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Determinants of CoCo issuance: liquidity and risk incentives

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Abstract

Purpose – This paper aims to study the impact of (regulatory and nonregulatory) liquidity on contingent convertible (CoCo) issuance and the relationship between CoCos and asset quality.

Design/methodology/approach – The analysis of this study comprises two stages. In the first stage, the authors used a logit model to test whether banks with riskier assets as well as lower solvency and (regulatory and nonregulatory) liquidity are more likely to issue CoCos. In the second stage, the authors used univariate analysis and fixed effects regression to measure the impact of Additional Tier 1 (AT1) CoCos on the quality of the issuer's assets.

Findings – The study shows that regulatory liquidity ratios are negatively related to CoCo issuance. This study also finds that the likelihood to issue CoCo is higher when banks have lower regulatory capital or are less risky. Asset quality is found to not change significantly after the issuance. All in all, these results suggest that while solvency regulation is primarily regarded as the main motivation for CoCo issuance, liquidity regulation also matters.

Research limitations/implications – Despite the fact that CoCos have been emerging as an alternative way to help banks meet regulatory capital requirements, the paper argues that the relation between liquidity regulation and CoCos should be taken into account.

Originality/value – This study presents an empirical analysis on the CoCos instrument, focusing on the relationship between AT1 CoCos and liquidity regulation. Therefore, it serves to fill a gap in the literature on the underlying forces behind CoCo issuance. Moreover, this study measures the impact of AT1 CoCos issuance on bank risk, particularly on the quality of the issuer's assets.

Keywords CoCos, Contingent capital, Liquidity, Risk incentives

Paper type Research paper

1. Introduction

Contingent convertible (CoCos) are regulatory hybrid securities that aim at increasing the loss-absorbing capacity of banks. They convert into new equity or suffer a full or partial write-down in principal upon a trigger event. According to Basel III rules, CoCos can be classified as Tier 1 or Tier 2 capital instruments [1]. Unlike bailout instruments, CoCos are designed to contingently convert before financial institutions go bankrupt. Additionally, CoCos operate as a coupon paying bond if no trigger event applies. CoCos have been mainly issued by European banks. The Lloyds Banking Group was the first one in 2009. Shortly

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after, they received increased attention from Asian banks. However, American banks are not allowed to use CoCos. From 2009 to 2019, banks issued more than $550bn in CoCos globally. European banks allocated around €290bn, where write-down CoCos (full and partial) represented 54% and conversion-to-equity CoCos 46% [2].

By converting CoCos into new equity at a predetermined conversion rate, issuers have additional equity capital to shore up their loss absorption capacity. This rate can be set up on the market share price when the loss absorption mechanism is activated or on a predetermined price (typically the share price at the time of issuance) (Avdjiev *et al.*, 2013). As for the write-down mechanism, it could be partial or full based on the contract design and provide additional equity by reducing the prespecified value from the issuance amount. Overall, the likelihood of occurrence of these mechanisms depends on the trigger definition. CoCo triggers could be discretionary or bank-specific (mechanical trigger). A discretionary trigger (point of nonviability) occurs when the regulatory authorities realize that the issuers will be prone to insolvency or they are delayed in applying a prespecified trigger. Then, the loss absorption mechanisms either convert the CoCos to equity or write them down partially or fully. A mechanical trigger operates when regulatory capital ratio (CET1) falls below a certain threshold, known as "book value trigger" or if the market value of the bank falls below a certain threshold, known as "market value trigger" (Avdjiev *et al.*, 2013).

There are different views on the underlying forces behind CoCo issuance and their implications on the overall banking sector. It has been argued that they provide flexibility for banks to meet the regulatory capital requirements or to use them as a tax shield (Flannery, 2005, 2014; Pazarbasioglu *et al.*, 2011; Calomiris and Herring, 2013). CoCos, compared to regular equity, are complex securities to design and carry some risk to issuers. The conversion price of CoCos could be manipulated, particularly when the trigger is potentially reached (Admati *et al.*,2013). In this paper, we examine two issues associated with CoCo issuance in Europe. First, we investigate whether (regulatory and nonregulatory) liquidity is related to CoCo issuance. Second, we examine the impact of CoCo issuance on bank asset quality. The analysis is restricted to Additional Tier 1 (AT1) CoCos since Tier 2 CoCos are considered as regular bonds with defined maturity date, and do not receive an equity-like treatment by supervision. As far as we are aware, there is no empirical study on how regulatory liquidity affects CoCo issuance (either AT1 or T2). Additionally, unlike previous empirical studies that focus on the impact of CoCos issuance on bank funding risk by examining the effect of CoCo issue announcements on bank credit default swap (CDS) spreads, we examine the impact of AT1 CoCos on asset quality.

Our analysis relies on a sample of 413 banks across 16 European markets. Out of a total of 413 banks, 92 banks have issued CoCos from 2011 to 2018. There were 158 issuances of AT1 CoCos used in our analysis. Our findings reveal 112 out of 158 issuances with a write-down loss absorption mechanism, either temporary or permanent and 46 issuances with a conversion-to-equity loss absorption mechanism. As for the trigger level, we have 99 issuances with a trigger level equal to 5.125% and 59 issuances with a trigger level above 5.125%. Our empirical analysis comprises two stages. In the first stage, we use a logit model to examine whether banks with riskier assets, and lower solvency and (regulatory and nonregulatory) liquidity are more likely to issue CoCos. We compute the marginal effects at means then average the marginal effects to assess economic impact. In the second stage, we measure the impact of AT1 CoCos on assets quality using univariate analysis and panel fixed effects regression.

Our main findings suggest that banks with lower regulatory capital (Tier 1 and CET1) ratios are more likely to issue CoCos. Although CoCos are not originally designed to deal with liquidity problems, our results show that banks in Europe have not only used CoCos for regulatory capital considerations but also to meet tighter liquidity requirements. We find that banks with lower liquidity regulatory ratios are more likely to issue CoCos. Additionally, we do not find evidence of significant changes in asset quality after CoCo issuance.

The remainder of the paper is as follows: Section 2 surveys the main studies on CoCo issuance and builds the hypotheses. Data and the relevant summary statistics are provided in Section 3. Section 4 explains the empirical methodology. Section 5 discusses the main empirical results. Section 6 presents the robustness checks. Section 7 draws conclusions.

2. Literature background and hypotheses

2.1 The motivation for contingent convertible issuance

CoCos capital instruments provide additional equity capital for the sake of shore up the loss absorption capacity or reducing debt upon the occurrence of any trigger event. Regulators have progressively allowed financial institutions to use them after the financial crisis (Pennacchi *et al.*, 2014). As regulation and supervision have focused on covering unexpected future losses, contingent capital has gained ground. Basel III sets the conditions that banks must follow to use these instruments and the trigger events that identify the contingency. By the end of 2013, the Capital Requirements Directive (CRD IV) of the European Union set a list of criteria for CoCos to classify as AT1 capital instruments. Four main criteria were established. First, they must be written down or converted to equity when a prespecified trigger occurs. Second, they must be perpetual with a probability of redemption but not before five years after the date of issuance. Third, they must rank below Tier 2 instruments in the event of insolvency. Fourth, the mechanical trigger level must be at least 5.125% of Common Equity Tier 1 (CET1)/risk-weighted assets (RWA). However, a higher trigger level above 5.125% of CET1/RWA also is allowed under CRD IV package [3].

Theoretical literature on contingent capital instruments has covered key issues such as their optimal design, the calibration of trigger events and their implications on wealth transfers between CoCo holders and shareholders. With regard to the potential benefits of CoCos and trigger events, Albul *et al.* (2015) suggest that contingent capital instruments increase banks' ability to absorb losses during times of financial distress as they provide an additional capital buffer when they are triggered. They also demonstrate that CoCos increase bank value as their coupons are tax-deductible. Zeng (2014) also suggests that CoCos help meeting regulatory capital requirements, which, in turn, improves shareholder value. Jaworski *et al.* (2021) develop a model to determine the optimal share of write-down CoCos (AT1 CoCos) in banks' capital structure. They show that depending on the CoCos instrument profitability, the further issuance of these instruments may reduce the probability of bank failure. McDonald (2013) develops a model in which CoCos reduce the probability of default when the trigger level follows some specific conditions. In particular, the conversion-to-equity CoCos should have a dual trigger based on a potential fall in issuers share price, and the value of a financial institutions index is below a trigger value. He also shows that the primary benefit occurs when the issuers rely on these triggers over accounting-based indicator triggers, and also suggests that regulators should not interfere in the conversion decision. Gupta *et al.* (2021) show the ability of a conversion-to-equity CoCo to reduce the probability of bank failure, as well as mitigate systemic risk. They also show that the conversion-to-equity CoCo with a dual trigger is more effective than a CoCo with a single trigger to avoid bankruptcy. Pennacchi (2010) added to these benefits the ability of CoCos to reduce the moral hazard problem relative to the other debt instruments. In particular, CoCos mitigate the likelihood of a negative impact of financial distress on taxpayers via bailouts. He also points out CoCos would be a less costly method of reducing financial distress, especially when the trigger is set at a relatively high level of issuer's equity value. Ma and Nguyen (2021) developed a model to analyze the too big to fail and its optimal regulation. They find that issuing CoCos together with further regulation on capital requirements could address the too big to fail inefficiency, as CoCos provide an additional equity capital buffer when they are triggered.

