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The Adverse Effect of Contingent Convertible Bonds on Bank Stability

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The Adverse Effect of Contingent Convertible Bonds on Bank Stability*

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Abstract

This paper examines the effect of CoCo bonds that qualify as additional tier 1 capital on bank fundamentals. The results reveal a significant reduction in the distance to insolvency following the hybrid bond issuance due to increased earnings volatility. Further analyses suggest a link between CoCo issuance and more active earnings management, evidenced by a higher standard deviation of loan loss provisions and impairment charges. The findings substantiate long-standing theoretical hypotheses suggesting that the regulatory design requirements for going-concern CoCos adversely affect bank stability. Furthermore, they correspond to the notion that private monitoring is largely absent as a corrective measure due to prevailing uncertainties and information frictions.

Keywords: AT1 capital, bank stability, Basel III, CoCo bonds, earnings volatility

JEL classification: G21, G28, G32

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1 Introduction

When asset values depreciated during the global financial crisis, highly leveraged banks faced severe difficulties raising additional capital needed to meet their debt obligations. Financial instruments that were supposed to absorb losses proved ineffective, and the regulatory system lacked mechanisms to ensure that subordinated creditors and preferential shareholders bear their share of the costs (Basel Committee on Banking Supervision, 2010, 2011). Eventually, national governments bailed out several institutions considered too big to fail, creating a moral hazard problem. Consequently, regulators have specified bail-in rules and implemented higher capital requirements over recent years, which banks try to meet most cost-effectively (Ammann et al., 2017; Fiordelisi and Scardozzi, 2022).

That is where contingent convertible (CoCo) bonds come in. A CoCo is a subordinated debt security with a fixed coupon rate that can qualify as regulatory capital while entailing a tax shield, giving it a cost advantage over equity instruments. The hybrid bond automatically converts from debt into equity or is subject to a write-down when a trigger event occurs that is prespecified at the time of issue. Thus, unlike other convertible securities, CoCo bonds do not entail an option for the investor or the issuer. Hence, these bonds can absorb losses before the issuer encounters difficulties recapitalizing, thereby contributing to bank stability (e.g., Flannery, 2005).

Yet, a large body of theoretical literature suggests that the bond design is decisive in that regard (e.g., Chen et al., 2017; Hilscher and Raviv, 2014; Martynova and Perotti, 2018; Pennacchi and Tchistyi, 2019; Sundaresan and Wang, 2015). Unfortunately, European regulators and legislators have implemented requirements for the design of CoCo bonds to qualify as additional tier 1 (AT1) capital that contradict what the literature suggests is sensible from the stability perspective (Glasserman and Perotti, 2017). First, the Capital Requirement Regulation (CRR), which defines capital adequacy for EU banks since January 2014, specifies the trigger event for AT1 CoCo bonds to be the Common Equity Tier 1 (CET1) ratio falling below 5.125% (European Union, 2013b). However, basing the trigger event on a book value is widely criticized for neither ensuring timeliness of conversion nor robustness against management manipulation in case of lax accounting rules and regulatory forbearance (Avdjiev and Kartasheva, 2013; Avdjiev et al., 2017; Flannery, 2005, 2014, 2016; Maes and Schoutens, 2012; McDonald, 2013). Second, the CRR does not require AT1 CoCos to absorb losses through equity conversion but permits a write-down of the bond when the trigger occurs. That effectively results in the breakdown of the seniority principle, with debt holders bearing losses before equity investors. Hence, write-down CoCos can create a moral hazard problem as stockholders and management can shift losses to CoCo investors without having to share potential profits, which creates an incentive to engage in excessive risk-taking (Berg and Kaserer, 2015; Goncharenko, 2022).[1]

Yet, empirical evidence for the adverse effect issuing AT1 CoCo bonds has on bank stability due to changes in bank fundamentals is lacking. Therefore, I investigate how issuing AT1 CoCo bonds impacts a bank's distance to insolvency and earnings volatility. This paper contributes to a better understanding of how banks adjust their operations in response to the opportunity to pass on potential losses to bondholders. From a policy standpoint, this is crucial as it might reveal insights regarding unintended negative consequences for the soundness of the banking system. Moreover, the aggregated annual outstanding volume of AT1 CoCos issued by listed banks in the EU has grown at an average of 12% p.a. since 2014 (see Figure 1), while the concentration in the issue market has declined, that is, more banks engage in issuing CoCos (see Figure 2).

My findings support the theoretical arguments that issuing CoCo bonds in line with EU regulatory requirements for AT1 capital negatively impacts bank stability. The analysis reveals that a bank's distance to insolvency significantly decreases after issuing AT1 CoCo bonds, all else equal. The effect is economically meaningful and corresponds to a drop of 0.8 standard deviations from the mean. Further analyses show that an increase in the volatility of returns on assets and, more specifically, a higher standard deviation of net income drives the result.

[1] For an in-depth discussion of the institutional and legal background regarding the design of contingent convertible bonds and their use to meet capital requirements in the EU, see Section 2.

My analysis draws upon an unbalanced panel of all listed banks in the EU for 2008-2021. I obtain annual bank balance sheet and income statement information from Bankfocus and augment my data set with stock market information retrieved from Refinitiv. Refinitiv also provides information on CoCo bond issuances, the issue amount, the amount outstanding over time, the regulatory classification, the loss absorption mechanism (i.e., equity conversion vs. write-down), and trigger level. I add two sets of important country-level control variables. First, I control for the corporate tax rate since contingent convertibles can entail a tax shield while outstanding due to tax deductible coupon payments. Hence, differences in the potential tax shield might affect a bank's likelihood of issuing a hybrid instrument rather than preferred shares, which also qualify as AT1 capital. Second, I append the European Banking Union directives database assembled by Koetter et al. (2022b) to my data set to control for the time variation in the implementation of regulatory changes concerning bank capital (CRD IV) and resolution (BRRD) across countries.

I estimate the average effect issuing an AT1-qualifying CoCo bond has on the default risk of the issuing bank based on the difference-in-differences estimator for staggered treatment adoption by Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020) for event windows of up to three years after the issuance. To address potential selection bias at the bank level, I control for bank size, regulatory capitalization, and capital quality, which previous studies have found to increase the likelihood of issuing contingent convertibles (Avdjiev et al., 2017; Fajardo and Mendes, 2020; Goncharenko et al., 2021) and also affect bank stability (e.g., Bhagat et al., 2015; Gornall and Strebulaev, 2018; Laeven et al., 2016). Additionally, I include a standard set of bank-level controls (CAMELs). My baseline results are robust to changes in the computation of the outcome, the sample selection, and additional bank-level confounders.

Next, I turn to the income subcomponents to identify which revenue streams or expenses become less stable after a bank issues contingent convertibles. I find a significant increase in the standard deviation of impairment charges on loans and other assets, including off-balance sheet items. That implies that banks engage in more active earnings management after issuing a subordinated debt security that could enable them to transfer losses to bond investors.

I supplement my data set with manually collected information from the bond prospectuses about how the bank plans to use proceeds from the CoCo issues. My baseline results are more pronounced when the issuer explicitly states that the proceeds will strengthen the bank's capital base rather than serve other corporate purposes. That further emphasizes the relevance of the regulatory capital designation in this link between CoCos and active earnings management. Lastly, the baseline effects are not exclusive to particular bank groups concerning size, capitalization, or business model.

The opportunity to shift losses to CoCo bond investors likely reduces the incentives for shareholders to engage in private monitoring. My findings suggest that CoCo bondholders do not pick up the slack. Recent events surrounding Credit Suisse provide anecdotal evidence for substantial uncertainty and possibly misconceptions among CoCo investors about the risks they bear. These likely limit their monitoring efforts.

After a significant outflow of deposits in the first quarter of 2023,[2] the Swiss Financial Market Supervisory Authority (FINMA) identified Credit Suisse as at risk of becoming illiquid. To safeguard depositors and stabilize financial markets, FINMA (2023a) approved a takeover by UBS and ordered the write-down of all AT1 contingent convertible bonds to increase the bank's core capital. The trigger events for all outstanding Credit Suisse AT1 CoCo bonds at the time of the merger were varying minimum thresholds for the bank's CET ratio, ranging from 3% to 9.75% (FINMA, 2023b). Given that Credit Suisse reported a CET1 ratio of 14.1% at the end of 2022 and of 20.3% after the write-down (Credit Suisse, 2022, 2023), the regulator's decision to order a write-down without a shareholders bail-in resulted in a public outcry of CoCo investors and reports about their plans to file lawsuits against FINMA (e.g., CNBC, 2023). However, according to the Swiss capital regulation, AT1 capital is subject to a write-down before a bank can receive public sector assistance,[3]

[2]Credit Suisse reported a decline in customer deposits by 67 billion Swiss francs and a net asset outflow of 61.2 billion in Q1'23, which amounts to 11% of the bank's total assets at the end of 2022 (Credit Suisse, 2023).

[3]See Article 29 of the Swiss Captial Adequacy Ordinance (Swiss Federal Council, 2012). That is also

which FINMA (2023b) considered the government-backed loan and liquidity guarantees Credit Suisse obtained in conjunction with the takeover to be.

All this prompted EU bank regulators to issue a joint statement emphasizing their commitment to the seniority principle, according to which equity shareholders must absorb losses before AT1 investors are subject to a bail-in (ECB, 2023). However, that is only true under recovery and resolution rules. Since CRR requires the trigger event for AT1 CoCos to be the CET1 ratio falling below 5.125%, bond investors are subject to a bail-in before the entire CET1 capital, which includes share capital, gets wiped out. These uncertainties about the bail-in likelihood and respective information frictions likely result in a lack of private monitoring on the part of CoCo investors as a corrective measure. That further highlights the importance of understanding how banks adjust after issuing CoCo bonds to inform the regulatory debate on sound and incentive-compatible regulatory requirements for 'going-concer' capital.

This paper contributes to the limited number of empirical studies examining the impact of going-concern contingent convertibles on bank-level risk (De Spiegeleer et al., 2017; Fatouh et al., 2022; Fiordelisi et al., 2020).[4] The results add to De Spiegeleer et al. (2017) findings, which show that the volatility of CET1 ratios increases after banks issue write-down AT1 CoCos. My findings indicate that this could be attributable to more volatile retained earnings resulting from less stable net income. Fatouh et al. (2022) and Fiordelisi et al. (2020) find market-based bank risk measures change following the issuance of equity conversion CoCo bonds.[5] My paper complements these analyses. I show that not only market participants perception of bank risk changes but that AT1 CoCo bonds also affect banks' book values and result in more volatile income, which suggests changes

in line with the recommendations of the Basel Committee on Banking Supervision (2011).

[4]Related literature studies the short-term announcement effect of CoCo issues on CDS spreads and stock prices (Ammann et al., 2017; Avdjiev et al., 2017; Goncharenko et al., 2021). While Ammann et al. (2017) and Avdjiev et al. (2017) interpret their findings of decreasing effects on CDS spreads as evidence for reduced bankruptcy risk, these findings do not speak to any actual changes in the bank business operations in the years following the issuance. Moreover, dos Santos Mendes et al. (2022) analyze banks' contributions to systemic risk following the issuance of CoCo bonds, whereas my analysis focuses on the changes observable at the individual bank level.

[5]Fatouh et al. (2022) find that issuing CoCo bonds increases British banks' risk based on market measures, whereas Fiordelisi et al. (2020) find a negative impact on EU banks.

in bank fundamentals.

The study is also part of the broader literature on the effectiveness of requirements for bail-inable debt (Bernard et al., 2022; Cutura, 2021; Kupiec, 2016; Martynova et al., 2022) and, more specifically, how recovery and resolution regulation impacts bank behavior and strategy (Fiordelisi and Scardozzi, 2022; Lambrecht and Alex, 2023; Pandolfi, 2022). My results imply that banks move closer to insolvency due to higher income volatility if regulatory requirements for subordinated debt instruments that are supposed to be bail-inable in a 'going concern' state leave room for shareholders to shift risk to bond investors and are associated with uncertainty for bond investors about their likelihood of bail-in. That suggests a bank can become 'safer' according to an improved regulatory capital ratio but simultaneously show higher earnings volatility and, possibly, default risk. A discrepancy Duchin and Sosyura (2014) also discover when studying the impact of government assistance.

Lastly, this paper relates to the literature on banks' earnings management and use of reporting discretion in the context of banking regulation (Bischof et al., 2021), capital adequacy (Bushman, 2016; Curcio and Hasan, 2015; Huizinga and Laeven, 2012), and risk (Cohen et al., 2014; Leventis et al., 2011). My findings indicate that more volatile impairment charges are associated with less stable reported income for banks after increasing their regulatory capital through issuing securities that can result in bond investors bearing losses before shareholders. Thus, it further speaks to the relevance of private monitoring for earnings management (Bouvatier et al., 2014; Bushman and Williams, 2012; Danisewicz et al., 2021; Di Fabio et al., 2021; Fonseca and Gonzalez, 2008). AT1 CoCo bonds seem to reduce the incentives for shareholders to monitor banks due to the possiblity of shifting losses to CoCo bond investors. CoCo investors might not fully realize the risk they bear and, therefore, limit their engagement in monitoring. Hence, my results suggest that reduced shareholder and creditor monitoring leads to less stable reported income.

2 Institutional and regulatory background

The financial crisis marks a fundamental shift in banking regulation towards higher capital requirements. When governments bailed out large banks, they mainly injected common equity to safeguard savers' deposits. As an unintended side effect, subordinated debt holders did not incur any losses either (Basel Committee on Banking Supervision, 2011). Thus, part of the Basel Committee's three-pronged strategy to improve bank capitalization has been to rectify the definitions that specify which financial instruments shall be accepted as part of the regulatory capital to ensure that all capital types satisfy their respective loss absorbency capacity (Basel Committee on Banking Supervision, 2010).

To that end, the Basel Committee on Banking Supervision (2010, 2011) has specified the following criteria for hybrid bonds to qualify as additional tier 1 capital that is supposed to absorb losses while the bank is still solvent (going-concern capital): Both a conversion into common equity and principal write-off is an acceptable loss absorption mechanism. In addition to an unspecified trigger event set by the issuer, regulators should reserve the right to initiate conversion or write-down if necessary. Public sector assistance to avoid bankruptcy is only possible after the conversion or write-down of the AT1 instruments. Moreover, the issuer must be capable of suspending the coupon payments at any time, and AT1 bonds are to be perpetual bonds (Basel Committee on Banking Supervision, 2022).

2.1 Regulatory changes and market growth

While banks issued hybrid securities similar to CoCo bonds before 2008, it was not until after the financial crisis that the idea of contingent convertibles, first proposed by Flannery (2005), gained traction. After some early issuances, aggregated outstanding issue volume of AT1 CoCos issued by listed banks in the EU remained fairly small and stable until 2012 ranging around 25 bn euros (see Figure 1), with the five most active banks accounting for 60-90% of new issues during those early years (see Figure 2). However, the figures also show that the outstanding AT1 CoCo issue volume increased after 2013, with more banks becoming active in the issue market. Noticeably, the rise in market dynamics coincides with the start of the Basel III phase-in period and its adoption into EU law.[6] The European Union (2013a,b) implemented the Basel III guidelines and principles by passing the Capital Requirement Regulation (CRR) and the Capital Requirement Directive IV (CRD IV). The CRR has been binding for all member states since January 2014. It sets the standards for adequately measuring capital and risk. CRD IV further specifies the framework for capital buffers and the supervisory review process, which can result in additional capital requirements. In May 2014, the European Union (2014) passed the Banking Recovery and Resolution Directive (BRRD). It prescribes the procedures applicable to banks in or close to failure. To ensure sufficient funds are available for bail-in, BRRD also introduces minimum requirements for own funds and eligible liabilities (MREL). The 2019 amendment to the Capital Requirement Regulation adds the concept of Total Loss Absorbency Capacity (TLAC), which pursues a goal similar to MREL but only applies to global systemically important banks (European Union, 2019). Contingent convertible bonds typically meet both MREL and TLAC standards. Hence, increased regulatory capital requirements have presumably driven market growth in the past, and CoCo bonds will likely only become more relevant as the new requirements are phased-in.

