Bank capital structure with contingent capital : Empirical evidence

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November 7, 2016

Abstract

We analyze the capital structure of banks within the European Economic Area (EEA) consisting of tier 1 contingent capital bonds (CoCos). We find that highly levered banks were more likely to issue CoCos and conditional on having issued CoCos levered banks had higher portion of CoCos in their capital structure. We also find that less risky banks were more likely to issue CoCos. The effect of bank riskiness on the fraction of CoCos in the capital structure is strongest for levered banks. We interpret these results as the response of constrained banks trying to optimize their return on equity (ROE) using CoCos.

JEL-Classification: G01, G12, G24

Keywords: CoCos, Contingent Convertible Bonds, Bank Capital Structure

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1 Introduction

The Basel III regulations have significantly increased capital requirements for banks. Banks are now compelled to have larger capital buffers to absorb future losses and protect creditors. Facing stricter capital regulations banks have been looking towards innovative solutions to meet these requirements. One of the suggested solutions is the introduction of contingent capital bonds (CoCos)[1] in the capital structure of banks. CoCos are subordinated debt which either get converted to equity or are written down when the bank's capital falls below a pre-specified capital level. Thus, theoretically, CoCos are instruments which recapitalize a bank exactly at the hour of the need, when the bank's existing capital is falling. Basel III grants CoCos the status of Additional Tier 1 (AT1) provided they meet some requirements [2]. Hence, they are treated as equity by the regulator. What makes CoCos all the more interesting is that in most jurisdictions across the world CoCo coupons are tax deductible. Hence, AT1 Cocos are unique instruments which are granted equity status by regulators but are treated as debt by the taxman.

In light of the regulatory treatment of these hybrid securities, one question that becomes pertinent is – why do banks issue contingent capital bonds? In other words, what drives the decision of a bank to issue these securities? CoCos appear to provide the benefit of tax deductibility of debt and the safety of equity. For example,Albul et al. (2013) demonstrate that CoCos increase a firm's value by increasing the tax shield and decreasing the bankruptcy costs. However, in practice many banks have shied away from issuing these securities. Hence, there must be costs or trade-offs associated with issuing these securities. For example, Berg and Kaserer (2015) show that some CoCo bonds may increase the risk shifting incentives due to wealth transfer from CoCo investors to equity holders. Empirical evidence, however, on the decision of banks to issue CoCos is missing. In this paper we fill this void by providing empirical evidence on the decision of banks to issue contingent capital.

The key question we aim to answer here is what drives the decision of banks to issue CoCos? We analyze publicly listed banks in the European Economic Area (EEA) (including Switzerland) and look at their decisions to issue CoCos. We limit our attention to EEA because the Basel III regulatory framework are binding on all the member countries. Moreover, EEA accounts for nearly 65% of the outstanding CoCo market. We only focus on CoCos which count as additional tier 1 (AT1) capital. We focus only on AT1 CoCos because bulk (almost 70%) of the CoCos

[1] CoCos were first suggested by Flannery (2002)

[2] To be granted AT1 status CoCos need to be perpetual and should have a trigger level above 5.125%. A bank also needs regulatory approval to call back these securities.

issued worldwide are AT1 CoCos. Tier 2 CoCos do not have equity like features and are indeed not treated as equity by the regulator. By focusing only on AT1 CoCos within EEA we make sure the regulatory and tax incentives to issue CoCos are the same for all institutions.

We have two main findings in our paper. We find that constrained banks (banks with lower equity over assets) issue CoCos to meet the increasing capital requirements. Second, we find that the riskiness of the bank is an important determinant of the decision to issue CoCos. Less risky banks were more likely to issue CoCos and (conditional on having issued) had higher fraction of CoCos in their capital structure.

We run a panel Tobit regression of AT1 CoCos outstanding (as a fraction of total assets) on equity over assets and a measure of bank riskiness and some standard controls. We find that banks which had lower equity over assets were (a) more likely to issue AT1 CoCos and (b) had a higher fraction of AT1 CoCos in their capital structure. We interpret these results as banks issuing AT1 CoCos to increase their non-risk based leverage ratio (equity over assets). The Basel III framework, over and above the risk based capital requirements, has proposed the non-risk based leverage ratio. The banks are expected to maintain a leverage ratio above 3%. This requirement, however, may become binding only in 2018 but there is evidence that banks have already started reacting to this proposed regulation (see Grill et al. (2015)). Constrained banks were issuing CoCos[3] to shore up their equity capital. Our findings are in-line with Boyson et al. (2016) who demonstrate that constrained banks take actions to relax their regulatory constraints without levering down[4]. Although CoCos have equity like features they are essentially deeply subordinated fixed income instruments. Issuing CoCos allows a bank to effectively maintain their leverage, although from a regulatory perspective they are levering down.

We next turn our attention to bank riskiness. Most theoretical models on contingent capital use the Leland (1994) framework. In these models there is a direct parameter which models firms' riskiness – asset volatility. In this paper we estimate bank asset volatility a.la Merton (1974) as a measure of bank riskiness. We find that less risky banks were more likely to issue AT1 CoCos and conditional on having issued, had fraction of AT1 CoCos in their capital structure. At first these results appear counter intuitive. Boyson et al. (2016) for example find that constrained banks which are more risky are likely to use hybrid securities to meet capital requirements at the same time maintaining their riskiness. We here find that constrained banks which are less risky

[3]As per the latest Capital Requirements Directive IV (CRD IV) published by the EU CoCos are the only instruments which count as additional Tier 1

[4]Boyson et al. (2016) look at Trust Preferred securities

use AT1 securities to meet regulatory requirements. In the Tobit model we can also estimate the partial effect of bank riskiness on contingent capital structure as a function of the asset volatility. We find the effect of bank riskiness on contingent capital structure diminishes as the leverage ratio of the bank increases. These results suggest that there must be features unique to the contingent capital bonds that give results different from other forms of hybrid instruments. We also compute yearly stock volatility and 1 year probability of default as additional proxies of bank riskiness to check whether our results are robust to other measure of bank riskiness.

