Can CoCo-bonds Mitigate Systemic Risk?

Arndt-Gerrit Kund & Matthias Petras*

Department of Bank Management, University of Cologne

This version: January 16, 2021

Abstract: After the 2008 financial crises, the idea of contingent convertible (CoCo) capital was revived as a means to stabilize individual banks, and hence the entire banking system. The purpose of this paper is to empirically test, whether CoCo-bonds indeed improve the stability of the banking system and reduce systemic risk. Using the broadly applied SRISK metric, we obtain contradicting results, which are based on the accounting of the CoCo-bond as debt or equity. This observation is problematic, as CoCo-bonds generally increase the loss absorbing capacity of a bank. We remedy this short-coming by proposing an adjustment to the original SRISK formula. Using empirical tests, we show that the undue disparity has been solved by our adjustment, and that CoCo-bonds reduce systemic risk, irrespective of their accounting. Our results are robust to different parametrizations and accounting standards, as well as issuance effects.

Keywords: CoCo-bonds, Financial Stability, Systemic Risk

JEL-Classification: G01, G21, G33

---

*Department of Bank Management, University of Cologne, Albertus-Magnus-Platz, 50923 Cologne, Germany

E-mail: kund@wiso.uni-koeln.de (Arndt-Gerrit Kund); petras@wiso.uni-koeln.de (Matthias Petras). We thank Alon Raviv, the participants of the 7th Bordeaux Workshop in International Economics and Finance, the 82nd Annual Meeting of the German Association for Business Research, and the 69th Annual Meeting of the Midwest Finance Association for their valuable comments. There are no competing interests to declare.

1 Introduction

Contingent convertible bonds (CoCo-bonds) gained particular recognition of bank regulators in the wake of the 2008 financial crisis. 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, by combining the respective advantages of debt and equity. They are characterized 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 importance of studying hybrid capital becomes evident, when considering their growing relevance, as illustrated in Figure (1). It is obvious to the eye that hybrid capital has seen a steep rise in dissemination across the financial sector since the advent of the 2008 Subprime Crisis. Only the the transition from Basel II to Basel III in 2010 managed to temporarily slow the growth in hybrid capital due to regulatory uncertainty surrounding the eligible capital tier. It has since continued its unprecedented growth at an annualized 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.

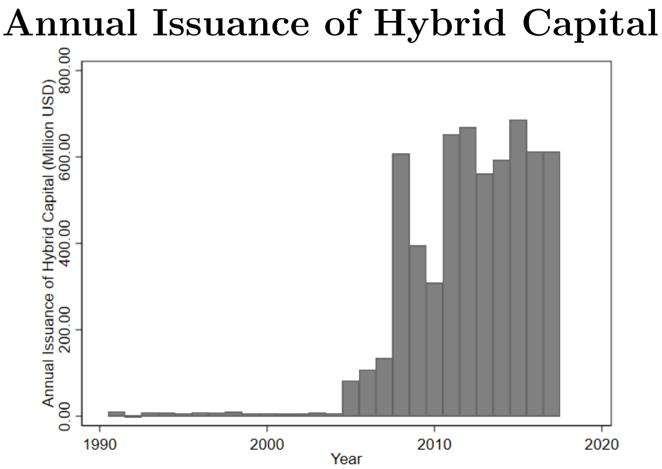


Figure 1: Development of annual issuance of hybrid capital over time.

We intend to shed new light on this discussion and to clarify, whether the usage of CoCo-bonds increases financial stability. Due to the plurality of proposed methods, measuring financial stability is intricate (see 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 bank's impact on systemic instability. In doing so, our contribution is threefold: First, we show that the original formula for SRISK does not capture the stability enhancing effect of CoCo-bonds correctly. Second, we show that the ability to capture 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 "trigger assumption", we imply a fictitious conversion of the CoCo-bonds directly at issuance, and eliminate the disparities induced by differences in accounting. As a result, we can draw an unbiased picture on systemic risk, and hence financial stability. Our results are robust to different parametrizations and accounting standards, as well as issuance effects. Hence, we can 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 (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). Section (4) summarizes our data and methodology, while Section (5) comprises the main results. Additional robustness tests can be found in Section (6). Section (7) discusses the policy implications of our results, while Section (8) concludes and gives and outlook.

2 Theoretical Background

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 (1) illustrates the trend towards the issuance of hybrid capital instruments even before the 2008 financial crisis. 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 either additional Tier 1 (AT1) or Tier 2 (T2) capital, depending on the specific national regulation. Throughout these early years, hybrids comprise preferred shares, silent participations, and various kinds of subordinated bonds broadly summarized 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. 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 (BCBS (2010)). In this way, they are predestined to provide going concern capital to a bank under financial distress. Although important, the conversion mechanism is 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 fulfill 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). The exact threshold has been subject to lengthy debate. As Hart & Zingales (2011) show, some CoCo-bonds preceding the Subprime Crisis had trigger levels, that were never met. While Fiordelisi et al. (2019) document a more sensible approach to the trigger levels of recently issued CoCo-bonds, they point to the instance of Banco Popular, where the CoCo-bonds still failed to convert in a timely manner. Nevertheless, CoCo-bonds are predestined to be designed in accordance with the requirements of AT1-capital, as they are the only remaining hybrid capital, that is eligible as AT1-capital under the Basel III accord. 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 addresses four central areas: the design, pricing, or risk-taking incentives of CoCo-bonds, respectively their implications for financial stability. The conceptualization of CoCo-bonds as going concern capital goes back to the seminal work of Flannery (2005), who initially calls them "reverse convertible debenture" and later extends them to "contingent capital certificates" (see Flannery (2016)). 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 recapitalized if the banking sector on aggregate reaches a situation of financial distress. More recently, Hart & Zingales (2011) discuss the idea of CoCo-bonds that behave like a margin account and are triggered based on CDS-spreads. 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 stabilize 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 bank's balance sheet equity and debt, depends on the conversion mechanism and ratio, as well as 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, 2020) empirically investigate the implications of CoCo-issuances on individual bank stability. By looking at the CDS-spreads of the issuing bank, they find, that banks with CoCo-bonds become more resilient. Their findings thus point to an interdependence, which might be problematic for the proposal of Hart & Zingales (2011). 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 incentivize 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. Boermans & van Wijnbergen (2018) can alleviate this concern, by showing that only a marginal proportion of CoCo-bonds is cross-held by other banks and 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 usage 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.

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 theorize 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 undercapitalization 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 a given bank i at time t 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:

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

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:

$$SRISK_{i,t} = kD_{i,t} - (1-k)E_{i,t}(1 - LRMES_{i,t}) \tag{2}$$

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 (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 (2). Under our proposed "trigger-assumption" we will show in the following section, how the usage of the indicator function allows us to mimic the omitted loss absorbency of CoCo-bonds. As a result, we correctly grasp, how they narrow the height, respectively presence of a funding gap in the first place. From there, we derive testable hypotheses, which we describe and interpret in the subsequent sections.

