0510*
	(0.06)	(0.06)	(0.06)	(0.02)	(0.03)	(0.03)
L.Workforce	0.3435***	0.3182***	0.2486***	-0.0396	-0.0310	-0.0374
	(0.05)	(0.05)	(0.06)	(0.03)	(0.04)	(0.04)
L.CSR-strategy	0.2440***	0.1742***	0.0890*	-0.0624**	-0.0482*	-0.0557**
	(0.05)	(0.05)	(0.05)	(0.02)	(0.03)	(0.03)
L.Management	0.1859***	0.1853***	0.1615***	-0.0307	-0.0164	-0.0178
	(0.04)	(0.04)	(0.04)	(0.02)	(0.03)	(0.03)
L.Shareholders	0.0150	0.0096	0.0116	-0.0423*	-0.0326	-0.0031
	(0.04)	(0.05)	(0.05)	(0.02)	(0.03)	(0.03)
Bank controls	No	Yes	Yes	No	Yes	Yes
Country controls	No	No	Yes	No	No	Yes
N	3,949	3,200	3,117	2,904	2,674	2,635

The sub-components Community, Human Rights, Product Responsibility, and Workforce are part of the social pillar. The Community-score is a proxy of companies' ethical behaviour and involvement with the society. However, we find no significance in any model. This means, that the sub-component does not affect idiosyncratic bank risk. Instead, we find high statistical significance in line with expectation for Human Rights in all six models. Human Rights, therefore, reduce both default risk as well as portfolio risk. It reflects the compliance with human rights and labour protection requirements. By renouncing the financing of e.g. the arms industry or companies with doubtful working standards (e.g. child labour), banks in particular can contribute to the worldwide compliance with human rights. Otherwise, disregard potentially causes lawsuits constituting operational risk and severe reputation damage. The interaction is in line with reputation theory, risk management theory, and stakeholder theory. For Product Responsibility, we find statistical significance in four of six models. Product Responsibility is determined by product quality control programs, a high-quality complaint management service, and the protection of sensitive customer data. Especially in banks, these aspects are important. Furthermore, this finding is in line with the reputation theory, as well as risk management theory, and stakeholder theory. The Workforce-score only affects the z-score with high statistical significance. This underlines the value of good working conditions as well as ongoing employee qualification training. Nonetheless, it has no significance for RD. In conclusion, we find a strong dependence on the specific sub-components considered in the social pillar, even though we do not find any contradicting and significant effects neither. The inconclusive results for the Workforce-score determine the effect of the aggregate social-score. Workforce accounts for 16 of 35.5 percentage points, while the unambiguously significant sub-component Human Rights accounts for only 4.5 percentage points.

The governance pillar consists of the sub-components for CSR-strategy, Management, and Shareholders. The CSR-strategy is the only sub-component within the governance pillar which has statistical significance in all six models in line with expectation. The CSR-strategy-score measures the extent to which a bank communicates that it considers social and environmental aspects in its day-to-day decision-making processes. To the extent that talk corresponds with action, the effect can be interpreted as a holistic risk management approach, considering also environmental and social risks in day-to-day business. For the Management-score, we observe high statistical significance in Models (1-3) for the z-score. This result is in line with our theoretical expectations. However, we cannot find any statistical significance for the RD. The Management-score measures the extent to which banks' corporate governance follows best practices. Our results indicate that such compliance affects default risk significantly but not portfolio risk. Moreover, the Shareholders-score does not have statistical significance in Models (1-3) concerning the effects on the z-score. Also, it has no statistical significance on RD in Models (5-6), only in the univariate Model (4) we observe a low significance on the 10% level. This sub-component identifies the degree of fair treatment and protection of shareholders by the bank, including anti-takeover action. In particular, anti-takeover actions can serve as an intuitive explanation that this sub-component does not have a clear risk-reducing effect. Considering extreme actions like so-called “poison pills” explains how such action can indeed lead to an increase in portfolio risk as well as default risk. In conclusion, we find mixed results for the sub-components of the governance pillar. While the CSR-strategy has a high statistical significance in all models, Shareholder has nearly no statistical significance. The positive effect of the CSR-strategy supports the risk management hypothesis. Shareholders are certainly the most important stakeholders. Though, they are only one of many groups of stakeholders with very different and conflicting interests. Therefore, the insignificant effect of the Shareholder does not provide evidence of the stakeholder theory. It should, however, neither be misunderstood as the opposite. The aggregate effect of the governance pillar is, however, dominated by the Management-score which accounts for 19 of 30.5 percentage points. In this way, the Management-score explains why the effect of the aggregate governance-score is not unambiguously risk-reducing.

Table (4.7) provides results for the Controversies-score. Models (1-3) provide the results for effects on the z-score. The univariate regression coefficient for the Controversies-score on the z-score in Model (1) is negative and statistically significant. This indicates that higher extents to which banks are involved in scandals and controversial media coverage lead to higher default risk, measured by the z-score. This result can be explained by lower earnings in the years after controversies and higher volatility of returns and equity during this time of stress. The effect remains statistically significant at the 5 % level if bank-specific control variables are considered in Model (2). Surprisingly, in Model (3) which additionally considers country-specific control variables the coefficient is not significant anymore. Models (4-6) provide the results for the effects of the Controversies-score on banks’ RD. All the coefficients are positive and statistically significant at the 1 % level. In line with ex-ante expectations based on reputation theory and risk management theory, this means that lower Controversies-scores lead to lower portfolio risk. This indicates that those banks which are characterised by little controversies are concerned about their good reputation and reduce the riskiness of their portfolios. In general, the results provide empirical support to our third hypothesis stating that more controversial banks have a higher idiosyncratic bank risk. Our findings are in line with earlier research i.a. by Murphy et al. (2009).