Earlier studies also identify corporate governance problems in contingent capital issuance, including risk shifting and debt overhang. Berg and Kaserer (2015) and Chan and van Wijnbergen (2017) suggest that the design of CoCos creates some risk-shifting incentives [4]. They illustrate that other than dilutive debt to equity conversion, the wealth transfer between CoCos holders and shareholders of nondilutive debt to equity conversion, as well as the CoCos that are written down, result in risk shifting incentives for banks. In addition, they suggest that if the risk level is noncontractible, they can introduce a perverse risk shifting incentive to the issuers, which, in turn, generates financial distress and restrictions to issue simple equity. As for the potential debt overhang, Goncharenko (2022) focuses on the temporary write-down CoCos, unlike most prior studies that focus on conversion-to-equity CoCos. The main conclusion is that the temporary write-down CoCos could benefit shareholders at the trigger event but induce a perverse incentive effect before the write-down and even after the trigger event. He suggests that the status of temporary write-down CoCos as the component of bank capital structure should be revised. Oster (2020) offers a comprehensive review of the literature regarding theoretical and empirical research on CoCos.

While solvency and agency problems have been mostly identified as the main motivations for CoCo issuance, liquidity may also play a relevant role. Bleich (2014) develops a theoretical model that illustrates that loss absorption through partial write-down CoCos creates stress on the issuer's liquidity. In particular, when the trigger is breached, the issuers should pay cash to CoCo investors, and this may put the issuer liquidity under pressure.

Empirical research on CoCos is sparse and relatively recent. Hesse (2018) examines CoCo design and potential risk-taking incentives. His study focuses on CoCos that qualify as AT1 instruments from banks from the European Economic Area (EEA) plus Switzerland. He finds the write-down CoCos incorporate a yield premium relative to the conversion-to-equity CoCos. However, he also shows that this potential premium of the write-down CoCos is highly correlated with existing moral hazard problems of the issuers. Kind *et al.* (2021) investigate the determinants of AT1 CoCo spreads issued by Eurozone banks. They find that the maximum distributable amount (MDA) is negatively related to CoCos spreads, while CDS spreads positively affect the CoCos spreads [5]. They also find that conversion-to-equity CoCos and low trigger CoCos trade at significantly lower spreads than write-down CoCos, as well as those with a high-trigger level. Avdjiev *et al.* (2020) investigate why banks in the EEA issue CoCos. Their results show that the best-capitalized and larger banks are more likely to issue CoCos. Additionally, they analyze the impact of CoCo issuance on issuers CDS spreads, finding that CoCo issuance reduces CDS spreads in the case of AT1 CoCos, conversion-to-equity CoCos and CoCos that have mechanical triggers.

Goncharenko and Rauf (2016) examine CoCo issuance in the EEA and find that larger banks and those with high leverage, and lower risk are more likely to issue CoCos. They argue that capital constrained banks seek to enhance the return-on-equity as well as to meet the regulatory capital by using contingent capital. Goncharenko *et al.* (2017, 2021) investigate the agency problems associated with AT1 CoCos. They find that banks with lower asset volatility are more likely to issue them. In particular, they find that once the bank risk increases, the likelihood of issuing equity over CoCos also increases. Moreover, they argue that the agency cost would be higher for issuing CoCos over issuing equity. As a result, risker banks prefer to issue equity. Fiordelisi *et al.* (2020) empirically find that conversion-to-equity CoCos issued by European banks cause a decline in bank risk and stock return volatility. More specifically, their analysis shows that the reduction in stock return variance appears mainly in those banks that issued CoCos with a conversion-to-equity loss absorption mechanism in place. Williams *et al.* (2018) investigate the determinants of CoCo issuance for largest 150 banks that are issue them globally. They find that systemically risky banks and those with a higher proportion of bad loans are more likely to issue CoCos. They also find that earnings management practices have a secondary role on banks' decision to issue CoCos. Fajardo and Mendes (2020) examine the determinants of CoCos issuance on a global level. They find that larger banks are more likely to issue CoCos in all regions. They also find that highly levered banks in Brazil, Russia, India, China, and South Africa and other emerging markets are more likely to issue CoCos to meet the regulatory capital requirements. Petras (2020) analyzes the use of CoCos that qualify as AT1 instruments as a source of bank capital structure. He finds that the ratio of earnings per assets and loan loss provisions increased the issuance of CoCos. Additionally, he examines the impact of the usage of AT1 CoCos on a bank's profitability. He finds that CoCos increase the bank's profitability due to the tax issue advantage on CoCo coupons and the positive risk-shifting incentives.

The two empirical studies closest to ours are Avdjiev *et al.* (2020) and Goncharenko *et al.* (2017, 2021) who focus on European markets. They explore the determinants of CoCo issuance and their impact on risk-taking. While they primarily examine how capital regulations and bank risk affect CoCo issuance, we also look at liquidity regulations as a potential determinant. Pazarbasioglu *et al.* (2011) and Greene (2016) state that some specific design of CoCos may boost bank liquidity at times of stress. Duffie (2009) suggests that to alleviate the negative impact on the liquidity position upon conversion-to-equity CoCos, the time of trigger should work long before a liquidity crisis starts. As previously shown, other studies show that CoCos provide flexibility and reduce the probability of bankruptcy. However, these positive effects on liquidity may disappear if a CoCo trigger is activated. Duffie (2009) and Maes and Schoutens (2012) argue that regardless of the loss absorption capacity upon the trigger, CoCos do not generate additional cash when a predetermined trigger is downward tripped [6]. They also point out that they are unlikely to stop a liquidity crisis once it has begun. As most of the CoCos issued in EEA have write-down loss absorption mechanisms (either partial or full), this would imply, according to the theoretical analysis of Bleich (2014), that the partial write-down CoCos generate liquidity stress on the issuer upon the occurrence of any trigger. In particular, issuers should pay cash to the CoCo holders and this may happen at a time when their liquidity is under pressure.

Hence, despite the fact that CoCos are designed with the aim of improving bank capital and not to deal with other issues such as liquidity problems, there are some controversies about the role of liquidity regulations on CoCo issuance and on how are affected by CoCos conversion into equity. As this is ultimately an empirical issue, we, therefore, hypothesize that liquidity regulatory requirements will drive to some extent the decision of banks to issue CoCos. We use liquidity regulatory ratios to test this issue. In particular, our focus on some benefits of CoCos that include funded CoCos that provide cash at the time of issuance, net cash flow emerging from the net of tax-deductible on CoCos coupon [7] and the stop of paying interest on CoCos when a predetermined trigger is downward tripped, in which they may motivate banks to issue CoCos to meet liquidity requirements. However, we also use nonregulatory liquidity ratios capturing liquidity needs regardless of the regulatory requirement. Therefore, our first hypothesis is as follows:

H1. Banks with low regulatory liquidity ratios are more inclined to issue CoCos.

Based on the previous discussion, we argue that banks will increase their issuances of CoCos because they are, in theory, less costly than common equity; there is tax-deductibility advantage on the CoCos coupon; and they help meeting capital requirements. Then, to benchmark our analysis with previous research, we will also test whether banks with lower solvency ratios are more inclined to issue CoCos.

As for the impact of CoCo issuance on risk-taking incentives, several issues arise. Martynova and Perotti (2018) show that the reduction in the issuers leverage upon the trigger will reduce risk-taking if the trigger level is set properly. Hilscher and Raviv (2014) argue that with an appropriate conversion price of conversion-to-equity CoCos can lead to a reduction in risk-taking. Avdjiev *et al.* (2015, 2020) empirically find that depending on the design of CoCos, issuing CoCos generate risk reduction. However, it has been shown that issuing CoCos results in risk shifting incentives for banks in some specific case of CoCos such as nondilutive debt to equity conversion (Koziol and Lawrenz, 2012; Berg and Kaserer, 2015; Chan and van Wijnbergen, 2017) [8]. Banks may also prefer to issue CoCos because they are less costly than common equity and the tax issue advantage. Therefore, in light of the above discussions, our second hypothesis is as follows:

H2. Banks with lower asset quality are more inclined to issue CoCos.

