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The Agency of CoCo:
Why Do Banks Issue Contingent Convertible Bonds?

Roman Goncharenko* Steven Ongena † Asad Rauf ‡

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Abstract

Why do banks issue contingent convertible debt? To answer this question we study comprehensive data covering all issues by publicly traded banks in Europe of contingent convertible bonds (CoCos) that count as additional tier 1 capital (AT1). We find that banks with lower asset volatility are more likely to issue AT1 CoCos than their riskier counterparts, but that CDS spreads do not react following issue announcements. Our estimates therefore suggest that agency costs play a crucial role in banks' ability to successfully issue CoCos. The agency costs may be higher for CoCos than for equity explaining why we observe riskier or lowly capitalized banks to issue equity rather than CoCos.

JEL-Classification: G01, G12, G24

Keywords: CoCos, Contingent Convertible Bonds, Bank Capital Structure

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1 Introduction

The recent financial crisis provided dramatic evidence that banks may have been holding too little capital prior to 2007. Banks, it was argued, operated with capital levels that were maybe privately optimal, but definitely not socially optimal Admati, DeMarzo, Hellwig, and Pfleiderer (2013). The policy response to the crisis was to raise minimum capital requirements across the board. But Basel III (2010) in particular allows banks to partially meet the increased capital requirements with certain types of contingent convertible bonds (CoCos). Using comprehensive data on publicly traded banks in Europe, we examine CoCo issuance and CDS spreads around issue announcements. Our evidence overall suggests that agency cost considerations may play an important role in banks' decisions to issue CoCos.

CoCos are financial instruments which improve the absorption of any bank's unexpected future losses through automatic recapitalization when a pre-defined trigger event is reached. Prior to the trigger event CoCos are perpetual coupon paying bonds.[1] The trigger event is usually defined in terms of the common equity tier 1 ratio (CET1): Once a bank's CET1 ratio falls below a pre-defined level the loss absorption mechanism is activated. The loss absorption mechanism improves the bank's CET1 capital either through the conversion of CoCos to equity (EC CoCo) or through a principal write down (WD CoCo). The latter can be permanent (P-WD CoCo) or temporary (T-WD CoCo). A temporary write down implies that the principal will be written back up once the bank's financial situation improves.

The theoretical literature on CoCos provides insights in the tradeoffs that exist for banks to issue CoCos. On the one hand, CoCos can reduce the probability of bank failure when it replaces debt. This is so, because CoCos add an additional buffer to the balance sheet of banks. Thus, issuing CoCos should mechanically lead to lower CDS spreads since bank default becomes less likely. On the other hand, however, the theoretical literature also argues that CoCos could induce risk shifting which could potentially lead to a higher probability of bank failure. CDS spreads will then actually increase after CoCo issuance reflecting the higher probability of default.

Depending on the contractual terms CoCos can result in an anticipated positive wealth transfer from CoCo holders to equity holders when triggered: The equity holders gain from the (permanent

[1] A necessary condition for a CoCo to be counted as equity is a perpetual coupon stream and a trigger level above 5.125%

or temporary) suspension of coupon payments but may lose because of equity dilution, in the case of the conversion of the CoCo to equity, or, in the case of a temporary principal write down, on the obligation to resume the payments once the financial situation of the bank improves. The wealth transfer from CoCo holders to equity holders is then given by the difference between the gains and the losses to the equity holders when triggered. When the wealth transfer is positive the equity holders have less incentive to avoid the triggering, amplifying the debt overhang and risk shifting problems.

In this paper we empirically study the presence of such agency problems associated with CoCos. We first analyze the determinants of CoCo issuance in the current European Association Area (EAA) and Switzerland (henceforth, Europe). We then compare CoCo against equity issues. We find that lowly capitalized or riskier banks are more likely to issue equity than CoCos. In particular, increasing bank risk decreases the ratio of the probability of issuing CoCo over the probability of issuing equity. We interpret this decline in the ratio as suggestive evidence that agency problems associated with these instruments is what discouraged riskier banks to issue them. This is because increasing bank risk would increase both the cost of equity and CoCos. The fact that we see this switch towards equity for riskier banks suggests that for riskier banks the benefits of issuing CoCos (e.g., tax benefits) are lower than its costs (i.e., agency costs of risk shifting and debt overhang).

Next we conduct an event study of bank CDS spreads around CoCo issue announcements. Absent agency costs, an announcement of a CoCo issue should result in a drop of the issuing bank‘s CDS spread reflecting the lower probability of default. However, once a bank issues CoCos the incentives of the bank may change. If CoCos induce higher risk shifting then the effects of lower leverage (because of the CoCo issue) and the corresponding lower default probability could be offset by the increase in default probability because of more risk shifting. In our analysis of CDS spreads we do not find any evidence that announcements of CoCo issues are followed by a reduction in CDS spreads. This suggests that the risk shifting agency problem may be present and that bond holders price it in. As a result CDS spreads do not decrease significantly.

In sum, our finding show that lowly capitalized or riskier banks are more likely to issue equity than CoCos. We also find evidence that the announcements of CoCo issues do not reduce CDS spreads significantly. This evidence suggests that riskier banks are facing an exacerbation of agency problems when issuing CoCos.

Our paper contributes to several strands of the literature. First, our paper broadly relates to the literature on bank capital structure (Admati et al. (2013), DeAngelo and Stulz (2014)), bank debt overhang (Admati, DeMarzo, Hellwig, and Pfleiderer (2012) and Admati, DeMarzo, Hellwig, and Pfleiderer (2017)) and determinants of bank capital structure (Gropp and Heider (2010)).

Specifically, our paper contributes empirically to the debate on the impact on bank credit risk of the use of CoCos as an alternative to common equity, because it shows how such instruments perform in practice. The literature on CoCos originates from a proposal by Flannery (2005); for an extensive discussion on CoCo in bank capital regulation see Kashyap, Rajan, and Stein (2008). As indicated before, the theoretical literature on CoCos provides various arguments about CoCos. Replacing debt with CoCos reduces the probability of default via the deleveraging which takes when the loss absorption mechanism is activated (Albul, Jaffee, and Tchistyi (2013), Pennacchi (2011), and McDonald (2013)). But the risk shifting incentives induced by CoCos may result in upward pressure on probability of default (Koziol and Lawrenz (2012), Hilscher and Raviv (2014), Berg and Kaserer (2015), Chan and van Wijnbergen (2017), Goncharenko (2017)).

The empirical work on CoCos is somewhat sparse. The two papers closest to our study are Avdjiev, Bolton, Jiang, Kartasheva, and Bogdanova (2017) and Vallée (2016). Avdjiev et al. (2017) study the effect of CoCo issuance on bank funding cost, while Vallée (2016) investigate the liability management exercises by banks from Euro area which bear comparable effects to the triggering of contingent capital.

Our work also contributes to the literature on financial innovation. Papers in this literature study financial innovations on the asset side of the balance sheet (Loutskina (2011)), whereas we focus on importance of financial innovation on the liability side. Some work shows that financial innovations can be driven by adverse incentives (Pérignon and Vallée (2017)), whereas we show that financial innovations themselves may create adverse incentives. Finally, our paper also contributes to an empirical literature documenting agency costs (e.g., Gilje (2016)).

2 Data and Summary Statistics

We collect data on all issues of contingent capital bonds (CoCo) that took place until 31st December, 2016. We limit our attention to contingent capital bonds issued by banks within Europe, i.p., the European Association Area (EAA) and Switzerland. We do this to focus on banks which operate under a similar regulatory framework.[2] Further, we only focus on bonds which count as additional tier 1 capital (AT1) under the Basel III regulations. That is, we focus only on perpetual bonds with a trigger level above 5.125%. Tier 2 CoCos are more like traditional bonds with a fixed maturity (with the additional contingent conversion feature) hence we drop them from our sample. We remove any issuance where the amount issued is missing. Most CoCo issues happened after 2010 and a few of those issues were retired over the next couple of years. For example, Llyods Banking Group issued some AT1 CoCos with a trigger level of 5%. However, the Basel III and CRD IV guidelines later set the minimum trigger level of AT1 CoCos at 5.125%. Lloyds Bank then proceeded to recall these AT1 CoCos and issued new AT1 CoCos in 2014. We remove these recalled AT1 CoCos from our sample.

We merge the CoCo issuance data with bank fundamentals data from SNL Financial. We focus on all publicly traded banks within Europe where at least one publicly listed bank issued AT1 CoCos. The time period runs from 2010 to end of year 2015. We also collect stock price data for the publicly listed banks from Datastream.

We compare CoCo issuance against the issuance of common equity. To this effect we collect common equity issuance data (via rights offering, private placement, initial public offering, etc.) for all the banks in our sample from SNL Financial. We collect data for time period of 2010 to 2016 to overlap with the time frame during which some of these banks were active in the AT1 CoCo bond market. We recognize that some of the external equity issuance could be a case of existing shareholders cashing-out. Since our analysis mainly focuses on raising capital for retention, we compute the amount of external capital retained by the banks (similar to Erel, Julio, Kim, and Weisbach (2012)). SNL Financial provides data for the amount of secondary shares sold by existing shareholders. For each issuance we recompute the actual capital inflow to the bank by subtracting the amount of secondary shares sold (if any).

[2] The other countries where most of the remaining CoCos were issued were India, China and Russia. Differences in regulatory and accounting frameworks is substantial so we decided to focus on Europe.

2.1 CoCo Issuance

We collect data on 247 active (i.e., not retired or recalled) AT1 CoCo issues from across the world between 2010 and 2016. The total outstanding notional from across the world is about $236 billion. 193 out of the 247 issuances were made by 94 banks in Europe and the total notional outstanding is about $146 billion accounting for about 63% of AT1 CoCo market in the world. Figure 1 plots the year-wise total AT1 CoCos issued in Europe and the rest of the world. China, Russia, India and Brazil are the countries which account for almost all the of the issuance outside Europe. AT1 CoCo issuance started in 2010 [3] and most of the issuance happened in 2014 after which there was decline in the number of issues. The reason behind the decline could be because most of the large banks had already issued CoCos in 2014 and did not access the market in the subsequent years.

In Figure 2 we plot the country-wise AT1 CoCo outstanding within Europe. Banks in UK, France and Switzerland issued about $86 billion CoCos. The amount of CoCos issued by banks in Germany was only about $ 7.9 billion. The tax treatment of CoCo by respective governments seemed to have played an important role in the issuance of these securities. For example, all the CoCo issuance by German banks happened after 10th April, 2014 when the German Federal Ministry of Finance issued a circular letter clarifying the tax of treatment of Basel III-compliant Additional Tier 1 (AT1) instruments. The position taken by the Ministry was mostly favorable for banks, in particular as it treated the AT1 instruments as debt, which allows for the tax deductibility of coupons. The large amount ($18 billion) of issuance by the Swiss banks could be because the Swiss regulators forced many of the Swiss banks to issue AT1 CoCos. Since our analysis mainly focuses on the endogenous choice of issuing CoCo we decided to exclude the Swiss banks from our empirical analysis.

Table 1 provides the summary statistics of the additional tier 1 CoCos issued in the world (Panel A) and in Europe (Panel B). The average size of an issuance in Europe was about $816 million and the trigger level in Europe ranges from 5% [4] to 9%. Almost all the CoCos were issued at par and hence the coupon was the YTM at issuance. The coupon paid by banks within Europe range from

[3] There were a few issues in 2009 but they were later recalled or retired and hence are not included in the sample

[4] 4 of the issuance made by Norwegian banks have CoCo trigger level set at 5% although the minimum trigger level for the CoCos to attain Tier 1 status equals 5.125%

2.25% to 11.88% and the mean coupon is about 6.4%.