4.5 Robustness

In order to test the robustness of the results provided above, we perform a battery of additional tests. First, we re-estimate our results provided above substituting all the variables of interest by the same variables with a two years lag, respectively without any time lag. This should

Table 4.7: **Multivariate Robust FE Regressions of Bank Risk on the Controversies-Score**

The table shows the coefficients and standard errors (in parenthesis) of multivariate robust FE-regressions. The dependent variables are the bank risk measures z-score and RD. The independent variables are the Controversies-score and bank and country specific control variables. The independent variables are 1 year lagged. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level. Data is winsorised at the 1^{st} and the 99^{th} percentile.

	(1) z-score Coef./se	(2) z-score Coef./se	(3) z-score Coef./se	(4) RD Coef./se	(5) RD Coef./se	(6) RD Coef./se
L.Controversies	-0.0999***	-0.0907**	-0.0620	0.0599***	0.0490***	0.0473***
	(0.04)	(0.04)	(0.04)	(0.01)	(0.02)	(0.02)
L.logFTE		10.0989**	9.7704**		-5.3123	-4.8038
		(4.64)	(4.47)		(5.02)	(5.17)
L.LR		-0.0000***	-0.0000**		0.0000	0.0000**
		(0.00)	(0.00)		(0.00)	(0.00)
L.LoanRatio		0.2359	0.1866		0.2582**	0.2608**
		(0.17)	(0.17)		(0.12)	(0.12)
L.DepRatio		0.3543***	0.2520**		-0.1032	-0.1062
		(0.12)	(0.12)		(0.13)	(0.13)
L.ROE		-0.0007***	-0.0004**		-0.0000	0.0000
		(0.00)	(0.00)		(0.00)	(0.00)
L.Inflation			-0.3003			0.0812
			(0.36)			(0.12)
L.GDP_{Cap}^{Growth}			1.1399***			0.3694*
			(0.36)			(0.19)
L.GDP_{Cap}			0.0019*			-0.0000
			(0.00)			(0.00)
Constant	52.4499***	-78.4168*	-140.5514***	59.0874***	100.2436*	95.9554*
	(1.75)	(47.10)	(50.62)	(0.62)	(57.35)	(57.81)
N	3,949	3,200	3,117	2,904	2,674	2,635
R^2_{adj}	0.0016	0.0134	0.0425	0.0024	0.0087	0.0090

ensure that the effects measured do not depend on the specific time lag considered. Table (4.8) provides the results for the ESG-score and its three pillars. As illustrated, the results do not significantly change. The ESG-score remains highly significant for the z-score. For the RD, the ESG-score has an even higher significance considering a two years lag, the significance for the ESG-score without a time lag is slightly lower. The environmental pillar remains significant in all models, independent of the time lag considered. The social pillar remains highly significant for the z-score. For the RD, the social pillar has no significance considering one year lagged variables, it is however surprisingly weakly significant on the 10% level in two of three models if the variables are considered without time lag. The governance pillar remains highly significant for the z-score. For RD it remains insignificant, except for the univariate model.

Table 4.8: **Multivariate Robust FE Regressions of Risk on CSR. Robustness Tests for Different Time Lags**

The table shows the coefficients and standard errors (in parenthesis) of multivariate robust FE-regressions of risk on the ESG-score, respectively its three pillars, as well as the Controversies-score. Column (1) and (4) provide univariate results. The regression coefficients in column (2) and (5) account for bank specific control variables, in column (3) and (6) account for bank and country specific controls. The first panel provides results for variables of interest without time lag. The second panel provides results for variables of interest with a 2 years time lag. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level. Data is winsorised at the 1^{st} and the 99^{th} percentile.

	(1) z-score Coef./se	(2) z-score Coef./se	(3) z-score Coef./se	(4) RD Coef./se	(5) RD Coef./se	(6) RD Coef./se
Without lag						
ESG-score	0.7169***	0.6900***	0.5526***	-0.1211***	-0.0838	-0.1020*
	(0.09)	(0.10)	(0.11)	(0.04)	(0.06)	(0.06)
EnvPillar	0.5274***	0.5015***	0.4175***	-0.1100***	-0.1224***	-0.1341***
	(0.07)	(0.07)	(0.08)	(0.03)	(0.03)	(0.03)
SocPillar	0.4465***	0.3495***	0.2013**	-0.0685*	-0.0695	-0.0813*
	(0.07)	(0.08)	(0.09)	(0.04)	(0.05)	(0.05)
GovPillar	0.2366***	0.2235***	0.1798***	-0.0242	-0.0089	-0.0092
	(0.06)	(0.06)	(0.06)	(0.03)	(0.04)	(0.04)
Controversies	-0.0913**	-0.0672*	-0.0374	0.0579***	0.0584***	0.0570***
	(0.04)	(0.04)	(0.04)	(0.01)	(0.01)	(0.01)
2 years lagged						
L2.ESG-score	0.7421***	0.6945***	0.5589***	-0.1700***	-0.1359**	-0.1544***
	(0.09)	(0.09)	(0.10)	(0.05)	(0.06)	(0.06)
L2.EnvPillar	0.5214***	0.4962***	0.4041***	-0.1292***	-0.1082***	-0.1180***
	(0.07)	(0.07)	(0.07)	(0.04)	(0.04)	(0.04)
L2.SocPillar	0.4971***	0.4472***	0.3208***	-0.0817*	-0.0576	-0.0661
	(0.08)	(0.08)	(0.09)	(0.05)	(0.04)	(0.04)
L2.GovPillar	0.2217***	0.2067***	0.1588**	-0.0705***	-0.0402	-0.0388
	(0.07)	(0.07)	(0.07)	(0.03)	(0.03)	(0.03)
L2.Controversies	-0.0920***	-0.0908**	-0.0456	0.0676***	0.0614***	0.0592***
	(0.03)	(0.04)	(0.04)	(0.01)	(0.01)	(0.01)
Bank controls	No	Yes	Yes	No	Yes	Yes
Country controls	No	No	Yes	No	No	Yes
N	4,143	3,365	3,282	3,001	2,776	2,733