3. Data

Our sample consists of bank-level data from the EEA plus Switzerland (hereafter, Europe). We focus on this region as it concentrates the majority of CoCo issuances. We collect data from different sources for the period 2011–2018 [9]. First, we select the largest 50 banks “ranked by assets” from 16 markets from the Orbis database [10]. We focus on the largest 50 banks in each market, as the bigger banks are more inclined to issue CoCos (Goncharenko and Rauf, 2016; Avdjiev *et al.*, 2020; Williams *et al.*, 2018), and face more pressure from regulatory authorities to rise their capital ratios. In addition, small banks rely more on internal funds and have less access to the capital markets. They also face higher transaction costs when they issue hybrid securities such as CoCo bonds (Titman and Wessels, 1988).

We collect information on all CoCo issuances available in the Dealogic –DCM database. We restrict our attention on CoCos that classify only as AT1 with trigger level equal to and above 5.125%. We eliminate the CoCos that have a defined maturity date. CoCo information includes issue date, trigger level, loss absorption mechanism (write-down CoCos either temporary write-down or permanent write-down and conversion-to-equity CoCos), issue size, coupon, currency (issuer local currency and dollar) and maturity date which is perpetual for all CoCos in our sample. As some of this information is missing for some CoCos in the Dealogic database, we extract them from supplementary sources such as the issuer annual reports and from CoCo certificates that are available on the issuer websites. We drop from the sample insurance firms and those banks that have more than two variables with missing values [11]. The final sample consists of 413 banks. Out of 413 banks, 92 banks issued 220 issuances, 158 issuances are used in our study because there are some banks have issued more than one instrument in the same year.

Table A1 reports the summary statistics of CoCos and their contract design. Write-down CoCos and conversion-to-equity CoCos represent 70.8% and 28.5%, respectively. As for the trigger level, CoCos with trigger levels equal to 5.125% represent 62.6%, while high-trigger CoCos represent 36.7%. The average coupon on these issues is 6% for write-down CoCos and 6.8% for conversion-to-equity CoCos. Overall, the majority of CoCo issuances in European markets have a write-down loss absorption mechanism (either partial or full) with a trigger level equal to 5.125% [12].

4. Methodology

4.1 Measuring the determinants of contingent convertible issuance

To test our hypotheses, we use a standard logit model that assesses differences between issuers and nonissuers, including time and country fixed effects and where standard errors are clustered at the bank level [13].

The baseline equation is expressed as follows:

$$P\left(\text{CoCo}_{i,t} = 1 | \text{X}_{i,t-1}, \text{Z}_{i,t-1}\right) = \Lambda\left(\alpha + \alpha_f + \beta_{\text{X}i,t-1} + \gamma_{\text{Z}i,t-1}\right) \quad (1)$$

where the outcome variable takes the value 1 if banks (i) issue at least one CoCo in year (t) and 0 otherwise, Xi are the explanatory factors capturing regulatory and nonregulatory indicators, while Zi includes a number of control variables. Λ is a logistic distribution function, α is an intercept and αf includes the time and country fixed effects. All the explanatory variables are lagged and are winsorized at the 1st and 99th percentiles.

In our empirical analysis, we offer estimation results for several models for both hypotheses. The differences between these models are the measures by which the hypotheses are used in the model, control variables, and the use of the year and country fixed effects. To test the quality of each estimated model, we apply various measures. First, we use the Pseudo R-Squared as a descriptive goodness-of-fit test. It is a useful measure to compare the goodness-of-fit with different models but cannot be used as a measure of goodness-of-fit for the overall model [14]. Second, we apply Hosmer and Lemeshow's goodness-of-fit test. This test assesses the extent to which the predictions of the logit model are calibrated to the data. A well-fitting model should show no significant difference between the model and the data (Hosmer and Lemeshow, 2000). Next, we apply the area-under-the-curve [AUC-a receiver operating characteristic curve (ROC)] measure to assess the predictability of each estimated model (DeLong *et al.*, 1988). The effective range of the AUC measure is from 0.5 to 1.0.

We also estimate the model with random effects to control for unobserved bank heterogeneity as a robustness check, as in most of earlier studies (Dinger and Vallascas, 2016; Goncharenko *et al.*, 2021). We use both time and country fixed effects and where standard errors are clustered at the bank level. As for the goodness-of-fit measures, Hosmer and Lemeshow's goodness-of-fit test cannot be used after random effects logit model. Thus, we apply Akaike's Information Criteria (AIC) and Bayesian Information Criteria (BIC).

We offer alternative definitions of liquidity and solvency to test the hypotheses. As for bank solvency regulatory ratios, we use CET1 and Tier 1 ratios. As for bank liquidity, we use regulatory and nonregulatory measures. First, we use the liquidity coverage ratio (LCR) implemented under the Basel III framework measured as "the value of high-quality liquid assets divided by net cash flows, over a 30-calendar day stress period [15]." Second, we use liquid assets to total assets and liquid assets to total deposits and short-term funding as the nonregulatory liquidity ratios. As for bank asset quality, we use two different indicators. In particular, we use both loan loss reserves over gross loans and impaired loans over gross loans. A loan loss reserve represents a cushion for credit losses, and hence, is a leading indicator of future impairment, while the impaired loans over gross loans ratio reflect the current asset quality.

As for the control variables, we follow Goncharenko and Rauf (2016) and Avdjiev *et al.* (2020). We use the natural logarithm of total assets to control for bank size, net loans over total assets to control for loan specialization, equity over total assets to control for banks leverage, return on assets and net interest margin (NIM) to control for banks performance and RWA over total assets to control for operational risk.

4.2 Contingent convertible issuance and bank risk-taking

The impact of CoCo issuance on bank risk-taking has been controversial due to the distinctive features that distinguish them from other hybrid securities. In this study, we aim to examine the impact of AT1 CoCos only on the asset side of the issuer. AT1 CoCos exhibit a number of conditions that may play an important role regarding bank risk-taking, unlike Tier 2 CoCos. To do so, we specify a panel fixed effects regression. The estimated equation is as follows:

$$\text{Asset Risk}_{i,t} = \alpha_{\text{i}} + \gamma^{*}\text{AT1COCOS}_{i,t} + \beta^{*}\text{X}_{i,t} + \epsilon_{i,t} \quad (2)$$

The dependent variable is the ratio of loan loss reserves to gross loans and impaired loans to gross loans of the issuer i in year t. AT1 CoCos is a dummy variable that takes the value 1 if the bank i issue at least one issuance in a year t and 0 otherwise, X is a vector of control variables, and αi and ϵ denote constant and error terms, respectively. All variables are winsorized at the 1st and 99th percentiles. As for the control variables, we use the natural logarithm of total assets to control for bank size, net loan over assets to control for loan specialization, equity over total asset ratio to control for banks leverage, total customer deposit over total asset to control for liquid liabilities, NIM to control for bank performance and the Tier 1 ratio to control for capital adequacy. Table A2 provides the summary statistics of the main variables including control variables [16].

5. Results

5.1 Baseline model: the impact of solvency on contingent convertible issuance

Table A3 shows the results of the analysis of the determinants of CoCo issuance as a benchmark to previous studies focusing on the impact of solvency. Columns (1)–(2) report the findings using Tier 1 as a broad measure of capitalization. The coefficient of the Tier 1 ratio is −6.912 and it is statistically significant at the 5% level. The negative sign suggests that banks with lower capital are more likely to issue CoCos. Columns (3)–(4) report the results using the CET1 ratio as a solvency indicator. The coefficient is −10.142 and is statistically significant at the 5% level. This supports the idea that banks with lower regulatory capital ratios are more likely to issue CoCos. To assess the economic significance of these estimates, we compute their marginal effects at means and average marginal effects. As shown in Columns (6)–(7), the marginal effect of Tier 1 ratio on the decision to issue CoCos is statistically significant and is equal to −0.178. This implies that 1% point increase in Tier 1 ratio is associated with a decrease of 0.178% points in the probability of CoCos issuance with the mean values for all the other variables. As for the CET1, we find that a 1% point increase in the CET1 decreases the probability of CoCo issuance by 0.356% points.

Overall, the results indicate, in line with the findings of Goncharenko and Rauf (2016) and Fajardo and Mendes (2020), that banks with lower regulatory capital ratios are more inclined to issue CoCo. This could imply that these banks attempt to meet capital requirements by issuing CoCos and substitute other debt instruments with them in their capital structure. These findings also correspond with the extant theory on why banks issue CoCos and which banks use CoCos as effective instruments for recapitalization in addition to boosting loss absorption capacity Basel III, Basel Committee on Banking Supervision (2010). As for the control variables, bank size is positively related to CoCo issuance and it is statistically significant at 1% across all models. This appears to suggest that larger banks are more likely to issue CoCos. The marginal effect shows that an increase of one unit in the logarithm of total assets in millions of euros is associated with an increase of 0.034% points in the probability of CoCos issuance. The finding concurs with prior studies (Goncharenko and Rauf, 2016; Avdjiev *et al.*, 2020; Williams *et al.*, 2018) that reveal larger banks are more inclined to issue CoCos. As shown in Column 3, the coefficient on return on average assets (ROAA) is positive and statistically significant at 1%. The marginal effect shows that the probability of issuing CoCos increases by 2.190% points per 1% point increase in ROAA. Overall, the evidence suggests more profitable banks are more likely to issue CoCos. The coefficient on RWA is negative and statistically significant at 1%, and this is consistent with the findings by Fajardo and Mendes (2020). We find that the probability of issuing CoCos decreases by 0.116% points per 1% point increase in RWA. However, the significant effect on the coefficients of ROAA and RWA is not found across all specifications.