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 generalized accounting treatment of CoCo-bonds as debt. In reality a substantial amount of CoCo-bonds is accounted for as equity, as illustrated in Tables (1) to (2) 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: while C2E-CoCos convert into CET1, PWD-CoCos yield extraordinary earnings, which need to be retained in order to become regulatory capital.

The starting point of our analysis is the understanding that the original SRISK formula depends on a strict classification of all CoCo-bonds as either debt or equity and does, therefore, not properly account for hybrid capital instruments. If CoCo-bonds are not unanimously classified – as 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 (2) illustrates the different effects of CoCo-bonds on SRISK, based on their balance sheet treatment.

Figure 2: Expected Implications of CoCo-bonds for SRISK

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

As a consequence of the identified differences, we cannot make an unambiguous or generalized 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, despite increasing the loss absorbing capacity of a bank, just as equity CoCo-bonds do. 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 1. *The differing accounting treatment of CoCo-bonds as debt or equity leads to contradictory implications for financial stability.*

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, which we denote using the indicator function. In this way, CoCo-bonds provide equity, irrespective of their accounting treatment prior to conversion. Alternatively, for PWD-CoCos, the principle amount is written down. Doing so adds equity in the form of extraordinary earnings and reduces the outstanding amount. 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) 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:

$$\begin{aligned} SRISK_{i,t} =& k\Big(D_{i,t} - DebtCoCos_{i,t}\mathbb{1}(Triggered)\Big) \\ & -(1-k)\Big(\big(E_{i,t} - EquityCoCos_{i,t}\mathbb{1}(Triggered)\big)(1 - LRMES_{i,t}) \\ & +DebtCoCos_{i,t}\mathbb{1}(Triggered) + EquityCoCos_{i,t}\mathbb{1}(Triggered)\Big) \end{aligned} \tag{3}$$

DebtCoCos (*EquityCoCos*) denotes the nominal amount of CoCo-bonds that are accounted for as debt (equity) on the balance sheet and convert into non-hybrid equity under the "trigger-assumption", which we refer to with the indicator function $\mathbb{1}$. As used before in Equation (2), D represents the book value of debt, where E indicates the equity. The regulatory capital fraction is denoted by k. In line with Equation (1), $LRMES$ refers to the Long Run Marginal Expected Shortfall.

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 analyze the true impact of CoCo-bonds on systemic risk, irrespective of potential biases from the balance sheet treatment.

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 (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 missing values, we obtain a sample of 533 CoCo-bonds, which were emitted by 126 banks from 33 countries around the world. Table (1) shows that the majority of CoCo-bonds in our sample are subject to the IFRS accounting regime (74 %). Amongst them, there appears to be a preference for AT1 CoCo-bonds, whereas the opposite is true for non-IFRS observations. This characteristic is in line with other literature. Avdjiev et al. (2020) report 55 % of the CoCo-bonds in their sample as AT1 capital, whereas the percentage is 52 % for ours. While the accounting as debt or equity is rather balanced for the

CoCo-bonds from the IFRS domain, there is a strong preference for debt in non-IFRS banks. It is important to note that the Tier 2 CoCo-bonds are classified exclusively as debt on the balance sheet. Table (2) shows that IFRS banks had no clear preference for C2E or PWD CoCo-bonds, whereas the prevalence of PWD is significantly higher for banks from non-IFRS countries. 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 survivor 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 volatility 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 calendar 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 (4). Our regressands are specifications of SRISK with the variables of interest being the nominal amounts of debt-CoCos $\left(\text{CoCo}^{\text{Debt}}\right)$ and equity-CoCos $\left(\text{CoCo}^{\text{Equity}}\right)$. We subsequently control for wellestablished 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 $\left(\text{GDP}^{\text{USD}}\right)$, annual GDP-growth $\left(\text{GDP}^{\text{Growth}}\right)$, 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 (5) in the Appendix. Summary statistics and correlation metrics are provided in Tables (6) and (7) respectively.

$$\begin{aligned} SRISK_{i,t+1} = & \beta_1 CoCo_{i,t}^{Debt} + \beta_2 CoCo_{i,t}^{Equity} + \beta_3 ln(Assets)_{i,t} + \beta_4 LR_{i,t} \\ & + \beta_5 ROA_{i,t} + \beta_6 ROID_{i,t} + \gamma_1 GDP_{c,t}^{USD} + \gamma_2 GDP_{c,t}^{Growth} \\ & + \gamma_3 CPI_{c,t} + \gamma_4 C2GDP_{c,t} + \alpha_i + \mu_t + \epsilon_{i,t} \end{aligned} \tag{4}$$

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 interdependence 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 (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.

$$\mathbb{P}(y_{i,t} = 1 | X = x_{i,t}) = \Phi\big(\beta_1 ln(Assets)_{i,t} + \beta_2 LR_{i,t} + \beta_3 ROA_{i,t} + \beta_4 ROID_{i,t} + \epsilon_{i,t}\big) \tag{5}$$

insert Table (3) about here

We generate evidence against the theorized source of endogeneity in Table (3). Our results hold for different measures of profitability and hence give credit to the transmission channels we have described in Section (3). We thus proceed with our actual analysis in the following section.

5 Results

5.1 Hypothesis 1

insert Table (8) about here

Table (8) 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 amounts of debt-CoCos and 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 idea 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 accounted for as equity does indeed reduce SRISK. 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 the theorized transmission channel between hybrid capital such as CoCo-bonds and systemic risk. Consequently, a closer investigation of the uncovered linkage is warranted.

Model (2) adds bank specific covariates. In doing so, evidence against an omitted variable bias is generated, as the previously significant intercept α becomes insignificant. At the same time, 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.

5.2 Hypothesis 2

Table (9) 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). The variables of interest are the nominal amount of debt-CoCos and equity-CoCos. Model (1) provides statistical evidence that after the adjustment, both types of CoCo-bonds decrease SRISK at a highly statistically significant 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 (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 effect size 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 observe significant gains in the explanatory power of the models. A possible explanation can be related to the information conveyed in Tables (1) to (2) 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.

insert Table (9) about here

Figures (5) and (6) 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 capitalization 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.

insert Figures (5) and (6) about here

6 Robustness

6.1 Parametrization

We assess the robustness of our results through a plurality of additional tests relating 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 (5). Figure (4) in the Appendix shows both types of returns, and illustrates their similarities. Table (4) 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^{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^{th} percentile, as illustrated in Figure (6) in the Appendix.

insert Tables (10) and (11) about here

Furthermore, we winsorize the independent variables of our regression at the 1^{st} and 99^{th} percentile as a means of robustness check. Tables (10) and (11) in the Appendix reiterate our results, as discussed in Section (5), and hence disperses concerns that our results might be driven by severe outliers. While the influence of bank size becomes significant in the winsorized model, the underlying dynamics remain the same. The sign of the variables is unchanged, while their economic significance grows relative to the unrestricted models in Tables (8) and (9).