Results for the Controversies-score without a time lag, respectively considering a two years time lag yield comparable results. Both alternative calculations underscore the previous results. Except for Model (3), in all other five models, the coefficients of the Controversies-score are statistically significant and suggest that higher Controversies-scores increase idiosyncratic bank risk.

Second, for the regression models performed throughout the study, we used panel OLS-regression models with bank and time fixed effects following the Hausman-test. However, the results hold as well if a random effects estimation model or a maximum likelihood estimation model is applied.

Third, we apply different levels of winsorisation to the data. We use winsorisation on the 5^{th} and the 95^{th} percentile to account for a broader definition of outliers. Alternatively, we abandon winsorisation and use the original data. These alternative procedures have no material effect on the coefficients of the variables of interest. As Tables (4.14–4.18) in the appendix show, however, the explanatory power of the models is higher considering a winsorisation on the 5^{th} and the 95^{th} percentile. Some control variables gain additional significance as well.

Fourth, we perform specific robustness checks for the measurement of the z-score. In particular, we calculate the z-score using standard deviations of ROA for rolling windows of ten, instead of only five years. Even though five years is a widely appreciated window, ten years should yield more reliable inputs. The results are robust to such an alternative calculation as well.

Fifth, we perform sub-sample analysis in order to investigate whether the effects depend on invariate differences between the banks considered. Our original sample is worldwide. Following Demirgüç-Kunt & Levine (1999), we analyse sub-samples of banks from bank versus market-based economies. Furthermore, we investigate whether a sub-sample of civil law countries yields different results compared to common law countries, motivated by the results of Miralles-Quirós et al. (2019). In both cases, we do not find elementary differences. These results which are not depicted here are available on demand. The risk-mitigating effect on default risk is strongly significant, while the effects on portfolio risk are not as unambiguous.

Sixth, analogous to Schulte & Winkler (2019), we decompose the z-score into changes associated with ROA and changes associated with the CAR. Such a decomposition yields a measure of the z-score which relates only the ROA to the standard deviation of ROA. This can be interpreted as a risk-adjusted ROA.

$$z\text{-}score_{i,t}^{ROA} = \frac{ROA_{i,t}}{\boldsymbol{\sigma}(ROA_{i,t})} \tag{4.4}$$

On the other hand, the decomposition yields a z-score measure relating only the CAR to the standard deviation of ROA. This can be interpreted as a risk-adjusted CAR.

$$z\text{-}score_{i,t}^{CAR} = \frac{CAR_{i,t}}{\boldsymbol{\sigma}(ROA_{i,t})} \tag{4.5}$$

Table (4.9) illustrates the results for the separate regressions of the risk-adjusted ROA on the overall ESG-score in Model (1-3) and for the risk-adjusted CAR in Model (4-6). The effect of the ESG-score remains significant in all models. This implies that CSR affects bank default risk through both channels. Table (4.10) provides the coefficients of regressions of the risk-adjusted ROA in Model (1-3), respectively of the risk-adjusted CAR in Model (4-6), on the three pillars of the ESG-score and its ten sub-components. Control variables are not depicted.

Table 4.9: **Multivariate Robust FE Regressions of the Two Channels of the z-Score on the ESG-Score**

The table shows the coefficients and standard errors (in parenthesis) of multivariate robust FE-regressions. The dependent variables are the different sub-components of the z-score, i.e. the risk-weighted ROA and the risk-weighted CAR. The independent variables are the ESG-score and bank and country specific control variables. The independent variables are 1 year lagged. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level. Data is winsorised at the 1^{st} and the 99^{th} percentile.

	(1) z-score (ROA) Coef./se	(2) z-score (ROA) Coef./se	(3) z-score (ROA) Coef./se	(4) z-score (CAR) Coef./se	(5) z-score (CAR) Coef./se	(6) z-score (CAR) Coef./se
L.ESG-score	0.0866***	0.0888***	0.0744***	0.7193***	0.6860***	0.5431***
	(0.01)	(0.01)	(0.02)	(0.08)	(0.08)	(0.09)
L.logFTE		-0.0743	0.1626		0.2593	2.1525
		(0.77)	(0.78)		(3.53)	(3.46)
L.LR		-0.0000***	-0.0000*		-0.0000***	-0.0000***
		(0.00)	(0.00)		(0.00)	(0.00)
L.LoanRatio		0.0207	0.0176		0.1224	0.1013
		(0.02)	(0.02)		(0.13)	(0.14)
L.DepRatio		0.0397**	0.0283		0.3004***	0.2234**
		(0.02)	(0.02)		(0.09)	(0.09)
L.ROE		-0.0001***	-0.0000		-0.0009***	-0.0006**
		(0.00)	(0.00)		(0.00)	(0.00)
L.Inflation			-0.0217			-0.0056
			(0.05)			(0.31)
L.GDP_{Cap}^{Growth}			0.2431***			1.0090***
			(0.05)			(0.31)
L.GDP_{Cap}			0.0002			0.0014
			(0.00)			(0.00)
Constant	2.6238***	-0.6165	-7.884	3.7116	-24.2422	-83.4566**
	(0.70)	(6.95)	(7.57)	(4.13)	(33.98)	(40.96)
N	3,949	3,200	3,117	3,953	3,203	3,120
R^2_{adj}	0.0231	0.0283	0.0427	0.0432	0.0466	0.0626