5.2 Liquidity and contingent convertible issuance

Table A4 reports the results that test *H1*. This incorporates liquidity to the baseline model to check whether regulatory and nonregulatory liquidity have an impact on CoCo issuance. Columns (1)–(4) show the results when bank liquidity is measured by the LCR. The coefficient is negative and statistically significant. The marginal effect shows that the probability of issuing CoCos decreases by 0.028% points per each percentage point increase in LCR. This indicates that banks with lower regulatory liquidity are more likely to issue CoCos, which supports *H1*. Columns (5)–(7) report the findings using liquid assets over total assets and liquid assets over total deposits and short-term funding as nonregulatory liquidity ratios. We do not find a significant effect of these variables on CoCo issuance. This would suggest that only regulatory liquidity plays a role in CoCo issuance. As for the control variables, we include bank solvency indicator to this model. By using this indicator, we are able to separate out the effect of bank capital on the impact of bank liquidity on CoCos issuance. The finding is consistent with the previous result on the impact of banks solvency on CoCos issuance. The coefficients on total assets and ROAA are still positive and statistically significant. In line with the data from Goncharenko and Rauf (2016), we find that the coefficient on the ratio of total equity over total assets is negative and statistically significant in most specifications. The marginal effect shows that the probability of issuing CoCos decreases by 0.709% points per each percentage point increase in the total equity over total assets ratio.

Additionally, we measure the impact of liquidity regulations on CoCo issuance breaking down banks into two groups: more capitalized and less capitalized banks as suggested by the median of the CET1 ratio. Results are provided in Table A5. Columns (1)–(3) refer to more capitalized banks, while Columns (4)–(6) correspond to the findings for less capitalized banks. The coefficient on LCR is negative and statistically significant at 1% in all the specifications for Group 1. The marginal effect shows that the probability of issuing CoCos decreases by 0.017% points per each percentage point increase in LCR. This implies that more capitalized banks holding lower regulatory liquidity are more likely to issue CoCos. The negative sign on LCR coefficient for Group 2 is constant for all models, but the coefficient loses its significance when we control for bank size. All in all, these results lend further support to *H1* that banks with less regulatory liquidity change their debt funding structure by issuing CoCo bonds to meet liquidity requirements. In line with this theory, it appears that CoCos provide cash at the time of issuance. The net cash flow emerging from the tax-deductibles on CoCo coupons, and the stopping of interest payments on CoCos when a predetermined trigger is downward tripped seem to contribute to the decision to issue CoCos.

5.3 Contingent convertible issuance and asset quality

As for the tests of *H2*, the findings are reported in Table A6. Columns (1)–(2) show the results of the bank risk and CoCos issuance using impaired loans ratio, while Columns (3)–(4) report the results using loan loss reserve ratio. The estimated coefficients are −4.464 and −8.855, respectively, and statistically significant at the 5% level in most specifications. The marginal effect shows that the probability of issuing CoCos decreases by 0.128% points per each percentage point increase in impaired loans ratio and decreases by 0.244% points per each percentage point increase in loan loss reserve ratio. These estimates appear to suggest that riskier banks are less likely to issue CoCos, a finding that would lead us to reject *H2*. However, these results contradict the findings of Petras (2020) and Fajardo and Mendes (2020), but they are in line with the data from Goncharenko *et al.* (2017, 2021). One possible explanation is that before any trigger event occurs, CoCos operate as coupon paying bonds, which, in turn, may make riskier banks bear more costs, in addition to the existing risk related to issuing CoCos, such as debt overhang or agency problems. As for the control variables, the coefficient on bank size measure is again positive and statistically significant across all models. As for bank's profitability, the coefficient on NIM is positive and statistically significant. The marginal effect shows that the probability of issuing CoCos increases by 0.848% points per each percentage point increase in NIM [17].

We also examine the changes in bank risk-taking before and after CoCo issuance. Table A7 shows that the average impaired loan ratio is 4.90% before issuance and declines to 3.80% after the issuance. As for the loan loss reserves ratio, it is 2.63% before issuance and decreases to 1.94% after the issuance. The mean difference is statistically significant in all cases at 1%.

Table A8 examines the change in risk after CoCo issuance alongside with a set of control variables. Columns (1)–(3) show the results when bank risk is measured by loans loss reserve ratio. The coefficient on CoCo is statistically significant at 1% in all the specifications that include both banks and time fixed effects, and standard errors clustered at bank level. The results show a negative relationship between CoCo and the risk measures. This suggests that issuing CoCos reduce risk-taking. On the other side, Columns (4)–(6) show the results when bank risk is measured by impaired loans ratio. Overall, we do not find evidence of an ex post increase in bank risk-taking after CoCo issuance. The results show that issuing CoCos has no significant impact in reducing risk-taking incentives.

There are three possible interpretations of these results. First, risker banks in Europe are not inclined to hold CoCos in their capital structure. Intuitively, when less risky banks issue CoCos they seem to have more flexibility to control the potential risks. Second, although speculative in our empirical framework, the tax advantage of CoCos' coupon may play a role in reducing risk-taking. Third, CoCos have been emerging as an alternative way to helping banks meeting regulatory requirements. As noted previously, banks in Europe issuing CoCos for regulatory considerations, which, in turn, lead to use CoCos only for the sake of shore up the loss absorption capacity.

6. Robustness check

Our baseline estimations are based on a logit model with both time and country fixed effects and where standard errors are clustered at the bank level. However, to test the robustness of the logit regression results, we also estimate the model with random effects to control for unobserved bank heterogeneity adding also both time and country fixed effects. Overall, the main findings remain very similar. Table A9 reports the results of the impact of banks solvency on CoCos issuance. The coefficients on Tier 1 and CET1 remain negative and statistically significant at the 5% level. Table A10 reports the test of *H1*. The coefficient on

LCR is negative and statistically significant at 5% level across all models, while the coefficients on nonregulatory liquidity ratios are negative but still not significant. In fact, the random effect model shows a larger impact of liquidity regulations on the odds of issuing CoCos. As for the tests of *H2*, we include country fixed effect to the loan loss reserve model, unlike standard logit regression and the coefficients are still found to be negative and statistically significant at the 5% level in most model specifications as reported in Table A11. However, the coefficients on the control variables are similar to the previous regressions. Bank profitability and size indicators are found to have a positive effect coefficient and are statistically significant, while the coefficient on banks leverage is negative and statistically significant in most model specifications.

We also examine how CoCo design (write-down CoCos and conversion-to-equity CoCos) affect banks risk-taking, as suggested by some theoretical studies. Hence, we examine the impact of loss absorption mechanisms of CoCos on the risk-taking incentives of issuers at the time of issuance. To do so, we create dummy variables identifying each trigger mechanism. The first dummy equals 1 when the CoCos are issued as a write-down mechanism and 0 otherwise. The second dummy equals 1 when the CoCos are issued as equity conversion and 0 otherwise. The results are reported in Table A12. Overall, we do not find a statistically significant effect of these mechanisms on the risk-taking at the time of issuance. This suggests that the type of loss absorption mechanism have no impact on risk-taking.

7. Conclusion

CoCos capital instruments are hybrid securities that convert into common share or suffer a partial or full write-down in principal when a predetermined trigger is downward tripped. Precisely because CoCos are an innovative instrument that have gained ground since they were first issued in 2009, there are differing views on the underlying forces behind their issuance and their impact on bank risk. This study aims to investigate two issues associated with CoCo issuance. First, we explore if banks with riskier assets and lower regulatory liquidity and solvency are more likely to issue CoCos that qualify as AT1 instruments. To the best of our knowledge, this paper is the first to study how regulatory liquidity affects CoCo issuance (either AT1 or T2). Our analysis relies on a data set from the Dealogic and Orbis databases. This data set contains information on CoCos instrument and banks' characteristics. We rely on a sample of 413 banks across 16 European markets. Out of a total of 413 banks, 92 banks have issued CoCos. Using logit regression, we find that banks with lower regulatory requirements for capital and liquidity are more likely to issue CoCos, while nonregulatory liquidity ratios do not seem to affect CoCo issuance, providing support for *H1*. Contrary to our *H2*, our results show that less risky banks are more likely to issue CoCos.