In contrast to the dynamic European market, US banks have largely refrained from issuing CoCos because all AT1 capital instruments must be treated like equity (Flannery, 2014). That implies that coupon payments on AT1-qualifying CoCos are not tax-deductible in the US, making issuing these bonds less cost-effective. In contrast, it has been a widespread practice in European countries to allow coupon payments to be tax-deductible for the issuer (Bundgaard, 2017). Sweden and the Netherlands are an exception to that. The former abolished the tax deductibility for coupon payments on securities that qualify as AT1 capital in 2017. In 2019, the Netherlands followed suit (S&P Global,

[6] CoCo bonds can also qualify as tier 2 (T2) instruments. However, T2 capital intends to offset losses following bankruptcy and upon liquidation (gone-concern capital) (Basel Committee on Banking Supervision, 2010). Hence, these securities are not supposed to reduce the default probability of a single institution but rather mitigate the risk of a systemic crisis once a bank becomes insolvent. Thus, these T2 CoCo bonds are unlikely to affect the individual bank's risk-taking behavior and are, therefore, not the subject of this study.

2018). Yet, in most European jurisdictions, tax shields on CoCos continue to apply, making CoCo bonds the financially more attractive option to increase AT1 capital versus, for instance, preferred shares. That is despite research showing that more similar tax rules for debt and equity instruments can significantly reduce bank risk (Schepens, 2016).

Figure 3 displays the annual outstanding volumes of AT1-qualifying CoCo bonds issued by listed banks in the EU from 2008 to 2021 per country-year scaled by the banking sector size (total MFI assets) relative to the country- and year-specific corporate income tax rate. The scatter plot suggests a positive relation between banks choosing to issue AT1 CoCos and the corporate tax rate applicable to their income. Hence, the possibility to increase regulatory capital levels with contingent convertible bonds at lower costs due to a tax shield appears to be at least part of the reason EU banks issue these instruments.[7]

2.2 Regulatory design requirements

The European capital regulation CRR added one crucial detail to the requirements for financial instruments that are supposed to qualify as additional tier 1 capital to the Basel guidelines: CET1 capital falling short of constituting 5.125% of the bank's risk-weighted assets (RWAs) defines the trigger event (cf. CRR, Art. 54). That is a minimum requirement. Banks may choose higher levels for the CET1 ratio. They can also define additional trigger events.

2.2.1 Trigger event

The trigger event is supposed to identify the instant the issuer needs to recapitalize. Basing the trigger event on a book value like the CET1 ratio is widely criticized in the theoretic literature for neither ensuring timeliness of conversion nor robustness against management manipulation in case of lax accounting rules and regulatory forbearance

[7] Avdjiev et al. (2017) agree with this assessment. They further suggest that the growth could also be demand-driven: Due to the low-interest-rate environment, fixed-income investors are looking for opportunities in line with their investment restrictions. CoCo bonds that are written-off and do not convert into equity can meet their demand and provide reasonably high coupon payments.

(Avdjiev and Kartasheva, 2013; Avdjiev et al., 2017; Flannery, 2005, 2014, 2016; Maes and Schoutens, 2012; McDonald, 2013). Moreover, the trigger level should be reasonably high to ensure the bond is triggered before the bank faces insolvency (Jaworski et al., 2017). Pennacchi et al. (2014) find that if banks affected by the financial crisis had issued contingent convertible bonds with trigger events based on regulatory capital ratios, these instruments would likely not have absorbed any losses on time.[8]

Avdjiev and Kartasheva (2013), Calomiris and Herring (2013), Flannery (2005, 2016), Maes and Schoutens (2012), and McDonald (2013) are among the many scholars arguing that these shortcomings could largely be overcome by simply defining the trigger contingent on a market value like, for instance, the stock price. Market triggers are more robust towards balance sheet manipulations and diverging accounting standards. Furthermore, it mitigates the issue of regulatory forbearance. The figures underlying market triggers reflect expectations of future performance. Hence, they are forward-looking and observable daily.[9]

In contrast to what the Basel Committee on Banking Supervision (2011) recommends, CRR does not prescribe that AT1 CoCos must give discretion to the regulator to decide whether it is necessary to trigger a CoCo bond conversion, which reduces uncertainty and the risk of regulatory forbearance (Avdjiev and Kartasheva, 2013; Maes and Schoutens, 2012).

[8]The information defining a trigger event is not necessarily limited to a single financial institution. Some scholars propose to rely on industry-wide data to determine the point in time when banks should recapitalize to overcome the moral hazard problem (e.g., Allen and Tang, 2016; McDonald, 2013). Critics argue that a systemic trigger can cause a domino effect jeopardizing financial system stability (e.g., Avdjiev et al., 2017; Flannery, 2016; Maes and Schoutens, 2012). Based on a contingent claim analysis, Barucci and Del Viva (2012) infer that systemic trigger CoCos do not reduce bankruptcy costs.

[9]Sundaresan and Wang (2015) raise the concern that, under certain circumstances, neither an equilibrium stock nor bond price exists for CoCos with a market-value-based trigger event. Pennacchi et al. (2014) suggest relying on a trigger threshold defined by the market value of total capital to overcome this issue. Moreover, Glasserman and Nouri (2016) and Pennacchi and Tchistyi (2019) show that, under certain conditions, a unique price equilibrium exists.

2.2.2 Loss absorption mechanism

CRR does not make any further specifications regarding the permissible loss absorption mechanism for AT1 instruments. Hence, contingent convertibles can absorb losses and appreciate the value of a bank's equity by a write-down or a conversion into a certain number of shares.

The main criticism regarding the principal write-down mechanism concerns its implicit reversal of the seniority principle. It leaves bond investors liable before using up all equity. The European Securities and Markets Authority (ESMA) issued a warning about the risks associated with investing in CoCo bonds in that regard, stating that "contrary to classic capital hierarchy, CoCo investors may suffer a loss of capital when equity holders do not" (ESMA, 2014).

Considering the specific CRR trigger event requirement, CoCo investors can get bailed in before shareholders if distressed banks draw down CET1 capital sources other than share capital first. These alternative sources are retained earnings, additional reserves, accumulated income, funds for general banking risk, and share premiums (Article 26 of CRR). The CET1 ratio of listed EU banks in my sample is 17.5% in 2021.[10] Yet, the ratio of CET1 capital other than common equity, i.e., share capital and capital surplus, to risk-weighted assets amounts to almost 11%. Hence, the CET1 ratio of an average bank in my sample can drop to 6.5% before the share capital value depreciates. Since I cannot differentiate between share capital and capital surplus in my data, this can be considered an upper bound for the ratio of share capital to risk-weighted assets. Thus, a situation in which shareholders are only partly, or not at all, bailed in while the CET1 ratio falls below 5.125% of RWA seems feasible.

However, if the resolution authority gets involved, the European Banking Recovery and Resolution Directive stipulates that shareholders must bear losses first (cf. BRRD, Art. 34), effectively restoring the order of seniority. Yet, the prerequisites which would

[10]Similarly, the ECB (2022) reports a CET1 ratio of 15.5% for significant institutions in the fourth quarter of 2021.

mandate authorities to assume resolution powers are not unambiguous as they include, for instance, the authority's assessment of whether the bank is failing or likely to fail (cf. BRRD, Art. 32). In the prospectus of a write-down AT1 CoCo Deutsche Bank AG (2021) issued in May 2021, the bank itself points out the risk that, "to avoid the use of public resources, the competent authority may decide that the Issuer should allow a Trigger Event to occur at a time when it is feasible to avoid it."

Avdjiev et al. (2017), Flannery (2014, 2016), and Hilscher and Raviv (2014) argue that the possibility of shifting losses to investors in CoCos with a write-down mechanism likely encourages the management and shareholders of a bank to engage in excessive risk-taking.[11] Moreover, it would not be in the shareholders' interest to raise new equity to overcome financial difficulties due to the debt overhang problem (Pennacchi et al., 2014). In the previously mentioned prospectus, Deutsche Bank AG (2021) discloses to that effect that they "may decide not to raise capital at a time when it is feasible to do so, even if that would result in the occurrence of a Trigger Event."

Conversely, stockholders of banks that issue conversion-to-equity CoCos face the possibility of share dilution if the bond is triggered. Hence, this likely deters them from taking inordinate risks (Flannery, 2005, 2014). If an AT1 CoCo can convert to equity, CRR does not prescribe a particular conversion ratio. The conversion ratio specifies the amount of stock a bondholder receives. Conditional on the conversion ratio, the incurred loss gets divided between bondholders and shareholders: A higher ratio results in more severe dilution.[12] Thus, existing shareholders face incentives to exercise more prudent risk management (Berg and Kaserer, 2015; Calomiris and Herring, 2013; Hilscher and Raviv, 2014; Maes and Schoutens, 2012) and possibly even inject additional equity to prevent conversion (Calomiris and Herring, 2013; Chen et al., 2017).[13]

[11] Martynova and Perotti (2018) present a theoretical model suggesting the opposite, i.e., that principal write-down CoCos reduce risk-taking incentives. They argue that the leverage reduction after conversion reduces returns on equity and, thus, risk incentives. However, this hinges on the assumption that the trigger activation is exogenous.

[12] A principal write-down CoCo is an extreme case in which the bondholder does not receive any equity and absorbs the entire loss.

[13] Koziol and Lawrenz (2012) disagree with this widespread reasoning. Based on theoretical models, they predict CoCo bonds to incentivize excessive risk-taking if shareholders can change investment policies

To summarize, scholars largely concur that the trigger event of a going-concern CoCo bond should depend on a high threshold for a market capitalization measure to ensure that the contingent convertible is triggered as soon as a bank needs to recapitalize. Any delay in activating the loss absorption mechanism impairs the bond's capacity to reduce the bank's default probability. Moreover, a CoCo bond should absorb losses by being converted into equity at a reasonably high conversion ratio to deter excessive risk-taking.

In contrast, the regulatory requirements for bonds to qualify as AT1 capital in the EU stipulate a trigger based on a low minimum regulatory capital ratio and leave the choice of a loss absorption mechanism open to the issuer. Expectedly, two-thirds of AT1 CoCos issued by listed EU banks during 2008-2021 are write-down bonds (see Table 2). In less than 20% of issues, the trigger event is a CET1 ratio higher than the regulatory minimum requirement of 5.125%. Moreover, uncertainty surrounding the likelihood of bail-in might impede private monitoring as a corrective measure. Consequently, I hypothesize that issuing CoCo bonds that qualify as additional tier 1 capital according to European regulations adversely affects bank stability.

3 Empirical strategy and data

Figure 2 illustrates that listed EU banks issued CoCo bonds qualifying as AT1 capital in different years from 2008-2021. Moreover, previous research has shown that the decision to issue an AT1-qualifying CoCo bond depends on time-varying bank characteristics like, for instance, size (e.g., Fajardo and Mendes, 2020), variables that can also directly affect bank-level stability (e.g., Bhagat et al., 2015).

Until recently, the standard way to 'uncover' the causal effect in this kind of a setting where the treatment, i.e., the issuance of an AT1-qualifying CoCo, is staggered over time and there is a need to control for confounders when determining the effect on an outcome

ex-post.

of interest $Y_{i,t}$, was to estimate the following two-way fixed effects (TWFE) model:

$$Y_{i,t} = \alpha_i + \gamma_t + \beta D_{i,t} + \delta X_{i,t-1} + \theta Z_{j,t-1} + \epsilon_{i,t}, \tag{1}$$

where α_i and γ_t are bank and time fixed effects. $X_{i,t-1}$ and $Z_{j,t-1}$ are sets of lagged bank and country-level controls, respectively. $D_{i,t}$ is an indicator that bank i is treated at time t, i.e., it issued an AT1-qualifying CoCo in $t-1$, making β the coefficient of interest.

However, the standard TWFE model has severe shortcomings when applied in such scenarios, and researchers have explored various approaches to address these issues in recent research (e.g., Athey and Imbens, 2022; Baker et al., 2022; Borusyak et al., 2023; Callaway and Sant'Anna, 2021; Goodman-Bacon, 2021). The primary issue results from treatment assignment changing over time and the treatment effect varying across different units or exhibiting dynamic changes over different periods. In estimating the model, one compares all cohorts with each other if there is a variation in treatment status within a given time frame. That can lead to comparisons between newly treated observations and already treated ones. In a worst-case scenario that can result in the TWFE estimation procedure yielding a negative treatment effect, whereas participation in treatment acutally positively affects the outcome. To overcome these challenges and identify appropriate control groups, I adopt the methodology proposed by Callaway and Sant'Anna (2021).

3.1 Model specification

The key identifying assumption in a difference-in-difference setting is that, in the absence of treatment, the difference in outcomes between the treatment and control groups remains constant over time. That assumption also applies to staggered treatment adoption scenarios with the additional restriction that controls must only comprise non-treated observations. Despite some banks never issuing AT1 CoCos in my sample period, i.e., constituting 'never-treated' controls, I also allow for 'not-yet treated' banks to serve as control observation. The reason is that previous research shows that particularly larger banks are more likely to issue CoCos (Avdjiev et al., 2017; Fajardo and Mendes, 2020;

Goncharenko et al., 2021). Thus, only allowing 'never-treated' banks to constitute controls might result in treatment and control groups not being similar enough. That also implies that the parallel trends assumption must hold based on not-yet treated units to uncover a causal effect accurately:

$$E[Y_t(0) - Y_{t-1}(0)|G = g] = E[Y_t(0) - Y_{t-1}(0)|D_s = 0, G \neq g], \quad (2)$$

for all $g, s, t = 2, \ldots, \mathcal{T}$ with $g \leq t$ and $t \leq s$, where $Y_t(0)$ is the untreated potential outcome in time t, and G indicates the treated group, i.e., the time of a bank's first treatment. $D_s = 0$ identifies the group of 'not-yet treated' observations in time s.

Staggered treatment adoption implies the non-reversibility of treatment. Thus, once a bank has issued an AT1-qualifying CoCo bond in the previous year, the bank remains treated. That is reasonable since AT1 contingent convertibles are perpetual bonds. However, banks sometimes redeem them, resulting in a potential bias I address in a robustness check. I define an issuance in the previous year as the treatment since I am interested in changes in bank fundamentals, which might need some time to materialize. Yet, I also find some evidence for an immediate effect in the issue year in additional tests.

Assuming the parallel trend assumption holds, I follow Callaway and Sant'Anna (2021) and define the group-time average treatement effect for all $g \leq t$ as follows:

$$ATT(g, t) = E[Y_t - Y_{g-1}|G = g] - E[Y_t - Y_{g-1}|D_t = 0, G \neq g], \quad (3)$$

where Y_t is the observed outcome at time t. This specification computes outcome differences solely on contemporaneous observations for treated and control banks, with the latter not having issued AT1 CoCos at time t.

I also control for time-varying bank characteristics that previous studies have shown to affect the likelihood of issuing CoCos (Avdjiev et al., 2017; Fajardo and Mendes, 2020; Goncharenko et al., 2021) and bank stability (e.g., Bhagat et al., 2015; Gornall and Strebulaev, 2018; Laeven et al., 2016). Callaway and Sant'Anna (2021) show that the parallel trend assumption specified in equation (2) easily generalizes to allow for conditioning on covariates across groups.

Estimating the ATT conditional on covariates requires computing the change in outcomes for units in the control group given the confounding factors and accounting for the distribution of covariates for individuals in the different treatment groups. I apply the doubly-robust method Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020) recommend, which combines the outcome regression and the inverse probability weighting approaches, to estimate the respective group-time average treatment effects. I aggregate the ATTs to evaluate the impact issuing AT1 CoCos has on bank stability over a period of up to three years after the issuance relative to the year before.