Table (4.11) illustrates the decomposed results for the Controversies-score. It can be inferred that the risk-increasing effect of the Controversies-score is only statistically significant for

Table 4.10: **Multivariate Robust FE Regressions of the Two Channels of the z-Score on the Pillars and Sub-Components of the ESG-Score**
The table shows the coefficients and standard errors (in parenthesis) of multivariate robust FE-regressions. The dependent variables are the different sub-components of the z-score, i.e. the risk-weighted ROA and the risk-weighted CAR. The independent variables are the ESG-score, its three pillars, and ten sub-components. Control variables are not depicted. Column (1) and (4) provide univariate results. The regression coefficients in column (2) and (5) account for bank specific control variables. Those in column (3) and (6) account for bank and country specific controls. The independent variables are 1 year lagged. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level. Data is winsorised at the 1^{st} and the 99^{th} percentile.

	(1) z-score (ROA) Coef./se	(2) z-score (ROA) Coef./se	(3) z-score (ROA) Coef./se	(4) z-score (CAR) Coef./se	(5) z-score (CAR) Coef./se	(6) z-score (CAR) Coef./se
L.EnvPillar	0.0629***	0.0649***	0.0555***	0.4958***	0.4766***	0.3837***
	(0.01)	(0.01)	(0.01)	(0.06)	(0.06)	(0.07)
L.SocPillar	0.0530***	0.0517***	0.0356***	0.4654***	0.4061***	0.2602***
	(0.01)	(0.01)	(0.01)	(0.07)	(0.07)	(0.08)
L.GovPillar	0.0300***	0.0286***	0.0247***	0.2581***	0.2420***	0.2016***
	(0.01)	(0.01)	(0.01)	(0.05)	(0.06)	(0.05)
L.Env. Innovation	0.0379***	0.0405***	0.0309***	0.2900***	0.2894***	0.2000***
	(0.01)	(0.01)	(0.01)	(0.05)	(0.06)	(0.06)
L.Emissions	0.0460***	0.0441***	0.0370***	0.3544***	0.3177***	0.2511***
	(0.01)	(0.01)	(0.01)	(0.04)	(0.05)	(0.05)
L.Resource Use	0.0500***	0.0495***	0.0437***	0.4138***	0.3782***	0.3205***
	(0.01)	(0.01)	(0.01)	(0.05)	(0.05)	(0.06)
L.Community	0.0009	-0.0037	-0.0114	0.0798*	0.0360	-0.0275
	(0.01)	(0.01)	(0.01)	(0.04)	(0.05)	(0.05)
L.Human Rights	0.0347***	0.0343***	0.0240***	0.2690***	0.2332***	0.1361***
	(0.01)	(0.01)	(0.01)	(0.05)	(0.05)	(0.05)
L.Product Respon.	0.0182**	0.0164**	0.0064	0.1564***	0.1129*	0.0320
	(0.01)	(0.01)	(0.01)	(0.05)	(0.06)	(0.05)
L.Workforce	0.0371***	0.0374***	0.0310***	0.3069***	0.2809***	0.2176***
	(0.01)	(0.01)	(0.01)	(0.04)	(0.05)	(0.05)
L.CSR-strategy	0.0303***	0.0248***	0.0167**	0.2127***	0.1495***	0.0723*
	(0.01)	(0.01)	(0.01)	(0.04)	(0.04)	(0.04)
L.Management	0.0202***	0.0205***	0.0184***	0.1653***	0.1644***	0.1430***
	(0.01)	(0.01)	(0.01)	(0.04)	(0.04)	(0.04)
L.Shareholders	-0.0025	-0.0037	-0.0031	0.0176	0.0134	0.0145
	(0.01)	(0.01)	(0.01)	(0.04)	(0.05)	(0.04)
Bank controls	No	Yes	Yes	No	Yes	Yes
Country controls	No	No	Yes	No	No	Yes
N	3,949	3,200	3,117	3,953	3,203	3,120

the risk-adjusted CAR illustrated in Formula (4.5). The coefficients in Models (1-3) for the risk-adjusted ROA illustrated in Formula (4.4) are not statistically significant, however, they point in the right direction.

Table 4.11: **Multivariate Robust FE Regressions of the Two Channels of the z-Score on the Controversies-Score**
The table shows the coefficients and standard errors (in parenthesis) of multivariate robust FE-regressions. The dependent variables are the different sub-components of the z-score, i.e. the risk-weighted ROA and the risk-weighted CAR. The independent variables are the Controversies-score and bank and country specific control variables. The independent variables are 1 year lagged. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level. Data is winsorised at the 1^{st} and the 99^{th} percentile.