Second, we measure the impact of AT1 CoCo issuance on bank risk-taking. We contribute to the literature regarding the relationship between CoCos and bank risk by examining the impact of AT1 CoCos on the issuer's asset quality. We use the ratio of loan loss reserves and impaired loans to gross loans as measures of asset risk. Using univariate analysis and panel fixed effect regression, the findings suggest there is no evidence that bank risk-taking increases after issuing CoCos. They also seem to indicate that issuing CoCos has no significant impact in reducing risk-taking. We also examine the impact of the loss absorption mechanisms of CoCos on issuers risk-taking. The results are not statistically significant, indicating that the type of loss absorption mechanisms of CoCos does not play a role in assessing the effect size on banks risk-taking.

Overall, these findings seem to have policy implications. At a time when regulators are focusing on increasing the availability of loss-absorption mechanisms for banks – when CoCos are being largely used – the relations between solvency, liquidity regulation and CoCos should be taken into account. While our approach is general in scope, we believe more in-depth analyses studying these relationships in times of stress, such as the period encompassing the COVID-19 pandemic, and with more granular information on risk and liquidity exposures, may provide further insight into these matters.

Notes

1. Under Basel III and CRD (IV), CoCo can be classified as either AT1 – "Going concern" CoCo or Tier 2 – "Gone concern" CoCo. CoCo (AT1) should be perpetual with trigger level equal to or above 5.125% in terms of the CET1 ratio, while CoCo with trigger level below 5.125% and has a defined maturity classified as Tier2. Indeed, in 2009, some CoCos issued with trigger level below 5.125% and they are legible for AT1 status, Basel III and CRD (IV) later set a new condition regarding trigger level.
2. Avdjiev *et al.* (2020), Dealogic database, Association for Financial Markets in Europe and our calculations.
3. Regulation (EU) No 575/2013 of the European Parliament and of the Council of June 26, 2013.
4. Berg and Kaserer (2015) do not suggest that CoCos should not be a component of a bank's capital structure. They suggest that it is important to set the conversion rate in such a way that does not encourage a redistribution of wealth from CoCo investors to shareholders upon trigger events. Similarly, Koziol and Lawrenz (2012) also show that the risk-shifting incentives from conversion-to-equity CoCos always increase relative to regular bonds. They suggest that its highly important to find a mechanism that prevents the risk-taking imposed by CoCo. Once this happens, CoCo will be a sufficient instrument for providing stability to the banks.
5. For more details about the MDA concept, see CRD V Article 141.
6. Prescott (2012) also demonstrates that even though conversion-to-equity CoCos increases the book value of equity, it does not provide new funds into a bank upon the conversion.
7. In most jurisdictions, the coupon on CoCo is tax-deductible. Recently, some governments have canceled this feature. For example, the Netherlands government announced at the end of June 2018 that the coupon on CoCo will not be tax-deductible as from January 2019. However, following theoretical literature, we assume that the coupon on our sample of CoCo is tax-deductible.
8. It is important to note that the relationship between CoCos and risk is critically depending on their specific design, including the timing of the trigger event.
9. The issuance of CoCos was rare in 2009 and 2010. According to the Dealogic – Debt Capital Markets (DCM) database, there are three issuances of CoCos. Two of these do not meet our sample conditions (AT1 CoCos with trigger level at least 5.125%). Moreover, even though Fiordelisi *et al.* (2020) state in their empirical study that the substantial CoCo issuances were from 2011 to 2017, we were not able to retrieve CoCo information after 2018 from the Dealogic database.
10. Austria, Belgium, Denmark, Estonia, France, Germany, Greece, Ireland, Italy, The Netherland, Norway, Portugal, Spain, Sweden, Switzerland and the UK. Greece and Estonia do not have any issuance in the Dealogic database.
11. There were some exceptions for some variables due to the nature of their data availability.

12. This is because write-down feature always induce a wealth transfer from CoCos holders to shareholders upon the occurrence of any trigger event.
13. Greene (2002) and Mckenzie (2002) discussed the issue of using fixed logit regression on this type of sample.
14. Pseudo R-Squared measure does not correspond to the R-Squared in linear regression. As there are different types of Pseudo R-Squared that have been used by different researchers, Veall and Zimmermann (1990) show that some Pseudo R-Squared yield values greater than others from the same data. However, based on our statistical package, this study used McFadden's pseudo-R squared. Moreover, some scholars recommend not using Pseudo R-Squared in logistic regression (Hosmer and Lemeshow, 2000; Hoetker, 2007).
15. The main liquidity regulations measure we aimed at investigating is the liquidity coverage ratio. In 2013, LCR – unlike the Net Stable Funding Ratio (NSFR) – was updated in terms of high-quality liquid assets (HQLA). This is happening at the same time when the new conditions on AT1CoCos have been applied as shown in Section 2.1. By using this indicator, we are able to see how these updated affect CoCos issuance that classify as AT1. Additionally, LCR is a short-term buffer and requires banks to hold enough HQLA, which, in turn, may contribute to banks decision to issue CoCos as they provide cash at the time of issuance. In any case, we reestimate our model using NSFR as a robustness purpose, but during the analysis, we had faced with the problem that we could not use all banks due to the lack of data on this ratio as we have only around 250 observations. However, as shown in appendix B table X, the coefficient on NSFR is negative across model and statistically significant in some model specifications which is matched the results of our main indicator of liquidity regulations.
16. All the variables are described in Table A13.
17. We report the results of the goodness-of-fit tests, together with the Log pseudo likelihood, *p*-value (chi2) and Pseudo R-Squared for each estimated model in the above Tables (A3–A6). The results show that the models fit the data well as indicated by the insignificant values of Hosmer–Lemeshow test. The predictive power in all models is excellent as indicated by the area under the ROC curve measure.

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Appendix 1. CoCos issuance results

Variable	Obs	Mean	SD	Min	Max
Panel A: All CoCos					
Amount issued(Million$)	158	862.462	905.603	1.063	4,742.844
Trigger level	157	0.058	0.009	0.051	0.08
Coupon%	130	6.352	1.802	1.7	11.875
Panel B: Only write-down – CoCos					
Amount issued(Million$)	111	671.459	765.877	1.063	4,742.844
Trigger level	112	0.056	0.008	0.051	0.08
Coupon%	85	6.085	1.765	1.7	9.5
Panel C: Only conversion-to-equity CoCos					
Amount issued(Million$)	45	1,331.853	1,052.824	60.497	4000
Trigger level	45	0.063	0.009	0.051	0.07
Coupon%	44	6.888	1.791	2	11.875
Panel D: Only higher-trigger CoCos above 5.125%					
Amount issued(Million$)	58	1,207.313	1,007.323	51.39	4,000
Trigger level	58	0.07	0.001	0.07	0.08
Coupon%	56	6.522	1.977	1.7	11.875
Panel E: Only CoCos with a trigger level equal to 5.125%					
Amount issued(Million$)	98	657.563	775.981	1.063	4,742.844
Trigger level	99	0.051	0	0.051	0.051
Coupon%	73	6.234	1.67	2	10.75

Notes: This table provides the summary statistics of the CoCos issued in Europe. Panel A lists the summary statistics of all the CoCos issued. Panel B provides the summary statistics of only write-down – CoCos, Panel C refers only to conversion-to-equity CoCos, Panel D provides information on CoCo issues with high-trigger level and Panel E covers CoCo issues with trigger level equal to5.125%

Table A1. Summary statistics of CoCos (and their contract design) issued in Europe during 2011–2018

Variable	Obs	Mean	Std. dev.	Min	Max
Tier 1	2,654	0.165	0.068	0.071	0.477
CET1	2,467	0.159	0.065	0.068	0.441
Liquid Asset	2,910	0.273	0.171	0.01	0.869
Liquid A/Dep	2,889	0.408	0.625	−0.079	9.245
LCR	1,002	2.017	1.239	0.82	7.327
Loan Loss Res	2,820	0.035	0.044	0	0.238
Impaired Loan	2,751	0.064	0.088	0	0.501
Net Loans	2,905	0.6	0.217	0.035	0.962
ROAA	2,910	0.005	0.009	−0.03	0.035
RWAs	2,539	0.454	0.196	0.07	0.958
Customer Depo	2,743	0.532	0.232	0.004	0.907
Total Assets(Million)	2,910	141,872.48	322,929.69	7.91	2,253,094.6
Equity/Assets	2,910	0.083	0.052	0.016	0.368
NIM	2,900	0.018	0.016	−0.001	0.106
NSFR	341	1.245	0.188	0.91	1.907

Table A2.
Summary statistics

Notes: This table provides the summary statistics of the variables considered in our analysis from 2011 to 2018. All variables are winsorized at the 1st and 99th percentile. Descriptive statistics

Table A3. Logit regression on the impact of bank solvency on the decision to issue CoCos (baseline model)