Next we turn our focus on the loss absorption mechanism of these securities. In Europe most (97) of the CoCos issued had temporary write down as the loss absorption mechanism (Table 2 panel B). Equity conversion was the second most favored loss absorption mechanism. However, equity conversion CoCo had the highest notional outstanding in Europe (about $71.6 billion). Data on conversion price or conversion ratio for equity conversion CoCos was not available. It is interesting to note that the average coupon on equity conversion CoCos were higher than those paid on temporary write-down and permanent write-down CoCos. The difference is statistically significant (not shown in table). Although this is just comparing the unconditional sample means, it is an interesting observation. In section 3 we further explore the role of bank characteristics in the pricing of these CoCos.

2.2 Bank Data Summary Statistics

We collect yearly data on all banks (consolidated at the top tier holding level) in Europe from 2010 to 2015. We limit our analysis on publicly traded banks from the 14 EAA[5] countries where at least one publicly listed bank issued AT1 CoCos[6] These banks collectively issued $138 billion in CoCos outstanding. We also collect data on a control group of publicly listed banks which did not issue AT1 CoCos. Our sample consists of 49 banks which issued AT1 securities and 101 banks which did not issue AT1 CoCos. The number of bank year observations in our sample is 629 (for a fully specified model with all controls [7]).

Table 3 provides the summary statistics of the bank characteristics of the two groups of banks (the ones which issued AT1 CoCos and the ones which did not). On average banks which issued AT1 CoCos were larger. Only 7 listed banks which had total asset value above $100 billion in 2015 had not issued any AT1 CoCos. Commerzbank in Germany is the largest bank in our sample not to have issued any AT1 CoCos.

[5]Austria, Belgium, Cyprus, Denmark, France, Germany, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden and UK

[6] We drop banks from Switzerland because as indicated earlier the national regulator forced some of the banks to issue CoCos and hence it was not an endogenous decision. As a robustness check we repeat our analysis including the banks from Switzerland but we find results mostly unaffected.

[7]For some model specifications the number bank-year observations are slightly higher

2.3 Equity Issuance Statistics

We collect data on common equity issuance by all European banks from 2010 to 2016 from SNL Financial. There were 665 common equity issues in this sample period wherein a total of $359 billion worth of equity capital was offered. In many issues a portion of the raised equity capital was used to pay existing shareholders. SNL Financial provides additional data which helps us separate the amount of raised capital between the part that was retained by the bank and the part used to pay off existing shareholders. Of the $359 billion of equity that was offered $337 billion was retained by the banks.

We limit our attention to the sample of listed banks as explained in the previous section. In Table 4 we report yearly the capital raised by the banks in our sample from AT1 CoCos and Equity. We note that more banks in our sample raised more AT1 CoCos than equity in years 2014, 2015 and 2016. The average number of equity issues remained fairly stable as opposed stark increase in the increase of CoCo issuance towards the later years.

3 Empirical Analysis and Results

It is well documented in the academic literature and commonly known among practitioners that banks are averse to raising capital (see Thakor (2014) for review). This aversion notwithstanding there has been a global drive of regulators towards ever higher capital requirements. Banks are now compelled to have larger capital buffers to absorb future losses and protect creditors. Facing stricter capital regulations, and given their aversion towards raising equity, banks have been looking towards innovative solutions to meet these requirements. One of the suggested solutions is the introduction of financial instruments such as CoCos, which are subordinated debt which either get converted to equity or are written down when the banks capital falls below a pre-specified capital level. Thus, theoretically, CoCos are instruments which recapitalize a bank in its hour of need, when the banks existing capital is falling. Some regulators grant CoCos the status of equity; for example Basel III grants CoCos the status of Additional Tier 1 (AT1) whereas the US regulators do not. What makes CoCos all the more interesting is that in most countries CoCo coupons are tax deductible. It seems intuitive that issuing CoCos should be interesting for banks. A source of regulatory capital with a tax treatment like debt it would be natural to expect that banks will rush to issue CoCos. However many banks in Europe have so far shied away from issuing CoCos. Hence, there must be costs associated with issuing these securities. Empirical evidence documenting these costs is missing. In this paper we fill this void by providing empirical evidence on the decision of banks to issue this contingent form of capital.

We use a two-pronged empirical strategy to find evidence of agency costs associated with CoCo issuance. We first use the variation in bank fundamentals to analyze the decision of a bank to issue AT1 CoCos in a given year. We then use a similar model to explain the decision of a bank to issue equity. We then jointly analyze the decision to either issue CoCos or equity in given in multinomial setting. Our second strategy looks at market reactions to CoCo issuance. We specifically look at CDS spread reactions to announcements of CoCo issues.

3.1 Analysing the Choice between CoCos and Equity

We perform both Probit and Logit regressions to explain the decision of a bank to issue AT1 CoCo in a given year. The Probit and Logit models help us identify (in a multivariate setting) the bank characteristics which are the main drivers of the decision to issue AT1 securities in a given year. The probability that a bank issues CoCos in a given year is modeled as follow:

$$P(Issue = 1|\mathbf{X}) = G(\beta_0 + \beta\mathbf{X}) \tag{1}$$

where G is a probability distribution function and $\mathbf{X}$ is the vector of explanatory variables. In the Logit model G is modeled as a logistic function and G is the standard normal cumulative distribution function in case of the Probit model.

The explanatory variables (vector $\mathbf{X}$) include equity over assets to account for the leverage of the bank, total CET1 ratio to account for the regulatory capital the bank has, we follow (cite paper) and use asset volatility to account for bank riskiness.[8], log of assets to account for bank size, loans over assets to control for heterogeneity in the lending business of the banks, deposits over assets to control for the heterogeneity in deposit financing across the sample and AT1 outstanding over assets to indicate whether (and how much) the bank has issued AT1 CoCos in the previous years. We also control for profitability (ROA), growth opportunities (Market-to-Book), dividend paying (total

[8] We use implied asset volatility à la Merton (1974) as a measure of bank risk. The calculation is in Appendix A.

dividend paid over book value of equity), Globally Systemically Important Bank (GSIB dummy), liquidity (Cash over Assets). All explanatory variables are lagged one year.

The Probit and Logit models, however, only help us to identify the drivers of the decision to issue CoCos and not the quantity issued. We also use a Tobit regression on the amount of AT1 securities (as a fraction of total assets) issued in a given year to identify what drives the quantity of CoCos issued. We use the Tobit model because a non-trivial portion of the banks in a given year do not issue any CoCos. A Tobit model expresses the observed response, y (i.e., the amount of CoCos issued by any given bank in a year), in terms of an underlying latent variable y^*.

$$y^* = \beta_0 + \beta\mathbf{X} + \epsilon_{it}, \tag{2}$$

$$y = max(0, y^*) \tag{3}$$

where $\epsilon_{it}|\mathbf{X}$ is$Normal(0, \sigma^2)$. Using the distributional assumption on ϵ we back out the parameters of interest using the maximum likelihood method.

Table 5 reports the results of the regression of Logit, Probit and Tobit regressions. In column 1 and column 2 the dependent variable is a dummy which equals 1 when a banks issues CoCo in a given year, and equals 0 otherwise. We find that lower the asset volatility higher the probability of issuing CoCos in a given year. The coefficient on asset volatility in the Logit regression is -0.252. The average marginal effect of asset volatility on the probability of issuance is -0.012 (not reported in the table). Thus, ceteris paribus, an increase in asset volatility of 5 percentage points makes it roughly 6% less likely that a bank will issue CoCos. This implies that risky banks are less likely to issue AT1 CoCos. The fact that riskier banks found it sub-optimal to include CoCos in their capital structure suggests that these banks may face some agency costs associated with CoCos issuance which are an increasing function of bank risk.

We also find that total CET 1 capital is not a significant driver of the decision to issue CoCos. This finding suggests that banks with lower regulatory capital were not any more likely to issue CoCos than banks with higher capital ratios. This goes against the conventional intuition that CoCos are substitutes for equity to meet regulatory capital requirements. Because a fraction of the T1 capital can be met with CoCos and because both the countercyclical buffer and the capital conservation buffer have to be met with CET1 capital there is some degree of substitutability between CoCos and CET1. Therefore, under the assumption that equity is more costly than CoCos we should see banks with lower CET1 issuing CoCos. However, we do not observe this in the data. Alternatively, one could expect that CoCos are issued to meet the non-risk based leverage ratio (equity over assets) requirement which can soon be introduced in the EU. However, we do not find evidence of that either, since the coefficient of the equity over assets variable is not statistically different from zero. In summary, we do not find evidence that CoCos are issued because of regulatory considerations but we do find that the measure of bank risk plays important role in the banks decision to issue CoCos.

In columns 3, 4 and 5 we estimate a Tobit model where the dependent variable is the total amount of CoCos issued over total assets. The results are similar only now the Tobit model confirms that the bank riskiness and size not only influence the decision to issue but also the quantity of issuance. The average marginal effect of asset volatility on CoCo issuance is -0.055. This is economically significant since the average amount of CoCos issued in a given year is 0.04% of total assets and a 1 percentage point increase in asset volatility decreases the "unconditional" expected value of CoCos over assets by 0.055 percentage points . Hence, risky banks are not only less likely to issue but when they do also issue lower amounts. We also find that size is an important determinant of issuing CoCos. This could be attributed to the fact that bigger banks have easier access to capital markets and find it easier to raise funds by issuing these hybrid securities.

We contrast the findings on CoCo issuance with those on equity issuance by the same sample of banks. There are two benefits of performing this analysis for equity issuance. First of all, we have a better understanding why banks issue equity and, thus, we can see if our approach when applied to equity issues yields results that we expect to obtain (given the extant literature). This validates our modeling approach. Secondly, since CoCos and equity are both sources of regulatory capital we expect that the determinants of their issue should have some commonality.

In Table 6 we report the results of Probit, Logit and Tobit regressions for equity issuance. We find that the coefficient of CET1 Ratio is negative and significant across all the models. This implies that banks with lower Tier 1 ratio are more likely to issue equity. This is fairly intuitive as banks with a lower Tier 1 ratio are the ones which are more likely to need to issue equity. The fact that the Tier 1 ratio did not seem to drive CoCo issuance but has an impact on equity issuance, suggests that banks with lower capital ratios were relying on equity and not CoCos to increase their regulatory capital. Although, we find that similar to CoCo issuance the decision to issue equity is affected by asset volatility, the quantitative effect is much more modest. In particular, our estimates from the Logit regression suggest that the probability for a bank, with all other regressors evaluated at the means, of issuing equity decreases from 0.16 to 0.14 as the asset volatility increases from 1 to 5, a fairly small effect economically speaking.

Thus far our analysis has looked at the decisions to issue AT1 CoCos and equity separately. We do control for the amount of AT1 CoCos outstanding in both the specifications however that does not capture the inter-dependence of the decision to issue CoCos or equity. We consequently model this choice in a multinomial framework. Multinomial Logit models provide a way to estimate how explanatory variables affect the choice among a finite number of alternatives. We estimate a multinomial Logit regression were the reference category is issuing equity in a given year. More specifically we estimate the following model:

$$Pr(IssueType = j) = \frac{e^{\beta_j' x}}{\sum_{k=0}^{8} e^{\beta_k' x}} \tag{4}$$

where j equals 0 if the bank issues nothing, 1 if it only issues CoCos, 2 if it only issues equity, and 3 for issuance of both. We control for other routes a bank could alter its capital base, i.e., by controlling for change in the total assets and controlling for the dividends paid by the bank. We keep the issuing of equity as the reference category such that we directly interpret the coefficient on Asset Volatility for CoCo issuance as the log odds ratio between issuing CoCo and issuing equity.