3.2 Measuring bank risk and stability

My first outcome variable is the z-score, which measures the distance to insolvency and is widely used in the literature (e.g., Bhagat et al., 2015; Houston et al., 2010; Hoque et al., 2015; Laeven and Levine, 2009):

$$\text{z-score}_{i,t} = \frac{(ROAA_{i,t} + \frac{assets_{i,t} - liabilities_{i,t}}{assets_{i,t}})}{\sigma^{ROA}_{i,t}}, \tag{4}$$

with $ROAA_{i,t}$ being the annual average return on assets and the associated standard deviation $\sigma^{ROA}_{i,t}$ measured over the preceding five-year rolling window. The z-score indicates how many standard deviations a bank's ROAA would have to fall below its anticipated value for bank capital to become depleted (Poczter, 2016). The higher the score, the more stable a bank is. Using the logarithm of this measure alleviates issues associated with its skewed distribution. The z-score can be sensitive to the estimation procedure for σ^{ROA}, which I address in robustness checks. The issuance of an AT1-qualifying CoCo bond increases hybrid capital, which qualifies as equity rather than liabilities, resulting in a higher capital-to-assets ratio by construction. To preclude that distorting my results, I run a robustness check where I exclude hybrid capital from the numerator of the capital-to-assets ratio when computing the z-score.

In additional analyses, I decompose the z-score and estimate the effect that issuing AT1 CoCos has on the different components of the measure, i.e., $ROAA$, the capital-to-assets ratio, and earnings volatility σ^{ROA}. To delve further into the effect on earnings stability, I estimate the standard deviations of average assets, net income, and different income components as additional outcome variables over five-year rolling windows. These components are interest income, interest expense, operating revenues, impairment charges, staff expenses, administrative expenses, and other operating expenses.

I also look at some standard measures for asset risk, that is, the ratio of non-performing loans to gross loans (NPL ratio), the ratio of risk-weighted assets to total assets (RWA/ Assets), and a proxy for asset volatility (ln(asset risk)). ln(asset risk) is the logarithm of the product of annualized stock volatility and the market leverage ratio, i.e., market capitalization divided by the sum of total liabilities and market capitalization (Goncharenko et al., 2021; Gropp and Heider, 2010).

Table A.1 in the Appendix defines all outcome variables.

3.3 Bank- and country-level confounders

Many studies find that bank-level risk increases with bank size (e.g., Bhagat et al., 2015; Gropp et al., 2014; Laeven et al., 2016). Moreover, Avdjiev et al. (2017) find that the propensity to issue CoCos is higher for larger banks in advanced economies. Fajardo and Mendes (2020) and Goncharenko et al. (2021) confirm the positive association between bank size and the likelihood of issuing contingent convertibles for European banks. Thus, I include ln(assets) as a proxy for bank size in all estimations to account for the potential selection bias associated with this variable.

I follow the literature on bank stability (e.g., Bremus and Ludolph, 2021) and also include a standard set of bank-level controls (CAMELs) for capital adequacy (Capital/Assets), asset quality (Loan loss provisions/Net interest revenues), management capability (Cost/Income), earnings (ROAA), and liquidity (Loans/Assets) in all estimations. Goncharenko et al. (2021) also find banks with larger loans-to-assets ratios to have a higher propensity to issue CoCo bonds, highlighting the importance of this confounder.

Furthermore, better capitalization is typically associated with lower bank risk (e.g., Gornall and Strebulaev, 2018; Hoque et al., 2015; Laeven et al., 2016). Empirical results on its impact on the propensity to issue contingent convertibles are mixed: While Avdjiev et al. (2017) find a positive effect of capitalization on the likelihood of issuing CoCo bonds, Fajardo and Mendes (2020) do not find evidence for a significant relation. Vallée (2019) even argues that banks with lower Tier 1 capital ratios might be more willing to rely on contingent capital securities. Figure 4 shows that the Tier 1 ratio of listed banks in the EU that issued AT1 CoCos in the 2008-2021 period is, on average, lower than for banks not issuing these hybrid securities despite both groups following a similar growth path. Yet, the lines converge as the issue activity gains greater dynamism in 2014 (see Section 2.1 and Figure 2) before diverging again in 2018. To preclude that pre-treatment differences in the regulatory capital quantity and quality confound my results, I add the ratio of Tier 1 capital to risk-weighted assets and Tier 1 capital to total regulatory capital to my final set of baseline controls.

At the country level, I control for the corporate income tax rate. A higher tax rate might increase incentives to issue AT1 CoCos due to the potential tax shield. Also, changes in corporate taxes might affect earnings management and income reporting. Moreover, I account for cross-country and time-varying differences in the regulatory environment possibly affecting the likelihood of a bank issuing AT1 CoCos and bank stability. Estimating group-time average treatment effects already accounts for any impact EU regulations, like the Capital Requirement Regulation from 2014 and its amendment from 2019, might have on the outcome since they directly apply to all member states. Contrary, federal governments must transpose EU directives into national law for them to become effective. Although the EU sets a transposition deadline, Koetter et al. (2022a) show considerable variation across countries, with some implementing BRRD and CRD IV early, while others delay passing the respective laws beyond the deadline. Thus, cross-country and time-varying differences in the regulatory requirements could impact both my outcome and treatment. Therefore, I append the European Banking Union directives database assembled by Koetter et al. (2022b) to my data set and create two dummies that indicate if the key law implementing the BRRD and CRD IV in a country has been published for at least six months in a given year.

Table A.1 in the Appendix defines all control variables.

3.4 Data on banks and CoCo bonds

I retrieve balance sheet and income statement data for EU banks from Bankfocus. I augment my accounting data with stock market data from Refinitiv. I restrict my sample to banks listed for at least three years during the 2008-2021 sample period and the respective observations.[14] To eliminate double counting, I retain banks with consolidation codes C1 (published statements are consolidated, companions not in the data set), C2 (published statements are consolidated, companions in the data set), U1 (unconsolidated statements, no companions in the data set or bank doesn't publish consolidated accounts), or A1 (aggregated statements with no companion). I exclude specialized institutions, which results in almost two-thirds of my sample being commercial banks and the remainder comprising bank holding companies, cooperative banks, and saving banks.[15] Next, I run plausibility checks to account for reporting errors on all balance sheet and income statement figures and replace a false entry with a missing value. Moreover, I winsorize the estimated bank-level outcomes at a one percent level from above and below to reduce distorting effects due to outliers.

Table 1 presents the summary statistics. Panel A refers to the full sample comprising 1,289 observations of my main outcome variable for 210 banks. These numbers shrink to 834 annual data points for 124 banks in my final baseline estimation sample (Panel B) due to missing values in control variables and an additional sample restriction to eliminate the potential bias from repeated CoCo issuances. Yet, the table illustrates that this does

[14] I also collect data for earlier years to estimate standard deviations for income statement variables based on a five-year rolling window and only later limit the data set to the sample period.

[15] According to Bankfokus definitions, approximately 5% of the observations in my sample belong to other types of financial institutions. Yet, Refinitiv designates these as banks or commercial banks.

not alter the summary statistics for the outcome and control variables in any meaningful way. Moreover, the statistics match the literature for similar samples (e.g., Goncharenko et al., 2021; Fiordelisi et al., 2020).

I collect data on AT1-qualifying Contingent Convertibles issued by the banks in my sample from Refinitiv. Again, I must control for double counting. Banks often emit CoCos as 144A/Reg S offerings, which do not require registration with the Securities and Exchange Commission (SEC) while allowing qualified institutional buyers from the US to invest. 144A/Reg S offerings come with two distinct ISINs. Thus, I drop duplicates in all observable variables but the ISIN and double-check using the prospectuses. I convert the issue amounts to euros based on the year-end exchange rate extracted from the Bankfocus data to ensure consistency. I also retrieve information on outstanding volumes over all subsequent years from Refinitiv to control for the redemption of a CoCo. Refintiv also provides data on the loss absorption mechanism and the trigger level. I hand-collect information on the use of proceeds from the prospectuses.[16]

Figure 5 depicts the different uses of proceeds specified in the prospectuses of AT1 CoCo bonds issued by publicly traded banks in the EU between 2008 and 2021. The left chart refers to the total issue volume of AT1 CoCos that convert to equity if triggered vs. loss absorption through write-down on the right-hand side. The category *strengthen capital base* includes all CoCos with stated use of proceeds like 'strengthen regulatory capital base', 'included in Tier 1 capital base', and 'strengthen the leverage ratio and MREL'. If the prospectus does not explicitly refer to *strengthening the capital base* but indicates what the use of proceeds is, the bond is included in the category *other reasons*. That, for example, includes 'general corporate purposes' and 'general financing purposes'. While less than 20% of the equity conversion CoCo volume is specifically issued to strengthen the capital, that is true for more than 45% of the CoCo issue volume that can be subject to a write-down.

Table 2 presents summary statistics at the bond level, in parts scaled by bank data in

[16]Refinitiv also offers a variable on that. However, it is very unspecific and has many missing values.

the year of issue. Panel A refers to the entire sample, i.e., all AT1 CoCos issued by the sample banks in the sample period. However, many banks issued CoCos in multiple years of my sample period. To avoid any bias due to repeated issues, I only include instances in my final baseline estimation where a bank issues an AT1 CoCo for the first time, and I can observe at least one 'clean' post-treatment observation without another AT1 CoCo issue. That results in 56 treated banks in my final estimation sample. The issue volume is, on average, larger for equity conversion CoCos, not though in relative terms, i.e., scaled by the bank's assets, total capital, or AT1 capital. The statistics further indicate first issues might be smaller than repeated issues in absolute terms. However, that is not true in relative terms. That hints at large banks being more likely to issue AT1 CoCos repeatedly.

4 Impact of AT1 CoCo issuances on bank stability

This section presents and discusses the empirical results of my analysis. First, I provide evidence for the negative impact of AT1 CoCo bonds on bank stability. Next, I show that more volatile earnings drive the baseline effect and zoom in on the determining income components. To alleviate concerns regarding additional bank-level confounders or sample selection issues, I present the results of several robustness checks. Lastly, I check whether my baseline results are sensitive to particular characteristics of the CoCo or bank.

4.1 CoCos and banks' distance to insolvency

Table 3 displays the baseline results for issuing CoCo bonds that qualify as AT1 capital on banks' distance to insolvency (ln(z-score)).

Panel A shows the results for estimating the two-way fixed effect model specified in equation (1). The treatment dummy indicates whether the bank issued an AT1 CoCo the previous year. I control for bank size (ln(assets)) in all regressions. I also include dummies to account for the country-time-variation in implementing BRRD and CRD IV into national law and the corporate tax rate. All controls are lagged, and standard errors are clustered at the bank level. All estimations include bank- and year-fixed effects. Column (1) shows a positive and weakly significant effect suggesting that issuing AT1 CoCos moves banks further away from insolvency, all else being equal. However, if I add a standard set of bank-level controls (CAMEL), the effect is no longer statistically significant. To limit the distorting impact of repeated CoCo issues, I restrict the post-treatment period to years before a bank issues another AT1 CoCo bond in column (3). In column (4), I add bank-level controls for regulatory capitalization (Tier 1/RWA) and capital quality (Tier 1/Tot. capital) that previous studies find to impact bank stability and the likelihood of issuing CoCos.[17] In both specifications, the parameter estimates for the treatment dummies remain insignificant.

To reduce the bias resulting from having already treated banks serve as controls for newly treated, as is the case in the specification described above, I re-code the treatment dummy such that it remains one for all periods after the first time the bank issues an AT1 CoCo bond. Yet, the results remain insignificant, but with a change in sign once I exclude the years of repeated issues (columns (3) & (4)).

These results correspond to other studies not finding statistically significant effects for accounting-based risk measures (Fatouh et al., 2022; Fiordelisi et al., 2020). However, as discussed in Section 3, recent econometric advances suggest estimates in TWFE models are unreliable for uncovering the causal effect in a staggered treatment adoption set-up. Thus, I next apply the approach of Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020) specified in Section 3.1 to estimate the average treatment effect on the treated.

Panels C, D, and E display the average treatment effect on the treated of issuing AT1 CoCos on a bank's ln(z-score) over one, two, and three years after the issuance relative to the year before.[18] All treatment effects are negative and statistically significant. The

[17]See Section 3.3 for a more detailed explanation of the choice regarding the bank- and country-level confounders.

[18]The issuance takes place at t = -1. Thus, t = 0 is the first full reporting year with the AT1 CoCo

effect becomes stronger when including CAMEL controls (column (2)) and dropping post-treatment observations with repeated issuances (column (3)). I find the strongest effect when controlling for regulatory capital quality and quantity (column (4)). The ATT is statistically significant at a 1% level and ranges from -0.25 to -0.29. The effect is also economically meaningful. Issuing an AT1-qualifying CoCo bond results in a bank's distance to insolvency dropping by almost 25%, all else equal. That corresponds to a drop of 0.8 standard deviations from the mean of 3.43 in the baseline estimation sample. Table A.2 shows that extending the post-treatment period by another year does not substantially alter my results (panel A), nor does including an additional pre-treatment period (panels B & C).

Next, I test the validity of the identifying assumption underlying my empirical strategy, that is, the parallel trends assumption based on not-yet treated observations (see equation (2)) conditional on the covariates. I first check the pre-treatment ATTs for my final baseline estimations (i.e., including all sets of controls and limiting the post-treatment years to 'clean' observations). Panel A of Table 4 presents the results for the year of issuance (τ_{-1}) and the three preceding years (τ_{-2}, τ_{-3}, and τ_{-4}). The effect is weakly statistically significant in $t = -1$. That indicates a bank's distance to insolvency already shrinks in the year of issuance. However, given that the direction of this 'pre-treatment' effect is also negative, it only suggests that I might underestimate the actual treatment effect. I find no statistically significant results for earlier years.

Furthermore, I perform placebo tests to check the validity of my empirical strategy. Panels B - D of Table 4 report the results for different event windows. To that end, I only keep never-treated and not-yet-treated observations in my baseline estimation sample. I randomly choose a set of banks to issue a placebo CoCo in a randomly assigned year, such that the share of treated observation is approximately similar to the baseline case. In line with my baseline estimations, the placebo treatment is non-reversible. I include the same set of fixed effects, bank- and country-level controls as before. None of the

outstanding.

placebo treatments result in significant ATTs, which further substantiates the validity of my identification.

Notably, a discernible positive treatment effect is absent when examining various asset risk measures commonly employed in the existing literature. Table 5 shows no significant estimates for the asset volatility proxy (ln(asset risk)), the ratio of risk-weighted assets to total assets (RWA/ Assets), or the ratio of non-performing loans to gross loans (NPL ratio). All estimations include the full set of controls and fixed effects. The sample is equivalent to the baseline estimation sample in column (4) of Table 3, except for missing observations in the alternate outcomes. While the lack of statistical significance is by no means evidence for the absence of a relation, it does prompt the question of what drives the baseline effect on the z-score if evidence for changes in asset risk is lacking.

That holds particularly true, given the robust nature of the baseline effects, which persist even when altering crucial elements of the z-score calculation. Column (1) of Table 6 replicates the baseline results in its final specification with asymptotic standard errors. Column (2) shows that the results remain unchanged when using wild-bootstrapped standard errors. In both cases, they are clustered at the bank level. More importantly, columns (3) and (4) illustrate that my results remain stable when only including equity rather than the sum of equity and hybrid capital in the capital ratio numerator of the z-score (cf. equation (4)). The element of the z-score computation that typically exhibits the highest sensitivity to modifications is the method for calculating the standard deviation of returns on average assets. In addition to calculating σ_{ROAA} over rolling windows, I adopt another approach applied in various contexts in the literature (e.g. Bremus and Ludolph, 2021; Loutskina and Strahan, 2015; Kalemli-Ozcan et al., 2014) and regress $ROAA$ on a set of time- and bank-fixed effects:

$$ROAA_{i,t} = \beta_t + \delta_i + shock_{i,t}, \tag{5}$$

where β_t is the time-fixed effect accounting for the average growth of all banks, and δ_i is the bank-fixed effect capturing the average growth over time of bank i. I run these regressions for each country separately and only for banks for which I observe $ROAA$ for at least three years. The $shock_{i,t}$ quantifies the extent to which bank i's return on assets deviates from both the average $ROAA$ across all banks in year t and the average $ROAA$ of bank i over time. The absolute value of the estimated residuals is a proxy for the time-varying annual volatility, which I use as the denominator in the z-score calculation for columns (5) and (6). The effect size slightly increases. However, the summary statistics presented in panel D show that the mean and standard deviation for ln(z-score) also grow due to the altered σ_{ROAA} estimation. Despite this substantial change in the computation approach, the ATTs for the two- and three-year post-treatment windows remain statistically significant at the 10% and 5% levels, respectively. When bootstrapping standard errors, all estimated ATTs maintain a high degree of statistical significance.