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 (8) and (9).

The choice to set k to 8.00 % in the original SRISK formula, as used in Equation (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 deliberations into account, we have re-evaluated Equations (2) and (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 (7) and (8) in the Appendix and show the same trend as described in Section (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.

6.2 Accounting Regime

By and large, the design features of a CoCo-bond are subject to contractual freedom. They can thus be chosen such that they best meet the banks' requirements. The specific design, however, determines the classification of the CoCo-bond as either debt or equity on the balance sheet. As we have shown, this attribution can have negative repercussions. If the design features necessitate a recognition of the CoCo-bond as debt on the balance sheet, the perception of systemic riskiness can be systemically biased on the bank-level. Hence, the classification as either debt or equity is a focal point in our analyses. In the interest of robustness, we demonstrated in Chapter (4) that bank characteristics do not determine whether a CoCo-bond is accounted for as debt or equity. In this section, we shed further light on the accounting standards (i.e. IFRS versus non-IFRS) as a superordinate classification criterion. Given that they are predetermined and cannot be influenced by the bank management, they might induce a bias, if comparable CoCo-bonds were systemically different recognized on the balance sheet under the respective accounting regime.

Recalling Table (1) attests to this concern, as there are statistically significant structural differences between the applied accounting standards. While non-IFRS banks issue more

Tier 2 capital, the opposite is true for IFRS banks. At the same time, there is a strong tendency for debt accounting of CoCo-bonds for non-IFRS banks, whereas the picture is less clear for IFRS banks. In light of these observations, we investigate, whether the accounting standards affect the impact of the accounting classification on systemic risk. Due to the invariableness of accounting regimes, we cannot use an intuitive accounting dummy in our fixed-effects regression to examine the impact of this observation (Mundlak (1978)). Instead, we resort to a decomposition of our variables of interest by not only differentiating between debt and equity CoCo-bonds, but also whether they are accounted for under (non) IFRS principles.

insert Table (12) about here

If the accounting standards were an omitted force in our analyses, its influence should be most pronounced in the non-IFRS coefficients, where the majority of issued CoCo-bonds is accounted for as debt. Consistent with previous results, we find that the old model in the first column fails to recognize the loss absorbing capacity of debt-CoCos. It is only after our proposed correction, that the undue disparity between CoCo-bonds accounted for as debt and equity is resolved. However, a strong divergence in the magnitude of the equity-CoCo coefficient becomes apparent under the non IFRS regime, where it appears to stronger reduce bank-level systemic risk. We know from Table (1) that there are only six observations for this combination of CoCo-bond and accounting regime. It may thus be the case that this observation is induced by outliers. Indeed, we find the corresponding banks to be among the worst capitalized banks in the sample. They fall up to five percentage points below the average reported capital requirements, which puts two of them in the lowest decile. From this observation, another possible transmission channel opens up: could it be the case, that the issuance of CoCo-bonds increases the perceived resilience of banks and hence reduces the volatility of the issuer's shares? If this theory were true, the LRMES coefficient would be impacted, which would explain the stronger risk reduction on the systemic level. Likewise, an alternative explanation for the insignificance of the coefficient for CoCo-bonds accounted for as debt opens up, which is why we investigate this theory in the pursuant section.

6.3 Issuance Effects

We conduct a difference in difference analysis, in order to evaluate, whether the stock returns of banks that issued CoCo-bonds has been impacted by the issuance. As the banks in our sample receive the treatment (i.e. issue CoCo-bonds) at different times, we standardize the time dimension by indexing the weeks before and after the issuance in integer increments from zero, where positive (negative) values indicate the time after (before) the treatment. Our control group has been determined through a propensity score matching, where we use assets and equity, as proxies for size, respectively capitalization. As all banks without CoCo-bonds in Thomson Reuters' Eikon were considered, we had a large population to choose from, which explains the goodness of our matches. All of them are on the support, with the differences in the estimated probabilities being no lager than 0.1321. We matched every bank from the control group only once, and minimized the difference at the treatment date, in order to obtain the most similar pairs of treatment and control banks. Furthermore, we can verify the assumption of parallel trends, and intuitively confirm that the treatment is irreversible, as no defaults occurred, and no CoCo-bonds were called.

insert Table (13) about here

Table (13) shows the results of the difference in difference analysis. It appears to be the case that the returns of banks have gone down through time, as the negative coefficient of Time suggests. Likewise, banks with CoCo-bonds have lower returns, as indicated by the negative coefficient of Treatment. The difference in difference estimator of the interaction term is slightly positive, but as the other coefficients, both economically, and statistically insignificant. Thus, we conclude that there are no issuance effects that stem from CoCo-bonds, which could interfere with our measurement. Our results are in line with the results of Ammann et al. (2017), Liao et al. (2017) and Avdjiev et al. (2020), who show that the issuance of CoCo-bonds affects stock prices only for a few days, and not systemically from there forth.

7 Policy Implications

Our results have profound policy implications as they substantially change the systemic riskiness of financial institutions when measured by SRISK. We remediate an undue discrepancy, which stems from the accounting treatment of CoCo-bonds and subsequently show that banks with CoCo-bonds accounted for as debt are inherently more resilient than initially thought. Figure (3) below illustrates the implications of our results exemplary for the global systemically important bank (G-SIB) Credit Suisse. The left graph shows the difference between the original definition of SRISK by Brownlees and Engle in the full line, vis à vis our new proposal in the dashed line. While the difference is initially small, it grows over time as more CoCo-bonds, which are accounted for as debt, are issued. Ultimately, the SRISK value of our new definition becomes negative in 2018, suggesting that the bank has capital in excess of the shortfall it would sustain in the given crisis scenario. This observation is very substantial and echoed by the graph to the right, where we rank the 126 banks in our sample by their SRISK score. A higher score thus directly translates to a larger funding gap in line with the defintion of SRISK. One can see that initially Credit Suisse is one of the riskiest banks, in line with its categorization as a G-SIB. However, following the continued issuance of debt CoCo-bonds, the riskiness decreases, as they can potentially be converted into equity in order to cover upcoming losses. As a result, the bank becomes one of the most resilient in our sample, and was only mis-classified due to the omitted loss-absorbency.