	(1) z-score (ROA) Coef./se	(2) z-score (ROA) Coef./se	(3) z-score (ROA) Coef./se	(4) z-score (CAR) Coef./se	(5) z-score (CAR) Coef./se	(6) z-score (CAR) Coef./se
L.Controversies	-0.0035	-0.0030	-0.0002	-0.0962***	-0.0875***	-0.0614*
	(0.01)	(0.01)	(0.01)	(0.03)	(0.03)	(0.03)
L.logFTE		1.1372	1.1339		8.9690**	8.6650**
		(0.79)	(0.78)		(3.94)	(3.79)
L.LR		-0.0000***	-0.0000		-0.0000***	-0.0000**
		(0.00)	(0.00)		(0.00)	(0.00)
L.LoanRatio		0.0312	0.0256		0.2026	0.1596
		(0.03)	(0.03)		(0.15)	(0.15)
L.DepRatio		0.0417**	0.0284		0.3151***	0.2252**
		(0.02)	(0.02)		(0.10)	(0.10)
L.ROE		-0.0001***	-0.0000		-0.0007***	-0.0004**
		(0.00)	(0.00)		(0.00)	(0.00)
L.Inflation			-0.0576			-0.2421
			(0.05)			(0.32)
L.GDP_{Cap}^{Growth}			0.2266***			0.9042***
			(0.05)			(0.32)
L.GDP_{Cap}			0.0002*			0.0017*
			(0.00)			(0.00)
Constant	7.2223***	-7.8273	-14.9412*	45.1960***	-70.7366*	-125.9049***
	(0.31)	(7.62)	(7.92)	(1.47)	(40.27)	(43.69)
N	3,949	3,200	3,117	3,953	3,203	3,120
R^2_{adj}	-0.0001	0.0070	0.0291	0.0021	0.01437	0.0438

4.6 Conclusions

In general, corporate social responsibility gained a lot of attention in recent years. Our study examines the relationship between CSR and idiosyncratic bank risk. We contribute to the literature in the following ways. Whereas the majority of studies explore the effects of CSR on risk for non-financial companies, our focus is specifically on banks. For this purpose we use a data set of 2,452 banks from 115 countries, covering the period from 2002 to 2018. Confirming the validity of our results, we specify our multivariate regression models with bank-specific and macroeconomic factors. In order to address the bank specifics, we analyse the CSR-effect on both default risk and portfolio risk. Namely, we use the z-score as a proxy for default risk and RD to measure portfolio risk. We examine the effect of CSR on bank risk at an aggregate CSR-level, individually for the three CSR-pillars, as well as for the pillars' ten sub-components. In this way, we identify the specific drivers of the risk-reduction in detail and explore its origins.

Starting on the aggregate level, our first hypothesis addresses the impact of overall CSR on banks' idiosyncratic default risk and portfolio risk. We find strongly significant risk-reducing effects for both risk measures. The breakdown of the default risk measure z-score into individual components indicates that CSR has a positive impact on both risk-adjusted ROA and risk-adjusted CAR.

On this basis, our second research question analyses the isolated effects of the environmental, social, and governance pillar on a bank's risk. In contrast to the overall results, the analysis of the individual pillars presents a slightly different picture. In concrete terms, the risk-reducing effect of the environmental pillar still applies to both risk measures. Conversely, for the social and the governance pillar, there is only a statistically significant risk-reducing effect on default risk, but not on portfolio risk. In order to understand the reasons for these results, we conduct an analysis at the pillars' sub-components. The observed effects of all the sub-components of the environmental pillar are consistent with previous results. Thereby, it appears that all sub-components of this pillar (Emissions, Environmental Innovation, Resource Use) have a strongly significant impact on z-score and RD. This implies that the environmental pillar and its sub-components are the origin and determinant drivers of the risk-reduction. Considering the social pillar and the governance pillar, this is different. We do not find unambiguous results here. Only the sub-components Human Rights and CSR-strategy have unequivocally risk-reducing effects for both risk measures. To conclude, our empirical analysis supports our second hypothesis entirely as concerns the environmental pillar. For the social and the governance pillar, we do not find unambiguous results. Only for specific sub-components of the social and the governance pillar, it can be unambiguously inferred that they reduce both idiosyncratic bank risk measures.

In addition, our third hypothesis investigates the impact of controversies on idiosyncratic bank risk. Thereby, we find a risk-enhancing effect of controversies. This is in line with the theoretical framework. In particular, it gives empirical support to the reputation theory.

Our results have relevant theoretical and practical implications. From a scientific and analytical point of view, we contribute additional insights into the identification of the drivers of banks' idiosyncratic default and portfolio risk. From a bank management's perspective, we provide additional rationale to consider in particular environmental aspects. The association with lower idiosyncratic risk should serve as encouragement and additional argument in internal decision-making processes. Because of the identified association, it is in the bank's very own interest to improve its environmental CSR. From a regulator's and law maker's perspective, our results support attempts to foster CSR-compliant behaviour. In this way, the associated lower idiosyncratic risk is a positive side effect of the promotion of better CSR.

We are aware of the limitations of our study. Certainly, one issue is the unbalanced panel structure. In addition, the unique use of the Thomson Reuters database carries the inherent risk of selection bias. Moreover, the use of additional risk measures could be interesting to enhance the validity of the results. However, due to a lack of data availability, e.g. CDS-spreads or non-performing loans, this is not feasible. Also, we are aware that we are not in a position to draw final conclusions about the suitability of a "Green Supporting Factor", because we only have evidence on the relationship between environmental engagement and risk, but not on the average risk-weight of a "green" investment.