We report the results of the multinomial Logit regression in Table 7. In Panel A we report the coefficients. The multinomial Logit regression confirms what we found in our separate analysis of AT1 CoCo and equity issuance. The coefficient on Asset Volatility is negative and significant. An increase in asset volatility by 1 percentage point decreases the log odds ratio between issuing CoCo and issuing equity by 0.265. Thus with increasing asset volatility there is likely going to be a switch towards equity from CoCos. The (average) marginal effect of bank risk on the probability of issuing CoCos is also negative and significant. On the other hand the marginal effect of capital ratios on equity issuance is positive and significant.

The evidence that riskier banks were more likely to issue equity than CoCos is indicative of the fact that agency costs with CoCos could be one of the reasons why riskier banks shied away from CoCos. Bank riskiness has a direct impact on CoCo prices. The riskier the bank the more expensive the CoCos will be. We show evidence of this standard relation in Table 8, i.e., CoCo spreads are increasing in our measure of bank risk. But increasing bank risk will also increase the cost of equity. If a hybrid instrument like CoCos does have not agency problems associated with it, then increasing bank risk should not alter the choice between CoCo and equity. The multinomial logit model provides evidence that it does, i.e., that riskier banks are more likely to issue equity than CoCos. This is suggestive of agency problems which are arguable stronger for riskier banks.

3.2 Announcement Effects on CDS Spreads

To better understand the incentives of a bank to issue CoCos we look at impact of the announcements of CoCo issues by banks on their CDS spreads. On the one hand, and intuitively, issuing CoCos should reduce CDS spreads because of the mechanical de-leveraging. The CoCo adds an additional buffer to the balance sheet of the banks and hence existing debt holders should price in the reduction in the probability of default and that should be reflected in the CDS spreads. However, on the other hand, CoCos can result in increased risk shifting incentives if the wealth transfer from CoCo to equity holders upon conversion is positive. The latter could then lead to higher likelihood of failure due to increased level of riskiness. Hence these forces will be pulling the spread in the opposite direction.

We use a (t-30,t-400) window to estimate a market model for each of the first CoCo issues by the banks in our sample. We use the 'Thomson Reuters DS 5 Year European Banks CDS Index' as the relevant market index for CDS spreads. We follow Callen, Livnat, and Segal (2009) and Shivakumar and Urcan (2011) in using relative changes of the CDS spreads and not absolute changes. We argue that the change in the credit worthiness of a bank is relative to its initial credit worthiness. In other words, we treat CDS spreads like stock prices when computing the impact of announcement of CoCo issues. The benefit of this approach is that we can use the cumulative abnormal returns procedure similar to what is done in event studies using equity returns.[9] We focus on a small event window of (t-1,t+1). There are two reasons for this. First, we aim to avoid

[9] We repeat the analysis with absolute changes as well and do find significant impact of the announcement of CoCo issuance.

picking up confounding effects over a longer event window. Second, longer event windows make the estimation of standard errors for aggregate cumulative returns more complicated because of the possibility of event window clustering between multiple events. Moreover, since we are focusing on announcement dates rather than issue dates we argue that a small event window is well suited for our analysis.[10]

Specifically, we measure abnormal CDS spread changes AR_i as

$$AR_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{mt}, \tag{5}$$

where R_{it} is the realized relative change in CDS spread on day t for bank i and R_{mt} is the relative change in the market index CDS spread on day t. $\hat{\alpha}_i$ and $\hat{\beta}_i$ for each bank i are estimated from the market model as follows:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \epsilon_{it}. \tag{6}$$

The Cumulative Abnormal Return (i.e., the cumulative relative change in CDS spreads over the event window) for each bank i is simply the sum of the single period prediction errors over the event window. That is for a t-1 to t+1 event window

$$CAR(t-1, t+1) = \sum_{k=t-1}^{t+1} AR_{ik} \tag{7}$$

We follow Salinger (1992) in computing standard errors of the CARS. Specifically, the variance of the CAR is estimated as

$$\varsigma_i = Var(CAR) = T\sigma_i^2 \left[1 + \frac{T}{U} + \frac{T\left[\frac{\sum^T R_m}{T} - \bar{r}_m\right]^2}{U\sigma_{R_m}^2} \right], \tag{8}$$

where T is the length of the event window and U is the length of the estimation window. σ_i^2 is the variance of ϵ_i $\bar{r}_m$ and $\sigma_{R_m}^2$ are the sample mean and variance of the market index return over the estimation period.[11] The adjustments between the big square brackets reflect the parameter estimation error. The size of the parameter estimation component of 8 relative to the true error

[10] For some banks for which we do not have announcement date we substitute it with issuance date. In robustness checks we vary the event window length and the results (unreported) remain unchanged. We also repeat the analysis entirely on issuance dates and qualitatively the results remain unaltered.

[11] ϵ_{it} is homoscedastic and hence the variance is assumed to be the same for all t

depends roughly on the length of event window divided by the length of the estimation window.

We finally aggregate the individual CARs and report the mean CAR for all N events. The test statistic for mean CAR for all events is calculated as:

$$t = \frac{\frac{\sum_N CAR_i}{N}}{\sqrt{\frac{\sum_N \varsigma_i}{N^2}}} \sim N(0,1). \tag{9}$$

We remove Banco Comercial Português from our sample because the credit spreads falls sharply by almost 250 basis points because of the bailout announcement by the Portuguese government, who was going to buy the CoCos. We argue this drop in the credit spreads was a reaction to the bailout announcement more than a reaction to the announcement of CoCo issuance.

Figure 3 suggests that there is no clear effect of CoCo issuance announcements on CDS spreads. We report the results of the event study analysis in Table 9. We do not find statistically significant effect of CoCo issuance announcements. In this respect our finding is different from from Avdjiev et al. (2017) and Ammann, Blickle, and Ehmann (2017) who document a statistically significant and negative effect. There could be two reasons: First, we only focus on AT1 CoCos in Europe. Second, we remove Banco Comercial Português as an outlier (given the active role played by the Portuguese government) which significantly alters the aggregate effects of CoCo announcements. If do not exclude Banco Comercial Português from our analysis we do find a statistically negative effect of CoCo issuance announcement[12]. Our finding that CoCos do not seem to reduce the default probabilities of banks suggests that some countervailing force acts against the mechanical de-leveraging effect of issuing CoCos. This is suggestive evidence on the risk shifting costs of CoCos.

4 Robustness Checks

In this section we run our results through some robustness checks. We first use a duration model to analyze CoCo and equity issuance. The duration model takes care of the concern that our sample of decision issuance ends in 2016 and we do not observe future decisions. Banks which have not issued CoCos now could issue in the future. We further use a different measure of bank risk (stock volatility) and rerun our analysis of the previous sections.

[12] It also requires that we measure the change in CDS spreads in terms of absolute changes rather than in terms of relative changes.

4.1 Duration Analysis

We know that the starting point of AT1 CoCo issues is 2011 since Basel III accords came out in the December 2010. If bank never issues a CoCo during the period of observation it does not necessarily mean it will not issue CoCos later on and, so, we treat non-realized observations as right-censored ones. The knowledge of when CoCo issues begin allows us to study them in terms of the multiple failure duration analysis. The duration analysis of CoCo issues can help us to gauge some more information on the determinants of CoCo issues.

In general a multiple failure duration analysis assumes that starting from a certain point in time an individual (bank) with time dependent characteristics is a subject to a "failure". Such a "failure", i.e., a CoCo issue, for each individual can take place multiple times during the observation period. It is possible that the CoCo issue never takes place for some individuals. In this case it is understood that the data for such an individual is right censored.

The passage time before the occurrence of the failure can be described by a hazard function

$$\lambda\left(t, X\left(t\right), \beta\right) = \lambda_0\left(t\right) \exp\left(\beta' X_t\right) \tag{10}$$

where X_t is a set of explanatory variables (bank's time-variant characteristics), β is the vector of unknown parameters associated with the explanatory variables, and $\lambda_0\left(t\right)$ is the baseline hazard function. Since the natural logarithm of $\lambda\left(t, X\left(t\right), \beta\right)$ is an affine function in X_t, β is the partial impact of each variable on the logarithm of the estimated hazard rate.

The two common specifications for the baseline hazard are the Weibull and exponential distributions. The Weibull specification is given by:

$$\lambda_0\left(t\right) = \lambda\alpha t^{\alpha-1} \tag{11}$$

which allows for duration dependence via parameter α. Whenever $\alpha < 1$ ($\alpha > 1$) the distribution exhibits negative (positive) duration dependence which means that the hazard decreases (increases) as time goes. The exponential distribution, on the other hand, exhibits constant duration dependence ($\alpha = 1$).

We use duration analysis to analyze the decision to issue CoCos and equity. It makes sense to apply the duration analysis to equity as well since the new higher capital requirement brought about by Basel III must have affected banks' decision to issue the security. For CoCos we have a total of 80 failures with the minimum and maximum number of failures per subject 0 and 4, respectively. For equity the total number of failures is 112 with the minimum and maximum number of failures per subject 0 and 5, respectively. The origin of our duration is 2011 since the Basel III accord came out in the December of 2010. The exit of the duration period is 2016 since the data for our explanatory variables ends in 2015. We use the same set of controls for the duration analysis as we used in previous regressions.

Table 10 reports the results of the estimation of the multiple failure duration model with the Weibull distribution. Regressions (1)-(4) have CoCo issues as dependent variable, while regressions (5)-(8) equity issues. The dependent variable takes value 1 if a security was issues in a given year, and 0 otherwise. We estimate each model with and without country fixed effects. In general the result of the estimation is consistent with the results found employing Logit, Probit, and Tobit models.

As far as CoCo issues are concerned the main determinants are, as before, size (positive), bank's risk (negative), the ratio of loans over assets (positive), and the last period $AT1/Asset$ ratio (negative). We do not find any evidence that bank's capital level played any role in the decision to issue CoCos.

The duration analysis suggests that the main determinants of equity issues are: Capital level measure as CET1 or totT1(negative), size (positive), Dividends/Equity (negative), MTB (negative), and cash (positive). This suggests that equity issues were motivated by the shortage of bank capital. Using the duration analysis, we also find that bank's risk and cash were statistically significant determinants of equity issues. We find that bank's risk had a negative effect on equity issue, although, the estimate is 4-8 times smaller in magnitude than that for CoCos and is no longer significant if the country fixed effects are included.

The duration dependence parameter α is estimated to be statistically higher than 1 for both CoCo and equity. However, the magnitude of estimated α is 2-3 times larger for CoCo than for equity implying that the CoCo issues accelerated greatly in time. A possible explanation of this finding is that it took some time for the market to learn about CoCo but then it was ready to digest higher volume of high yield instruments in the current low-yield environment. Alternatively, this can be explained by the fact that initially it took local tax authorities some time to clear up the uncertainty about the tax treatment of CoCos and once it was done the CoCo issues took place.

Figure 4 and 5 display the survival function from the duration analysis for CoCo and equity respectively. The survival functions are evaluated at means for all regressors except the asset volatility which takes value either 1% or 5%. The survival function represent the probability of not issuing CoCo/equity as a function of time. The figures clearly indicate that the likelihood of issuing CoCo is profoundly more sensitive to the measure of bank risk than that of issuing equity.