We separately try to analyze the impact of bank riskiness on the pricing of these AT1 CoCo bonds. We computed spreads between the coupons [5] and the YTM of the longest maturity government bond of the currency in which the CoCos were issued. We find a positive relation between the spreads and the riskiness of the bank. This is quite intuitive because one would expect that riskier banks pay higher spreads on their CoCos. This result is useful to us to understand the overall decision of banks to issue CoCos as we describe below.

Our findings suggests that increased capital requirement are the main reason why constrained banks issue CoCos. The fact that unconstrained banks do not issue CoCos suggest that the benefits of CoCos in the capital structure do not the outweigh the costs. We explain the fact that constrained banks choose CoCo and not equity to meet capital requirements from the perspective of banks trying to maximize their ROEs [6]. We hypothesize that banks which were required to raise their capital to meet the non-risk based leverage ratio requirement of Basel III would chose to issue CoCos as opposed to issuing equity *if* issuing these securities had favorable impact on their ROE. Holding the assets of a bank fixed if a bank replaces debt with equity (to meet capital requirements) this dampens the ROE. However, if the bank replaces debt with CoCos the reduction of ROE may be smaller (as compared to issuing equity) if the coupon paid on the CoCos is not too high. We show that the coupons (or spreads) paid by banks on Cocos increase with riskiness of banks. Hence, if the banks were too risky the coupons would be too high and would cancel out any benefits of ROE optimization.

The main contribution of our paper is to provide new insights on the contingent capital structure of banks. We analyze the determinants of contingent capital structure. Post the financial crisis much of the literature on contingent capital has focused on the design features of CoCos (see Flannery (2014) for comprehensive review). Several theoretical models have focused

[5] Almost all AT1 CoCo bonds were issued at par

[6] Although AT1 CoCos are treated as equity by regulators most banks do not include them in the denominator when computing ROE. This intuitively makes sense because when one subtracts the coupon payments from the numerator and what remains accrue to common shareholders, the residual claimants

on the trade-off associated with contingent capital. For example, Himmelberg and Tsyplakov (2014) use a model of dynamic capital structure choice to analyze how the contractual terms of CoCo bonds affect future capital structure incentives. Chen and Glasserman (2013) find that shareholders will want to issue CoCo bonds because the associated reduction in bankruptcy costs will reduce the interest rate on subsequent debt issues. Zeng (2014) uses optimal contracting approach to the study the effect of CoCos on bank's efficiency (ex post risk shifting) and the role of CoCo within banking regulation. Berg and Kaserer (2015) on the other hand, argue that some CoCo bonds may increase the risk shifting incentives due to wealth transfer from CoCo investors to equity holders. We provide empirical guidance to this field of research on bank capital structure. To the best of our knowledge ours is the first empirical paper that speaks to this theoretical literature on contingent capital. We provide a cross-sectional analysis of the contingent capital structure decisions of banks. The earlier empirical work on contingent capital bonds Avdjiev et al. (2015) focus on market reactions to a banks' decision to issue CoCos.

We also contribute to the literature on bank regulation and capital requirements. A large body of research examines the determinants of bank capital (see for review Thakor (2014)). Similar to Boyson et al. (2016) we find that capital constrained banks issue hybrid financial securities. Our findings are also in line with Berger et al. (2008) who find that banks actively manage their capital ratios.

The rest of the paper is organized as follows. In section 2 of this paper we discuss our sample and the relevant summary statistics. In section 3 we explain our empirical analysis and the associated results. Section 4 provides a logical interpretation of the results. Section 5 concludes.

2 Data and Summary Statistics

We collect contingent capital bond (CoCo) issuance data from Bloomberg. We collect issuance-wise data of all contingent capital bonds issued across the world until 31st August, 2016. We limit our attention to contingent capital bonds issued by banks within the European Economic Area (including Switzerland). 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%. We remove any issuance where the amount issued is missing. Most CoCo issuances happened after 2010 and a few of those issuances 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 such matured/recalled AT1 CoCos from our sample. We collect yearly bank data from SNL Financial from 2010 to 2015. We also collect stock price and daily returns data for the publicly traded banks in our sample from SNL Financial.

2.1 CoCo summary statistics

We have data on 236 active AT1 CoCo issuances from across the world. The total outstanding notional from across the world is about $255 billion. 81 banks in the EEA region issued AT1 CoCos and the total notional outstanding is about $165 billion accounting for about 65% of AT1 CoCo market in the world. Figure 1 plots the year-wise total AT1 CoCos outstanding in the EEA and the rest of the world. China, Russia, India and Brazil are the countries which account for almost all the of the issuances outside the EEA. Most of the issuances happened in 2014. Table 1 provides the summary statistics of the additional tier 1 CoCos issued in the world (Panel A) and in the EEA (Panel B). The average size of an issuance was about $1 billion. The trigger level ranges from 5% [7] to 9%. In the EEA most of the CoCos issued had temporary write down as the loss absorption mechanism (Panel C). Equity conversion was the second most favoured loss absorption mechanism. However, equity conversion CoCo had the highest notional outstanding in the EEA (about $70 billion). Data on conversion price or conversion ratio for equity conversion CoCos was not available.

Table 1 also provides summary data on the coupons paid by these CoCos. Almost all the CoCos were issued at par and hence the coupon was the YTM at issuance. 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.

In Figure 2 we plot the country-wise AT1 CoCo outstanding within the EEA. Banks in UK, France and Switzerland issued about $105 billion CoCos. The amount of CoCos issued by banks in Germany was only about $ 7.8 billion. The tax treatment of CoCo by respective governments

[7] 4 of the issuances made by Norwegian banks have CoCo trigger level set at 5% although the minimum trigger level for the CoCos to attain Tier 1 status have to be 5.125%

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 favourable for banks, in particular as it treated the AT1 instruments as debt, which allows for the tax deductibility of coupons. We explore the role of taxes later in section 3.

2.2 Bank data summary statistics

We collect yearly data on all banks (consolidated at the top tier holding level) in the EEA region from 2010 to 2015. 81 banks in our sample had issued AT1 Cocos. 53 out of these 81 banks are listed on a stock exchange. We also collect data on a control group of 3831 banks which did not issue any AT1 CoCos. 191 banks out of these 3831 are publicly listed. We limit most of our analysis on publicly traded banks. Hence our broad sample consists of 53 banks which issued AT1 securities and 191 banks which did not issue AT1 Cocos. The number of bank year observations in our sample is 938 (for a fully specified model with all controls [8]).