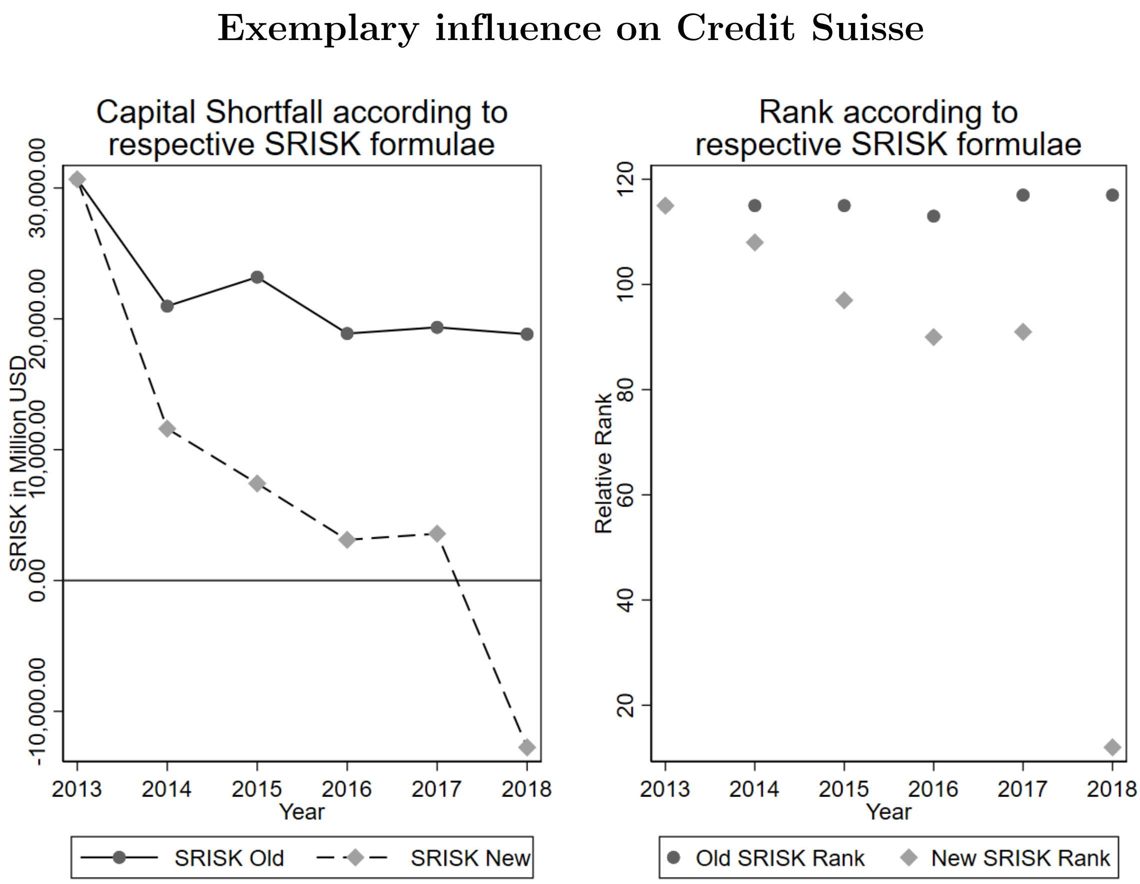


Figure 3: Systemic riskiness over time.

Taken together the above example comprehensively illustrates the implications of our results on the systemic riskiness of financial institutions. As such, it is paramount to correctly identify vulnerable banks during crises times. Hence, our proposed adjustment helps policy makers and regulators alike to look to the right banks in times of financial turmoil and to efficiently allocate their resources.

8 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 unstable, whereas the opposite is true.

We remedy this short-coming by proposing an alternative calculation of SRISK in Equation (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 generalized 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.

9 Appendix

Table 1: Accounting of CoCo-bonds by Accounting Standard and Capital Tier

	non-IFRS		IFRS	
	AT1	T2	AT1	T2
Debt	32.00	98.00	75.00	160.00
Equity	6.00	0.00	162.00	0.00
Observations	38.00	98.00	237.00	160.00
χ^2		16.19***		184.76***

The table above provides a breakdown of CoCo-bonds' accounting treatment by regulatory capital tier and applied accounting framework. The "non-IFRS" column denotes the multitude of local accounting standards.

Table 2: Accounting of CoCo-bonds by Accounting Standard and CoCo Characteristic

	non-IFRS		IFRS	
	C2E	PWD	C2E	PWD
Debt	1.00	129.00	123.00	112.00
Equity	3.00	3.00	76.00	86.00
Observations	4.00	132.00	199.00	198.00
χ^2		48.69***		1.13

The table above provides a breakdown of CoCo-bonds' accounting treatment by their loss absorption mechanism and applied accounting framework.

Table 3: Probit model with binary dependent Variable to test for Accounting on the Balance Sheet

	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

The table above 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 summarized in Table (5). 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: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Figure 4: Histograms of different Return Definitions

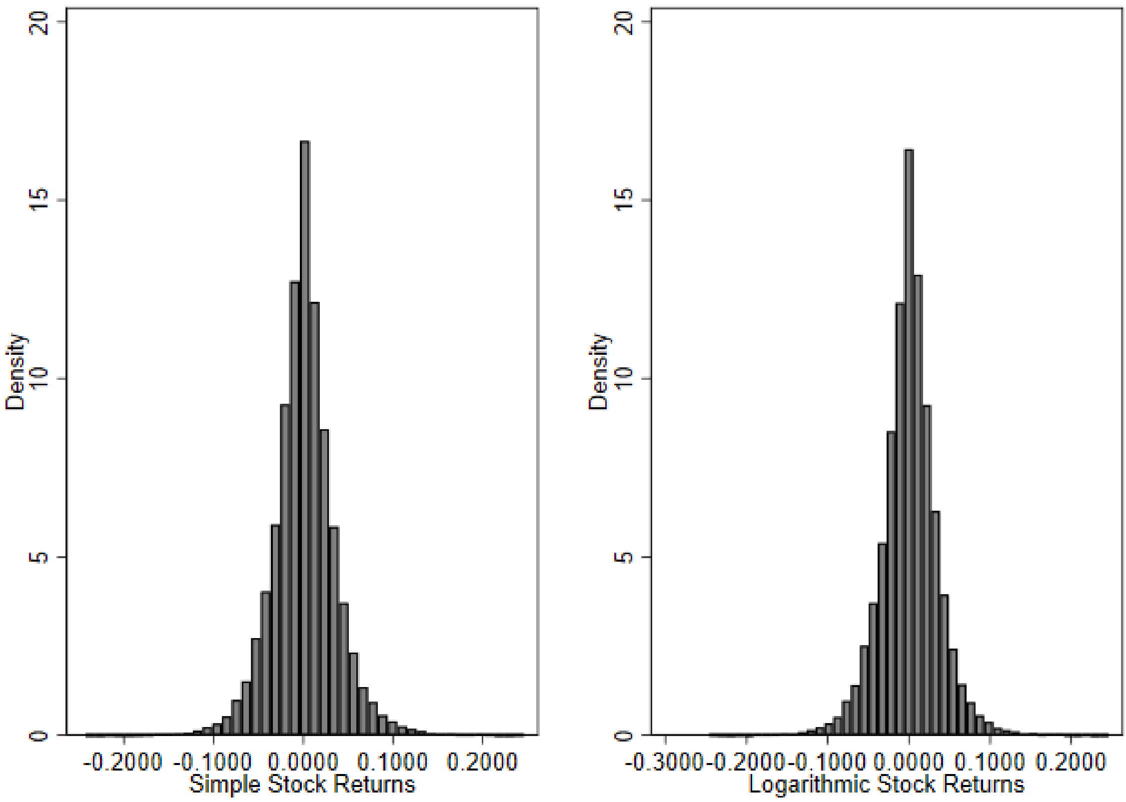


Table 4: Summary Statistics of Returns

	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

As can be seen in Figure (4), 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.