In summary, the results show that issuing AT1 CoCo bonds results in a significantly lower z-score versus the expected levels in the absence of treatment. The treatment effect is statistically significant, robust, and economically meaningful. Next, I will further investigate which z-score components drive these findings.

4.2 Increased earnings volatility drives baseline effect

I decompose the z-score (cf. equation (4)) and estimate the treatment effect of issuing AT1 CoCo bonds on a bank's return on average assets ($ROAA$), its capital-to-assets ratio (CA ratio), and the standard deviation of its return on average assets (sd(ROAA)). Columns (2) - (4) of Table 7 present the respective results. While I do not find any significant effects on the numerator components ($ROAA$ and CA ratio), the standard deviation of returns on average assets significantly increases in all event windows. That suggests that an increase in the denominator of the z-score is driving the negative baseline effect (column (1)). $ROAA$ is the ratio of net income over average assets. Thus, I compute the treatment effect on the standard deviation of net income (sd(net I)) in column (5) and of average assets (sd(AA)) in column (6).[19] The results show a positive ATT for the

[19]The standard deviation of a ratio is not the ratio of its standard deviations. It also depends on the covariance of the numerator and denominator and can be approximated with a first-order Taylor

earnings volatility measure sd(net I), which is consistently statistically significant at a 5% level for all event windows. The effect size is less economically meaningful than the baseline effect for the z-score but still corresponds to a change in earnings volatility of half a standard deviation in the baseline estimation sample (see Table 1 for the summary statistics). ATTs for the standard deviation of average assets are not significant. Hence, banks appear to move closer to insolvency due to higher income volatility following the issuance of AT1-qualifying CoCo, all else equal, while I find no evidence for an increase in asset risk. Although puzzling at first glance, this is similar to what Duchin and Sosyura (2014) discover when analyzing the impact of government assistance. They find earnings volatility and default risk increase while regulatory capital ratios improve.

I extend my analysis by another step to identify which income components exhibit diminished stability following the issuance of AT1-qualifying CoCo bonds. First, I estimate the treatment effects on the standard deviation of interest income (sd(int. I)) and interest expense (sd(int. E)), which I find not to be significant (see columns (2) and (3) of Table 8). Next, I turn to the volatility of operating income and expenses. While column (2) of Table 9 shows that issuing AT1 CoCo bonds seems not to impact the stability of operating income, operating expenses become more volatile. Column (3) reveals a statistically significant and positive ATT for the standard deviation of total impairment charges. That includes loss provisions for loans, advances, and off-balance sheet items as well as impairment charges on other assets such as loans and advances to banks and on securities. The finding indicates that banks are more actively engaging in earnings management through loss provisioning after the issuance of AT1-qualifying CoCo bonds. That is consistent with previous research providing evidence for an inverse relationship between creditor rights (Curcio and Hasan, 2015) and incentives for non-depositor monitoring (Danisewicz et al., 2021) with income smoothing and earning opacity. If AT1 CoCo investors are limited in their capabilities to engage in monitoring due to the prevailing uncertainty and misconceptions concerning the likelihood of bail-in, that results in a greater degree of income smoothing.

expansion. Yet, these estimations can indicate whether either one is a dominating factor.

Issuing AT1 CoCos also results in more volatile operating expenses (column (6)) unrelated to staff (column (4)) or administration (column (5)). These other operating expenses include, for instance, depreciation on operating assets but also audit and legal fees. Yet, the effect is small (approximately 0.04) and not necessarily economically meaningful (SD of 0.23, see panel D).[20]

4.3 Robustness checks

I perform several robustness checks to substantiate the validity of my baseline findings. In particular, I check for the potentially confounding impact of my sample selection and additional bank characteristics.

Table 10 presents the robustness tests for the baseline findings (column (1)) pertaining to the sample selection. The outcome variable is ln(z-score) in all estimations. First, I check that AT1 CoCo bonds issued before the regulatory change that specified the design requirements (CRR, applicable since 2014) or that might have altered the bail-in likelihood (BRRD, in effect in most countries since 2016) drive my results. Thus, I restrict the sample to AT1 CoCo issues from 2014-2021 and 2016-2021, respectively. Column (2) shows that the effects remain robust in size and statistical significance. Limiting the sample to the issues since 2016 does not substantively alter the effect sizes, but the ATTs for the longer event windows become weaker in statistical significance. However, dropping earlier observations implies losing disproportionately more treated units for which I can observe more post-treatment periods. Hence, I would refrain from interpreting that as evidence that the BRRD resolved the negative association between issuing AT1 CoCos and bank stability.

Furthermore, column (5) of Table 10 presents the results for the sample only comprising post-treatment observations for which outstanding bond volume remains constant. Hence, disregarding redemptions does not result in my baseline estimates being overly

[20] I also consider non-operating income and expense volatility for which I do not find statistically significant results. Yet, the variables have many missing values making the results less reliable.

upwards biased. In column (6), I drop all banks delisted at some point during my sample period. The ATTs become smaller in size and significance. That suggests banks that do not survive as standalone listed banks drive my baseline findings in parts. Yet, the results also show that issuing AT1-qualifying CoCos reduces the distance to insolvency even conditional on remaining listed.

Table 11 presents robustness tests for the baseline results (column (1)) concerning additional bank-level confounders. Fajardo and Mendes (2020) find the RWA-to-assets ratio to be associated with a lower propensity to issue CoCo bonds, while they do not uncover a significant effect for capitalization. Thus, I replace the regulatory capital control variables with RWA/Assets. Column (2) shows that my baseline findings remain unchanged. Panel D reports the summary statistics of the added confounder.

Next, I include a proxy for the the charter value of bank, that is, its future profit-generating potential. Previous studies find that banks with lower charter values are associated with higher risk (e.g., Hugonnier and Morellec, 2017; Gropp and Vesala, 2004). Moreover, if a bank expects to generate less profits, it might be more likely to issue AT1 CoCos to shift losses to the investors without going insolvent. Column (3) shows that treatment effects become even more pronounced.

I also control for the banks' regulatory leverage ratio, which is the ratio of Tier 1 capital to total on- and off-balance sheet exposure. The leverage ratio is not linked to risk-weighted assets and serves as a backstop to capital requirements. Banks with lower leverage ratios are likely associated with higher levels of instability but might also be more willing to issue CoCos that increase Tier 1 capital. Adding the regulatory leverage ratio to my set of controls considerably reduces the sample size. Again I predominantly lose earlier observations as the leverage ratio has only become a regulatory requirement with the amendment to CRR. Nonetheless, the effect in the one-year post-treatment window more than doubles in size and remains statistically significant at a 5% level (column (4) of Table 11).

4.4 Sensitivity to CoCo and bank characteristics

In a final set of tests, I examine whether my results are sensitive to differences in the characteristics of the CoCo bonds and issuers.

Table 12 presents the treatment effects of issuing AT1 CoCo bonds on banks' *ln*(z-score) in the one-year post-treatment window for subsamples of the treated dependent on characteristics of the issued bond.[21]

First, I split the set of CoCo issues along the median of issue volume relative to total assets. The top row in column (2) shows the ATT for issuing a below median-sized CoCo on the issuer's distance to insolvency. Interestingly the effect becomes more pronounced relative to the baseline results (column (1)) and the sub-sample comprising above median-sized CoCos (second row of column (2)). However, the test statistic and p-value for the difference in the estimated treatment effects (H_0: $\text{ATT}_{\text{sel}} = \text{ATT}_{\text{non-sel}}$) indicate this difference to be insignificant. Panel B reports the means of the issue volume relative to assets and total capital for the selected subsample in the top row. The summary statistics in the first column refer to the entire baseline estimation sample.

Next, I turn to the loss absorption mechanism (column (3)) and trigger level (column (4)). I find no significant differences in my estimates for the treatment effects on *ln*(z-score). However, Table 13 reveals that the impact of issuing an equity conversion CoCo on earnings volatility is significantly larger than the effect I uncover for the write-down sub-sample (p-value = 0.06). That result casts doubt on the superiority of equity conversion over write-down loss absorption suggested in the theoretical literature when it comes to earnings stability rather than asset risk.

The first row in column (5) presents the treatment effect estimates for the subsample of CoCos issued to strengthen the bank's capital base according. The effect for this subsample is more pronounced. While I cannot reject the null hypothesis of equality in the estimates for the z-score, for earnings volatility (column (5) in Table 13), that difference is

[21] Result tables for longer event windows are available upon request. The overall findings persist.

statistically significant at a 5% level. That finding suggests that banks explicitly stating they want to use the issuance to improve their capital base engage in more active earnings management.

Lastly, I check whether the treatment effects are larger in or exclusive to a subsample of smaller (ln(assets) < 50%ile), weaker capitalized (Tier 1/RWA < 50%ile), or less lending oriented (Loans/Assets < 50%ile) banks. Table 14 reveals that my baseline findings are persistent over the different subsamples and the ATTs do not significantly differ in size. The same holds true for the effects on earnings volatility (see Table 15).

5 Conclusions

In this paper, I provide empirical evidence that AT1 CoCo bonds significantly reduce bank stability due to increased earnings volatility. Additional analyses reveal that net income becomes less stable as loan loss provisions and impairment charges fluctuate more. That hints at banks engaging in active earnings management. If banks issue CoCos with the explicit goal of strengthening the capital base, the impact on earnings volatility gets even more pronounced.

My results are consistent with the premise in the literature that the regulatory requirements in the EU result in 'going-concern' subordinated debt instruments that negatively impact bank stability. Existing studies establish market participants consider CoCos to increase bank risk. I add to that by providing the first empirical evidence of how bank fundamentals change. Moreover, I interpret my results as supportive of an inverse relation between non-depositor monitoring and income smoothing (e.g., Danisewicz et al., 2021). The uncertainty and misconceptions among CoCo investors about their bail-in likelihood seem to limit their monitoring engagement, which results in more volatile impairment charges.

From a policy perspective, it seems unreasonable to continuously allow and even incentivize banks to rely on CoCo bonds for AT1 capital. BRRD establishes a clear order of bail-in, which is supposed to ensure that a bank recapitalizes by writing off equity first and as soon as the bank enters a going-concern state. That renders the necessity for AT1 CoCos questionable.

References

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.

Athey, S., Imbens, G. W., 2022. Design-based analysis in difference-in-differences settings with staggered adoption. Journal of Econometrics 226 (1), 62–79.

Avdjiev, S., Bogdanova, B., Bolton, P., Jiang, W., Kartasheva, A., 2017. Coco issuance and bank fragility. Journal of Financial Economics 138 (3), 593–613.

Avdjiev, S., Kartasheva, A., 2013. CoCos: a primer. BIS Quarterly Review, 43–56.

Baker, A. C., Larcker, D. F., Wang, C. C. Y., 2022. How much should we trust staggered difference-in-differences estimates? Journal of Financial Economics 144 (2), 370–395.

Barucci, E., Del Viva, L., 2012. Countercyclical contingent capital. Journal of Banking and Finance 36 (6), 1688–1709.

Basel Committee on Banking Supervision, 2010. Basel III: A global regulatory framework for more resilient banks and banking systems. Bank for International Settlement,.

Basel Committee on Banking Supervision, 2011. Basel Committee issues final elements of the reforms to raise the quality of regulatory capital. Press release,.

Basel Committee on Banking Supervision, 2022. Evaluation of the impact and efficacy of the Basel III reforms. Bank for International Settlement,.

Berg, T., Kaserer, C., 2015. Does contingent capital induce excessive risk-taking? Journal of Financial Intermediation 24 (3), 356–385.

Bernard, B., Capponi, A., Stiglitz, J. E., 2022. Bail-ins and bailouts: Incentives, connectivity, and systemic stability. Journal of Political Economy 130 (7), 1805–1859.

Bhagat, S., Bolton, B., Lu, J., 2015. Size, leverage, and risk-taking of financial institutions. Journal of Banking and Finance 59, 520–537.

Bischof, J., Laux, C., Leuz, C., 2021. Accounting for financial stability: Bank disclosure and loss recognition in the financial crisis. Journal of Financial Economics 141 (3), 1188–1217.

Borusyak, K., Jaravel, X., Spiess, J., 2023. Revisiting event study designs: Robust and efficient estimation. Working papaer.

Bouvatier, V., Lepetit, L., Strobel, F., 2014. Bank income smoothing, ownership concentration and the regulatory environment. Journal of Banking & Finance 41, 253–270.

Bremus, F., Ludolph, M., 2021. The nexus between loan portfolio size and volatility: Does bank capital regulation matter? Journal of Banking & Finance 127, 106122.

Bundgaard, J., 2017. International - Convertible Debt Instruments in International Tax Law - Part 1. European Taxation 57 (4), 137–144.

Bushman, R. M., 2016. Transparency, accounting discretion, and bank stability. Economic Policy Review, 129–149.

Bushman, R. M., Williams, C. D., 2012. Accounting discretion, loan loss provisioning, and discipline of banks' risk-taking. Journal of Accounting and Economics 54 (1), 1–18.

Callaway, B., Sant'Anna, P. H., 2021. Difference-in-differences with multiple time periods. Journal of Econometrics 225 (2), 200–230.

Calomiris, C. W., Herring, R. J., 2013. How to Design a Contingent Convertible Debt Requirement That Helps Solve our Too-Big-to-Fail Problem. Journal of Applied Corporate Finance 25 (2), 21–44.

Chen, N., Glasserman, P., Nouri, B., Pelger, M., 2017. Contingent capital, tail risk, and debt-induced collapse. Review of Financial Studies 30 (11), 3921–3969.

CNBC, 2023. Credit Suisse bondholders prepare lawsuit after contentious $17 billion write-down (March 21, 2023). Available here.

Cohen, L. J., Cornett, M. M., Marcus, A. J., Tehranian, H., 2014. Bank earnings management and tail risk during the financial crisis. Journal of Money, Credit and Banking 46 (1), 171–197.

Credit Suisse, 2022. Annual Report 2022 - Credit Suisse Group AG. Available here.

Credit Suisse, 2023. Ad hoc announcement pursuant to Art. 53 LR [Press release (April 24, 2023)]. Available here.

Curcio, D., Hasan, I., 2015. Earnings and capital management and signaling: the use of loan-loss provisions by european banks. The European Journal of Finance 21 (1), 26–50.

Cutura, J. A., 2021. Debt holder monitoring and implicit guarantees: did the brrd improve market discipline? Journal of Financial Stability 54, 100879.

Danisewicz, P., McGowan, D., Onali, E., Schaeck, K., 2021. Debtholder monitoring incentives and bank earnings opacity. Journal of Financial and Quantitative Analysis 56 (4), 1408–1445.

De Spiegeleer, J., Höcht, S., Marquet, I., Schoutens, W., 2017. CoCo bonds and implied CET1 volatility. Quantitative Finance 17 (6), 813–824.

Deutsche Bank AG, 2021. Prospectus - Euro 1,250,000,000 Undated Non-Cumulative Fixed to Reset Rate Additional Tier 1 Notes of 2021 - ISIN DE000DL19VZ9 (May 10, 2021).