Table 2 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 to not have issued any AT1 CoCos. In Figure 3 we plot the average equity over assets, CET1 ratio, tier 1 ratio and total capital ratio. As noted in Figure 3(a) the banks which issued CoCos were also highly leveraged (lower equity over assets) and had lower regulatory capital (Fig 3 (b),(c),(d)). This is intuitive because banks which had lower capital are the ones which are more likely to make use of these hybrid securities to shore up their capital.

2.3 Mesures of Bank Riskiness

Next, we turn our focus on bank riskiness. We estimated 3 market based measures of bank riskiness: 1. Yearly Stock volatilty 2. Implied asset volatility and 3. Probability of Default.

To compute the implied volatility of bank assets as well as the probability of default we use

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

Merton (1974) model. According to the mode the implied volatility of bank's assets is given by

$$\sigma_A = \sigma_E \frac{V_E}{V_A \Phi(d_1)} \tag{1}$$

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

$$V_E = V_A \Phi(d_1) - e^{-r(T-t)} D \Phi(d_2) \tag{2}$$

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 1 and 2.

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.

The probability of default, pd, is given by

$$pd = \Phi(-d_1) \tag{3}$$

In Table 2 we report the summary statistics of these market based risk measures. In section 1.3 we explain the methodology of the estimation of these risk measures. In Table 2 we note that the average implied asset volatility, stock volatility and average probability of default is lower for banks which issued AT1 CoCos as compared to banks which did not issue. In Figure 4 we plot the yearly average asset volatility and stock volatility of the two groups.

3 Empirical Analysis

3.1 Determinants of Contingent Capital Structure

Our goal is to identify the bank characteristics which help explain the fraction of CoCos a bank has in its capital structure. Since our dependent variable - the amount of CoCo outstanding - can naturally take zero values for many banks, linear panel models are not appropriate in this situation. Instead we use a panel Tobit model to account for the corner solution outcome.

We denote the amount of CoCo outstanding as a fraction of (risk-weighted) assets of bank i in year t by y_{it}. Let x_{it} be the row vector of regressors and β be the column vector of parameters. Then our statistical model can be represented as

$$\begin{aligned} y_{it}^{*} &= x_{it}\beta + u_{it}, \quad u_{it}|x_{it} \sim \mathcal{N}\left(0, \sigma^2\right) \\ y_{it} &= \max\{0, y_{it}^{*}\} \end{aligned} \tag{4}$$

where y_{it}^{*} is a latent variable. The latent variable y_{it}^{*} is an artificial construct in a corner solution outcome model and we do not place much emphasis on it. The objects of interest are the probability of having CoCo outstanding $\mathbb{P}\left(y = 1|x\right)$, the expected amount of CoCo outstanding $\mathbb{E}\left[y|x\right]$, and the expected amount of CoCo outstanding among CoCo issuing banks $\mathbb{E}\left[y|x, y > 0\right]$.

The expected amount of CoCo outstanding for bank i in year t is given by the following equation

$$\mathbb{E}\left[y_{it}|x_{it}\right] = \mathbb{P}\left(y_{it} > 0|x_{it}\right)\mathbb{E}\left[y_{it}|x_{it}, y_{it} > 0\right] \tag{5}$$

where $\mathbb{P}\left(y_{it} > 0|x_{it}\right) = \Phi(x_{it}\beta/\sigma)$, $\mathbb{E}\left[y_{it}|x_{it}, y_{it} > 0\right] = x_{it}\beta + \frac{\phi(x_{it}\beta/\sigma)}{\Phi(x_{it}\beta/\sigma)}$, and $\phi(.)$ and $\Phi(.)$ denote the pdf and cdf of the standard normal distribution, respectively. Therefore, both $\mathbb{E}\left[y_{it}|x_{it}\right]$ and $\mathbb{E}\left[y_{it}|x_{it}, y_{it} > 0\right]$ are nonlinear functions of β. This in turn implies that the partial effects are the functions of all regressors. Finally, it is important to stress that the partial effects in a Tobit model share the same sign with parameter estimates β.

The vector of regressors we use to explain the cross sectional variation in the level of CoCos in the capital structure include the leverage ratio (book equity over assets), measure of bank riskiness (stock volatility, implied asset volatility and probability of default), loans over assets, deposits over assets, common equity tier 1 ratio (CET1), return on assets, cash over assets and dummy indicating whether the bank is globally systemically important. All regressors are winsorized at the 1st and 99th percentile and are one-period lagged.

A potential criticism of the model specification in 4 is that the variable y is the outcome of supply and demand, and hence, it cannot be explained by bank's characteristics alone, that is, only by the supply side. However, we know that most of the CoCo issuances have been heavily oversubscribed[9] implying that it is the supply side that played the main role.

Tables 3 summarize the results of the panel Tobit estimation with and without time fixed effects for different proxies of bank risk. We identify variables such as the leverage ratio, bank risk, the loan-asset ratio, size, the CET1 ratio, and GSIB as important determinants of the bank contingent capital structure. Neither ROA nor deposit ratio are found to be an important factor in bank's decision over its contingent capital structure.

The coefficient of leverage ratio is negative and statistically significant in all model specifications. Therefore, the estimation shows that the banks with lower leverage ratio are the banks that are more likely to issue CoCo and, conditional on issuing CoCo, issue more of it. We interpret these finding as banks reacting in anticipation to a new regulatory requirement by Basel III which may come in force in 2018. The Basel III framework, over and above the risk based capital requirements, has proposed the non-risk based leverage ratio. The banks are expected to maintain a leverage ratio above 3%. The banks with lower leverage ratio (lower equity over assets) are the ones that issue CoCo to satisfy the requirement. The banks with higher leverage ratio, one the other hand, are less likely to issue CoCo since for them the new capital requirement is less likely to be a binding constraint. Figure 6 depicts the probability of issuing CoCo, $P(y > 0|x)$, as a function of bank's leverage ratio, assuming sample mean values for the rest of the regressors. Our estimation predicts that banks with the leverage ratio of 5% are twice as likely to issue CoCo than their counterparts with 10% leverage ratio.