4.2 Different Measure of Bank Risk

We redo the analysis in section 3.1 using a different measure of bank risk. We follow ¡cite paper¿ and use stock volatility as a measure of bank risk. In Table 11 we report the results of the Logit, Probit and Tobit specifications of AT1 CoCo issuances. In Table 12 we report the results of this same line-up of models on equity issuance. And finally in Table 13 we report the results of the multinomial Logit. Although the magnitudes are different the results are virtually the same as discussed in the previous sections.

5 Conclusion

We answered the question: Why do banks issue convertible debt? To do this end we study a comprehensive data set on issues of contingent convertible bonds (CoCos) that are countable as additional tier 1 capital (AT1) by publicly traded banks in Europe. We find that banks with lower asset volatility are more likely to issue AT1 CoCos than their riskier counterparts, but that their CDS spreads do not react following the issue announcements. We interpret our findings as evidence that agency costs play a crucial role in banks ability to successfully issue such CoCos. For riskier banks the agency costs related to CoCos may be even higher than those for equity explaining why we observe riskier, lowly capitalized banks to issue equity rather than CoCos. Our results suggest that CoCos may not be a panacea and that more work may be needed to determine the optimal conditions for CoCo issuance.

Tables and Figures

Table 1

Summary Statistics of AT1 CoCos

This table provides the summary statistics of the additional tier 1 contingent convertible bonds (AT1 CoCos) issued. Panel A lists the summary statistics of all the CoCos issued across the world. Panel B provides the summary statistics of the CoCos issued in the European Economic Area (EEA). The CoCo trigger level is set on the Common Equity Tier 1 ratio (as a % of Risk Weighted Assets) of the bank.

Panel A: All CoCos issued

Statistic	N	Mean	Std. Dev.	Min	Median	Max
Amount Issued ($ Million)	247	956.30	1,222.30	1.07	557.82	7,045.24
Coupon (%)	247	6.55	1.98	2.25	6.25	12.50
Trigger Level (%)	245	5.69	0.87	5.00	5.12	9.00

Panel B: CoCos issued in Europe (EEA)

Statistic	N	Mean	Std. Dev.	Min	Median	Max
Amount Issued ($ Million)	193	758.30	776.47	1.07	521.37	3,795.33
Coupon (%)	193	6.33	1.82	2.25	6.25	11.88
Trigger Level (%)	192	5.80	0.94	5.00	5.12	9.00

Table 2

Summary Statistics of AT1 CoCos by Loss Absorption Mechanism

This table provides the summary statistics of the additional tier 1 contingent convertible bonds (AT1 CoCos) grouped by their loss absorption mechanism. The three loss absorption mechanisms are Equity Conversion, Temporary Write Down (Temporary WD) and Permanent or Partial Permanent Write Down (Permanent/Partial WD). Panel A lists the summary statistics of all the CoCos issued across the world. Panel B provides the summary statistics of the CoCos issued in the European Economic Area (EEA). The CoCo trigger level is set on the Common Equity Tier 1 ratio (as a % of Risk Weighted Assets) of the bank.

Panel A: All CoCos issued

Equity Conversion		**Temporary WD**		**Permanent/Partial WD**	
Number of Issuances	78	Number of Issuances	111	Number of Issuances	50
Total Issued ($ Billion)	145	Total Issued ($ Billion)	57.1	Total Issued ($ Billion)	40.9
Average Coupon (in %)	6.67	Average Coupon (in %)	6.64	Average Coupon (in %)	6.11
Average Trigger (in %)	6.04	Average Trigger (in %)	5.38	Average Trigger (in %)	5.88

Panel B: CoCos issued in Europe (EEA)

Equity Conversion		**Temporary WD**		**Permanent/Partial WD**	
Number of Issuances	51	Number of Issuances	97	Number of Issuances	41
Total Issued ($ Billion)	67.6	Total Issued ($ Billion)	51.3	Total Issued ($ Billion)	26.7
Avergae Coupon (in %)	7.32	Avergae Coupon (in %)	6.25	Avergae Coupon (in %)	5.36
Average Trigger (in %)	6.51	Average Trigger (in %)	5.36	Average Trigger (in %)	5.97

Table 3

Summary Statistics of Listed Banks

This table provides the summary statistics of the publicly listed banks in our sample. We separate the banks which issued additional tier 1 CoCos from banks which did not. The summary statistics are calculated over bank-year observations from 2010 - 2015. All variables are winsorized at the 1st and 99th percentile. *CET1* is common equity tier 1 ratio, *ROA* is return on assets and *MTB* is the market to book ratio of equity. *Dividends/Equity* is total dividends paid on common stock as a fraction of the book value of equity.

	Issued CoCos		No CoCos		
	Mean	Std. Dev.	Mean	Std. Dev.	Difference in Mean
Asset Volatility (%)	3.290	4.440	4.260	6.220	-0.970**
Stock Volatility (%)	35.590	21.190	35.580	19.890	-0.010
CET1 1 Ratio (%)	12.520	2.960	13.700	5.900	-1.190***
Tier 1 Ratio (%)	14.020	3.110	14.670	5.600	-0.650*
Log(Assets)	18.510	2.480	15.500	2.110	3.020***
Loans/Assets (%)	61.790	16.810	63.790	21.450	-2.000
Equity/Assets (%)	6.660	2.400	10.630	8.470	-3.970***
Deposits/Assets (%)	47.480	16.070	58.250	18.150	-10.770***
Dividends/Equity (%)	1.880	2.250	2.880	5.000	-1.000***
ROA (%)	0.330	0.870	0.510	1.650	-0.180*
MTB	0.830	0.710	0.940	1.170	-0.110
Asset Growth (%)	-1.950	11.850	0.720	18.790	-2.670**
Cash/Assets (%)	0.090	0.060	0.100	0.110	-0.010**

Table 4

Summary of Additional Tier 1 and Equity Issuances by Publicly Listed Banks between 2010 and 2016)

This table provides the summary of the external tier 1 issuances by the 150 publicly listed banks in the European Economic Area (EEA) between 2010 and 2016. This includes equity issuances and additional tier 1 contingent convertible bond (AT1 CoCo) issuances.

Year	Number of Equity Issuances	Equity Capital Raised (in $ Billion)	Number of AT1 CoCo Issuances	AT1 CoCo Raised (in $ Billion))
2010	15	39.10	1	0.64
2011	18	46.73	0	0.00
2012	20	9.58	2	3.85
2013	19	22.81	6	8.92
2014	17	33.85	21	55.66
2015	24	27.02	27	29.51
2016	14	10.36	24	20.56

Table 5

Issuance of Contingent Convertible Bonds countable as Additional Tier 1 Capital between 2011 and 2016

This table reports the results of Logit, Probit and Tobit model estimations of the issuance of the additional tier 1 contingent convertible bonds (AT1 CoCos) by banks within the European Economic Area between 2011 and 2016. In these settings the main measure of risk is implied asset volatility (à la Merton (1974)). In Columns 1 and 2 the dependent variable is a dummy which is equal to 1 when a bank issues AT1 CoCos in a given year. In Columns 3, 4 and 5 the dependent variable is the amount of the additional tier 1 contingent convertible securities issued in a given year expressed as a fraction of total assets. Column 5 is the same specification as Column 4 and includes country fixed effects. All explanatory variables are one year lagged values. The coefficients are reported in the first row and the standard errors (in parentheses below) are clustered at the firm level. *CET1* is common equity tier 1 ratio, *ROA* is return on assets, *GSIB* is a dummy variable for globally systemically important banks, *Dividends/Equity* is total dividends paid on common stock as a fraction of the book value of equity, *AT1/Assets* is the ratio of additional tier 1 CoCos outstanding divided by the total assets of the bank and *MTB* is the market to book ratio of equity. *Sigma* is the additional estimated parameter of the Tobit models.

	(1)	(2)	(3)	(4)	(5)
	Logit	Probit	Tobit	Tobit	Tobit
Asset Volatility$_{t-1}$	-0.182**	-0.094***	-0.088***	-0.066**	-0.051**
	(0.072)	(0.032)	(0.032)	(0.027)	(0.020)
CET1 Ratio$_{t-1}$	-0.021	-0.006	0.032*	-0.010	-0.014
	(0.054)	(0.028)	(0.017)	(0.025)	(0.033)
Log(Assets$_{t-1}$)	0.445***	0.217***	0.163***	0.152**	0.147**
	(0.126)	(0.062)	(0.061)	(0.064)	(0.058)
(Loans/Assets)$_{t-1}$	0.027*	0.015*	0.014**	0.015*	0.015**
	(0.015)	(0.008)	(0.007)	(0.008)	(0.007)
GSIB	0.969	0.582*	0.325	0.275	0.402
	(0.600)	(0.337)	(0.217)	(0.227)	(0.245)
(Equity/Assets)$_{t-1}$	-0.061	-0.042	-0.028	-0.039	-0.062
	(0.055)	(0.031)	(0.023)	(0.029)	(0.042)
(Deposits/Assets)$_{t-1}$	-0.017	-0.008	0.001	-0.004	-0.009
	(0.014)	(0.008)	(0.007)	(0.007)	(0.007)
(Dividends/Equity)$_{t-1}$	-0.042	-0.022	-0.036	-0.027	-0.004
	(0.055)	(0.031)	(0.025)	(0.024)	(0.025)
ROA$_{t-1}$	0.408*	0.186	0.123	0.135	0.230
	(0.213)	(0.117)	(0.084)	(0.095)	(0.173)
MTB$_{t-1}$	0.075	0.012	0.099	0.030	0.023
	(0.221)	(0.121)	(0.113)	(0.100)	(0.086)
(AT1/Assets)$_{t-1}$	-0.468	-0.236	-0.042	-0.195	-0.384
	(0.335)	(0.153)	(0.147)	(0.139)	(0.238)
Asset Growth$_{t-1}$	0.001	-0.000	-0.010	-0.003	-0.002
	(0.011)	(0.006)	(0.007)	(0.005)	(0.004)
(Cash/Assets)$_{t-1}$	1.234	1.088	1.247	1.970	0.817
	(3.260)	(1.680)	(1.669)	(1.859)	(1.126)
Constant	-26.651***	-10.873***	-5.176***	-8.355***	-7.699***
	(2.883)	(1.401)	(1.663)	(2.340)	(2.180)
Sigma			0.903***	0.876***	0.795***
			(0.203)	(0.206)	(0.157)
Observations	629	629	629	629	629
Year Fixed Effects	Y	Y	N	Y	Y
Country Fixed Effects	N	N	N	N	Y
Pseudo R^2	0.371	0.364	0.163	0.246	0.307

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6

Issuance of Common Equity between 2011 and 2016

This table reports the results of Logit, Probit and Tobit model estimations of the capital raised via common equity issuance by banks within Europe between 2011 and 2016. In this setting the main measure of risk is implied asset volatility (à la Merton (1974)). In Columns 1 and 2 the dependent variable is a dummy which is equal to 1 when a bank issues common equity in a given year, and is equal to 0 otherwise. In Columns 3, 4 and 5 the dependent variable is the amount of common equity raised in a given year expressed as a fraction of total assets. Column 5 is the same specification as Column 4 and includes country fixed effects. All explanatory variables are one year lagged values. The coefficients are reported in the first row and the standard errors (in parentheses below) are clustered at the firm level. *CET1* is common equity tier 1 ratio, *ROA* is return on assets, *GSIB* is a dummy variable for globally systemically important banks, *Dividends/Equity* is total dividends paid on common stock as a fraction of the book value of equity, *AT1/Assets* is the ratio of additional tier 1 CoCos outstanding divided by the total assets of the bank and *MTB* is the market to book ratio of equity. *Sigma* is the additional estimated parameter of the Tobit models.