Dependent variable: AT1 CoCos	(1)	(2)	(3)	(4)	(6)	(7)
Independent variables						
Tier 1_{t-1}	−8.042*** (2.287)	−6.912** (3.502)			−0.178** (0.086)	−0.376** (0.188)
$CET1_{t-1}$			−6.194** (2.716)	−10.142** (3.938)	−0.356*** (0.130)	−0.627** (0.245)
Control variables						
Net $Loans_{t-1}$	−0.333 (0.557)	−0.776 (0.658)	0.552 (0.63)	−0.730 (0.685)	0.022 (0.025)	0.035 (0.039)
$ROAA_{t-1}$	23.688 (15.297)	26.679 (22.727)	53.039*** (17.75)	28.616 (23.131)	2.190*** (0.711)	3.386*** (1.159)
$RWAs_{t-1}$	−2.71*** (0.653)	0.853 (0.942)	0.286 (0.856)	0.608 (0.964)	−0.116*** (0.032)	−0.163*** (0.044)
Total $Assets_{t-1}$		0.642*** (0.101)	0.543*** (0.086)	0.63*** (0.102)	0.022*** (0.003)	0.034*** (0.006)
_cons	−2.958*** (1.137)	−12.487*** (2.147)	−7.878*** (1.396)	−8.016*** (1.611)		
Observations	2115	2043	1821	1765		
Pseudo R^2	0.081	0.227	0.154	0.21		
H-L	0.831	0.682	0.174	0.460		
ROC	0.727	0.845	0.792	0.832		
Log pseudolikelihood	−478.51501	−398.33952	−417.36018	−386.39255		
p-value (chi2)	0.000	0.000	0.000	0.000		
Time fixed effect	Yes	Yes	Yes	Yes		
Country fixed effect	No	Yes	No	Yes		

Notes: Cluster-robust standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. This table shows the coefficients and the marginal effects of the baseline logit regressions examining the impact of bank solvency on the issuance of the AT1 CoCos in Europe between 2011 and 2018. The dependent variable is a dummy which is equal to 1 when a bank issue CoCos in a given year and 0 otherwise. The variables of interest are the ratio of total Tier 1 capital to risk-weighted assets (RWA) and the ratio of bank Common Equity Tier 1 (CET1) to RWA. Control variables are the proportion of bank net loans to its total assets, the return on average assets (ROAA), the ratio of RWA to total assets and the natural logarithm of bank total assets. All explanatory variables are winsorized at the 1st and 99th percentile and lagged one year. Standard errors are clustered at the bank level. Columns 1–4 report the coefficients for the logit regressions, Column 6 reports the results of marginal effects at means and Column 7 reports the results of average marginal effects

Table A4.
Logit regression on the impact of bank regulatory and nonregulatory liquidity on the decision to issue CoCos – Testing *H1*

Dependent variable: AT1 CoCos	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Independent variables									
LCR_{t-1}	−0.466** (0.209)	−0.295* (0.154)	−0.472** (0.206)	−0.314* (0.182)				−0.028** (0.011)	−0.039** (0.017)
Liquid $Asset_{t-1}$					−0.421 (0.758)	−0.368 (0.758)		−0.014 (0.029)	−0.022 (0.046)
Liquid A/Dep_{t-1}							−0.119 (0.144)	−0.003 (0.004)	−0.007 (0.008)
Control variables									
$Equity/Assets_{t-1}$	−11.348* (6.408)	−4.522 (5.343)	−11.919* (6.28)					−0.709* (0.377)	−0.998* (0.535)
$CET1_{t-1}$				−11.63** (4.68)	−5.406** (2.259)	−6.343** (2.466)	−10.61*** (3.557)	−0.252*** (0.095)	−0.390** (0.152)
Total $Assets_{t-1}$	0.523*** (0.137)	0.513*** (0.128)	0.501*** (0.135)	0.543*** (0.122)	0.449*** (0.074)	0.508*** (0.075)	0.618*** (0.093)	0.298*** (0.007)	0.042*** (0.011)
$ROAA_{t-1}$	62.727 (39.67)	73.413** (31.597)	63.538 (39.106)	38.03 (25.028)		53.869*** (15.917)	29.986 (20.027)	2.141*** (0.608)	3.313*** (1.004)
Net $Loans_{t-1}$		0.51 (0.658)	−0.552 (0.771)	−0.643 (0.942)				−0.032 (0.046)	−0.046 (0.064)
_cons	−6.551*** (1.763)	−7.549*** (1.873)	−5.958*** (1.755)	−5.603*** (1.712)	−6.04*** (1.021)	−6.877*** (1.037)	−7.863*** (1.198)		
Observations	728	748	728	707	1931	1931	1853		
Pseudo R^2	0.183	0.138	0.184	0.19	0.138	0.152	0.207		
H-L	0.737	0.428	0.139	0.463	0.374	0.850	0.835		
ROC	0.803	0.804	0.768	0.808	0.774	0.791	0.834		
Log pseudolikelihood	−207.73711	−207.47829	−221.19477	−203.90527	−437.22495	−429.94602	−397.45115		
p-value (chi2)	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Country fixed effect	Yes	No	Yes	Yes	No	No	Yes		

Notes: Cluster-robust standard errors are in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. This table reports the coefficients and the marginal effects of the logit regressions explaining the impact of bank liquidity on the issuance of AT1CoCos in Europe between 2011 and 2018. The dependent variable is a dummy which is equal to 1 when a bank issue CoCo in a given year and 0 otherwise. The variables of interest are the regulatory liquidity coverage ratio (LCR) measured as high-quality liquid assets divided by net cash flows, over a 30-calendar day stress period and two nonregulatory liquidity ratios: liquid assets over total assets and liquid assets over total deposits and short-term funding. Control variables are total equity over total assets, the ratio of bank Common Equity Tier 1 (CET1) to risk-weighted assets, the natural logarithm of bank total assets, the return on average assets (ROAA) and Net Loans as the proportion of bank net loans to total assets. All explanatory variables are winsorized at the 1st and 99th percentile and one year lagged. Standard errors are clustered at the bank level. Columns (1–7) report the coefficients for the logit regressions, Column (8) reports the results of marginal effects at means and Column (9) reports the results of average marginal effects

Table A5. Logit regression on the impact of bank liquidity regulations on the decision to issue CoCos at more capitalized and less capitalized banks

Dependent variable: AT1 CoCos	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Independent variable							
LCR_{t-1}	−1.179*** (0.346)	−0.475*** (0.18)	−1.138*** (0.33)	−0.638* (0.375)	−0.051 (0.251)	−0.163 (0.247)	−0.017** (0.009)
Control variables							
Equity/Assets $_{t-1}$	−57.99*** (19.292)	−19.383*** (6.132)	−55.951*** (18.93)	−7.827 (9.291)	8.315 (9.254)	−1.621 (12.276)	−0.861*** (0.316)
Total Assets $_{t-1}$	0.429*** (0.15)	0.338* (0.201)	0.419*** (0.152)		0.627*** (0.181)	0.574*** (0.212)	0.006* (0.003)
$ROAA_{t-1}$	170.055** (61.901)	137.083*** (36.69)	154.17** (59.853)	34.732 (34.953)	39.225 (38.09)	55.864 (56.247)	2.374*** (1.030)
Net $Loans_{t-1}$		0.933 (0.854)	−0.989 (1.256)		0.916 (1.27)	0.325 (1.74)	−0.015 (0.022)
_cons	−2.927 (1.984)	−5.116* (2.637)	−2.021 (2.32)	−0.673 (1.024)	−10.144*** (2.956)	−8.314** (3.476)	
Observations	324	390	324	342	348	342	
Pseudo R^2	0.312	0.14	0.315	0.103	0.131	0.164	
H-L	0.387	0.186	0.152	0.746	0.209	0.879	
ROC	0.880	0.781	0.880	0.730	0.757	0.780	
Log pseudolikelihood	−67.146173	88.814448	−66.907885	−130.82831	−127.60377	−121.85303	
p-value (chi2)	0.000	0.000	0.000	0.000	0.016	0.000	
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	
Country Fixed Effect	Yes	No	Yes	Yes	No	Yes	

Notes: Cluster-robust standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. This table shows the coefficients and the marginal effects of the logit regressions exploring the impact of bank liquidity on the issuance of AT1CoCos offering a breakdown for more capitalized and less capitalized banks in Europe between 2011 and 2018. The dependent variable is a dummy which is equal to 1 when a bank issue CoCo in a given year and 0 otherwise. The variable of interest is regulatory liquidity coverage ratio (LCR) measured as "high quality liquid assets divided by net cash flows, over a 30-calendar day stress period." Control variables are total equity over total assets, the natural logarithm of bank total assets, the return on average assets (ROAA) and the proportion of bank net loans to total assets. All explanatory variables are winsorized at the 1st and 99th percentile and are lagged one year. Standard errors are clustered at the bank level. Columns 1, 2 and 3 report the coefficients for more capitalized banks; Columns 4–6 report the coefficients for the logit regressions for less capitalized banks and Column 7 reports the marginal effects

Table A6.
Logit regression on the impact of bank asset quality on the decision to issue CoCos – Testing *H2*