We also find that bank risk is an important factor in determining whether a bank issues CoCo or not. Regardless of how bank risk is measured (implied asset volatility, probability of default or stock volatility) the coefficient of the measure of bank risk is found to be negative and statistically significant. Therefore, our estimation suggest that the banks with lower risk are more likely to issue CoCo and, conditional on issuing CoCo, issue more of it.

The fact that bank risk has a negative relation with the amount of CoCo it issues is not obvious. One could argue that we should observe riskier banks issue more CoCo since that would allow them to lower the cost of financial distress which is, ceteris paribus, higher for riskier banks. One could also argue that riskier banks would use CoCos for regulatory arbitrage

[9]Financial Times FEBRUARY 19, 2016

purposes. However, what we find is the opposite. If one assumes a positive relation between bank risk and CoCo credit spreads then a rationale for a reverse relation between bank risk and the amount of CoCo issued is that for riskier banks CoCo may be too expensive. We later verify that bank risk indeed has a positive relation with CoCo credit spreads.

Figure 5 depicts the probability of issuing CoCo, $P(y > 0|x)$, as a function of bank risk (asset volatility), assuming sample mean values for the rest of the regressors. Our estimation predicts that banks with the asset volatility of 5% are four times more likely to issue CoCo than their counterparts with 20% asset volatility.

Figure 7 plots the partial effect of volatility on the mean of CoCo issued, $\frac{\partial \mathbb{E}[y|x,y>0]}{\partial \sigma}$, as a function of the leverage ratio and other controls are evaluated at the sample mean. The figure demonstrates that the partial effect of volatility is decreasing in the leverage ratio, that is, the effect of volatility on AT1 CoCo issuance almost disappears for banks with low leverage and is very strong for banks with high leverage. This evidence suggest that bank risk mattered for constraint banks, that is, banks that needed to increase their regulatory capital substantially, and played less role for unconstrained banks.

Bank's size, measure as the natural logarithm of bank's assets, is found to be an important factor in how much CoCo a bank issues. In particular we find that bigger banks issue more CoCo. CoCo is a non-standard type of a security, and, therefore, one can expect the cost associated with it issuance to be quite high. Thus, large banks possibly use economy of scale when organizing placement of such securities. The statistical significance of bank's size is robust to deferent model specifications.

We find that the global systematically important banks (G-SIB) are more likely to issue CoCo and issue more of it. The Financial Stability Board (FSB) and the Basel Committee on Banking Supervision (BCBS) publish a list of the G-SIB banks. These banks have higher minimum capital requirements. In particular a G-SIB bank has higher requirement for T1 ratio. Since CoCo counts as the T1 capital the G-SIB banks have additional incentive to issue relatively higher amount of CoCo.

Another important factor in determining the amount of CoCo a bank issues is the ratio of loans over assets. We find that the bank with higher proportion of loans in its portfolio issues more CoCo. Since loans are less liquid part of bank's assets the ratio of loans over assets can be thought of as the measure of bank's illiquidity. Given such an interpretation we find that banks with less liquid assets issue more CoCo. Intuitively, the cost of financial distress is higher for the bank with less liquid assets. Therefore, having CoCos in the capital structure instead of debt could be a way to minimize the cost of financial distress. An alternative explanation to why the loan-over-asset ratio is negatively related to amount of CoCo issued has to do with the fact that banks with more loans find it harder to decrease their leverage by shrinking their balance sheet. Therefore, banks with higher loan over-asset ratio issue more CoCo.

3.2 Determinants of CoCo Spreads

Next we turn to explaining the credit CoCo credit spreads. We compute CoCo spreads as the difference between the CoCo coupon and the matching yield of a government bond on the day of the issuance. We choose the comparable government bond based on the currency of issuance. For USD, GBP, EUR and CHF we use the 30 year US, UK, German and Swiss bonds respectively. For NOK, DKK and SEK we use the 10 year (because of the lack of 30 year yields) Norwegian, Danish and Swedish bonds, respectively. It is important to understand which bank characteristics contribute to pricing of CoCo since that can help to clarify banks incentives to issue CoCo in the first place. To identify which bank characteristics determine CoCo spread we run a cross-sectional regression with dependent variable being CoCo credit spread. Denote CoCo spread by CCS_i and the row vector of controls by X_i, then our statistical model for the spreads is given by

$$CCS_i = \alpha + X_i\beta + \epsilon_i \tag{6}$$

Our set of regressors include similar controls as in the previous subsection as well as variables we believe are important in pricing CoCo. In particular, the vector of regressors, x_{it} leverage ratio (regulatory equity over the book value of assets), the measure of bank risk (proxied, in different specifications, by implied asset volatility, probability of default, and stock volatility), bank size (measured as the log of assets), the ratio of loans over assets, the ratio of cash over assets, the ratio of deposits over asset, a dummy variable taking value one if the bank is a globally systemically important bank (GSIB) and zero otherwise, bank's return on assets (ROA), and the minimum capital requirement on T1 capital ratio. Instead of the CET1 ratio we use the trigger buffer defined as the difference between bank's CET1 ratio at the moment of issue and the CoCo's trigger level and we do not use the minimum T1-capital requirement. We do not include the time fixed effects since our sample is relatively small consisting of 121-124 observations depending on model specification.

Table 4 summarizes the estimation result of the model in equation 6. The estimation results in a good fit with R^2 about 0.45.

We confirm that bank risk is indeed an important factor in the pricing of CoCo. Regardless of how bank risk is measured the estimate of the coefficient next to it is positive and statistically significant. Therefore, a riskier bank has to pay higher interest on CoCo. Intuitively, riskier banks are more likely to face the breach of the trigger which manifests itself in the higher spreads these banks have to pay.

The positive relation between bank risk and CoCo spreads could potentially explain why bank risk is an important factor in the decision to issue CoCo. Since riskier banks have to pay higher spreads it is possible that CoCo, as a source of funding, is simply too expensive.