Di Fabio, C., Ramassa, P., Quagli, A., 2021. Income smoothing in european banks: The contrasting effects of monitoring mechanisms. Journal of International Accounting, Auditing and Taxation 43, 100385.

dos Santos Mendes, L., de Oliveira Leite, R., Fajardo, J., 2022. Do contingent convertible bonds reduce systemic risk? Journal of International Financial Markets, Institutions and Money 78, 101554.

Duchin, R., Sosyura, D., 2014. Safer ratios, riskier portfolios: Banks' response to government aid. Journal of Financial Economics 113 (1), 1–28.

ECB, 2022. ECB publishes supervisory banking statistics for the fourth quarter of 2021 (April 8, 2022). Available here.

ECB, 2023. ECB Banking Supervision, SRB and EBA statement on the announcement on 19 March 2023 by Swiss authorities [Press release (March 20, 2023)]. Available here.

ESMA, 2014. Potential Risks Associated with Investing in Contingent Convertible Instruments [Press release (July 14, 2014)]. Available here.

European Union, 2013a. Directive 2013/36/EU. Official Journal of the European Union L 176, 338–436.

European Union, 2013b. Regulation (EU) No 575/2013. Official Journal of the European Union L 176, 1–337.

European Union, 2014. DIRECTIVE 2014/59/EU. Official Journal of the European Union L 173, 190–348.

European Union, 2019. Regulation (EU) No 2019/876. Official Journal of the European Union L 150, 1–225.

Fajardo, J., Mendes, L., 2020. On the propensity to issue contingent convertible (CoCo) bonds. Quantitative Finance 20 (4), 691–707.

Fatouh, M., Neamţu, I., van Wijnbergen, S., 2022. Risk-taking, competition and uncertainty: Do contingent convertible (coco) bonds increase the risk appetite of banks? Working paper.

FINMA, 2023a. FINMA approves merger of UBS and Credit Suisse [Press release (March 19, 2023)]. Available here.

FINMA, 2023b. FINMA provides information about the basis for writing down AT1 capital instruments [Press release (March 23, 2023)]. Available here.

Fiordelisi, F., Pennacchi, G., Ricci, O., 2020. Are contingent convertibles going-concern capital? Journal of Financial Intermediation 43.

Fiordelisi, F., Scardozzi, G., 2022. Bank funding strategy after the bail-in announcement. Journal of Corporate Finance 74, 102215.

Flannery, M. J., 2005. No pain, no gain? effecting market discipline via "reverse convertible debentures". In: Scott, H. S. (Ed.), Capital Adequacy Beyond Basel: Banking, Securities, and Insurance. Oxford University Press, pp. 171–196.

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

Flannery, M. J., 2016. Stabilizing Large Financial Institutions with Contingent Capital Certificates. Quarterly Journal of Finance 6 (2), 1–26.

Fonseca, A. R., Gonzalez, F., 2008. Cross-country determinants of bank income smoothing by managing loan-loss provisions. Journal of Banking & Finance 32 (2), 217–228.

Glasserman, P., Nouri, B., 2016. Market-Triggered Changes in Capital Structure: Equilibrium Price Dynamics. Econometrica 84 (6), 2113–2153.

Glasserman, P., Perotti, E., 2017. The Unconvertible CoCo Bonds. In: Evanoff, D. D., Kaufman, G. G., Leonello, A. (Eds.), Achieving Financial Stability: Challenges to Prudential Regulation. World Scientific, pp. 317–329.

Goncharenko, R., 2022. Fighting fire with gasoline: Cocos in lieu of equity. Journal of Money, Credit and Banking 54 (2-3), 493–517.

Goncharenko, R., Ongena, S., Rauf, A., 2021. The Agency of CoCo: Why Do Banks Issue Contingent Convertible Bonds? Journal of Financial Intermediation.

Goodman-Bacon, A., 2021. Difference-in-differences with variation in treatment timing. Journal of Econometrics 225 (2), 254–277.

Gornall, W., Strebulaev, I. A., 2018. Financing as a supply chain: The capital structure of banks and borrowers. Journal of Financial Economics 129 (3), 510–530.

Gropp, R., Gruendl, C., Guettler, A., 2014. The impact of public guarantees on bank risk-taking: Evidence from a natural experiment. Review of Finance 18, 457–488.

Gropp, R., Heider, F., 2010. The determinants of bank capital structure. Review of Finance 14 (4), 587–622.

Gropp, R., Vesala, J., 2004. Deposit insurance, moral hazard and market monitoring. Review of Finance 8 (4), 571–602.

Hilscher, J., Raviv, A., 2014. Bank stability and market discipline: The effect of contingent capital on risk taking and default probability. Journal of Corporate Finance 29, 542–560.

Hoque, H., Andriosopoulos, D., Andriosopoulos, A., Douady, R., 2015. Bank regulation, risk and return: Evidence from the credit and sovereign debt crises. Journal of Banking and Finance 50, 455–474.

Houston, J. F., Lin, C., Lin, P., Ma, Y., 2010. Creditor rights, information sharing, and bank risk taking. Journal of Financial Economics 96 (3), 485–512.

Hugonnier, J., Morellec, E., 2017. Bank capital, liquid reserves, and insolvency risk. Journal of Financial Economics 125 (2), 266–285.

Huizinga, H., Laeven, L., 2012. Bank valuation and accounting discretion during a financial crisis. Journal of Financial Economics 106 (3), 614–634.

Jaworski, P., Liberadzki, K., Liberadzki, M., 2017. How does issuing contingent convertible bonds improve bank's solvency? A Value-at-Risk and Expected Shortfall approach. Economic Modelling 60, 162–168.

Kalemli-Ozcan, S., Sorensen, B., Volosovych, V., 2014. Deep financial integration and volatility. Journal of the European Economic Association 12 (6), 1558–1585.

Koetter, M., Krause, T., Sfrappini, E., Tonzer, L., 2022a. Completing the European Banking Union: Capital cost consequences for credit providers and corporate borrowers. European Economic Review 148, 104229.

Koetter, M., Krause, T., Sfrappini, E., Tonzer, L., Zgherea, C., 2022b. The European Banking Union and its directives: Staggered implementation of the new regulatory framework. mimeo.

Koziol, C., Lawrenz, J., 2012. Contingent convertibles. Solving or seeding the next banking crisis? Journal of Banking and Finance 36 (1), 90–104.

Kupiec, P. H., 2016. Will tlac regulations fix the g-sib too-big-to-fail problem? Journal of Financial Stability 24, 158–169.

Laeven, L., Levine, R., 2009. Bank governance, regulation and risk taking. Journal of Financial Economics 93 (2), 259–275.

Laeven, L., Ratnovski, L., Tong, H., 2016. Bank size, capital, and systemic risk: Some international evidence. Journal of Banking & Finance 69, S25–S34.

Lambrecht, B. M., Alex, S. L., 2023. Liquidation, bailout, and bail-in: Insolvency resolution mechanisms and bank lending. Journal of Financial and Quantitative Analysis 58 (1), 175–216.

Leventis, S., Dimitropoulos, P. E., Anandarajan, A., 2011. Loan loss provisions, earnings management and capital management under IFRS: The case of EU commercial banks. Journal of Financial Services Research 40, 103–122.

Loutskina, E., Strahan, P. E., 2015. Financial integration, housing, and economic volatility. Journal of Financial Economics 115 (1), 25–41.

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

Martynova, N., Perotti, E., 2018. Convertible Bonds and Bank Risk-Taking. Journal of Financial Intermediation 35 (B), 61–80.

Martynova, N., Perotti, E., Suarez, J., 2022. Capital forbearance in the bank recovery and resolution game. Journal of Financial Economics 146 (3), 884–904.

McDonald, R. L., 2013. Contingent capital with a dual price trigger. Journal of Financial Stability 9 (2), 230–241.

Pandolfi, L., 2022. Bail-in and bailout: Friends or foes? Management Science 68 (2), 1450–1468.

Pennacchi, G., Tchistyi, A., 2019. Contingent convertibles with stock price triggers: The case of perpetuities. The Review of Financial Studies 32 (6), 2302–2340.

Pennacchi, G., Vermaelen, T., Wolff, C., 2014. Contingent capital: The case of COERCs. Journal of Financial and Quantitative Analysis 49 (3), 541–574.

Poczter, S., 2016. The long-term effects of bank recapitalization: Evidence from indonesia. Journal of Financial Intermediation 25, 131–153.

Sant'Anna, P. H., Zhao, J., 2020. Doubly robust difference-in-differences estimators. Journal of Econometrics 219 (1), 101–122.

Schepens, G., 2016. Taxes and bank capital structure. Journal of Financial Economics 120 (3), 585–600.

S&P Global, 2018. European insurers likely to stay sweet on CoCo bonds despite loss of tax break (July 30, 2018). Available here.

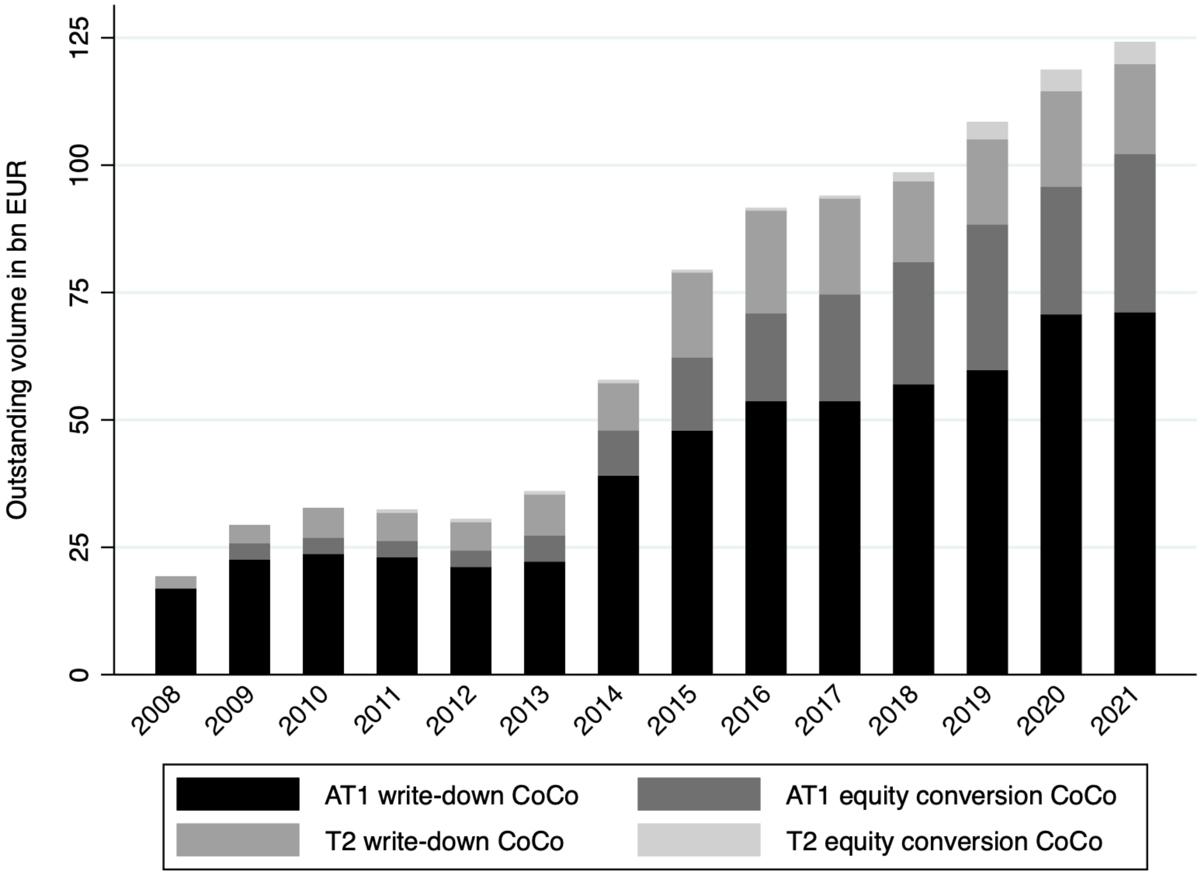
Sundaresan, S., Wang, Z., 2015. On the Design of Contingent Capital with a Market Trigger. Journal of Finance 70 (2), 881–920.

Swiss Federal Council, 2012. Ordinance on the Capital Adequacy and Risk Diversification of Banks and Securities Firms. Available here.

Vallée, B., 2019. Contingent capital trigger effects: Evidence from liability management exercises. Review of Corporate Finance Studies 8 (2), 235–259.