	(1) Logit	(2) Probit	(3) Tobit	(4) Tobit	(5) Tobit
Asset Volatility$_{t-1}$	-0.038*	-0.022*	-0.038*	-0.035	-0.031
	(0.020)	(0.012)	(0.023)	(0.022)	(0.024)
CET1 Ratio$_{t-1}$	-0.142***	-0.080***	-0.115***	-0.113***	-0.161***
	(0.037)	(0.021)	(0.038)	(0.039)	(0.056)
Log(Assets$_{t-1}$)	0.440***	0.247***	0.320***	0.331***	0.405**
	(0.099)	(0.056)	(0.102)	(0.103)	(0.160)
(Loans/Assets)$_{t-1}$	0.021*	0.014**	0.018*	0.019**	0.015
	(0.012)	(0.006)	(0.009)	(0.009)	(0.014)
GSIB	-1.020**	-0.511*	-0.844**	-0.857**	-1.002**
	(0.488)	(0.265)	(0.355)	(0.351)	(0.411)
(Equity/Assets)$_{t-1}$	-0.036	-0.011	-0.012	-0.010	-0.002
	(0.040)	(0.019)	(0.034)	(0.034)	(0.047)
(Deposits/Assets)$_{t-1}$	0.012	0.006	0.010	0.010	0.003
	(0.011)	(0.006)	(0.011)	(0.011)	(0.012)
(Dividends/Equity)$_{t-1}$	-0.288**	-0.157***	-0.233***	-0.237***	-0.248***
	(0.114)	(0.052)	(0.088)	(0.086)	(0.086)
ROA$_{t-1}$	0.055	0.035	-0.138*	-0.117	-0.053
	(0.094)	(0.053)	(0.080)	(0.085)	(0.099)
MTB$_{t-1}$	-1.095	-0.519*	-0.632	-0.665	-0.853
	(0.672)	(0.293)	(0.529)	(0.536)	(0.633)
(AT1/Assets)$_{t-1}$	0.038	0.052	0.173	0.175	0.190
	(0.156)	(0.098)	(0.116)	(0.121)	(0.144)
(Asset Growth)$_{t-1}$	-0.020	-0.013	-0.022*	-0.021	-0.020
	(0.018)	(0.009)	(0.013)	(0.016)	(0.014)
(Cash/Assets)$_{t-1}$	6.233***	3.509***	3.224**	3.412**	4.803**
	(1.908)	(1.067)	(1.622)	(1.643)	(1.940)
Constant	-8.802***	-5.264***	-7.028**	-7.438***	-7.532*
	(2.373)	(1.346)	(2.828)	(2.853)	(4.259)
Sigma			1.800***	1.784***	1.762***
			(0.349)	(0.336)	(0.334)
Observations	629	629	629	629	629
Year Fixed Effects	Y	Y	N	Y	Y
Country Fixed Effects	N	N	N	N	Y
Pseudo R^2	0.225	0.225	0.145	0.151	0.169

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7

Multinomial Logit for Contingent Convertible Bonds countable as Additional Tier 1 and Equity Issuances

This table reports the results of the multinomial Logit model estimation of CoCo and equity issuances. The base category of the Multinomial Logit is equity issuance by banks in a given year. In total there are 4 choices including the base category. Panel A reports the coefficients of the multinomial Logit regression with equity issuance choice as the base category. The standard errors (in parenthesis below) are clustered at the firm level. *CET1* is common equity tier 1 ratio, *ROA* is return on assets, *GSIB* is a dummy variable for globally systemically important banks, *Dividends/Equity* is total value of dividends paid as a fraction of the book value of equity, *AT1/Assets* is the ratio of additional tier 1 CoCos outstanding divided by the total assets of the bank and *MTB* is the market to book ratio of equity. Panel B reports the average marginal effects for a subset of regressors (Common Equity Tier 1 (CET1) Ratio, Asset Volatility and Log (Assets)). The t-statistics are reported in parenthesis.

Panel A: Coefficients

	Issued Nothing	Issued CoCos	Issued Both
Asset Volatility$_{t-1}$	0.051*	-0.265**	-0.037
	(0.024)	(0.098)	(0.095)
CET1 Ratio$_{t-1}$	0.165***	0.256***	0.126
	(0.049)	(0.065)	(0.083)
Log(Assets$_{t-1}$)	-0.451***	0.015	0.218
	(0.113)	(0.165)	(0.199)
(Loans/Assets)$_{t-1}$	-0.010	0.010	0.029
	(0.014)	(0.019)	(0.034)
GSIB	1.430*	2.113**	1.778
	(0.610)	(0.808)	(1.013)
(Equity/Assets)$_{t-1}$	0.046	0.015	-0.026
	(0.051)	(0.066)	(0.103)
(Deposits/Assets)$_{t-1}$	-0.012	-0.019	0.014
	(0.012)	(0.018)	(0.024)
(Dividends/Equity)$_{t-1}$	0.437**	0.360*	0.329
	(0.136)	(0.149)	(0.173)
ROA$_{t-1}$	-0.047	0.327	0.280
	(0.097)	(0.267)	(0.257)
MTB$_{t-1}$	1.876***	2.029***	2.225**
	(0.528)	(0.604)	(0.699)
(AT1/Assets)$_{t-1}$	-0.119	0.030	-0.520
	(0.198)	(0.271)	(0.477)
Asset Growth$_{t-1}$	0.013	-0.006	-0.070*
	(0.014)	(0.023)	(0.028)
(Cash/Assets)$_{t-1}$	-4.832*	-7.337	3.886
	(2.130)	(4.195)	(6.439)
Constant	7.124**	-4.569	-12.427*
	(2.756)	(3.857)	(5.585)
Observations	629		
Pseudo R^2	0.253		

Panel B: Average Marginal Effects

	Issued Nothing	Issued CoCos	Issued Equity	Issued Both
Asset Volatility$_{t-1}$	0.0213***	-0.0197***	-0.00134	-0.00029
	(4.05)	(-3.55)	(-0.68)	(-0.15)
CET1 Ratio$_{t-1}$	0.00754	0.00745***	-0.0144***	-0.00061
	(-1.74)	(-2.59)	(-3.78)	(-0.46)
Log(Assets$_{t-1}$)	-0.0653***	0.0236***	0.0315***	0.0101***
	(-5.90)	(2.54)	(3.75)	(2.58)

Table 8

Regressing CoCo Spreads on Bank and Security Characteristics

This table reports the results of the regression of CoCo spreads on bank fundamentals and issuance characteristics. The spreads are calculated based on the currency of issuance. The yields of longest maturity government bonds are used as the risk free rate (for EUR we use German 30 year yields). Trigger Buffer is the difference between the CET1 ratio of the issuing bank and the trigger level of the CoCo being issued. *ROA* is return on assets and *GSIB* is a dummy variable for globally systemically important banks. All bank level explanatory variables are lagged one year. Standard errors (in parenthesis below) are clustered at the bank level.

	Coupon Spread		
	(1)	(2)	(3)
Asset Volatility$_{t-1}$	0.270***	0.236**	0.146**
	(0.092)	(0.100)	(0.074)
Log(Assets$_{t-1}$)		−0.109	−0.184
		(0.204)	(0.182)
GSIB		−0.884	−0.404
		(0.626)	(0.537)
(Loans/Assets)$_{t-1}$		−0.008	−0.003
		(0.012)	(0.011)
(Deposits/Assets)$_{t-1}$		−0.008	−0.005
		(0.015)	(0.013)
ROA$_{t-1}$		−0.730*	−0.823**
		(0.425)	(0.331)
(Equity/Assets)$_{t-1}$		0.218*	0.162
		(0.123)	(0.113)
Log(Amount Issued)	−0.222**	0.065	0.163
	(0.110)	(0.123)	(0.134)
Trigger Buffer	−0.173***	−0.164***	−0.178***
	(0.046)	(0.059)	(0.048)
Constant	10.200***	6.760*	6.183*
	(2.460)	(3.926)	(3.304)
Loss Absorption Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	No	No	Yes
Observations	123	123	123
Adjusted R^2	0.325	0.386	0.560

Note: *p<0.1; **p<0.05; ***p<0.01

Table 9

Announcement Effects of Contingent Convertible Bond Issuances on CDS Spreads
This table reports the results of the event study on the announcement date of additional tier 1 CoCo issuances by banks between 2010-2016. The event window is (t-1,t+1). The estimation window is (t-30,t-400). 'First Issuances' are the first instance of every bank in our sample issuing a CoCo. 'All issuances' are all CoCo issuances for which we can perform the event study. Percentage Negative are the number of observations for which the CAR(-1,1) is negative.

CDS Spreads (in %)

	Observations	Mean CAR(-1,1)	t-statistics	Percentage Negative
First Issuances	27	-0.2%	-0.285	48.14%
All Issuances	74	-0.1%	-0.31	53.40%

Table 10

Duration Model for CoCos and Equity Issuances (Weibull distribution)

This table reports the results of the multiple failure duration model with Weibull distribution. The origin of the duration is 2011 - the year in which Basel III was introduced with its new capital requirements. The exit of the duration period is 2016. The dependent variable for columns (1)-(4) is 1 when a CoCo is issued and 0 otherwise, for regressions (5)-(8) the dependent variable is equal to 1 if equity is issued and 0 otherwise. Columns (3), (4), (7) and (8) include country fixed effects. *CET1* is common equity tier 1 ratio, *ROA* is return on assets, *GSIB* is a dummy variable for globally systemically important banks, *Dividends/Equity* is total value of dividends paid as a fraction of the book value of equity, *AT1/Assets* is the ratio of additional tier 1 CoCos outstanding divided by the total assets of the bank and *MTB* is the market to book ratio of equity. *Alpha* is the duration dependence parameter.