We identify the trigger buffer to be an important factor in pricing CoCo. The effect of the trigger buffer is negative and statistically significant. Intuitively, banks with higher trigger buffers are less likely to breach the trigger and, thus, enjoy paying smaller spreads on CoCo. The economic significance of the trigger buffer is moderate: a percent point increase in the trigger buffer results in about 15-20bps decrease in the spread.

Whether a bank is a G-SIB one has a negative effect on CoCo spreads. The coefficient next to the dummy G-SIB is estimated to be negative and statistically significance. In fact a G-SIB bank pays the CoCo spreads which are on average about 115-120 bps lower than that payed by a non-G-SIB one. A potential explanation of this result is that G-SIB banks are under special control of the regulators and more strict rules applies to them. Therefore, it is possible that some of the risk associated with CoCo and which is not captured by other variables in the regression is lower for the G-SIB banks.

Bank's leverage too play role in pricing CoCo. In particular we find that higher leverage makes AT1 CoCo more expensive for the issuing bank. This is somewhat surprising finding. Because controlling for risk higher leverage implies higher CET1 ratio. But higher CET1 ratio reduces the likelihood of conversion thereby making CoCo cheaper.

A potential explanation to a positive relation between CoCo spread and the leverage ratio is the information content of CoCo issuance. When bank has low leverage ratio it is more likely to issue CoCo in order to meet the capital requirement. When, on the other hand, the bank has higher leverage ratio CoCo issuance could signal alternative motives. Since AT1 CoCo converts relatively early its holders are the first to absorb the bank's losses. As equity issuance can generate negative information content resulting in equity underpricing in line with pecking-order hypothesis, similarly the issuance of CoCo can lead to some underpricing resulting in higher spreads. To support this argument, for example, **?**), do not find evidence that equity issues motivated by the shortfall of capital leads to a drop in banks' equity prices.

4 Interpretation

5 Discussion

In this section we interpret our empirical findings. We find that banks with low leverage ratio (defined as the ratio of book value of equity over assets) and low volatility issue more CoCo. Banks that operate with relatively high leverage ratio have been unlikely to issue AT1 CoCo. This suggest that AT1 CoCos have been issued by banks because of its special regulatory treatment.

The theoretical literature on CoCo argues that CoCo's benefit include increased value of banks and decrease likelihood of failure. However, there is disagreement over shareholders incentives to voluntarily issue CoCo in the theoretical literature (,). This is not a trivial question since by reducing the likelihood of failure, CoCo issuance will result in an increase of bondholders claim value. Therefore, it is possible that most of benefits from CoCo issuance will go to the initial debtholders. Our research provides empirical evidence that banks may not be willing to issue CoCo voluntarily unless it gives some additional benefits (e.g. counts for the regulatory capital). Since not all banks have shortage of regulatory capital, this explains why we do not see many banks issuing CoCo despite its potential benefits.

Albul et al. (2013) analyze bank's shareholders incentives to issue CoCos in a Leland (1994) model. In their model CoCo bond does not have any special regulatory treatment, however, has tax deductible interest payment. They find that shareholders will never voluntary swap any existent debt with CoCo since such a swap results the value of equity decrease due to debt overhang effect. All the gains in firm value plus a fraction of the equity value are transfered to original debt holders.

Chen and Glasserman (2013) reexamine the question of equityholders incentives to issue CoCo within Leland and Toft (1996) framework. In this settings,as apposed to the analysis by Albul et al. (2013), debt has finite maturity. The authors find that under some parameter constellation shareholders could find it optimal to issue CoCos because the associated reduction in the likelihood of failure will result in the lower interest rate for consequent debt issues. Hence the benefit from decrease likelihood of default accrues to shareholders providing incentives to issue CoCo.

Our empirical analysis indicates that AT1 CoCos are issued by constrained bank with the aim to meet the regulatory capital requirement. Banks with high leverage ratio do not issue CoCo since its equity-like regulatory treatment has no value to them. This suggest that without the special regulatory treatment AT1 CoCos would not be issued. This conclusion, of course, should not necessarily be applied to T2 CoCos which usually have much lower trigger level.

Although, the constrained banks have to recapitalize, it is still unclear why they do it by issuing CoCo rather than equity. A typical argument against equity issuance is that it results in underpricing making equity quite expensive. However, the above mentioned paper by **?** suggest that such underpricing is not present when equity issuance is motivated by regulatory capital shortage. We propose an alternative rationale behind banks decision to raise capital with CoCo. We argue that if a bank has to increase its regulatory capital it will do so by issuing CoCo since the associated drop in ROE is smaller than under equity issuance, provided that CoCo is not too expensive. One needs to note that, although, AT1 CoCo counts as equity by regulator it is effectively debt.

Basel III brings a new piece of regulation - the minimum leverage ratio requirement - which is expected to become binding in 2018 for all banks. Given a large heterogeneity in banks' leverage ratio (in our sample bank's leverage ratio varies from as small as 1.17% to as high as 58.61%) the new piece of regulation does not affect all bank equally. Banks with low leverage ratios are the ones that are affected by the minimum leverage ratio requirement.

There are roughly three way a bank can raise its regulatory capital: issue equity, issue AT1 CoCos, and shrink assets by retiring debt. The latter option is problematic if bank has many loans among its assets since most of loans cannot be easily unloaded. Assuming fixed investment policy there are only two options: equity or CoCo. We argue that issuing CoCo is a better option if bank's objective is to maximize ROE. There is ample evidence that bankers pay a lot of attention to return on equity (ROE). ROE is one of the main measures of bank performance. Banks' CEOs compensation is often linked to ROE Moussu and Petit-Romec (2014).