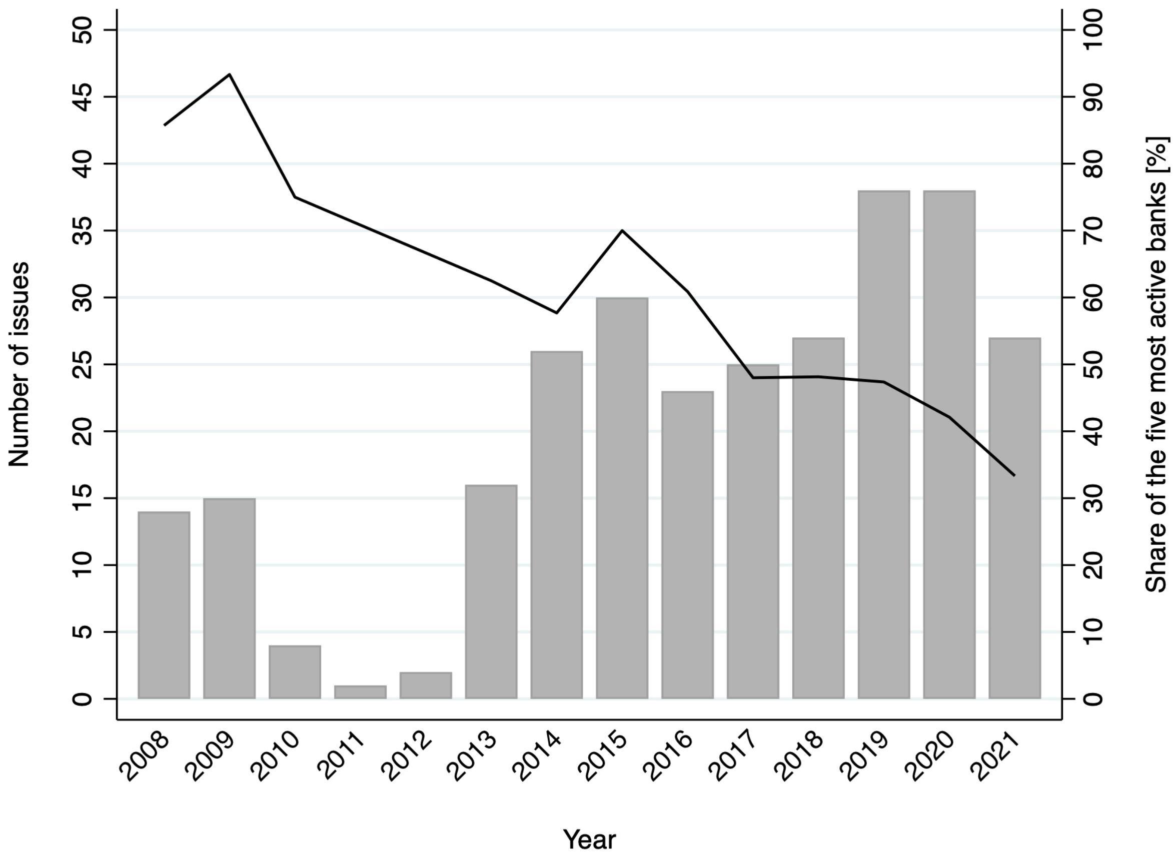
Figures

Figure 1: Aggregated outstanding issue volume of CoCo bonds



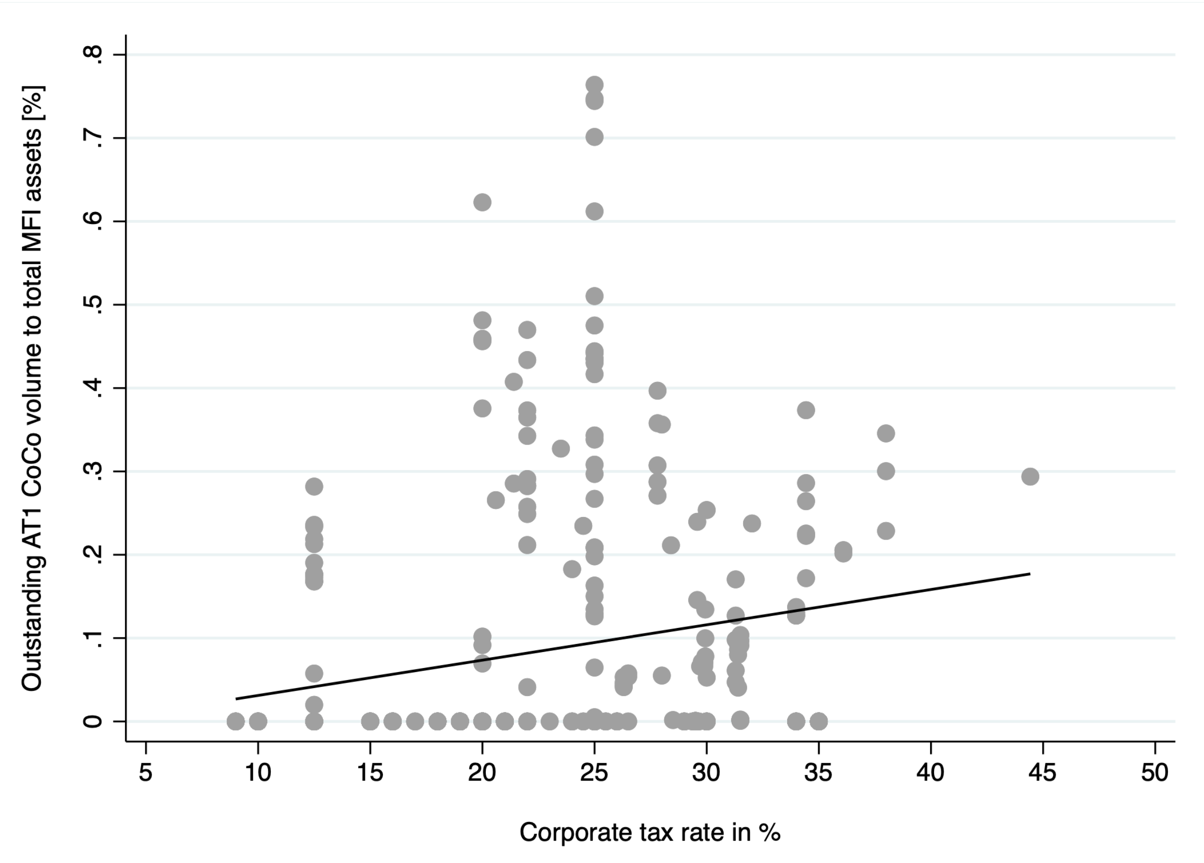
This figure shows the aggregated annual outstanding issue volume of CoCo bonds issued by publicly traded banks in the EU over the 2008 - 2021 sample period in billion euros that qualify as regulatory capital. CoCo bonds can either qualify as Additional Tier 1 (AT1) or Tier 2 (T2) capital and differ with respect to their loss absorption mechanism, i.e., write-down or equity conversion.

Figure 2: Issue activity in the EU CoCo bond market



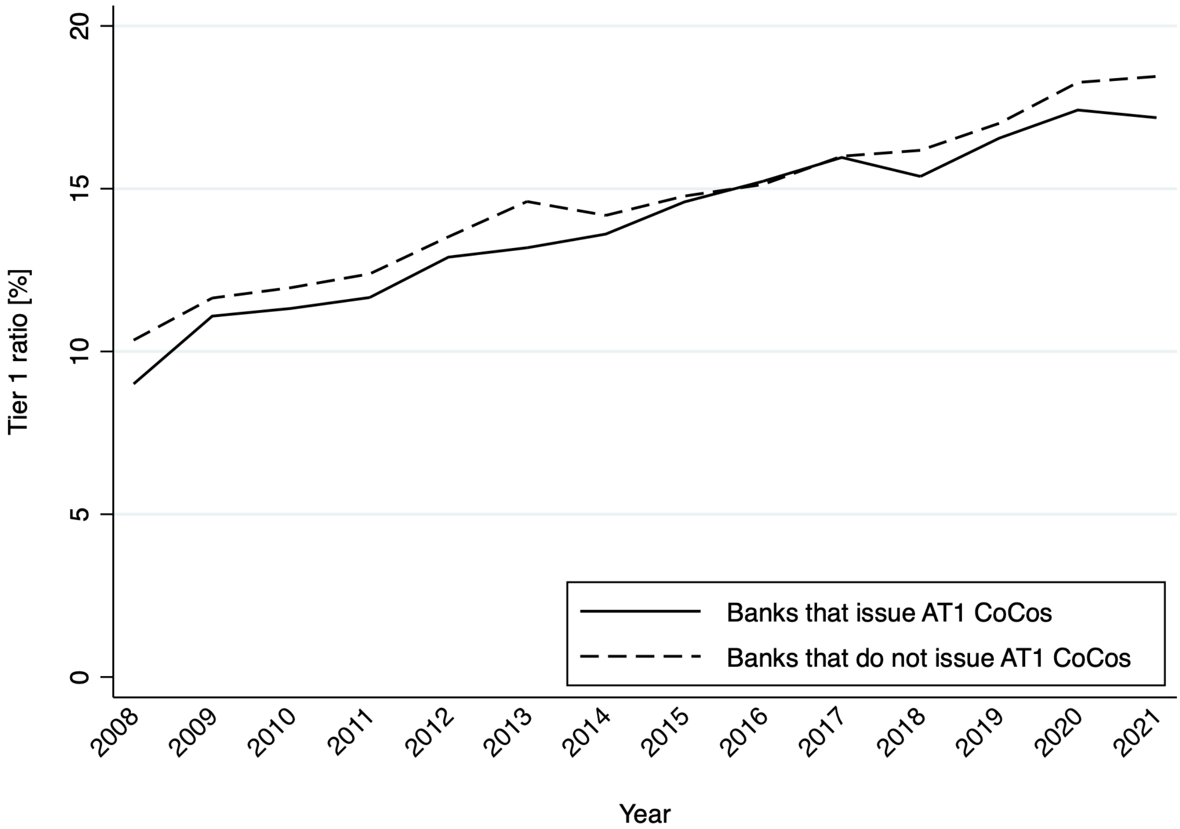
This figure shows the annual number of CoCo bond issues (bars, left-hand side) by publicly traded banks in the EU over the 2008 - 2021 sample period and the share of new issues attributable to the five most active banks over the entire period in % (line, right-hand side).

Figure 3: Annual outstanding AT1 CoCo bond volume and corporate income tax rates



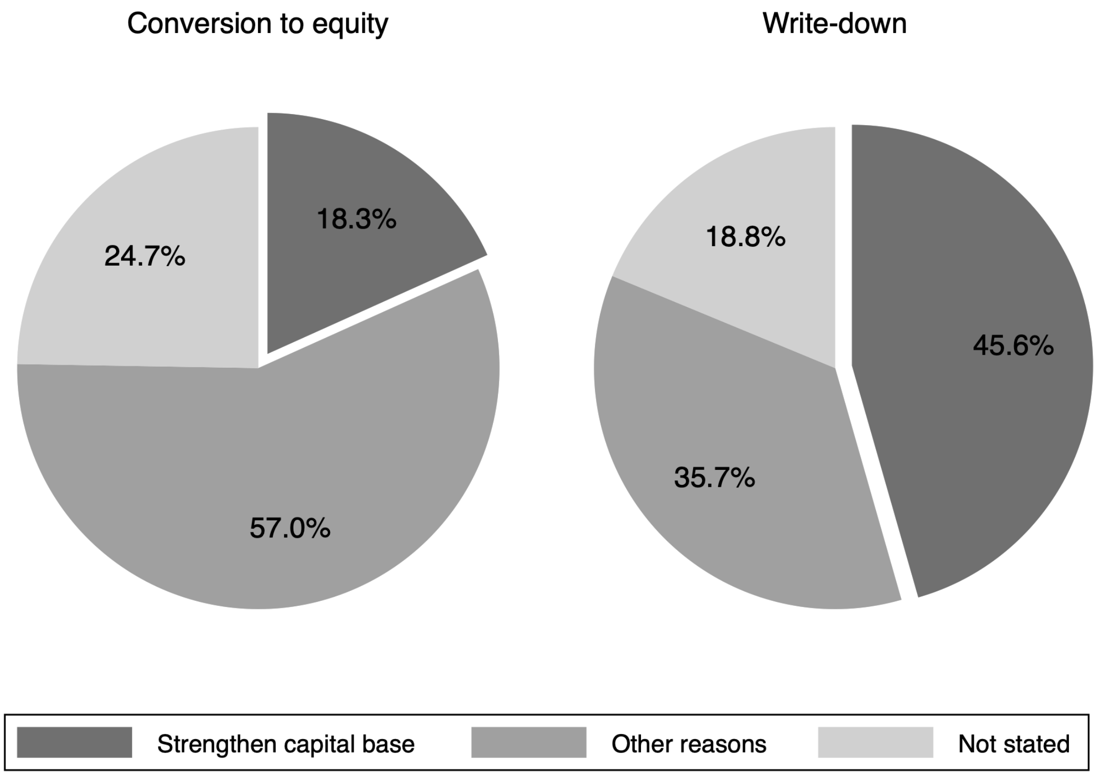
This figure displays the outstanding volume of AT1-qualifying CoCo bonds issued by listed banks in the EU from 2008 to 2021 per country-year scaled by the banking sector size (total MFI assets) in percent relative to the country- and year-specific corporate income tax rate.

Figure 4: Tier 1 ratio development of listed EU banks



This figure depicts the average Tier 1 ratio of listed banks in the EU that issued AT1 CoCos (solid line) over the 2008-2021 period vs. those that did not issue AT1 CoCos (dashed line).

Figure 5: Stated use of the proceeds from AT1 CoCo issues



The pie charts depict the different uses of proceeds specified in the prospectuses of AT1 CoCo bonds issued by publicly traded banks in the EU between 2008 and 2021. The left chart refers to the total issue volume of AT1 CoCos that convert to equity if triggered vs. loss absorption through write-down on the right-hand side. The category *strengthen capital base* includes all CoCos with stated use of proceeds like 'strengthen regulatory capital base', 'included in Tier 1 capital base', and 'strengthen the leverage ratio and MREL'. If the prospectus does not explicitly refer to strengthening the capital base but indicates what the use of proceeds is, the bond is included in the category *other reasons*. That, for example, includes 'general corporate purposes' and 'general financing purposes'.

Tables

Table 1: Summary statistics at the bank-level

Panel A: Full sample	**Mean**	**SD**	**Min**	**Max**	**N**
Outcome variables:					
ln(z-score)	3.45	1.16	0.23	5.66	1,289
ln(asset risk)	0.39	1.42	-7.82	9.45	1,604
RWA/Assets [%]	53.62	18.33	0.07	190.43	1,553
NPL ratio [%]	9.40	10.62	0.00	89.80	1,884
sd(ROAA)	0.63	0.98	0.03	5.75	1,307
sd(net inc.)	0.38	0.98	0.00	5.77	1,453
sd(AA)	3.97	10.88	0.00	79.69	1,273
Control variables:					
ln(assets)	16.20	2.21	8.33	21.51	1,905
Capital/Assets [%]	10.60	8.23	0.25	86.45	1,895
Llp/Int. inc. [%]	32.04	61.29	-343.56	865.53	1,855
Cost/Income [%]	64.12	33.98	-525.33	586.12	1,905
ROAA [%]	0.46	2.28	-42.23	20.26	1,840
Loans/Assets [%]	61.13	16.48	0.57	97.44	1,899
Tier 1/RWA [%]	14.57	4.86	0.50	47.10	1,395
Tier 1/Tot. capital [%]	87.19	10.65	43.73	100.00	1,345
BRRD dummy	0.44	0.50	0.00	1.00	1,905
CRD IV dummy	0.52	0.50	0.00	1.00	1,905
Corp. tax rate [%]	25.61	6.94	9.00	44.43	1,905
Panel B: Baseline estimation sample					
Outcome variables:					
ln(z-score)	3.43	1.10	0.23	5.66	834
ln(asset risk)	0.42	1.30	-7.82	9.45	739
RWA/Assets [%]	51.94	17.20	4.42	104.75	793
NPL ratio [%]	9.49	10.87	0.02	66.79	817
sd(ROAA)	0.55	0.80	0.03	5.75	834
sd(net inc.)	0.32	0.78	0.00	5.77	834
sd(AA)	3.48	10.61	0.00	79.69	818
Control variables:					
ln(assets)	16.50	1.93	11.53	21.50	834
Capital/Assets [%]	9.63	3.82	0.93	34.19	834
Llp/Int. inc. [%]	30.90	58.13	-304.13	693.95	834
Cost/Income [%]	63.11	22.19	-263.40	182.83	834
ROAA [%]	0.54	1.44	-21.10	8.91	834
Loans/Assets [%]	60.45	15.26	4.95	88.70	834
Tier 1/RWA [%]	15.04	4.53	0.50	34.94	834
Tier 1/Tot. capital [%]	88.17	10.11	53.53	100.00	834
BRRD dummy	0.57	0.49	0.00	1.00	834
CRD IV dummy	0.67	0.47	0.00	1.00	834
Corp. tax rate [%]	25.06	6.67	9.00	44.43	834

This table presents summary statistics for outcome and control variables in the pre-processed unbalanced bank panel from 2008 to 2021. Panel A refers to the entire sample. Panel B depicts the summary statistics for the bank-level observations used in the final baseline estimation, i.e., column (4) of Table 3, and all subsequent analyses. For details on how the variables are defined and on the data sources, see Table A.1 in the Appendix.

Table 2: Summary statistics - bond-level

Panel A: Full set of AT1 CoCo issues	**Mean**	**SD**	**Min**	**Max**	**N**
Issue vol. [mn EUR]	646.42	437.64	2.01	1,750.00	153
Write-down CoCos	574.21	434.99	2.01	1,750.00	102
Equity-conversion CoCos	790.85	410.01	70.72	1,500.00	51
Issue vol./Assets [%]	0.34	0.39	0.02	2.14	151
Write-down CoCos	0.38	0.42	0.02	2.14	100
Equity-conversion CoCos	0.25	0.32	0.04	1.46	51
Issue vol./Tot. capital [%]	4.33	4.05	0.48	19.63	144
Write-down CoCos	4.59	4.07	0.48	19.63	96
Equity-conversion CoCos	3.81	4.01	0.82	17.67	48
Issue vol. /AT1 capital [%]	70.70	130.19	5.26	1,054.21	105
Write-down CoCos	77.48	149.85	5.26	1,054.21	74
Equity-conversion CoCos	54.51	61.04	8.24	302.07	31
Panel B: Baseline estimation sample					
Issue vol. [mn EUR]	549.40	467.77	2.01	1,750.00	56
Write-down CoCos	507.76	479.10	2.01	1,750.00	38
Equity-conversion CoCos	637.32	443.01	70.72	1,500.00	18
Issue vol./Assets [%]	0.47	0.46	0.04	2.14	56
Write-down CoCos	0.49	0.46	0.05	2.14	38
Equity-conversion CoCos	0.42	0.48	0.04	1.46	18
Issue vol./Tot. capital [%]	6.20	4.91	0.82	19.63	56
Write-down CoCos	6.24	4.67	0.86	19.63	38
Equity-conversion CoCos	6.12	5.52	0.82	17.67	18
Issue vol. /AT1 capital [%]	91.81	101.63	6.58	475.38	32
Write-down CoCos	92.91	117.05	6.58	475.38	23
Equity-conversion CoCos	88.99	48.34	19.36	175.88	9

This table presents summary statistics for AT1 CoCos issued between 2008 and 2021 by EU listed banks. Panel A refers to the entire sample. Panel B depicts the summary statistics for all CoCos used in the final baseline estimation, i.e., column (4) of Table 3, and all subsequent analyses. For details on how the variables are defined and on the data sources, see Table A.1 in the Appendix.