Dependent variable: AT1 CoCos	(1)	(2)	(3)	(4)	(5)	(6)
Independent variables						
Impaired Loan$_{t-1}$	−4.464** (1.804)	−1. 199 (1.382)			−0.128** (0.056)	−0.226** (0.095)
Loan Loss Res$_{t-1}$			−6.822** (3.176)	−8.855** (3.871)	−0.244** (0.116)	−0.443** (0.200)
Control variables						
Net Loans$_{t-1}$	0.316 (0.604)	−0.697 (0.636)	0.793 (0.537)	0.454 (0.575)	0.009 (0.017)	0.016 (0.304)
Total Assets$_{t-1}$	0.522*** (0.084)	0.6*** (0.099)	0.518*** (0.086)	0.525*** (0.084)	0.015*** (0.002)	0.026*** (0.005)
Equity/Assets$_{t-1}$	−2.254 (3.413)	−6.736 (4.154)	2.812 (2.439)	−2.82 (3.385)	−0.064 (0.098)	−0.114 (0.173)
NIM$_{t-1}$	29.523*** (8.028)	29.113*** (8.109)		29.195*** (7.999)	0.848*** (0.233)	1.497*** (0.420)
_cons	−10.629*** (1.512)	−11.149*** (1.533)	−10.76*** (1.498)	−10.711*** (1.493)		
Observations	2362	2273	2429	2425		
Pseudo R^2	0.168	0.213	0.159	0.171		
H-L	0.901	0.768	0.628	0.455		
ROC	0.808	0.841	0.812	0.801		
Log pseudolikelihood	−444.25941	−416.15319	−450.37204	−457.41197		
p-value (chi2)	0.000	0.000	0.000	0.000		
Time Fixed Effect	Yes	Yes	Yes	Yes		
Country Fixed Effect	No	Yes	No	No		

Notes: Cluster-robust standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. This table reports the coefficients and marginal effects of the logit regressions explaining the issuance of AT1CoCos and banks assets quality in Europe between 2011 and 2018. The dependent variable is a dummy which is equal to 1 when a bank issue a CoCo in a given year and 0 otherwise. The variables of interest are Loan loss reserves to gross loans and Impaired loans to gross loans. Control variables are the proportion of bank net loans to total assets, the natural logarithm of bank total assets, total equity over total assets and the net interest margin (NIM). All explanatory variables are winsorized at the 1st and 99th percentile and are lagged one year. Standard errors are clustered at the bank level. Columns 1–4 report the coefficients for the logit regressions, Column 5 reports the results of marginal effects at means and Column 6 reports the marginal effects

Table A7.
Univariate statistics on the impact of CoCo issuance on bank risk before and after issuance (issuers only sample)

Risk measures	(1) Before issuance	(2) After issuance	(3) Differences
Loan Loss Res	0.0263 (0.0007)	0.0194 (0.0008)	−0.006*** (0.001)
Impaired Loans	0.049 (0.0013)	0.038 (0.0016)	−0.011*** (0.002)

Notes: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. This table reports a univariate analysis on how bank risk-taking is affected before and after CoCo issuance. We focus only on the issuers sample

Table A8. Fixed effects regression on the impact of CoCo issuance on bank risk [equation (2)]

Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
Independent variable						
CoCos	−0.003*** (0.001)	−0.003*** (0.001)	−0.002* (0.001)	−0.004* (0.002)	−0.003 (0.002)	−0.001 (0.002)
Control variables						
Total Assets		0.003 (0.004)	−0.008 (0.005)	−0.003 (0.006)	0.007 (0.007)	−0.007 (0.006)
Net Loans		−0.036** (0.016)	−0.045** (0.018)	−0.051 (0.036)	−0.031 (0.037)	−0.057 (0.044)
Customer Depo		−0.005 (0.013)	−0.009 (0.015)	−0.031 (0.025)	−0.024 (0.025)	−0.026 (0.024)
NIM		0.174 (0.245)	0.132 (0.241)	0.207 (0.435)	−0.272 (0.466)	−0.049 (0.539)
Equity /Assets		0.149** (0.075)		0.13 (0.124)	0.237* (0.135)	
Tier 1			−0.039 (0.029)			−0.044 (0.057)
_cons	0.028*** (0.001)	0.009 (0.046)	0.141** (0.057)	0.125* (0.073)	0.008 (0.084)	0.18** (0.075)
Observations	2,820	2,665	2,458	2,608	2,608	2,409
R-Squared	0.062	0.096	0.097	0.017	0.069	0.077
Time Fixed Effect	Yes	Yes	Yes	No	Yes	Yes
Cluster	Bank	Bank	Bank	Bank	Bank	Bank

Notes: Cluster-robust standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. This table provides the results of a panel regression with bank and time fixed effects explaining the impact of CoCo issuance on risk-taking incentives of issuers during 2011 to 2018. The dependent variables are Loan loss reserves to gross loans (Columns 1, 2 and 3) and Impaired loans to gross loans (Columns 4, 5 and 6). The variable of interest is CoCo issuance, a dummy that takes the value 1 when a bank issue CoCos in a given year and 0 otherwise. Control variables are the natural logarithm of bank total assets, the proportion of bank net loans to total assets, total customer deposits to total assets, the net interest margin (NIM), total equity over total assets and bank Tier 1 to risk-weighted assets. All variables are winsorized at the 1st and 99th percentile

Appendix 2. Robustness checks

Dependent variable: AT1 CoCos	(1)	(2)	(3)	(4)
Independent variables				
Tier 1_{t-1}	−11.535*** (3.883)	−9.11** (4.595)		
$CET1_{t-1}$			−8.502** (3.629)	−11.713** (4.759)
Control variables				
Net $Loans_{t-1}$	0.189 (0.777)	−0.742 (0.789)	1.064 (0.74)	−0.669 (0.8)
$ROAA_{t-1}$	27.134 (22.781)	17.971 (25.705)	50.438** (22.88)	20.162 (27.064)
$RWAs_{t-1}$	−3.372*** (1.092)	0.98 (1.157)	0.089 (1.092)	0.786 (1.227)
Total $Assets_{t-1}$		0.695*** (0.112)	0.559*** (0.1)	0.685*** (0.114)
_cons	−4.725*** (1.429)	−14.322*** (2.383)	−8.579*** (1.664)	−9.28*** (1.939)
/lnsig2u	1.359*** (0.218)	0.559** (0.269)	0.78*** (0.262)	0.515* (0.286)
AIC	879.285	816.374	815.805	792.972
BIC	934.368	962.551	881.890	929.869
Observations	2,115	2,043	1,821	1,765
Time Fixed Effect	Yes	Yes	Yes	Yes
Country Fixed Effect	No	Yes	No	Yes

Notes: Cluster-robust standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. This table reports the results of the random effects logistic regression explaining the issuance of the AT1CoCos and bank solvency in Europe between 2011 and 2018. The dependent variable is a dummy which is equal to 1 when a bank issue CoCo in a given year and 0 otherwise. The variables of interest are the ratio of total Tier 1 capital to risk-weighted assets (RWA) and the ratio of bank Common Equity Tier 1 (CET1) to RWA. Control variables are the proportion of bank net loans to its total assets, the return on average assets (ROAA), RWA to total assets and the natural logarithm of bank total assets. All explanatory variables are winsorized at the 1st and 99th percentile and are lagged one year. Standard errors are clustered at the bank level

Table A9. The impact of bank solvency on the decision to issue CoCos. A logit random effects model

Table A10. The impact of bank liquidity on the decision to issue CoCos. A logit random effects model. Alternative measures of liquidity, regulations and extra controls (alternative test of *H1*)

Dependent variable: AT1 CoCos	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Independent variables								
LCR_{t-1}	−0.489** (0.217)	−0.376** (0.18)	−0.500** (0.218)					
$NSFR_{t-1}$				−3.257** (1.584)	−2.616* (1.581)			
Liquid $Asset_{t-1}$						−1.285 (0.848)	−1.204 (0.829)	
Liquid A/Dep_{t-1}								−0.293 (0.192)
Control variables								
$Equity/Assets_{t-1}$	−17.196** (7.586)	−9.315 (6.348)	−17.71** (7.528)	−43.483* (22.562)		−1.133 (3.179)	−4.34 (4.709)	−2.688 (5.064)
Total $Assets_{t-1}$	0.548*** (0.147)	0.48*** (0.144)	0.521*** (0.146)			0.468*** (0.093)	0.495*** (0.092)	0.638*** (0.112)
$ROAA_{t-1}$	79.143* (45.196)	84.417** (37.579)	78.826* (44.418)	8.426 (41.772)	14.538 (39.101)		48.161** (24.303)	22.026 (27.427)
Net $Loans_{t-1}$		0.669 (0.788)	−0.746 (0.915)	−2.686* (1.493)	−1.202 (1.196)			
$CET1_{t-1}$					−20.692* (12.308)			
$RWAs_{t-1}$				6.31 (3.875)	−2.991 (2.16)			
_cons	−7.042*** (1.91)	−7.344*** (2.109)	−6.269*** (1.938)	4.985** (2.423)	7.307** (2.995)	−10.761*** (1.549)	−10.933*** (1.561)	−13.003*** (1.76)
/lnsig2u	0.275 (0.488)	0.489 (0.467)	0.276 (0.487)	−0.626 (1.506)	−2.854 (9.531)	1.013*** (0.224)	0.908*** (0.233)	0.706*** (0.246)
AIC	451.38	453.94	452.85	184.87	184.71	922.58	918.56	897.07
BIC	556.95	509.35	563.02	254.65	254.39	986.69	988.49	1,041.63
Observations	728	748	728	205	204	2,510	2,510	2,398
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effect	Yes	No	Yes	Yes	Yes	No	No	Yes