Consider a bank with fixed investment policy. Assume that the bank's current equity is given by E and it has some debt outstanding at the interest rate r^d. Further, suppose its earnings are given by I. Then the bank's ROE is given by

$$ROE = \frac{I}{E}.$$

Now, suppose that this bank needs to increase its regulatory capital from E to $E+\epsilon$. ϵ can be raised by replacing the part of the outstanding debt either with equity or with At1 CoCo. Assume further that the interest on CoCo is given by $r^c > r^d$. If the bank raises the required ϵ by equity then its ROE will become

$$ROE^{\epsilon} = \frac{I + r^d \epsilon}{E + \epsilon}.$$

Alternatively, if the bank replaces debt with CoCo its ROE will become

$$ROE^{c} = \frac{I + r^d \epsilon - r^c \epsilon}{E}.$$

The ordering between ROE^c and ROE^d is not immediate. Issuing equity decreases ROE by increasing the denominator and has no effect on the numerator. In contrary, issuing CoCo has no effect on the denominator but decreases the numerator, thereby, lowering ROE. In fact it can be shown that $ROE^c > ROE^d$ if the following inequality holds

$$r^c < \frac{I + r^d \epsilon}{E + \epsilon} \tag{7}$$

Effectively, equation 7 stipulates that a ROE-maximizing bank will increase its regulatory capital by issuing CoCo if the interest rate payed on CoCo is not too large. Therefore, if ROE maximization is indeed the driving force behind issuing CoCo then we should find that it is the safer banks with higher CET1 and low leverage ratio that have been issuing CoCo. Banks with low leverage ratio find themselves constrained by the new regulatory requirement - the minimum leverage ratio - and hence are in a need for recapitalization. Low bank risk and high CET1 ratio, on the other hand, are associated with lower interest rate on CoCo, making CoCo a preferred option to raise the regulatory capital. In the previous section we have confirmed that (i) the amount of CoCo issued is negatively related to bank risk and leverage ratio, and positively related to the CET1 ratio and (ii) CoCo spreads are negatively related to bank risk and positively related to the trigger buffer.

If ROE maximization is indeed one of the reasons behind AT1 CoCo issuance, then why did all bank not issue AT1 CoCo to boost their ROEs? If it is true that banks which optimally operated under low leverage ratio found themselves constrained by the new piece of regulation opt for issuing CoCo instead of equity because it insured smaller loss in their ROE, then why did other banks, with higher leverage ratio, not replace some of their equity with CoCo to increase their ROEs? With fixed investment policy, a bank that is not affected by the introduction of the minimum leverage ratio requirement, that is, a bank which optimally operates under relatively high leverage ratio, will never replace any of its equity with CoCo to increase its ROE. The reason is simple, if this bank could increase its ROE by levering up it would do it with debt and not CoCo. Replacing equity with debt, rather than with CoCo, will result in a smaller decrease in bank's earnings - the numerator of ROE - since CoCo is more expensive than debt. The decrease in the denominator of ROE due to this levering up is the same regardless of whether equity is replaced by CoCo or debt. Hence, the bank's ROE after levering up will be higher if equity is replaced with debt.

6 Conclusion

We analyze the capital structure of banks within the European Economic Area (EEA) consisting of tier 1 contingent capital bonds (CoCos). We find that highly levered banks were more likely to issue CoCos and conditional on having issued CoCos levered banks had higher portion of CoCos in their capital structure. We also find that less risky banks were more likely to issue CoCos. The effect of bank riskiness on capital structure is strongest for levered banks. We interpret these results as the response of constrained banks trying to optimize their return on equity (ROE) using CoCos.

Tables and Figures

Figure 1: **Additional Tier 1 CoCos outstanding by year**
This figure plots the total AT1 CoCo notional outstanding country wise within the EEA and the rest of the world. The rest of the world primarily includes China, Russia, Brazil and India.