Table 5: Used Variables and their Sources

Variable	**Description**	**Source**
$SRISK^{old}$	SRISK as computed in Brownlees & Engle (2016)	Brownlees & Engle (2016)
$SRISK^{new}$	SRISK as computed in Equation (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}	Annualized GDP Growth	Worldbank Indicator Code NY.GDP.MKTP.KD.ZG
Inflation	Annualized GDP Deflator	Worldbank Indicator Code NY.GDP.DEFL.KD.ZG
C2GDP	Credit to GDP	Worldbank Indicator Code FS.AST.DOMS.GD.ZS

The Table above 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.

Table 6: Summary Statistics of Variables Included

Variables	N	Min	1 %	50 %	Mean	99 %	Max	Std. Dev.
$\text{SRISK}^{\text{old}}$	40,950	-35,549.5117	-9,721.7051	400.3422	6,172.7323	66,027.8359	115,482.8047	14,611.0927
$\text{SRISK}^{\text{new}}$	40,950	-172,098.6250	-44,070.0391	78.1388	3,245.5836	63,734.8008	115,482.8047	16,084.9918
$\text{CoCo}^{\text{Debt}}$	45,864	0.0000	0.0000	0.000	2,632.8436	56,262.7148	229,334.0156	11,566.7717
$\text{CoCo}^{\text{Equity}}$	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
$\text{GDP}^{\text{Growth}}$	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

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 winsorize in Tables (10) and (11) in the robustness section with these percentiles.

Table 7: Correlation Table

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

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 $CoCo^{Debt}$ and $SRISK^{new}$. 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.

Table 8: SRISK: original formula

	Model (1)	Model (2)	Model (3)
$CoCo^{Debt}$	-0.0074	0.0193	-0.0057
	(0.6664)	(0.2678)	(0.8311)
$CoCo^{Equity}$	-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)
GDP^{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

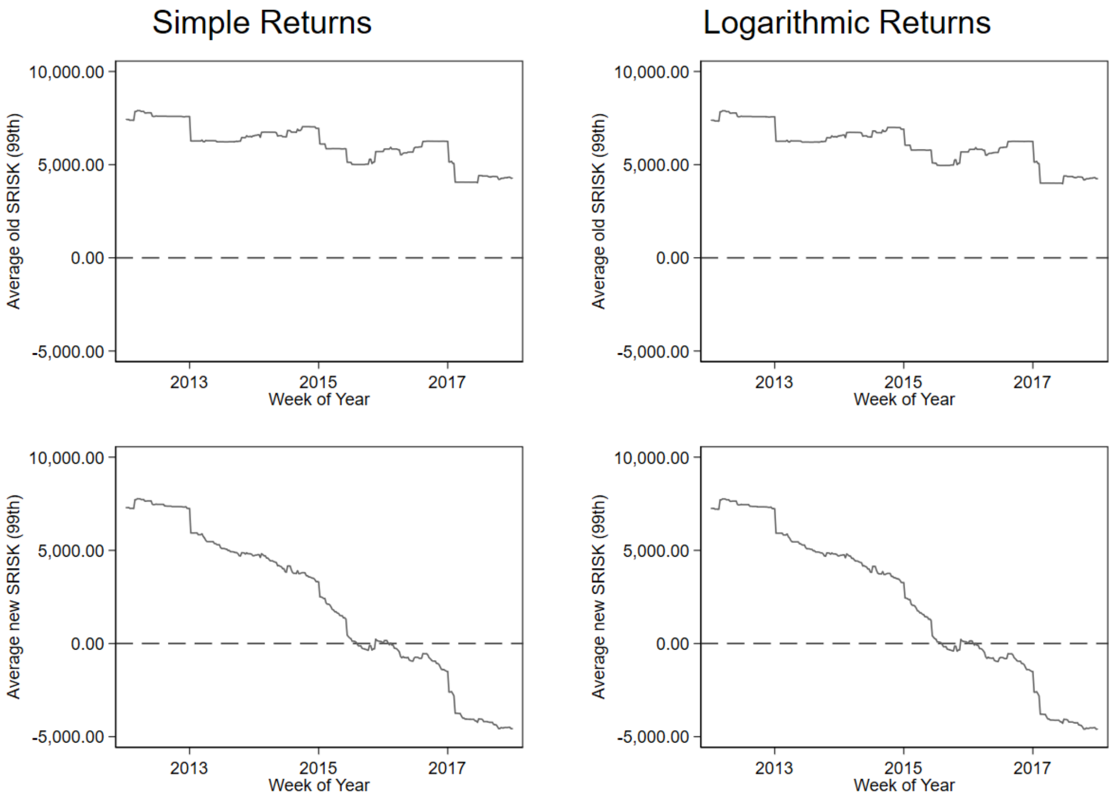
The Table above shows the coefficients and p-values (in parenthesis) of regressions with bank and time fixed effects. The dependent variable is SRISK measuring systemic risk, calculated by the original formula. The variables of interest are $CoCo^{Debt}$ and $CoCo^{Equity}$, indicating the nominal amounts 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: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 9: SRISK: adjusted formula

	Model (1)	Model (2)	Model (3)
$CoCo^{Debt}$	-1.0076***	-0.9806***	-1.0054***
	(0.0000)	(0.0000)	(0.0000)
$CoCo^{Equity}$	-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)
GDP^{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^2_w	0.8518	0.8735	0.7950