Notes: Cluster-robust standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. This table reports the results of the random effects logistic regression explaining the impact of bank liquidity on the issuance of the regulatory hybrid securities (AT1CoCos) in Europe between 2011 and 2018. The dependent variable is a dummy which is equal to 1 when a bank issue CoCo in a given year and 0 otherwise. The variables of interest are regulatory liquidity coverage ratio (LCR) measured by "high quality liquid assets divided by net cash flows, over a 30-calendar day stress period," Net Stable Funding Ratio and two nonregulatory liquidity ratios: Liquid Assets over total assets and Liquid assets over total deposits and short-term funding. Control variables are total equity over total assets, the natural logarithm of bank total assets, the return on average assets (ROAA), the proportion of bank net loans to total assets, the ratio of bank Common Equity Tier 1 (CET1) to risk-weighted assets (RWA) and the RWA to total assets. All explanatory variables are winsorized at the 1st and 99th percentile and are lagged one year. Standard errors are clustered at the bank level

Dependent variable: AT1 CoCos	(1)	(2)	(3)	(4)
Independent variables				
$Impaired\ Loan_{t-1}$	−5.809** (2.3)	−1.263 (1.744)		
$Loan\ Loss\ Res_{t-1}$			−9.667** (4.032)	−0.105 (3.924)
Control variables				
$Net\ Loans_{t-1}$	0.703 (0.75)	−0.653 (0.794)	1.245* (0.673)	−0.362 (0.751)
$Total\ Assets_{t-1}$	0.576*** (0.098)	0.679*** (0.11)	0.543*** (0.1)	0.708*** (0.111)
$Equity/Assets_{t-1}$	−3.726 (4.326)	−9.317* (5.488)	2.056 (3.501)	−9.429* (5.421)
NIM_{t-1}	36.141*** (9.915)	36.626*** (10.417)		36.796*** (10.33)
_cons	−12.74*** (1.685)	−13.431*** (1.778)	−12.517*** (1.689)	−13.918*** (1.789)
/lnsig2u	0.921*** (0.238)	0.696*** (0.249)	0.974*** (0.23)	0.632** (0.249)
AIC	857.62	842.02	879.57	854.50
BIC	932.59	990.97	949.12	1,004.13
Observations	2,362	2,273	2,429	2,333
Time Fixed Effect	Yes	Yes	Yes	Yes
Country Fixed Effect	No	Yes	No	Yes

Notes: Cluster-robust standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. This table reports the results of a random effects logistic regression explaining the impact of the issuance of the regulatory hybrid securities (AT1CoCos) on bank asset quality in Europe between 2011 and 2018. The dependent variable is a dummy which is equal to 1 when a bank issue CoCo in a given year and 0 otherwise. The variables of interest are Loan loss reserves to gross loans and Impaired loans to gross loans. The control variables are the proportion of bank net loans to its total assets, the natural logarithm of bank total assets, total equity over total assets and the net interest margin (NIM). All explanatory variables are winsorized at the 1st and 99th percentile and are lagged one year. Standard errors are clustered at the bank level

Table A11. The impact of banks asset quality on the decision to issue CoCos. A logit random effects model (alternative test of *H2*)

Dependent variable	(1)	(2)	(3)	(4)
Independent variables				
PWD	−0.001 (0.001)	−0.003 (0.003)		
CE			0.001 (0.001)	0.003 (0.003)
Control variables				
Total Assets	−0.031** (0.012)	−0.038* (0.02)	−0.031** (0.012)	−0.038* (0.02)
Net Loans	0.012 (0.023)	0.132** (0.058)	0.012 (0.023)	0.132** (0.058)
Customer Depo	−0.119*** (0.034)	−0.259*** (0.083)	−0.119*** (0.034)	−0.259*** (0.083)
NIM	−1.522*** (0.555)	−2.342* (1.393)	−1.522*** (0.555)	−2.342* (1.393)
Equity/Assets	−0.284 (0.231)	−0.278 (0.335)	−0.284 (0.231)	−0.278 (0.335)
_cons	0.468*** (0.158)	0.571** (0.253)	0.467*** (0.158)	0.568** (0.253)
Observations	144	142	144	142
R-Squared	0.551	0.575	0.551	0.575
Time Fixed Effect	Yes	Yes	Yes	Yes
Cluster	Bank	Bank	Bank	Bank

Notes: Cluster-robust standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. This table provides the results of a panel regression with bank and time fixed effects checking the impact of the loss absorption mechanisms of CoCos on banks risk-taking during 2011–2018. The dependent variables are loan loss reserves to gross loans (Columns 1–3) and Impaired loans to gross loans (Columns 2–4). The variables of interest are PWD (write-down CoCos), a dummy which is equal 1 when the issuance is a write-down CoCo and 0 otherwise and CE (conversion-to-equity CoCos), a dummy which is equal 1 when the CoCo is issued as conversion-to-equity and 0 otherwise. Controls variables are the natural logarithm of bank total assets, the proportion of bank net loans to total assets, total customer deposits to total assets, the net interest margin (NIM) and total equity to total assets. All variables are winsorized at the 1st and 99th percentile

Table A12. The impact of CoCo issuance on bank risk based on CoCos' contract design (write-down CoCos and conversion-to-equity CoCos)

Variable	Description	Source and reference
AT1 CoCos	Dummy which is equal to 1 when a bank issues CoCos in a given year (2011–2018) and 0 otherwise	Dealogic database and our calculations
PWD	Write-down CoCos, a dummy which is equal to 1 when the issuance is a write-down CoCo and 0 otherwise	Dealogic database and our calculations
CE	Conversion-to-equity CoCos, a dummy which is equal to 1 when the CoCo is issued as conversion-to-equity and 0 otherwise	Dealogic database and our calculations
Tier 1	Ratio of total Tier 1 capital to RWA	Orbis database (Bureau van Dijk). Avdjiev *et al.* (2020) and Fajardo and Mendes (2020)
CET1	Ratio of bank Common Equity Tier 1 to RWA	Orbis database (Bureau van Dijk). Goncharenko *et al.* (2017, 2021)
LCR	Ratio of high-quality liquid assets to net cash flows over a 30-calendar day stress period	Orbis database (Bureau van Dijk)
NSFR	Ratio of the available source of stable funding (ASF) to the required source of stable funding (RSF) over a one-year horizon	Orbis database (Bureau van Dijk)
Liquid Asset	Ratio of total liquid assets to total assets	Orbis database (Bureau van Dijk). Fajardo and Mendes (2020)
Liquid A/Dep	Ratio of total liquid assets to total deposits and short-term funding	Orbis database (Bureau van Dijk).
Impaired loans	Ratio of Impaired loans to gross loans	Orbis database (Bureau van Dijk). Petras (2020) and Williams *et al.* (2018)
Loan Loss Res	Ratio of loan loss reserves to gross loans	Orbis database (Bureau van Dijk). Williams *et al.* (2018)
ROAA	Return on average assets	Orbis database (Bureau van Dijk). Goncharenko *et al.* (2017, 2021) and Williams *et al.* (2018)
Net Loans	Ratio of bank net loans to total assets	Orbis database (Bureau van Dijk). Goncharenko and Rauf (2016) and Avdjiev *et al.* (2020)
Equity/Assets	Ratio of total equity to total assets	Orbis database (Bureau van Dijk). Goncharenko *et al.* (2017, 2021)
Total Assets	The natural logarhythm of bank total assets	Orbis database (Bureau van Dijk) and our calculations. Avdjiev *et al.* (2020) and Goncharenko *et al.* (2017, 2021)
NIM	Ratio of net interest income (expense) to interest earning assets	Orbis database (Bureau van Dijk). Williams *et al.* (2018)
Customer Depo	Ratio of total customer deposits to total assets	Orbis database (Bureau van Dijk) and our calculations. Avdjiev *et al.* (2020)
RWA	Ratio of total RWA to total assets	Orbis database (Bureau van Dijk) and our calculation Fajardo and Mendes (2020)

Table A13.
Description of the variables