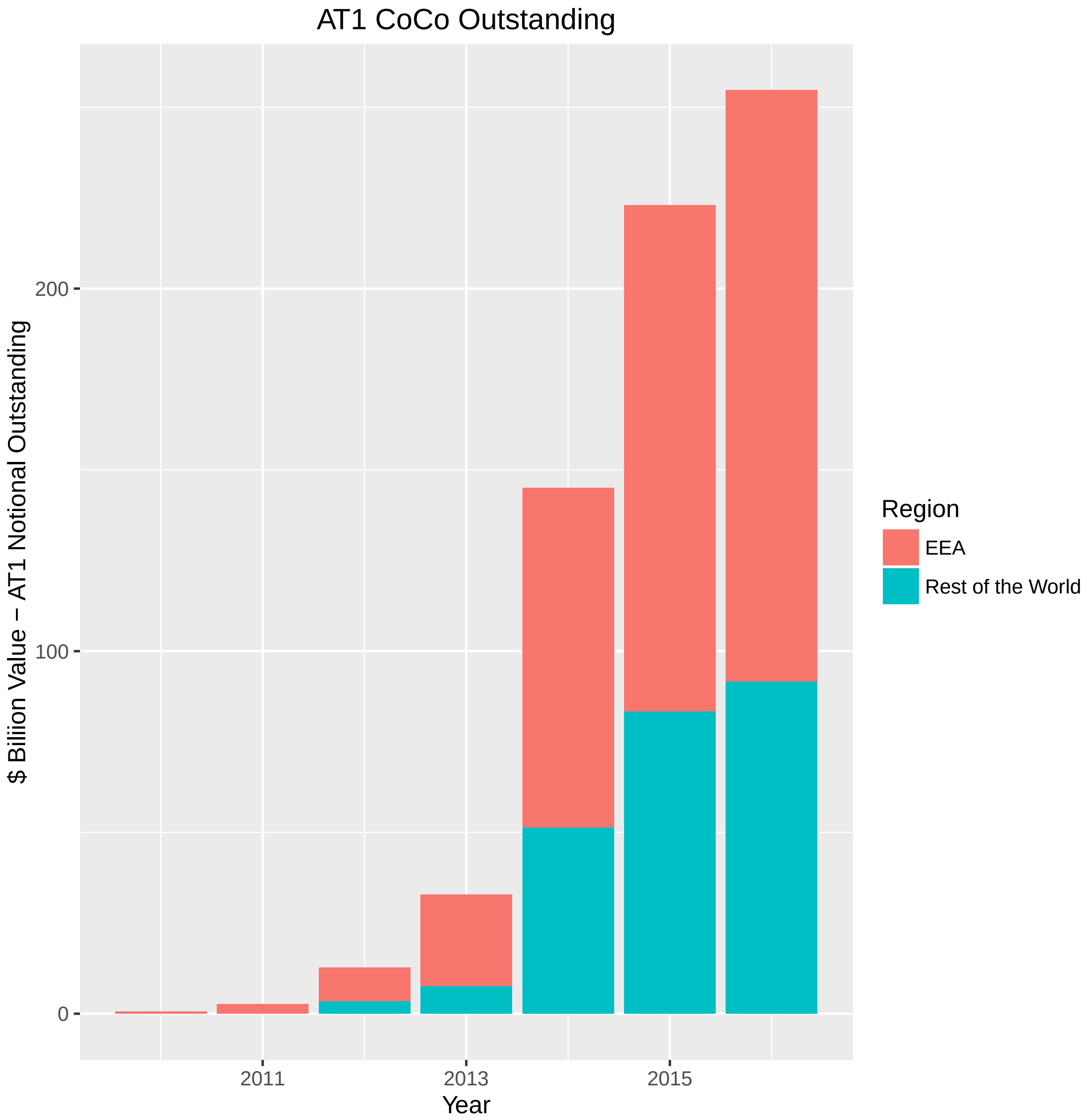

Figure 2: **Additional Tier 1 CoCos outstanding by country within the EEA**
This figure plots the country-wise AT1 CoCo notional outstanding for banks within the EEA.

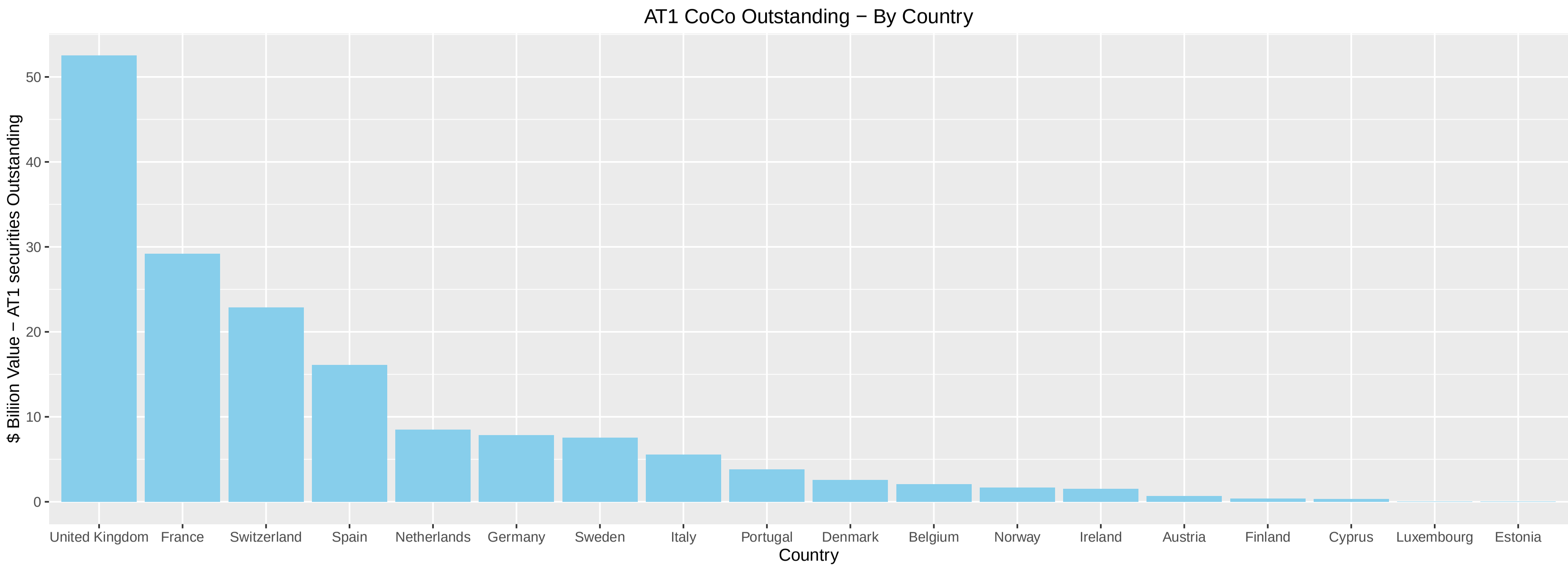

Figure 3: **Bank capital for issuing and non-issuing banks**

This figure plots the average equity over assets, common equity tier 1 ratio, tier 1 ratio and total capital ratio for issuing and non-issuing banks.