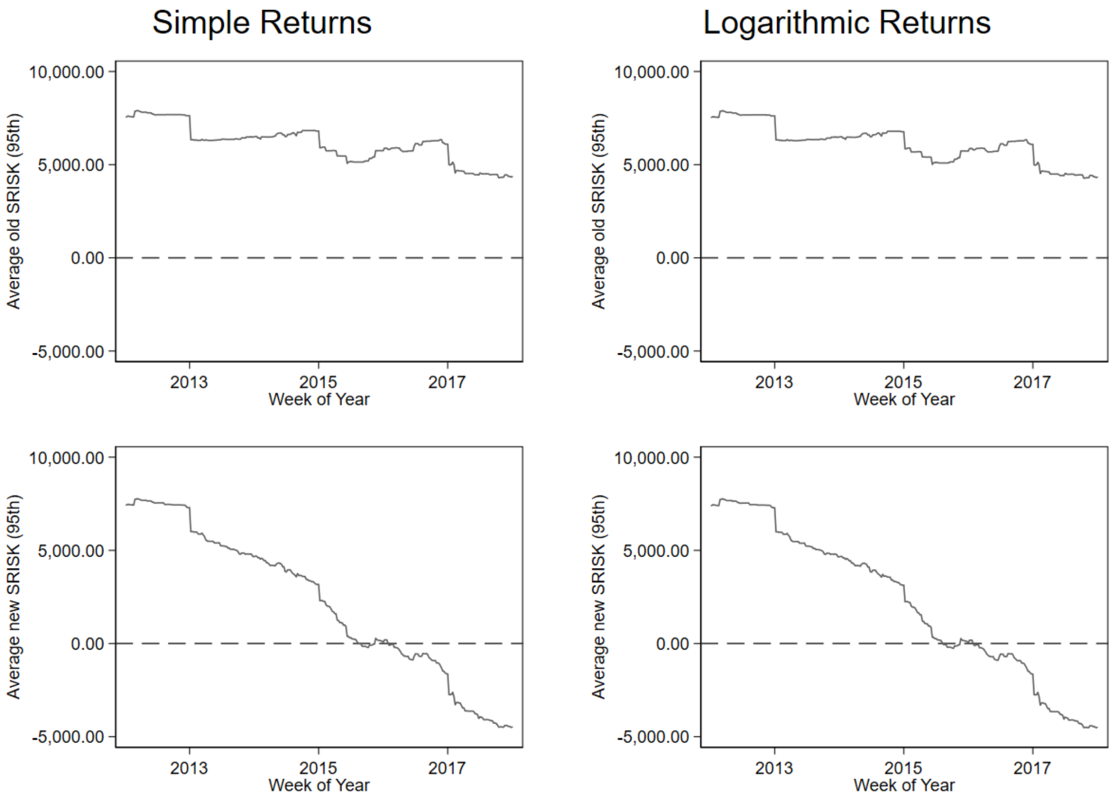
The Table above shows the coefficients and p-values (in parenthesis) of regressions with bank and time fixed effects. The dependent variable is SRISK measuring systemic risk, calculated by the adjusted formula. The variables of interest are $CoCo^{Debt}$ and $CoCo^{Equity}$, indicating the nominal amounts 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: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Figure 5: Comparison of SRISK with Simple and Logarithmic Returns at the 99th 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 (2), the bottom row contains it with our adjustment as proposed in Equation (3). One directly realizes 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 6: Comparison of SRISK with Simple and Logarithmic Returns at the 95^{th} Percentile



The Figure above reinstates our findings from Figure (5) 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.

Table 10: SRISK: original formula with Winsorization

	Model (1)	Model (2)	Model (3)
$CoCo^{Debt}$	-0.0347	-0.0172	-0.0122
	(0.0807)	(0.3964)	(0.5556)
$CoCo^{Equity}$	-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)
GDP^{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

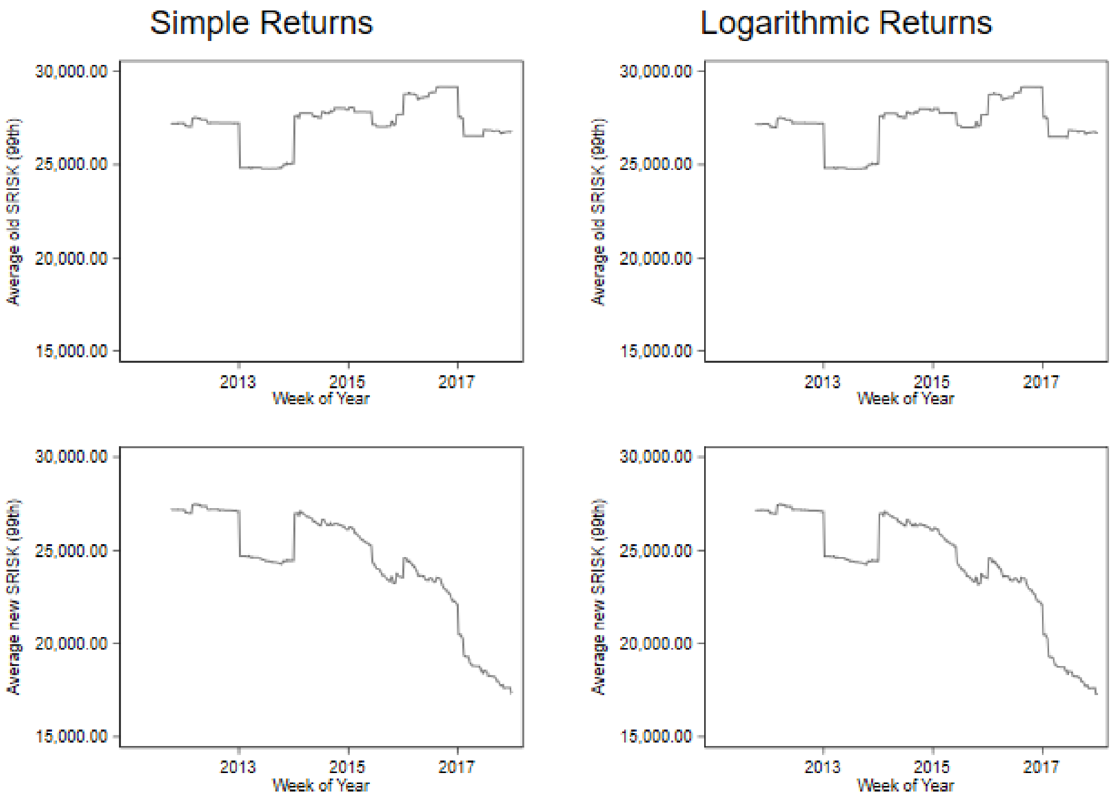
The Table above shows the coefficients and p-values (in parenthesis) of regressions with bank and time fixed effects. The dependent variable is SRISK measuring systemic risk, calculated by the original formula. The variables of interest are $CoCo^{Debt}$ and $CoCo^{Equity}$, indicating the nominal amounts 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 winsorized at the 1^{st} and 99^{th} percentile. p-values in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 11: SRISK: adjusted formula with Winsorization

	Model (1)	Model (2)	Model (3)
$CoCo^{Debt}$	-1.1424***	-1.1313***	-1.1295***
	(0.0000)	(0.0000)	(0.0000)
$CoCo^{Equity}$	-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)
GDP^{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