	(1) CoCo	(2) CoCo	(3) CoCo	(4) CoCo	(5) Equity	(6) Equity	(7) Equity	(8) Equity
Asset Volatility$_{t-1}$	-0.16**	-0.16***	-0.13**	-0.13**	-0.02*	-0.03**	-0.02	-0.02
	(0.06)	(0.06)	(0.06)	(0.05)	(0.01)	(0.01)	(0.02)	(0.02)
CET1 Ratio$_{t-1}$	-0.05		-0.10		-0.19***		-0.32***	
	(0.04)		(0.09)		(0.04)		(0.06)	
Total Tier 1 Ratio$_{t-1}$		-0.02		-0.05		-0.13***		-0.27***
		(0.04)		(0.09)		(0.03)		(0.05)
Log(Assets$_{t-1}$)	0.39***	0.40***	0.41***	0.40***	0.33***	0.30***	0.47***	0.44***
	(0.11)	(0.11)	(0.12)	(0.12)	(0.07)	(0.07)	(0.12)	(0.13)
(Loans/Assets)$_{t-1}$	0.03**	0.03**	0.02	0.02	0.02*	0.02*	0.02	0.02*
	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
GSIB	0.66	0.64	0.75	0.64	-0.90**	-0.82**	-1.26***	-1.43***
	(0.41)	(0.42)	(0.53)	(0.60)	(0.40)	(0.42)	(0.43)	(0.48)
(Equity/Assets)$_{t-1}$	-0.05	-0.04	-0.09	-0.08	-0.04	-0.08**	0.00	-0.04
	(0.05)	(0.05)	(0.13)	(0.13)	(0.04)	(0.04)	(0.04)	(0.04)
(Deposits/Assets)$_{t-1}$	-0.02	-0.01	-0.02	-0.02	-0.00	0.00	-0.01	-0.01
	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
(Dividends/Equity)$_{t-1}$	-0.02	-0.01	-0.01	0.01	-0.23**	-0.16*	-0.27***	-0.20**
	(0.04)	(0.04)	(0.05)	(0.05)	(0.09)	(0.09)	(0.09)	(0.09)
ROA$_{t-1}$	0.24	0.14	0.28	0.10	0.13*	0.06	0.25***	0.22***
	(0.17)	(0.17)	(0.34)	(0.33)	(0.07)	(0.07)	(0.07)	(0.07)
MTB$_{t-1}$	0.09	0.04	0.07	0.01	-0.86*	-1.09**	-1.22*	-1.59**
	(0.19)	(0.22)	(0.23)	(0.27)	(0.49)	(0.53)	(0.64)	(0.71)
(AT1/Assets)$_{t-1}$	-1.56**	-1.50**	-1.93**	-1.83**	-0.01	-0.01	-0.02	0.05
	(0.66)	(0.69)	(0.79)	(0.91)	(0.08)	(0.10)	(0.09)	(0.12)
Asset Growth$_{t-1}$	0.01	0.01*	0.01	0.01	-0.01	-0.01	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
(Cash/Assets)$_{t-1}$	1.14	0.90	0.73	0.39	5.00***	4.96***	6.82***	6.71***
	(2.06)	(2.06)	(2.08)	(2.13)	(1.47)	(1.56)	(1.56)	(1.66)
Constant	-16.25***	-16.26***	-14.92***	-14.79***	-6.81***	-6.40***	-7.74***	-7.07**
	(3.12)	(3.17)	(3.71)	(3.76)	(1.79)	(1.82)	(2.89)	(2.95)
α	5.27^{+++}	5.04^{+++}	5.86^{+++}	5.53^{+++}	1.75^{+++}	1.66^{+++}	2.13^{+++}	2.04^{+++}
	(0.67)	(0.64)	(0.74)	(0.74)	(0.15)	(0.14)	(0.21)	(0.19)
Observations	629	638	629	638	629	638	629	638
Country Fixed Effects	N	N	Y	Y	N	N	Y	Y

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

$^{+}$ $p < 0.10$, $^{++}$ $p < 0.05$, $^{+++}$ $p < 0.01$ statistically larger than 1

Table 11

Issuance of Contingent Convertible Bonds countable as Additional Tier 1 Capital between 2011 and 2016 - Stock Volatility as measure of Bank Risk

This table reports the results of Logit, Probit and Tobit model estimation on the issuance of additional tier 1 contingent convertible bonds (AT1 CoCos) by banks within Europe between 2011 and 2016. In this setting the main measure of risk is stock return volatility. In Columns 1 and 2 the dependent variable is a dummy which is equal to 1 when a bank issues AT1 CoCos in a given year. In Columns 3, 4 and 5 the dependent variable is the amount of the additional tier 1 contingent convertible securities issued in a given year expressed as a fraction of total assets. Column 5 is the same specification as Column 4 and includes country fixed effects. All explanatory variables are one year lagged values. The coefficients are reported in the first row and the standard errors (in parentheses below) are clustered at the firm level. *CET1* is common equity tier 1 ratio, *ROA* is return on assets, *GSIB* is a dummy variable for globally systemically important banks, *Dividends/Equity* is total dividends paid on common stock as a fraction of the book value of equity, *AT1/Assets* is the ratio of additional tier 1 CoCos outstanding divided by the total assets of the bank and *MTB* is the market to book ratio of equity. *Sigma* is the additional estimated parameter of the Tobit models.

	(1) Logit	(2) Probit	(3) Tobit	(4) Tobit	(5) Tobit
Stock Volatility$_{t-1}$	-0.044***	-0.024***	-0.022***	-0.016***	-0.015**
	(0.014)	(0.006)	(0.006)	(0.005)	(0.006)
CET1 Ratio$_{t-1}$	-0.014	-0.004	0.029	-0.010	-0.016
	(0.056)	(0.029)	(0.018)	(0.026)	(0.032)
Log(Assets$_{t-1}$)	0.460***	0.232***	0.173***	0.156**	0.141**
	(0.124)	(0.058)	(0.060)	(0.063)	(0.060)
(Loans/Assets)$_{t-1}$	0.031**	0.017**	0.016**	0.017**	0.016**
	(0.016)	(0.008)	(0.008)	(0.009)	(0.007)
GSIB	1.082*	0.642*	0.372*	0.314	0.439*
	(0.621)	(0.343)	(0.223)	(0.227)	(0.250)
(Equity/Assets)$_{t-1}$	-0.067	-0.046	-0.026	-0.042	-0.068
	(0.061)	(0.033)	(0.026)	(0.030)	(0.044)
(Deposits/Assets)$_{t-1}$	-0.016	-0.008	0.000	-0.004	-0.008
	(0.013)	(0.007)	(0.007)	(0.006)	(0.007)
(Dividends/Equity)$_{t-1}$	-0.065	-0.037	-0.049*	-0.037	-0.008
	(0.064)	(0.034)	(0.028)	(0.027)	(0.026)
ROA$_{t-1}$	0.221	0.095	0.029	0.079	0.214
	(0.233)	(0.120)	(0.095)	(0.097)	(0.191)
MTB$_{t-1}$	0.166	0.074	0.134	0.060	0.023
	(0.269)	(0.131)	(0.116)	(0.109)	(0.094)
(AT1/Assets)$_{t-1}$	-0.506	-0.244	-0.035	-0.189	-0.378*
	(0.484)	(0.201)	(0.144)	(0.143)	(0.228)
Asset Growth$_{t-1}$	-0.006	-0.004	-0.012	-0.006	-0.004
	(0.013)	(0.007)	(0.008)	(0.006)	(0.005)
(Cash/Assets)$_{t-1}$	0.858	1.150	1.488	2.145	0.955
	(3.529)	(1.910)	(1.883)	(2.029)	(1.186)
Constant	-26.776***	-10.371***	-4.937***	-8.099***	-7.418***
	(3.012)	(1.438)	(1.672)	(2.293)	(2.251)
Sigma			0.907***	0.876***	0.796***
			(0.202)	(0.201)	(0.152)
Observations	650	650	650	650	650
Year Fixed Effects	Y	Y	N	Y	Y
Country Fixed Effects	N	N	N	N	Y
Pseudo R^2	0.381	0.377	0.178	0.251	0.309

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12

Issuance of Common Equity between 2011 and 2016 - Stock Volatility as a Measure of Bank Risk

This table reports the results of Logit, Probit and Tobit models on the capital raised via common equity issuance by banks within Europe between 2011 and 2016. In this setting the main measure of risk is stock return volatility. In Columns 3, 4 and 5 the dependent variable is the amount of common equity raised in a given year expressed as a fraction of total assets. Column 5 is the same specification as Column 4 and includes country fixed effects. All explanatory variables are one year lagged values. The coefficients are reported in the first row and the standard errors (in parentheses below) are clustered at the firm level. *CET1* is common equity tier 1 ratio, *ROA* is return on assets, *GSIB* is a dummy variable for globally systemically important banks, *Dividends/Equity* is total dividends paid on common stock as a fraction of the book value of equity,*AT1/Assets* is the ratio of additional tier 1 CoCos outstanding divided by the total assets of the bank and *MTB* is the market to book ratio of equity. *Sigma* is the additional estimated parameter of the Tobit models.

	(1) Logit	(2) Probit	(3) Tobit	(4) Tobit	(5) Tobit
Stock Volatility$_{t-1}$	-0.020**	-0.009**	-0.011	-0.011	-0.016*
	(0.010)	(0.004)	(0.007)	(0.007)	(0.010)
CET1 Ratio$_{t-1}$	-0.127***	-0.071***	-0.100***	-0.101***	-0.150***
	(0.037)	(0.021)	(0.037)	(0.039)	(0.055)
Log(Assets$_{t-1}$)	0.415***	0.222***	0.284***	0.292***	0.342**
	(0.105)	(0.056)	(0.099)	(0.099)	(0.141)
(Loans/Assets)$_{t-1}$	0.019*	0.013**	0.017**	0.019**	0.014
	(0.011)	(0.006)	(0.009)	(0.009)	(0.012)
GSIB	-0.954**	-0.443*	-0.751**	-0.753**	-0.784*
	(0.482)	(0.261)	(0.353)	(0.350)	(0.416)
(Equity/Assets)$_{t-1}$	-0.057	-0.022	-0.028	-0.025	-0.025
	(0.042)	(0.019)	(0.033)	(0.033)	(0.045)
(Deposits/Assets)$_{t-1}$	0.013	0.006	0.010	0.010	0.005
	(0.011)	(0.006)	(0.010)	(0.010)	(0.012)
(Dividends/Equity)$_{t-1}$	-0.272**	-0.152***	-0.214**	-0.217***	-0.225**
	(0.114)	(0.052)	(0.086)	(0.083)	(0.090)
ROA$_{t-1}$	-0.070	-0.029	-0.214**	-0.194**	-0.148
	(0.118)	(0.064)	(0.095)	(0.096)	(0.103)
MTB$_{t-1}$	-1.318*	-0.547	-0.715	-0.726	-0.938
	(0.760)	(0.334)	(0.598)	(0.594)	(0.689)
(AT1/Assets)$_{t-1}$	0.114	0.089	0.217*	0.233*	0.270*
	(0.164)	(0.103)	(0.126)	(0.136)	(0.152)
Asset Growth$_{t-1}$	-0.021	-0.013	-0.020*	-0.022	-0.020*
	(0.016)	(0.008)	(0.012)	(0.014)	(0.012)
(Cash/Assets)$_{t-1}$	5.869***	3.303***	2.928*	3.011*	4.536**
	(1.920)	(1.091)	(1.642)	(1.697)	(1.990)
Constant	-7.567***	-4.495***	-6.073**	-6.430**	-6.045*
	(2.289)	(1.285)	(2.629)	(2.642)	(3.654)
Sigma			1.808***	1.800***	1.774***
			(0.337)	(0.326)	(0.326)
Observations	639	639	639	639	639
Year Fixed Effects	Y	Y	N	Y	Y
Country Fixed Effects	N	N	N	N	Y
Pseudo R^2	0.213	0.211	0.135	0.139	0.158

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 13

Multinomial Logit for CoCo and Equity Issues - Stock Volatility as a Measure of Bank Risk

This table reports the results of the multinomial Logit model estimation for additional tier 1 contingent convertible bonds (AT1 CoCos) and equity issuances. In this setting the main measure of risk is stock return volatility. The base category of the Multinomial Logit is equity issuance by banks in a given year. In total there are 4 choices including the base category. Panel A reports the coefficients of the multinomial Logit regression with equity issuance choice as the base category. The standard errors (in parenthesis below) are clustered at the firm level. *CET1* is common equity tier 1 ratio, *ROA* is return on assets, *GSIB* is a dummy variable for globally systemically important banks, *Dividends/Equity* is total value of dividends paid as a fraction of the book value of equity, *AT1/Assets* is the ratio of additional tier 1 CoCos outstanding divided by the total assets of the bank and *MTB* is the market to book ratio of equity. Panel B reports the average marginal effects for a subset of regressors (Common Equity Tier 1 (CET1) Ratio, Stock Volatility and Log (Assets)). The t-statistics are reported in parenthesis.