Table 3: Impact of AT1 CoCo issuances on banks' distance to insolvency

Panel A: TW-FE model - reversible treatment	(1)	(2)	(3)	(4)
ATT	0.150*	0.110	0.093	0.056
	(0.080)	(0.076)	(0.090)	(0.094)
N	1,273	1,244	1,171	863
R^2	0.74	0.75	0.76	0.76
Panel B: TW-FE model - non-reversible treatment				
ATT	0.160	0.068	-0.004	-0.070
	(0.126)	(0.118)	(0.122)	(0.131)
N	1,273	1,244	1,171	863
R^2	0.74	0.75	0.75	0.76
Panel C: CS-DiD model - Event $ATT_{(-2,0)}$				
ATT	-0.164**	-0.185*	-0.185*	-0.261***
	(0.074)	(0.101)	(0.101)	(0.093)
N	1228	1198	1151	834
Panel D: CS-DiD model - Event $ATT_{(-2,1)}$				
ATT	-0.166**	-0.192**	-0.212**	-0.245***
	(0.082)	(0.090)	(0.099)	(0.094)
N	1228	1198	1151	834
Panel E: CS-DiD model - Event $ATT_{(-2,2)}$				
ATT	-0.159*	-0.217**	-0.239**	-0.292***
	(0.090)	(0.091)	(0.108)	(0.110)
N	1228	1198	1151	834
Bank size control	Yes	Yes	Yes	Yes
Country controls	Yes	Yes	Yes	Yes
CAMEL controls	No	Yes	Yes	Yes
First issues only	No	No	Yes	Yes
Regulatory capital controls	No	No	No	Yes

This table displays the average treatment effect on the treated from issuing CoCo bonds that qualify AT1 capital on banks' distance to insolvency (ln(z-score)). Panels A and B show the results for estimating the two-way fixed effect model specified in equation (1). The treatment dummy in panel A indicates whether the bank issued an AT1 CoCo in the previous year. For panels B-E, the dummy also remains one for all subsequent periods, i.e., the treatment is non-reversible. Panels C, D, and E show the results for estimating the ATT based on the difference-in-differences estimator for staggered treatment adoption by Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020) for different event windows. I control for bank size (ln(assets)) in all regressions. I further include dummies to control for the country-time-variation in implementing BRRD and CRD IV into national law and the corporate tax rate. In column (2), I add a set of standard bank-level controls (CAMEL) for capital adequacy (Capital/Assets), asset quality (Llp/Int. inc.), management capabilities (Cost/Income), earnings (ROAA), and liquidity (Loans/Assets). In column (3), I limit the post-treatment period to years before a bank issues another AT1 CoCo bond. In column (4), I add bank-level controls for regulatory capitalization (Tier 1/RWA) and capital quality (Tier 1/Tot. capital). All control variables are lagged. For details on how the variables are defined, see Table A.1 in the Appendix. All regressions include bank- and year-fixed effects. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Pre-treatement trend and placebo tests

Panel A: Pre-treatment ATTs	(1)
τ_{-1}	-0.319*
	(0.187)
τ_{-2}	-0.333
	(0.247)
τ_{-3}	0.218
	(0.264)
τ_{-4}	0.149
	(0.260)
N	834
Panel B: Placebo test - Event $\text{ATT}_{(-2,0)}$	
ATT	0.140
	(0.235)
N	651
Panel C: Placebo test - Event $\text{ATT}_{(-2,1)}$	
ATT	-0.050
	(0.258)
N	651
Panel D: Placebo test - Event $\text{ATT}_{(-2,2)}$	
ATT	-0.289
	(0.288)
N	651

This table presents the result for pre-treatment ATTs (Panel A) and placebo tests for different event windows (Panels C-E). The dependent variable is *ln*(z-score). All results are based on the DiD estimator for staggered treatment adoption by Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020), assuming the non-reversibility of treatment. I include the full set of controls (bank size, country controls, CAMEL, regulatory capital controls) and limit the sample to first issues only. For the placebo tests (Panels C-E), I only keep never-treated and not-yet-treated observations in my sample. I randomly choose a set of banks to issue a placebo CoCo in a randomly assigned year, such that the share of treated observation is approximately similar to the baseline case, i.e., 10%. In line with my baseline estimations, the placebo treatment is non-reversible. All control variables are lagged. For details on how the variables are defined, see Table A.1 in the Appendix. All regressions include bank- and year-fixed effects. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Impact of AT1 CoCo issuances on other bank-risk measures

Panel A: Event $ATT_{(-2,0)}$	(1)	(2)	(3)
ATT	0.059	-0.297	-0.742
	(0.091)	(0.566)	(0.653)
N	736	781	813
Panel B: Event $ATT_{(-2,1)}$			
ATT	0.051	-0.628	-0.456
	(0.086)	(0.607)	(0.814)
N	736	781	813
Panel C: Event $ATT_{(-2,2)}$			
ATT	0.060	-0.732	-0.299
	(0.093)	(0.665)	(1.074)
N	736	781	813
Outcome variable:	*ln*(asset risk)	RWA/Assets	NPL ratio

This table displays the average treatment effect on the treated from issuing CoCo bonds that qualify AT1 capital on different bank-risk measures, i.e., (1) *ln*(asset risk), (2) RWA/Assets, and (3) NPL ratio. All results are based on the DiD estimator for staggered treatment adoption by Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020), assuming the non-reversibility of treatment. I include the full set of controls (bank size, country controls, CAMEL, regulatory capital controls) and limit the sample to first issues only. All control variables are lagged. For details on how the variables are defined, see Table A.1 in the Appendix. All regressions include bank- and year-fixed effects. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Baseline results for differently estimated z-scores

Panel A: Event $ATT_{(-2,0)}$	(1)	(2)	(3)	(4)	(5)	(6)
ATT	-0.261***	-0.288***	-0.249***	-0.278***	-0.288	-0.376***
	(0.093)	(0.040)	(0.092)	(0.039)	(0.176)	(0.073)
N	834	834	834	834	810	810
Panel B: Event $ATT_{(-2,1)}$						
ATT	-0.245***	-0.272***	-0.228**	-0.258***	-0.319*	-0.323***
	(0.094)	(0.037)	(0.095)	(0.038)	(0.188)	(0.075)
N	834	834	834	834	810	810
Panel C: Event $ATT_{(-2,2)}$						
ATT	-0.292***	-0.328***	-0.272**	-0.313***	-0.382**	-0.366***
	(0.110)	(0.049)	(0.113)	(0.051)	(0.191)	(0.075)
N	834	834	834	834	810	810
Panel D: Summary statistics of *ln*(z-score)						
Mean	3.426	3.426	3.408	3.408	3.709	3.709
SD	1.103	1.103	1.112	1.112	1.339	1.339
Min	0.235	0.235	0.085	0.085	0.550	0.550
Max	5.661	5.661	5.661	5.661	7.814	7.814
Capital ratio numerator:	eq+hy	eq+hy	eq	eq	eq+hy	eq+hy
Estimation of *sd*(ROAA):	rw	rw	rw	rw	reg	reg
Estimation of SE:	asymp	wboot	asymp	wboot	asymp	wboot

This table presents robustness tests for the baseline results (column (1)) concerning the estimation choices related to the outcome variable *ln*(z-score). In columns (3)-(4), the numerator of the capital ratio used to calculate the z-score (cf. equation (4)) does not include hybrid capital. In columns (5)-(6), the estimation of *sd*(ROAA) is based on the regression specified in equation (5) vs. 5-year rolling windows in columns (1)-(4). Standard errors in columns (1), (3), and (5) are asymptotic vs. bootstrapped in columns (2), (4), and (6). All results are based on the DiD estimator for staggered treatment adoption by Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020), assuming the non-reversibility of treatment. Panels A-C present the results for different event windows. Panel D displays the summary statistics for the differently estimated z-scores in the regression samples. I include the full set of controls (bank size, country controls, CAMEL, regulatory capital controls) and limit the sample to first issues only. All control variables are lagged. For details on how the variables are defined, see Table A.1 in the Appendix. All regressions include bank- and year-fixed effects. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Decomposition of the baseline effect on banks' distance to insolvency

Panel A: Event $ATT_{(-2,0)}$	(1)	(2)	(3)	(4)	(5)	(6)
ATT	-0.261***	-0.037	0.161	0.150*	0.264**	-0.134
	(0.093)	(0.113)	(0.152)	(0.080)	(0.125)	(1.433)
N	834	834	834	834	834	800
Panel B: Event $ATT_{(-2,1)}$						
ATT	-0.245***	-0.026	0.176	0.159**	0.288**	-0.145
	(0.094)	(0.114)	(0.182)	(0.071)	(0.120)	(1.273)
N	834	834	834	834	834	800
Panel C: Event $ATT_{(-2,2)}$						
ATT	-0.292***	-0.023	0.229	0.174**	0.317**	-0.331
	(0.110)	(0.117)	(0.210)	(0.072)	(0.130)	(1.251)
N	834	834	834	834	834	800
Outcome variable:	*ln*(z-score)	ROAA	CA ratio	*sd*(ROAA)	*sd*(net I)	*sd*(AA)

This table presents the treatment effects of issuing AT1 CoCo bonds on the different components of banks' z-score (see column (1) for the baseline results). Columns (2) and (3) display the results for the components of the z-score numerator, i.e., ROAA and capital-to-assets ratio. Column (4) shows the treatment effects for the z-score denominator, i.e., the standard deviation of ROAA. The dependent variable in columns (5) and (6) are the standard deviation of net income and average assets, respectively. All results are based on the DiD estimator for staggered treatment adoption by Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020), assuming the non-reversibility of treatment. Panels A-C present the results for different event windows. I include the full set of controls (bank size, country controls, CAMEL, regulatory capital controls) and limit the sample to first issues only. All control variables are lagged. For details on how the variables are defined, see Table A.1 in the Appendix. All regressions include bank- and year-fixed effects. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Subcomponents of net income volatility: interest income and expenses

Panel A: Event $ATT_{(-2,0)}$	(1)	(2)	(3)
ATT	0.264**	-0.098	-0.142
	(0.125)	(0.084)	(0.107)
N	834	834	829
Panel B: Event $ATT_{(-2,1)}$			
ATT	0.288**	-0.070	-0.107
	(0.120)	(0.098)	(0.101)
N	834	834	829
Panel C: Event $ATT_{(-2,2)}$			
ATT	0.317**	-0.125	-0.144
	(0.130)	(0.100)	(0.091)
N	834	834	829
Panel D: Summary statistics of *outcome*			
Mean	0.315	0.413	0.373
SD	0.783	1.308	1.297
Min	0.001	0.000	0.000
Max	5.774	11.092	11.618
Outcome variable:	*sd*(net I)	*sd*(int I)	*sd*(int E)

This table presents the treatment effects of issuing AT1 CoCo bonds on the standard deviations of the interest subcomponents of net income (column (1)). Columns (2) and (3) display the results for the standard deviation of interest income and expenses, respectively. All results are based on the DiD estimator for staggered treatment adoption by Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020), assuming the non-reversibility of treatment. Panels A-C present the results for different event windows. Panel D displays the summary statistics for the outcome variables in the regression samples. Panels A-C present the results for different event windows. I include the full set of controls (bank size, country controls, CAMEL, regulatory capital controls) and limit the sample to first issues only. All control variables are lagged. For details on how the variables are defined, see Table A.1 in the Appendix. All regressions include bank- and year-fixed effects. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Table 9: Subcomponents of net income volatility: operating income and expenses

Panel A: Event $ATT_{(-2,0)}$	(1)	(2)	(3)	(4)	(5)	(6)
ATT	0.264**	-0.103	0.183**	-0.023	0.011	0.039*
	(0.125)	(0.076)	(0.088)	(0.018)	(0.015)	(0.022)
N	834	834	822	827	747	822
Panel B: Event $ATT_{(-2,1)}$						
ATT	0.288**	-0.031	0.150*	-0.016	0.021	0.039**
	(0.120)	(0.064)	(0.077)	(0.018)	(0.023)	(0.020)
N	834	834	822	827	747	822
Panel C: Event $ATT_{(-2,2)}$						
ATT	0.317**	0.010	0.144**	-0.021	0.027	0.052**
	(0.130)	(0.058)	(0.070)	(0.023)	(0.023)	(0.021)
N	834	834	822	827	747	822
Panel D: Summary statistics of *outcome*						
Mean	0.315	0.264	0.221	0.057	0.057	0.088
SD	0.783	0.773	0.515	0.154	0.165	0.288
Min	0.001	0.001	0.000	0.000	0.000	0.000
Max	5.774	7.167	4.139	1.224	1.163	2.766
Outcome variable:	sd(net I)	sd(op I)	sd(imp C)	sd(st E)	sd(adm E)	sd(oth E)

This table presents the treatment effects of issuing AT1 CoCo bonds on the standard deviations of the operating subcomponents of net income (column (1)). Columns (2) and (3) display the results for the standard deviation of operating income and impairment charges, respectively. Columns (4) - (6) present the results for the standard deviations of different operating expenses, i.e., staff, administrative, and other operating expenses. All results are based on the DiD estimator for staggered treatment adoption by Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020), assuming the non-reversibility of treatment. Panels A-C present the results for different event windows. Panel D displays the summary statistics for the outcome variables in the regression samples. Panels A-C present the results for different event windows. I include the full set of controls (bank size, country controls, CAMEL, regulatory capital controls) and limit the sample to first issues only. All control variables are lagged. For details on how the variables are defined, see Table A.1 in the Appendix. All regressions include bank- and year-fixed effects. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Table 10: Robustness of the baseline result to the sample selection

Panel A: Event $ATT_{(-2,0)}$	(1)	(2)	(3)	(4)	(5)
ATT	-0.261***	-0.280***	-0.310**	-0.230**	-0.181**
	(0.093)	(0.096)	(0.130)	(0.103)	(0.086)
N	834	805	731	792	715
Panel B: Event $ATT_{(-2,1)}$					
ATT	-0.245***	-0.272***	-0.241*	-0.249***	-0.160*
	(0.094)	(0.097)	(0.136)	(0.095)	(0.084)
N	834	805	731	792	715
Panel C: Event $ATT_{(-2,2)}$					
ATT	-0.292***	-0.306***	-0.238*	-0.254***	-0.203**
	(0.110)	(0.113)	(0.132)	(0.090)	(0.090)
N	834	805	731	792	715
Robustness check:	Baseline	Issues in 2014-2021	Issues in 2016-2021	Const. amount out	Not delisted

This table presents robustness tests for the baseline results (column (1)) concerning the sample selection. The outcome variable is *ln*(z-score) in all regressions. In column (2) and (3), I restrict the sample to AT1 CoCo issues from 2014-2021 and 2016-2021, respectively. In column (4), I drop all post-treatment observations once the outstanding bond volume changes. In column (5), I drop all banks delisted at some point in the 2008-2021 period. All results are based on the DiD estimator for staggered treatment adoption by Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020), assuming the non-reversibility of treatment. Panels A-C present the results for different event windows. I include the full set of controls (bank size, country controls, CAMEL, regulatory capital controls) and limit the sample to first issues only. All control variables are lagged. For details on how the variables are defined, see Table A.1 in the Appendix. All regressions include bank- and year-fixed effects. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Table 11: Robustness of the baseline result to bank-level confounders