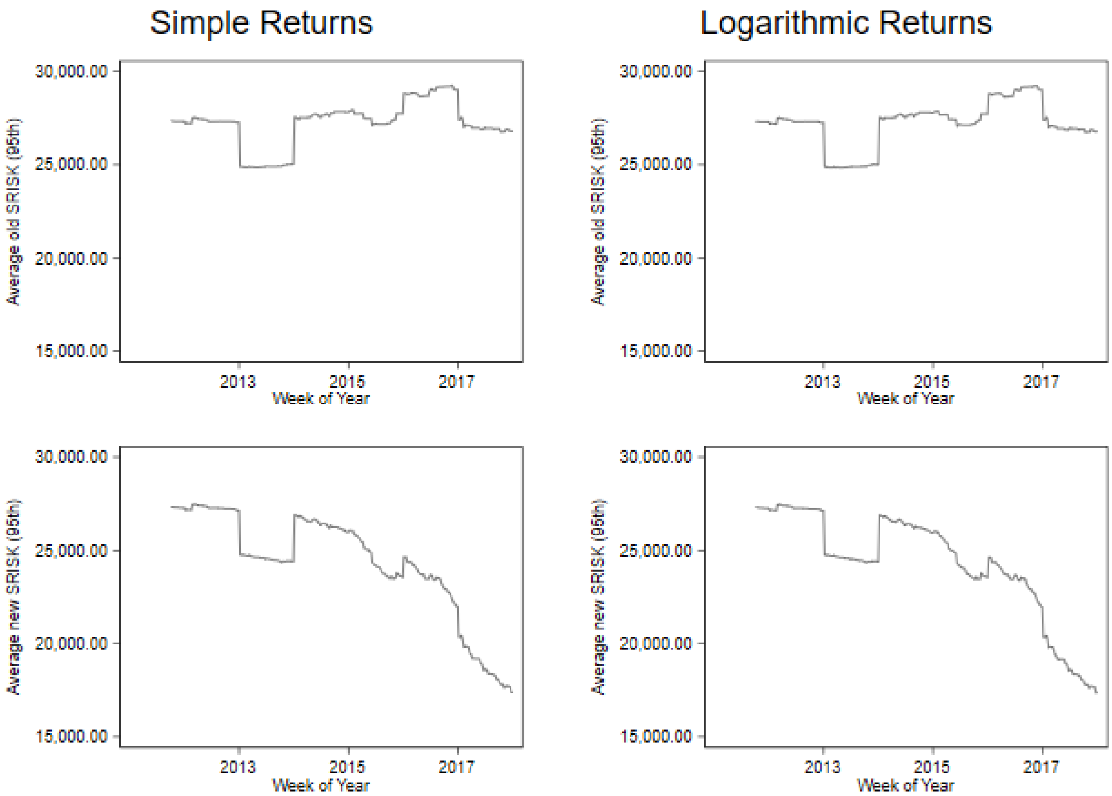
The Table above shows the coefficients and p-values (in parenthesis) of regressions with bank and time fixed effects. The dependent variable is SRISK measuring systemic risk, calculated by the adjusted formula. The variables of interest are $CoCo^{Debt}$ and $CoCo^{Equity}$, indicating the nominal amounts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

Figure 7: 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 (5). 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 (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 8: Comparison of SRISK with Simple and Logarithmic Returns at the 95$^{\text{th}}$ Percentile computed with an alternative k



The Figure above reinstates the findings made in Figure (7). Changing the severity of the market downturn, as we have done between Figures (5) and (6) with the old k, does not drive our results, as indicated by the absence of noteworthy differences.

Table 12: SRISK: Comparison of old and new formula by Accounting Standard

	Old Model	New Model
IFRS × $\text{CoCo}^{\text{Debt}}$	-0.0269	-1.0270***
	(0.3969)	(0.0000)
IFRS × $\text{CoCo}^{\text{Equity}}$	-0.3107***	-0.3044***
	(0.0000)	(0.0000)
$(1-\text{IFRS})$ × $\text{CoCo}^{\text{Debt}}$	0.0672	-0.9318***
	(0.0951)	(0.0000)
$(1-\text{IFRS})$ × $\text{CoCo}^{\text{Equity}}$	-1.9508***	-1.9465***
	(0.0000)	(0.0000)
Size	407.6885	429.0487
	(0.7020)	(0.6845)
LR	817.6635***	822.9857***
	(0.0000)	(0.0000)
ROA	-176.9095	-178.2291
	(0.6215)	(0.6157)
ROID	3,104.8911	3,151.4481
	(0.1044)	(0.0963)
GDP^{USD}	-0.0429	-0.0435
	(0.6685)	(0.6610)
$\text{GDP}^{\text{Growth}}$	195.1402	195.6363
	(0.0559)	(0.0531)
Inflation	22.0391	21.7142
	(0.6768)	(0.6785)
C2GDP	35.2477**	34.6560**
	(0.0080)	(0.0085)
Constant	-15,304.8313	-15,523.7485
	(0.1364)	(0.1274)
N	625	625
R_w^2	0.3367	0.8180

The Table above 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 current formula in column one, and the adjusted formel in column two. We interact $\text{CoCo}^{\text{Debt}}$ and $\text{CoCo}^{\text{Equity}}$ with the respective accounting regimes, in order to investigate possible influences from the accounting regime. Given that we can reinstate previous results, we can curtail our results to the theorized transmission channel. All independent variables are one year lagged in order to disperse simultaneity concerns. p-values in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 13: Difference in Difference regarding Issuance Effects

	Difference in Difference Model
Time	-0.0012
	(0.2370)
Treatment	-0.0005
	(0.6626)
Time × Treatment	0.0001
	(0.9142)
Intercept (α)	0.0025**
	(0.0029)
N	15,709
R^2	0.0002

The table above depicts the results of our difference in difference analysis, where we control for market effects that might coincide with the issuance of CoCo-bonds. We find that there is neither an economically, nor statistically significant issuance effect. The independence of CoCo-issuance and the stock returns of the issuer is underscored by the significance of the constant, which hints at other explanatory powers. *p*-values in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

References

Acharya, V. V., Gujral, I., Kulkarni, N., & Shin, H. S. (2011). *Dividends and Bank Capital in the Financial Crisis of 2007-2009* (Tech. Rep.). National Bureau of Economic Research.

Acharya, V. V., Pedersen, L. H., Philippon, T., & Richardson, M. (2017). Measuring Systemic Risk. *Review of Financial Studies*, *30*(1), 2-47.

Adrian, T., & Brunnermeier, M. K. (2016). CoVaR. *American Economic Review*, *106*(7), 1705-1741.

Allen, L., Bali, T. G., & Tang, Y. (2012). Does Systemic Risk in the Financial Sector predict future Economic Downturns? *The Review of Financial Studies*, *25*(10), 3000–3036.

Allen, L., & Tang, Y. (2016). What's the Contingency? A Proposal for Bank Contingent Capital triggered by Systemic Risk. *Journal of Financial Stability*, *26*, 1–14.

Ammann, M., Blickle, K., & Ehmann, C. (2017). Announcement effects of contingent convertible securities: Evidence from the global banking industry. *European Financial Management*, *23*(1), 127-152.

Avdjiev, S., Bogdanova, B., Bolton, P., Jiang, W., & Kartasheva, A. (2020). CoCo Issuance and Bank Fragility. *Journal of Financial Economics*.

Avdjiev, S., Bolton, P., Jiang, W., Kartasheva, A., & Bogdanova, B. (2015). Coco Bond Issuance and Bank Funding Costs. *BIS and Columbia University working paper*.

Avdjiev, S., Kartasheva, A., & Bogdanova, B. (2013). CoCos: A Primer. *BIS Quarterly Review*, 43.