Panel A: Coefficients

	Issued Nothing	Issued CoCo	Issued Both
Stock Volatility$_{t-1}$	0.028*	-0.053***	-0.001
	(0.011)	(0.015)	(0.030)
CET1 Ratio$_{t-1}$	0.135**	0.219**	0.098
	(0.050)	(0.069)	(0.094)
Log(Assets$_{t-1}$)	-0.436***	0.080	0.213
	(0.119)	(0.179)	(0.194)
(Loans/Assets)$_{t-1}$	-0.010	0.014	0.025
	(0.013)	(0.021)	(0.031)
GSIB	1.265*	2.228*	1.642
	(0.602)	(0.892)	(1.007)
(Equity/Assets)$_{t-1}$	0.074	0.056	0.021
	(0.052)	(0.078)	(0.107)
(Deposits/Assets)$_{t-1}$	-0.015	-0.024	0.005
	(0.012)	(0.020)	(0.025)
(Dividends/Equity)$_{t-1}$	0.391**	0.268	0.252
	(0.135)	(0.152)	(0.178)
ROA$_{t-1}$	0.126	0.215	0.253
	(0.133)	(0.352)	(0.295)
MTB$_{t-1}$	2.135***	2.433***	2.578***
	(0.528)	(0.650)	(0.744)
(AT1/Assets)$_{t-1}$	-0.175	0.101	-0.492
	(0.177)	(0.355)	(0.478)
Asset Growth$_{t-1}$	0.015	-0.011	-0.065*
	(0.013)	(0.026)	(0.028)
(Cash/Assets)$_{t-1}$	-4.764*	-7.659	3.846
	(2.178)	(4.974)	(6.526)
Constant	6.178*	-4.843	-11.796*
	(2.654)	(4.206)	(5.486)
Observations	639		
Pseudo R^2	0.264		

Panel B: Average Marginal Effects

	Issued Nothing	Issued CoCos	Issued Equity	Issued Both
Stock Volatility$_{t-1}$	0.006***	-0.005***	-0.002	-0.0001
	(5.54)	(-5.98)	(-1.77)	(-0.23)
CET1 Ratio$_{t-1}$	0.006	0.0065*	-0.012**	-0.0007
	(1.40)	(2.11)	(-3.02)	(-0.42)
Log(Assets$_{t-1}$)	-0.0664***	0.0257***	0.0314***	0.0093***
	(-5.70)	(2.65)	(3.4)	(2.43)

Figure 1. Number of Additional Tier 1 CoCos Issued Between 2010 and 2016, by Year
This figure plots the total number of additional tier 1 CoCos (AT1 CoCos) issued, yearly, within Europe and the rest of the world. The rest of the world primarily includes China, Russia, Brazil and India.

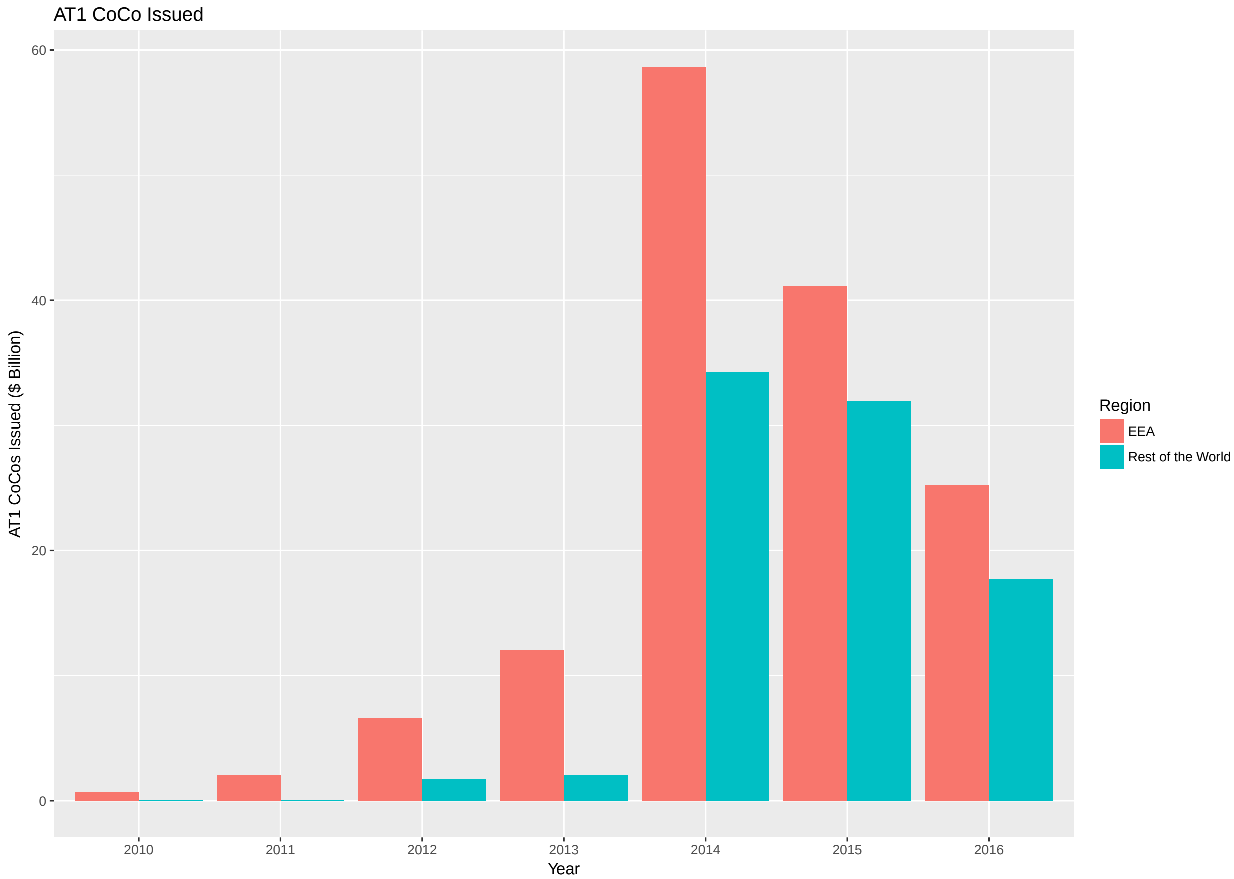


Figure 2. Country-wise (Europe) Breakdown of Additional Tier 1 CoCos Outstanding at the End of 2016
This figure plots the country-wise additional tier 1 CoCo (AT1 CoCos) notional outstanding for banks within Europe.

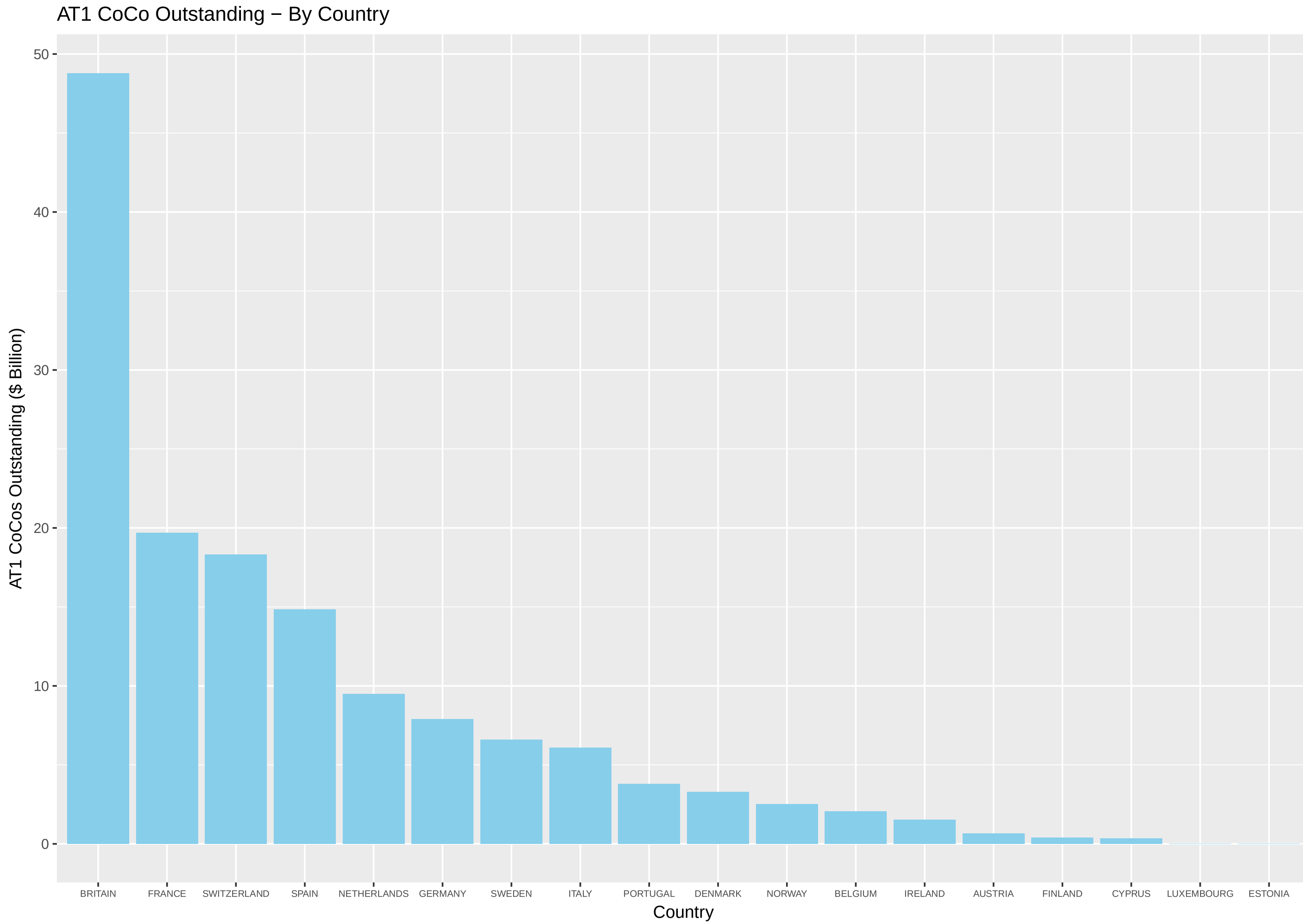


Figure 3. Announcement Effects of Contingent Convertible Bond Issuances on CDS Spreads

This figure plots CARs of the percentage change in the CDS spreads on the announcement of additional tier 1 contingent convertible bond (AT1 CoCos) issuances.