Panel A: Event $ATT_{(-2,0)}$	(1)	(2)	(3)	(4)
ATT	-0.261***	-0.243***	-0.315***	-0.695**
	(0.093)	(0.094)	(0.117)	(0.353)
N	834	789	728	329
Panel B: Event $ATT_{(-2,1)}$				
ATT	-0.245***	-0.218**	-0.307***	-0.517*
	(0.094)	(0.094)	(0.110)	(0.306)
N	834	789	728	329
Panel C: Event $ATT_{(-2,2)}$				
ATT	-0.292***	-0.222**	-0.374**	-0.445
	(0.110)	(0.091)	(0.150)	(0.281)
N	834	789	728	329
Panel D: Summary statistics of *confounder*				
Mean	.	53.52	1.28	7.60
SD	.	17.21	6.05	2.32
Min	.	4.58	0.00	1.30
Max	.	104.75	126.38	16.03
Robustness check:	Baseline	RWA/ Assets	Charter value	Leverage ratio

This table presents robustness tests for the baseline results (column (1)) concerning additional bank-level confounders. The outcome variable is *ln*(z-score) in all regressions. In column (2), I replace the regulatory capital control variables with RWA/Assets. In column (3), I add an additional control for the banks' charter value to my baseline controls. In column (4), I add the regulatory leverage ratio to my baseline set of controls. All results are based on the DiD estimator for staggered treatment adoption by Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020), assuming the non-reversibility of treatment. Panels A-C present the results for different event windows. I include the full set of controls (bank size, country controls, CAMEL, regulatory capital controls) and limit the sample to first issues only. All control variables are lagged. For details on how the variables are defined, see Table A.1 in the Appendix. All regressions include bank- and year-fixed effects. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Table 12: Sensitivity of $\text{ATT}_{(-2,0)}$ on *ln*(z-score) to CoCo characteristics

Panel A: Sub-sample ATT	(1)	(2)	(3)	(4)	(5)
ATT_{sel}	-0.261***	-0.329***	-0.276***	-0.321***	-0.330***
	(0.093)	(0.097)	(0.090)	(0.105)	(0.107)
N	834	793	813	807	762
$\text{ATT}_{\text{non-sel}}$	-0.261***	-0.253**	-0.297***	-0.228**	-0.258***
	(0.093)	(0.112)	(0.102)	(0.113)	(0.098)
N	834	773	770	778	806
Chi2	.	1.36	0.12	1.67	1.94
p-value	.	0.24	0.73	0.20	0.16
Panel B: CoCo issues (*means*)					
Issue vol./Assets	0.671	0.206	0.638	0.559	0.293
Issue vol./Tot. cap.	7.888	3.232	7.486	6.753	3.446
Sample selection criteria:	Baseline	Issue/Assets <50%ile	WD mechanism	Low trigger level	Used for capital base

This table presents the treatment effects of issuing AT1 CoCo bonds on banks' *ln*(z-score) for subsamples of the treated dependent on characteristics of the issued bond. Column (1) presents the baseline results for the entire sample. In column (2), I do a median split with respect to issue volume to total assets. In columns (3) and (4), I differentiate between write-down (sel) vs. equity conversion (non-sel) and low trigger level (sel) vs. high trigger level (non-sel), respectively. In column (5), I select those CoCos for which the information about the use of proceeds in the prospectus includes any statement regarding strengthening the capital base. The table also presents the test statistics and p-values for a difference in the estimated treatment effects (H_0: $\text{ATT}_{\text{sel}} = \text{ATT}_{\text{non-sel}}$). All results are based on the DiD estimator for staggered treatment adoption by Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020), assuming the non-reversibility of treatment. Panel A presents the results for the (-2,0)-event window. Panel B displays the means of the characteristics of the selected CoCos. I include the full set of controls (bank size, country controls, CAMEL, regulatory capital controls) and limit the sample to first issues only. All control variables are lagged. For details on how the variables are defined, see Table A.1 in the Appendix. All regressions include bank- and year-fixed effects. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Table 13: Sensitivity of $ATT_{(-2,0)}$ on sd(ROAA) to CoCo characteristics

Panel A: Sub-sample ATT	(1)	(2)	(3)	(4)	(5)
ATT_{sel}	0.150*	0.190*	0.159*	0.200**	0.222**
	(0.080)	(0.100)	(0.086)	(0.093)	(0.111)
N	834	793	813	807	762
$ATT_{non\text{-}sel}$	0.150*	0.167*	0.217**	0.163	0.149*
	(0.080)	(0.098)	(0.104)	(0.105)	(0.090)
N	834	773	770	778	806
Chi2	.	0.63	3.55	1.36	4.41
p-value	.	0.43	0.06	0.24	0.04
Panel B: CoCo issues (*means*)					
Issue vol./Assets	0.671	0.206	0.638	0.559	0.293
Issue vol./Tot. cap.	7.888	3.232	7.486	6.753	3.446
Sample selection criteria:	Baseline	Issue/Assets <50%ile	WD mechanism	Low trigger level	Used for capital base

This table presents the treatment effects of issuing AT1 CoCo bonds on banks' sd(ROAA) for subsamples of the treated dependent on characteristics of the issued bond. Column (1) presents the baseline results for the entire sample. In column (2), I do a median split with respect to issue volume to total assets. In columns (3) and (4), I differentiate between write-down (sel) vs. equity conversion (non-sel) and low trigger level (sel) vs. high trigger level (non-sel), respectively. In column (5), I select those CoCos for which the information about the use of proceeds in the prospectus includes any statement regarding strengthening the capital base. The table also presents the test statistics and p-values for a difference in the estimated treatment effects (H_0: $ATT_{sel} = ATT_{non\text{-}sel}$). All results are based on the DiD estimator for staggered treatment adoption by Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020), assuming the non-reversibility of treatment. Panel A presents the results for the (-2,0)-event window. Panel B displays the means of the characteristics of the selected CoCos. I include the full set of controls (bank size, country controls, CAMEL, regulatory capital controls) and limit the sample to first issues only. All control variables are lagged. For details on how the variables are defined, see Table A.1 in the Appendix. All regressions include bank- and year-fixed effects. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Table 14: Sensitivity of $ATT_{(-2,0)}$ on *ln*(z-score) to bank characteristics

Panel A: Sub-sample ATT	(1)	(2)	(3)	(4)
ATT_{sel}	-0.261***	-0.321***	-0.340***	-0.331***
	(0.093)	(0.119)	(0.102)	(0.105)
N	834	794	802	788
$ATT_{non\text{-}sel}$	.	-0.379***	-0.289***	-0.290***
	.	(0.102)	(0.093)	(0.097)
N	.	777	775	782
Chi2	.	0.46	1.15	0.60
p-value	.	0.50	0.28	0.44
Panel B: Issuing bank characteristics (*means*)				
ln(assets)	17.50	15.55	18.19	17.86
Tot. capital/Assets	8.129	9.312	7.678	7.838
Llp/Int. inc.	24.69	14.96	32.29	25.75
Cost/Income	65.37	64.22	63.53	66.54
ROAA	0.490	0.806	0.357	0.479
Loans/Assets	58.48	59.59	60.48	51.83
Tier 1/RWA	14.62	15.15	12.21	14.82
Tier 1/Tot. capital	86.06	88.51	83.05	84.20
Sample selection criteria:	Baseline	*ln*(assets) <50%ile	Tier 1/RWA <50%ile	Loans/Assets <50%ile

This table presents the treatment effects of issuing AT1 CoCo bonds on banks' *ln*(z-score) for subsamples of the treated dependent on the characteristics of the issuing bank. Column (1) presents the baseline results for the entire sample. In columns (2) - (4), I do a median split with respect to *ln*(assets), Tier 1/RWA, and Loans/Assets, respectively. The table also presents the test statistics and p-values for a difference in the estimated treatment effects (H_0: $ATT_{sel} = ATT_{non\text{-}sel}$). All results are based on the DiD estimator for staggered treatment adoption by Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020), assuming the non-reversibility of treatment. Panel A presents the results for the (-2,0)-event window. Panel B displays the means of the characteristics of the selected CoCo-issuing banks. I include the full set of controls (bank size, country controls, CAMEL, regulatory capital controls) and limit the sample to first issues only. All control variables are lagged. For details on how the variables are defined, see Table A.1 in the Appendix. All regressions include bank- and year-fixed effects. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Table 15: Sensitivity of $\text{ATT}_{(-2,0)}$ on sd(ROAA) to bank characteristics

Panel A: Sub-sample ATT	(1)	(2)	(3)	(4)
ATT_{sel}	0.150*	0.243**	0.200**	0.205**
	(0.080)	(0.108)	(0.096)	(0.096)
N	834	794	802	788
$\text{ATT}_{\text{non-sel}}$	.	0.227**	0.184*	0.176*
	.	(0.103)	(0.097)	(0.101)
N	.	777	775	782
Chi2	.	0.05	0.63	0.60
p-value	.	0.82	0.43	0.44
Panel B: Issuing bank characteristics (*means*)				
ln(assets)	17.50	15.55	18.19	17.86
Tot. capital/Assets	8.129	9.312	7.678	7.838
Llp/Int. inc.	24.69	14.96	32.29	25.75
Cost/Income	65.37	64.22	63.53	66.54
ROAA	0.490	0.806	0.357	0.479
Loans/Assets	58.48	59.59	60.48	51.83
Tier 1/RWA	14.62	15.15	12.21	14.82
Tier 1/Tot. capital	86.06	88.51	83.05	84.20
Sample selection criteria:	Baseline	*ln*(assets) <50%ile	Tier 1/RWA <50%ile	Loans/Assets <50%ile

This table presents the treatment effects of issuing AT1 CoCo bonds on banks' sd(ROAA) for subsamples of the treated dependent on the characteristics of the issuing bank. Column (1) presents the baseline results for the entire sample. In columns (2) - (4), I do a median split with respect to *ln*(assets), Tier 1/RWA, and Loans/Assets, respectively. The table also presents the test statistics and p-values for a difference in the estimated treatment effects (H_0: $\text{ATT}_{\text{sel}} = \text{ATT}_{\text{non-sel}}$). All results are based on the DiD estimator for staggered treatment adoption by Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020), assuming the non-reversibility of treatment. Panel A presents the results for the (-2,0)-event window. Panel B displays the means of the characteristics of the selected CoCo-issuing banks. I include the full set of controls (bank size, country controls, CAMEL, regulatory capital controls) and limit the sample to first issues only. All control variables are lagged. For details on how the variables are defined, see Table A.1 in the Appendix. All regressions include bank- and year-fixed effects. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Appendix

Table A.1: Variable definitions

Variable	Definition	Source
Outcome variables:		
ln(z-score)	Logarithm of the z-score, i.e., the distance to insolvency defined as the sum of ROAA and the capital to asset ratio divided by the standard deviation of ROAA	Bankfocus & own calculations
ln(asset risk)	Logarithm of the product of the annualized stock volatility and the market leverage ratio, i.e., market capitalization divided by the sum of total liabilities and market capitalization	Bankfocus, Refinitiv & own calculations
RWA/Assets [%]	Ratio of risk-weighted assets to total assets	Bankfocus & own calculations
NPL ratio [%]	Ratio of non-performing loans to gross loans	Bankfocus
sd(ROAA)	Standard deviation of ROA over a five-year rolling window	Bankfocus & own calculations
sd(net I)	Standard deviation of net income over a five-year rolling window	Bankfocus & own calculations
sd(AA)	Standard deviation of average assets over a five-year rolling window	Bankfocus & own calculations
sd(int I)	Standard deviation of total interest income over a five-year rolling window	Bankfocus & own calculations
sd(int E)	Standard deviation of total interest expense over a five-year rolling window	Bankfocus & own calculations
sd(op I)	Standard deviation of operating revenues over a five-year rolling window	Bankfocus & own calculations
sd(imp C)	Standard deviation of total impairment charges over a five-year rolling window	Bankfocus & own calculations
sd(st E)	Standard deviation of staff expenses over a five-year rolling window	Bankfocus & own calculations
sd(adm E)	Standard deviation of other administrative expenses over a five-year rolling window	Bankfocus & own calculations
sd(oth E)	Standard deviation of other operating expenses over a five-year rolling window	Bankfocus & own calculations
Additional bank-level variables:		
ln(assets)	Logarithm of total assets	Bankfocus & own calculations
Capital/Assets [%]	Ratio of the difference between assets and liabilities to assets	Bankfocus & own calculations
Llp/Int. inc. [%]	Ratio of loan loss provisions to net interest revenues	Bankfocus
Cost/Income [%]	Ratio of total operating expenses to total operating income	Bankfocus
ROAA [%]	Ratio of net income to average assets	Bankfocus
Loans/Assets [%]	Ratio of loans to assets	Bankfocus
Tier 1/RWA [%]	Ratio of Tier 1 capital to risk-weighted assets	Bankfocus
Tier 1/Tot. capital [%]	Ratio of Tier 1 capital to total regulatory capital	Bankfocus & own calculations
Charter value	Ratio of the book value of assets minus equity plus the market value of equity to the book value of assets	Bankfocus, Refinitiv & own calculations

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Table A.1 – continued from previous page

Variable	**Definition**	**Source**
Leverage ratio [%]	Ratio of Tier 1 capital to total exposure	Bankfocus
CoCo bond-level variables:		
Issue vol. [mn EUR]	Issue amount in mn EUR	Refinitiv
Issue vol./Assets [%]	Ratio of issue amount to lagged total assets	Bankfocus, Refinitiv & own calculations
Issue vol./Tot. capital [%]	Ratio of issue amount to lagged total regulatory capital	Bankfocus, Refinitiv & own calculations
Issue vol. /AT1 capital [%]	Ratio of issue amount to lagged AT1 capital	Bankfocus, Refinitiv & own calculations
Country-level variables:		
BRRD dummy	Dummy = 1 if the key law implementing the Bank Recovery and Resolution Directive in a country has been published in the second half of the previous year or the first half of the current year	Koetter et al. (2022b)
CRD IV dummy	Dummy = 1 if the key law implementing the Capital Requirements Directive IV in a country has been published in the second half of the previous year or the first half of the current year	Koetter et al. (2022b)
Corp. tax rate	Country-specific corporate taxe rate in %	OECD & Tradingeconomics

Table A.2: Baseline results for varying event-window lengths

Panel A: Event $\text{ATT}_{(-2,3)}$	(1)	(2)	(3)	(4)
ATT	-0.220**	-0.185**	-0.235**	-0.302***
	(0.102)	(0.089)	(0.098)	(0.111)
N	1228	1198	1151	834
Panel B: Event $\text{ATT}_{(-3,2)}$				
ATT	-0.130*	-0.178**	-0.192**	-0.220**
	(0.071)	(0.080)	(0.088)	(0.102)
N	1228	1198	1151	834
Panel C: Event $\text{ATT}_{(-3,3)}$				
ATT	-0.184**	-0.155**	-0.193**	-0.231**
	(0.083)	(0.078)	(0.081)	(0.103)
N	1228	1198	1151	834
Bank size control	Yes	Yes	Yes	Yes
Country controls	Yes	Yes	Yes	Yes
CAMEL controls	No	Yes	Yes	Yes
First issues only	No	No	Yes	Yes
Regulatory capital controls	No	No	No	Yes

This table displays the average treatment effect on the treated from issuing CoCo bonds that qualify AT1 capital on banks' *ln*(z-score) for different event windows lengths. All results are based on the DiD estimator for staggered treatment adoption by Callaway and Sant'Anna (2021) and Sant'Anna and Zhao (2020). I control for bank size (*ln*(assets)) in all regressions. I further include dummies to control for the country-time-variation in implementing BRRD and CRD IV into national law and the corporate tax rate. In column (2), I add a set of standard bank-level controls (CAMEL) for capital adequacy (Capital/Assets), asset quality (Llp/Int. inc.), management capabilities (Cost/Income), earnings (ROAA), and liquidity (Loans/Assets). In column (3), I limit the post-treatment period to years before a bank issues another AT1 CoCo bond. In column (4), I add bank-level controls for regulatory capitalization (Tier 1/RWA) and capital quality (Tier 1/Tot. capital). All control variables are lagged. For details on how the variables are defined, see Table A.1 in the Appendix. All regressions include bank- and year-fixed effects. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

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