The following aspects could be interesting for further investigation: First, the validity of our results could be verified by using other risk measures, in particular market-based measures. In the same way, natural disasters like Fukushima or Hurricane Sandy can be used as a reference for natural experiments to investigate the relationship and test our results. These would, furthermore, provide evidence on the perceived risk of market participants. Second, it is reasonable to abstract the share of systematic risk from idiosyncratic risk. Third, it would be a promising undertaking to perform a detailed analysis of banks' asset structures. In this way, we could further analyse the effect on the risk density. Fourth, our study provides first exploratory insights into relevant determinates of the effects of CSR on bank risk. Further research should focus on the specific cause-effect relations between bank risk and the sub-components that were identified as significant drivers.

4.7 Appendix

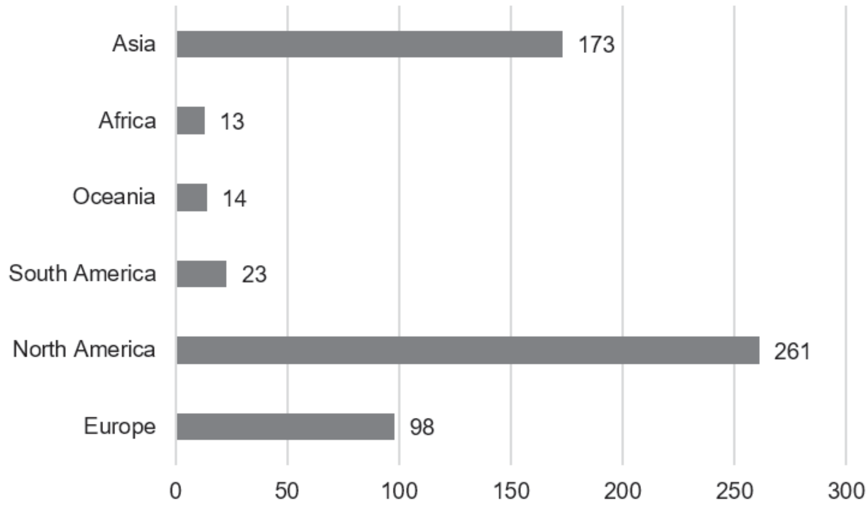

Figure 4.2: **Origin of the Banks**
The graph above provides information on the regional origin of the banks. Depicted are the absolute numbers of banks per continent. The total number of banks with available ESG-scores in the sample is 582.

Table 4.12: **Description of Variables**

The table gives short descriptions of the variables used in this study. Panel A comprises the risk measures, Panel B comprises the ESG-data, Panel C comprises the bank specific control variables, and Panel D comprises the country specific control variables.

Variable	Description
Panel A:	
z-score	Measure of default risk. It is calculated as the sum of ROA and CAR over the 5 year standard deviation of ROA.
RD	Measure of portfolio risk. It is calculated as risk-weighted assets over total assets and measures the risk on the balance sheet.
Panel B:	
ESG-score	Measure of the overall corporate social responsibility. It is calculated as weighted average of the Environmental-score, Social-score, and Governance-score.
Environmental-score	Measure of company‘s environmental performance that indicates the impact on natural systems.
Social-score	Measure of company‘s social performance about the confidence with employees, customers and society.
Governance-score	Measure of company‘s governance practice that indicates the systems and processes installed to guarantee that the management acts in the interests of stakeholders.
Controversies-score	Measure of company‘s charge to ESG-controversies and negative media coverage.
Emissions	Measures company‘s emission efficiency in the context of its business activities.
Env. Innovation	Reflects company’s commitment to sustainability e.g. by offering an innovative sustainable product portfolio.
Resource Use	Reflects company‘s eco-efficiency in terms of materials, energy or water.
Community	Reflects company’s social responsibility activities and it‘s business ethics commitment.
Human Rights	Reflects compliance with human rights conventions by the company.
Product Responsibility	Reflects the quality and reliability of the offered products.
Workforce	Reflects on the one hand the working conditions in the company and on the other the offered development opportunities.
CSR-strategy	Reflects company‘s the adoption, application, and reporting of the CSR-strategy.
Management	Reflects management’s compliance within the corporate governance guidelines.
Shareholders	Reflects the handling of shareholders and the prevention of takeovers.
Panel C:	
logFTE	Company size is approximated by the natural logarithm of full-time employees.
LR	Capital structure is considered as the ratio of total liabilities over total equity, i.e. the leverage ratio.
LoanRatio	Business model indicator which measures the loan exposures as total gross loans over total assets.
DepRatio	Business model indicators which measures the deposits exposures as total deposits over total assets.
ROE	Return on equity measures profitability. It is calculated as net income before taxes over total equity.
Panel D:	
Inflation	Rate of price change in the whole economy. Measured by annual growth rate of GDP implicit deflator. *Source: Worldbank*
GDP_{Cap}	Gross domestic product divided by midyear population. *Source: Worldbank*
GDP_{Cap}^{Growth}	Annual growth rate of GDP per capita. *Source: Worldbank*

Table 4.13: **Correlation Metrics**
The table shows pairwise correlation coefficients of the risk measures, the ESG-score, its pillars, and the Controversies-score.

	z-score	RD	ESG-score	EnvPillar	SocPillar	GovPillar	Controversies
z-score	1.00						
RD	-0.01	1.00					
ESG-score	-0.11	-0.29	1.00				
EnvPillar	-0.13	-0.33	0.88	1.00			
SocPillar	-0.12	-0.23	0.88	0.72	1.00		
GovPillar	-0.03	-0.14	0.72	0.42	0.44	1.00	
Controversies	0.09	0.17	-0.41	-0.38	-0.39	-0.24	1.00

Table 4.14: **Robustness: Winsorisation Level. Multivariate Robust FE Regressions of Risk on the ESG-Score**
The table shows the coefficients and standard errors (in parenthesis) of multivariate robust FE-regressions. The dependent variables are the bank risk measures z-score and RD. The independent variables are the ESG-score and bank and country specific control variables. The independent variables are 1 year lagged. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level. Data is winsorised at the 5^{st} and the 95^{th} percentile.