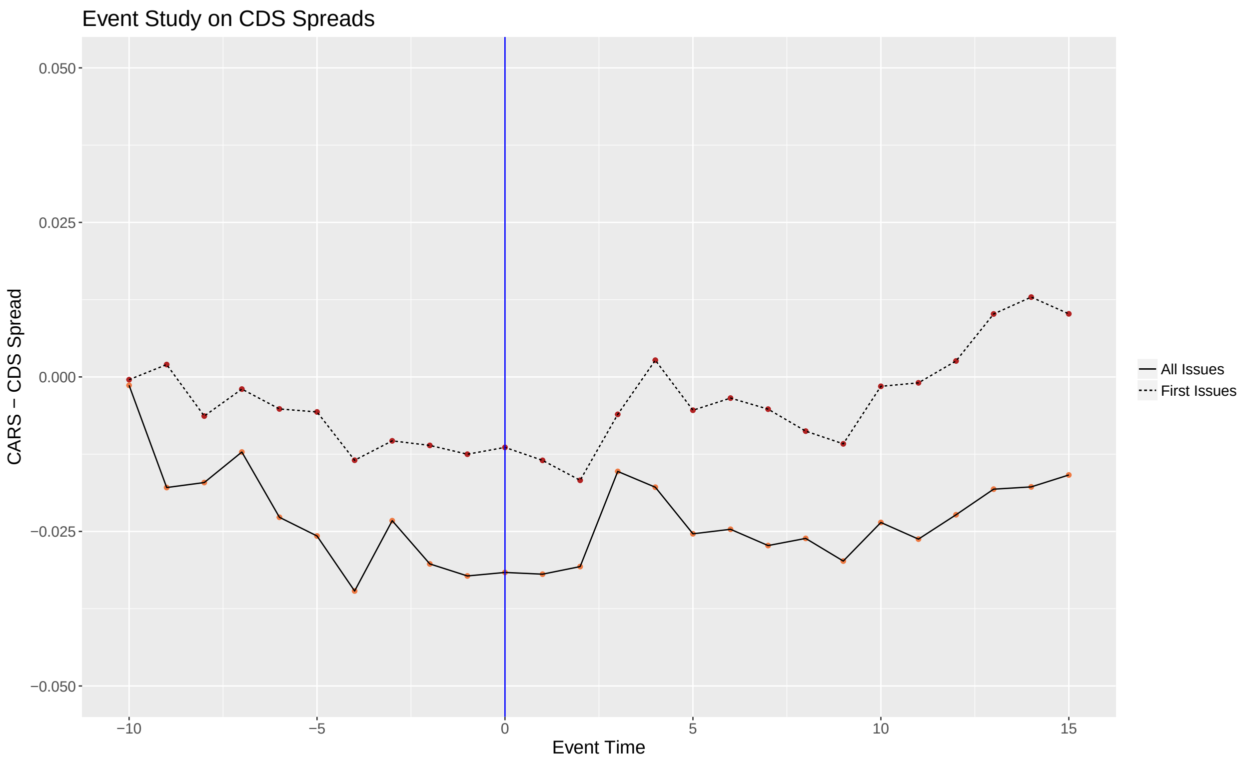


Figure 4. Survival Function of CoCo Issues

This figure plots the probability of CoCo issue as a function of time (year). The probability is evaluated at mean values of all variables except Asset Volatility. The Asset Volatility takes value 1% (blue) and 5% (red).

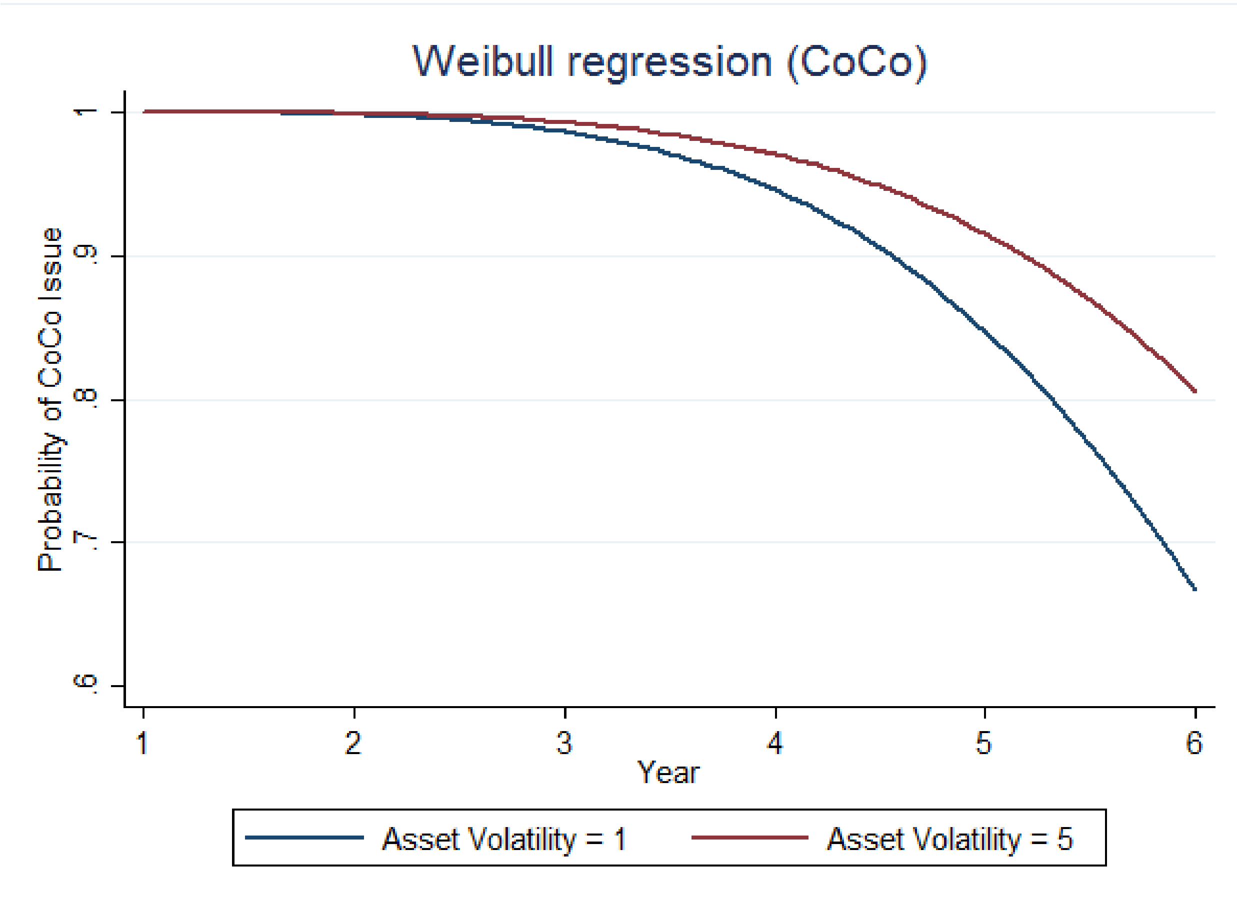
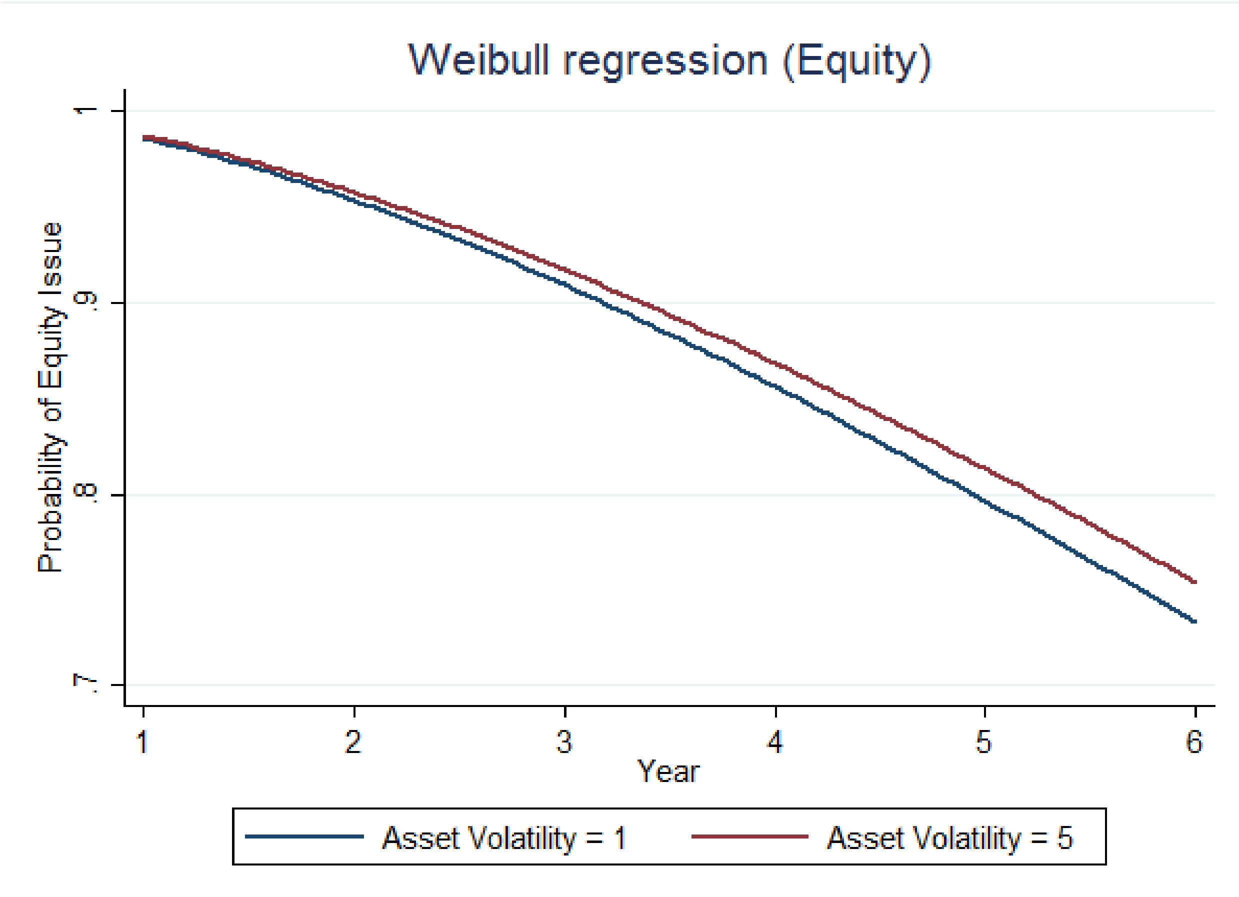


Figure 5. Survival Function of Equity Issues
This figure plots the probability of Equity issue as a function of time (year). The probability is evaluated at mean values of all variables except Asset Volatility. The Asset Volatility takes value 1% (blue) and 5% (red).



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A Asset Volatility as a Measure of Bank Risk

To compute the implied volatility of bank assets as well as the probability of default we use Merton (1974) model. According to the mode the implied volatility of bank's assets is given by

$$\sigma_A = \sigma_E \frac{V_E}{V_A \Phi(d_1)} \tag{A1}$$

where σ_E is the volatility of bank's equity, V_E is the market value of bank's equity, V_A is the implied asset value, and $\Phi(.)$ is the standard normal cdf with

$$d_1 = \frac{\log(\frac{V_A}{D}) + (r - 0.5\sigma_A^2)(T - t)}{\sigma_A \sqrt{T - t}}$$

where r is a risk-free rate, D is the face value of debt, and $T - t$ is time to maturity.

The second equation is the option formulation of equity value which is given by the following expression

$$V_E = V_A \Phi(d_1) - e^{-r(T-t)} D \Phi(d_2) \tag{A2}$$

where $d_2 = d_1 - \sigma_A \sqrt{T - t}$.

From the data we observe the face value of debt, D, the market value of equity E, and the equity volatility σ_E (which is also one of our bank risk measures). Therefore, the implied asset volatility, σ_A and asset value, V_A can be obtained by solving the system of two equations in A1 and A2.

For the value of the risk free rate, r, we use German short-term rate. We set the time to maturity to 1 year. For the face value of debt we use banks total debt multiplied by a scaling factor which we set to 0.8. The reason we scale the total debt is to capture the idea that entire debt of the bank is not due in one year.

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