Basel Committee on Banking Supervision. (2010). *Basel III: A global regulatory framework for more resilient Banks and Banking Systems* (Tech. Rep.).

Benczur, P., Cannas, G., Cariboni, J., Di Girolamo, F., Maccaferri, S., & Giudici, M. P. (2017). Evaluating the effectiveness of the new EU bank regulatory framework: A farewell to bail-out? *Journal of Financial Stability*, *33*, 207–223.

Benoit, S., Colliard, J.-E., Hurlin, C., & Pérignon, C. (2017). Where the Risks Lie: A Survey on Systemic Risk. *Review of Finance*, *21*(1), 109-152.

Billio, M., Getmansky, M., W., L. A., & Pelizzon, L. (2012). Econometric Measures of Connectedness and Systemic Risk in the Finance and Insurance Sectors. *Journal of Financial Economics*, *104*(3), 535–559.

Bisias, D., Flood, M., Lo, A., & Valavanis, S. (2012). A Survey of Systemic Risk Analytics. *Annual Review of Financial Economics*, *4*(1), 255-296.

Boermans, M. A., & van Wijnbergen, S. (2018). Contingent Convertible Bonds: Who invests in European CoCos? *Applied Economics Letters*, *25*(4), 234–238.

Brownlees, C., & Engle, R. F. (2016). SRISK: A Conditional Capital Shortfall Measure of Systemic Risk. *The Review of Financial Studies*, *30*(1), 48-79.

Cahn, A., & Kenadjian, P. (2014). Contingent Convertible Securities: from Theory to CRD IV. *Institute for Law and Finance Working Paper Series*(143).

Chan, S., & Van Wijnbergen, S. (2014). CoCos, Contagion and Systemic Risk. *Working Paper*.

Chan, S., & Van Wijnbergen, S. (2016). CoCo Design, Risk Shifting and Financial Fragility. *CEPR Discussion Paper No. DP11099*.

Coffee Jr., J. C. (2011). Systemic Risk after Dodd-Frank: Contingent Capital and the Need for Regulatory Strategies beyond Oversight. *Columbia Law Review*, *111*, 795.

Constâncio, V. (2016). The Role of Stress Testing in Supervision and Macroprudential Policy. *Stress Testing and Macroprudential Regulation*, 51.

Daníelsson, J., Shin, H. S., & Zigrand, J.-P. (2013). Endogenous and Systemic Risk. In *Quantifying Systemic Risk* (p. 73-94). National Bureau of Economic Research.

de Bandt, O., & Hartmann, P. (2000). *Systemic Risk: A Survey* (Working Paper Series No. 35). European Central Bank.

Demirgüç-Kunt, A., Detragiache, E., & Merrouche, O. (2013). Bank Capital: Lessons from the Financial Crisis. *Journal of Money, Credit and Banking*, *45*(6), 1147-1164.

ECB. (2010). Analytical Models and Tools for the Identification and Assessment of Systemic Risks. *Financial Stability Review*.

Fajardo, J., & Mendes, L. (2018). CoCos Bond and Systemic Risk. *Working Paper*.

Fiordelisi, F., Pennacchi, G., & Ricci, O. (2019). Are Contingent Convertibles going-concern Capital? *Journal of Financial Intermediation*, 100822.

Flannery, M. (2005). No Pain, No Gain? Effecting Market Discipline via reverse Convertible Debentures. *Capital adequacy beyond Basel: Banking, securities, and insurance*, 171–196.

Flannery, M. (2014). Contingent Capital Instruments for large financial Institutions: A Review of the Literature. *Annual Review of Financial Economics*, *6*(1), 225–240.

Flannery, M. (2016). Stabilizing Large Financial Institutions with Contingent Capital Certificates. *Quarterly Journal of Finance*, *06*(02), 1650006.

FSB, IMF, & BIS. (2009). Guidance to Assess the Systemic Importance of Financial Institutions, Markets and Instruments: Initial Considerations. *Report to the G20 Finance Ministers and Central Bank Governors*.

Gadanecz, B., & Jayaram, K. (2009). Measures of Financial Stability - A Review. In *Proceedings of the IFC Conference on Measuring Financial Innovation and its Impact* (Vol. 31, p. 365-380). Bank for International Settlements.

Gupta, A., Lu, Y., & Wang, R. (2018). Addressing Systemic Risk Using Contingent Convertible Debt. A Network Analysis. *Working Paper*.

Hakkio, C. S., & Keeton, W. R. (2009). Financial Stress: What Is It, How Can It Be Measured, and Why Does It Matter? *Kansas City FED Economic Review*.

Hart, O., & Zingales, L. (2011, 09). A New Capital Regulation for Large Financial Institutions. *American Law and Economics Review*, *13*(2), 453-490.

Kashyap, A. K., Rajan, R. G., & Stein, J. C. (2008, 3). Rethinking Capital Regulation. *Maintaining Stability in a Changing Financial System*.

Koziol, C., & Lawrenz, J. (2012). Contingent Convertibles. Solving or Seeding the next Banking Crisis? *Journal of Banking & Finance*, *36*(1), 90–104.

Kund, A.-G. (2018). *Can Systemic Risk Measures explain Bank Defaults?*

Laeven, L., & Levine, R. (2007). Is there a Diversification Discount in Financial Conglomerates? *Journal of Financial Economics*, *85*(2), 331–367.

Liao, Q., Mehdian, S., & Rezvanian, R. (2017). An Examination of Investors' Reaction to the Announcement of CoCo Bonds Issuance: A global Outlook. *Finance Research Letters*, *22*, 58 - 65.

Maes, S., & Schoutens, W. (2012). Contingent Capital: An In-Depth Discussion. *Economic notes*, *41*(1-2), 59–79.

McDonald, R. L. (2013). Contingent Capital with a dual Price Trigger. *Journal of Financial Stability*, *9*(2), 230-241.

Mundlak, Y. (1978). On the Pooling of Time Series and Cross Section Data. *Econometrica*, *46*(1), 69–85.

Pagano, M., Langfield, S., Acharya, V. V., Boot, A., Brunnermeier, M. K., Buch, C., ... van den Burg, I. (2014). *Is Europe Overbanked?* (Report of the Advisory Scientific Committee). European Systemic Risk Board.

Raviv, A. (2004). Bank Stability and Market Discipline: Debt-for-Equity Swap versus Subordinated Notes. *Working Paper*.

Schwarcz, S. L. (2008). Systemic risk. *Georgetown Law Journal*, *97*, 193.

Segoviano, M. A., & Goodhart, C. (2009). *Banking Stability Measures* (Working Paper). International Monetary Fund.

Squam-Lake-Working-Group. (2009). An expedited Resolution Mechanism for distressed Financial Firms: Regulatory hybrid Securities. *Council on Foreign Relations*, *10*.

Steffen, S. (2014). *Robustness, Validity and Significance of the ECB's Asset Quality Review and Stress Test Exercise.* Study for the European Parliament.