	(1) z-score Coef./se	(2) z-score Coef./se	(3) z-score Coef./se	(4) RD Coef./se	(5) RD Coef./se	(6) RD Coef./se
L.ESG-score	1.2470***	0.9437***	0.7554***	-0.3249***	-0.1711**	-0.1977**
	(0.12)	(0.13)	(0.15)	(0.10)	(0.08)	(0.08)
L.logFTE		-13.3226*	-10.5866		14.1429	15.5211
		(7.81)	(7.79)		(10.95)	(10.82)
L.LR		0.0000	0.0000*		0.0000	0.0000
		(0.00)	(0.00)		(0.00)	(0.00)
L.LoanRatio		0.2007	0.1580		-0.2862*	-0.2791*
		(0.18)	(0.21)		(0.17)	(0.15)
L.DepRatio		1.5239***	1.3797***		-0.6572***	-0.6790***
		(0.25)	(0.25)		(0.13)	(0.13)
L.ROE		0.2869**	0.2178**		0.1798	0.1603
		(0.13)	(0.10)		(0.14)	(0.13)
L.Inflation			0.9130			0.5084*
			(0.57)			(0.27)
L.GDP_{Cap}^{Growth}			2.4507***			0.4935*
			(0.52)			(0.29)
L.GDP_{Cap}			0.0034**			0.0004
			(0.00)			(0.00)
Constant	-6.5554	-6.1129	-135.8365*	101.7768***	36.8341	12.04271
	(6.19)	(67.25)	(75.47)	(5.49)	(95.11)	(94.01)
N	3,949	3,200	3,117	2,904	2,674	2,635
R^2_{adj}	0.03863	0.1217	0.1485	0.01910	0.1321	0.1381

Table 4.15: **Robustness: Winsorisation Level. Multivariate Robust FE Regressions of Risk on the Environmental-Score**

The table shows the coefficients and standard errors (in parenthesis) of multivariate robust FE-regressions. The dependent variables are the bank risk measures z-score and RD. The independent variables are the ESG-environment-pillar-score and bank and country specific control variables. The independent variables are 1 year lagged. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level. Data is winsorised at the 5^{st} and the 95^{th} percentile.

	(1)	(2)	(3)	(4)	(5)	(6)
	z-score	z-score	z-score	RD	RD	RD
	Coef./se	Coef./se	Coef./se	Coef./se	Coef./se	Coef./se
L.EnvPillar	0.8414***	0.6674***	0.5480***	-0.2973***	-0.2166***	-0.2390***
	(0.09)	(0.09)	(0.10)	(0.07)	(0.05)	(0.05)
L.logFTE		-13.1616*	-10.8003		15.5576	16.9864
		(7.61)	(7.58)		(11.00)	(10.90)
L.LR		0.0000	0.0000		0.0000	0.0000
		(0.00)	(0.00)		(0.00)	(0.00)
L.LoanRatio		0.1798	0.1303		-0.2520	-0.2475
		(0.18)	(0.21)		(0.17)	(0.15)
L.DepRatio		1.5579***	1.4059***		-0.6669***	-0.6930***
		(0.25)	(0.25)		(0.13)	(0.13)
L.ROE		0.2916**	0.2241**		0.1648	0.14435
		(0.13)	(0.10)		(0.14)	(0.12)
L.Inflation			0.8935			0.45077*
			(0.58)			(0.26)
L.GDP^{Growth}_{Cap}			2.3539***			0.5154*
			(0.53)			(0.29)
L.GDP_{Cap}			0.0035**			0.0005
			(0.00)			(0.00)
Constant	13.8755***	5.1654	-126.9003*	100.534***	25.1409	-2.3088
	(4.61)	(66.73)	(74.30)	(3.67)	(95.61)	(94.68)
N	3,949	3,200	3,117	2,904	2,674	2,635
R^2_{adj}	0.0356	0.1220	0.1498	0.0326	0.1418	0.1486

Table 4.16: **Robustness: Winsorisation Level. Multivariate Robust FE Regressions of Risk on the Social-Score**

The table shows the coefficients and standard errors (in parenthesis) of multivariate robust FE-regressions. The dependent variables are the bank risk measures z-score and RD. The independent variables are the ESG-social-pillar-score and bank and country specific control variables. The independent variables are 1 year lagged. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level. Data is winsorised at the 5^{st} and the 95^{th} percentile.

	(1) z-score Coef./se	(2) z-score Coef./se	(3) z-score Coef./se	(4) RD Coef./se	(5) RD Coef./se	(6) RD Coef./se
L.SocPillar	0.8381***	0.5875***	0.4035***	-0.1452*	-0.0340	-0.0504
	(0.10)	(0.11)	(0.12)	(0.08)	(0.06)	(0.06)
L.logFTE		-10.0831	-7.3860		12.7165	13.9480
		(8.00)	(7.96)		(10.93)	(10.78)
L.LR		0.0000	0.0000		0.0000	0.0000
		(0.00)	(0.00)		(0.00)	(0.00)
L.LoanRatio		0.2696	0.2013		-0.3070*	-0.2920*
		(0.19)	(0.22)		(0.17)	(0.15)
L.DepRatio		1.5414***	1.3856***		-0.6658***	-0.6853***
		(0.25)	(0.25)		(0.13)	(0.13)
L.ROE		0.2699**	0.2023**		0.1861	0.1663
		(0.12)	(0.09)		(0.15)	(0.14)
L.Inflation			0.6410			0.5933**
			(0.56)			(0.27)
L.GDP_{Cap}^{Growth}			2.3818***			0.5064*
			(0.53)			(0.29)
L.GDP_{Cap}			0.0037**			0.0002
			(0.00)			(0.00)
Constant	14.5633***	-22.9463	-160.6256**	92.3738***	44.9294	24.7033
	(4.93)	(69.05)	(77.25)	(4.20)	(94.87)	(93.62)
N	3,949	3,200	3,117	2,904	2,674	2,635
R^2_{adj}	0.0242	0.1113	0.1408	0.0047	0.1281	0.1333

Table 4.17: **Robustness: Winsorisation Level. Multivariate Robust FE Regressions of Risk on the Governance-Score**

The table shows the coefficients and standard errors (in parenthesis) of multivariate robust FE-regressions. The dependent variables are the bank risk measures z-score and RD. The independent variables are the ESG-governance-pillar-score and bank and country specific control variables. The independent variables are 1 year lagged. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level. Data is winsorised at the 5^{st} and the 95^{th} percentile.

	(1)	(2)	(3)	(4)	(5)	(6)
	z-score	z-score	z-score	RD	RD	RD
	Coef./se	Coef./se	Coef./se	Coef./se	Coef./se	Coef./se
L.GovPillar	0.4429***	0.2986***	0.2331***	-0.0948	-0.0046	-0.0067
	(0.08)	(0.08)	(0.08)	(0.07)	(0.06)	(0.07)
L.logFTE		-3.8763	-3.5309		12.2327	13.3483
		(8.01)	(7.85)		(10.83)	(10.70)
L.LR		0.0000	0.0000		0.0000	0.0000
		(0.00)	(0.00)		(0.00)	(0.00)
L.LoanRatio		0.3397*	0.2430		-0.3129*	-0.2971*
		(0.19)	(0.22)		(0.17)	(0.15)
L.DepRatio		1.5292***	1.3678***		-0.6648***	-0.6828***
		(0.25)	(0.25)		(0.13)	(0.13)
L.ROE		0.2328**	0.1768**		0.1885	0.1694
		(0.10)	(0.08)		(0.15)	(0.14)
L.Inflation			0.5368			0.6159**
			(0.57)			(0.27)
L.GDP_{Cap}^{Growth}			2.4503***			0.4994*
			(0.54)			(0.29)
L.GDP_{Cap}			0.0039**			0.0002
			(0.00)			(0.00)
Constant	34.5381***	-67.3896	-192.8314***	89.5592***	47.7339	29.0979
	(4.20)	(70.68)	(74.38)	(3.72)	(94.54)	(93.01)
N	3,949	3,200	3,117	2,904	2,674	2,635
R^2_{adj}	0.0090	0.1040	0.1384	0.0027	.1278047	0.1328

Table 4.18: **Robustness: Winsorisation Level. Multivariate Robust FE Regressions of Risk on the Controversies-Score**

The table shows the coefficients and standard errors (in parenthesis) of multivariate robust FE-regressions. The dependent variables are the bank risk measures z-score and RD. The independent variables are the ESG-Controversies-score and bank and country specific control variables. The independent variables are 1 year lagged. Significance is denoted at the 10% (*), 5% (**), and 1% (***) significance level. Data is winsorised at the 5^{st} and the 95^{th} percentile.

	(1) z-score Coef./se	(2) z-score Coef./se	(3) z-score Coef./se	(4) RD Coef./se	(5) RD Coef./se	(6) RD Coef./se
L.Controversies	-0.4047***	-0.2629***	-0.2357***	0.2325***	0.1566***	0.1569***
	(0.08)	(0.08)	(0.08)	(0.04)	(0.03)	(0.03)
L.logFTE		-3.7850	-3.6540		13.1669	14.2524
		(7.96)	(7.86)		(10.89)	(10.79)
L.LR		0.0000	0.0000*		0.0000	0.0000
		(0.00)	(0.00)		(0.00)	(0.00)
L.LoanRatio		0.3263*	0.2239		-0.2931*	-0.2828*
		(0.19)	(0.22)		(0.17)	(0.15)
L.DepRatio		1.5122***	1.3501***		-0.6390***	-0.6588***
		(0.26)	(0.25)		(0.13)	(0.13)
L.ROE		0.2610**	0.2033**		0.1634	0.1449
		(0.11)	(0.09)		(0.14)	(0.13)
L.Inflation			0.5186			0.5769**
			(0.56)			(0.26)
L.GDP^{Growth}_{Cap}			2.4020***			0.4760
			(0.54)			(0.29)
L.GDP_{Cap}			0.0039**			0.0003
			(0.00)			(0.00)
Constant	77.0923***	-38.2658	-167.6103**	73.4273***	28.3925	8.0485
	(3.76)	(71.85)	(75.95)	(1.98)	(94.80)	(93.46)
N	3,949	3,200	3,117	2,904	2,674	2,635
R^2_{adj}	0.0119	0.1053	0.1404	0.0304	0.1406	0.1456

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