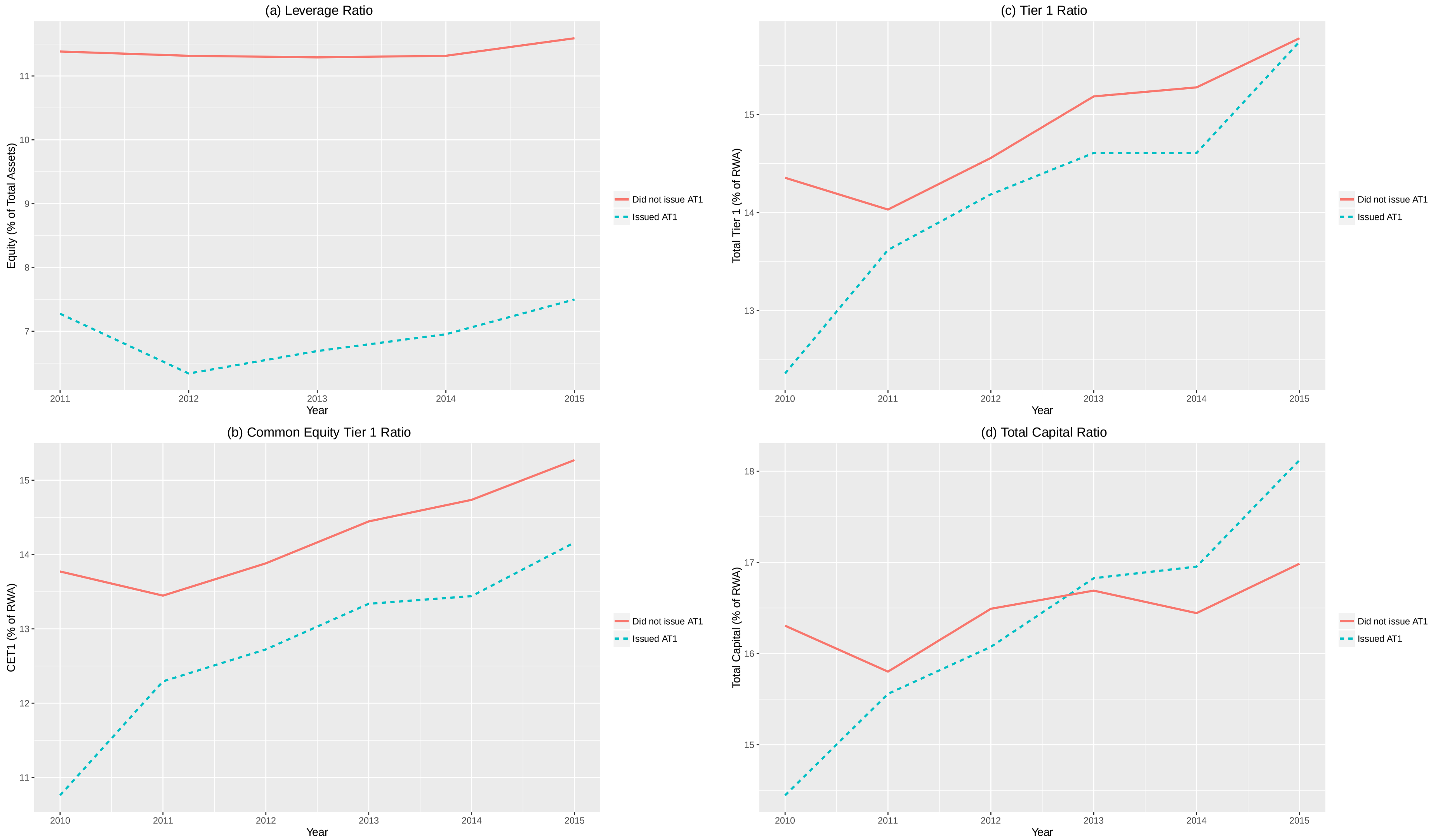

Figure 4: **Bank Riskiness for issuing and non-issuing banks**
This figure plots the average asset volatility and stock volatility for issuing and non-issuing banks.

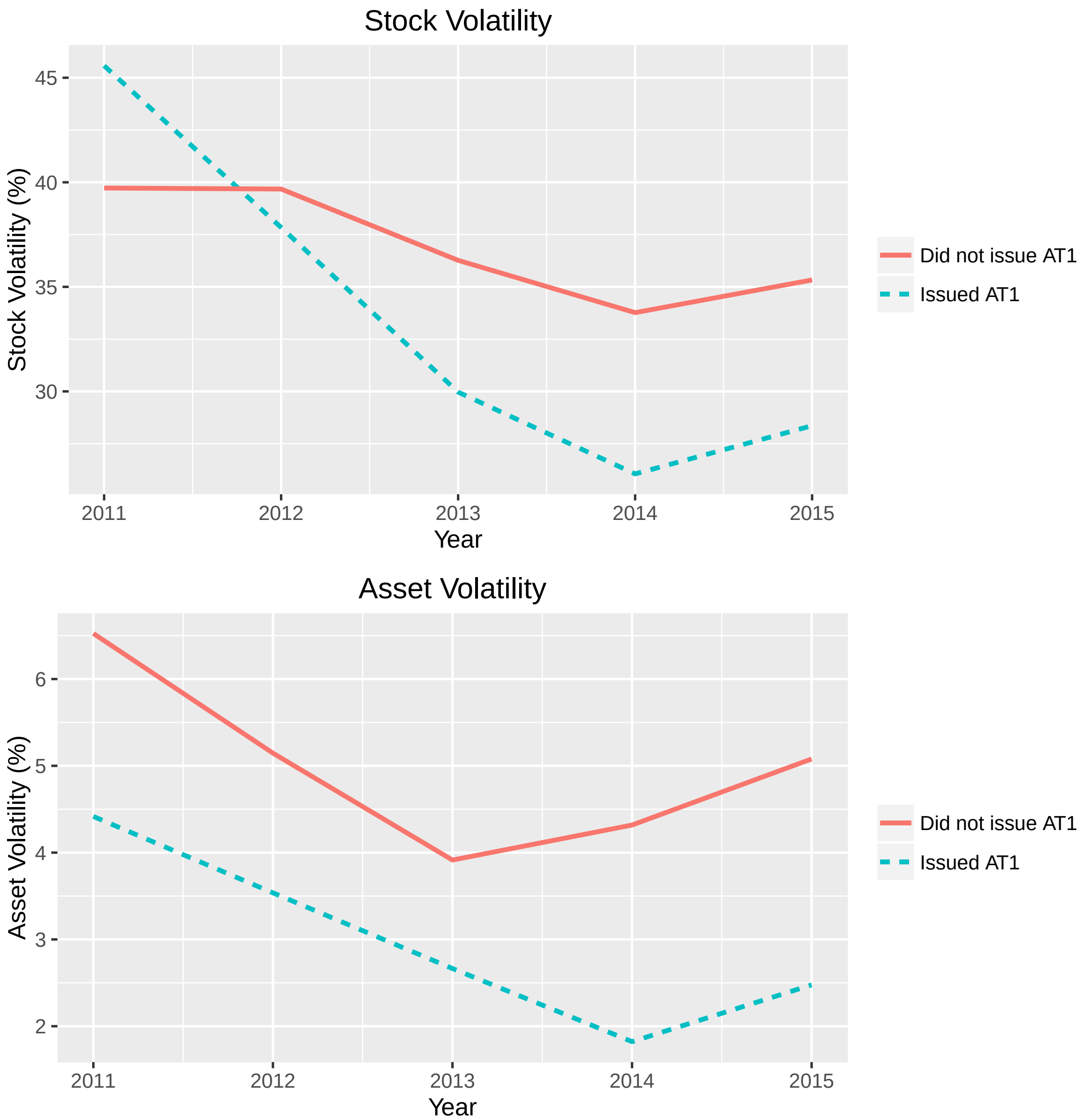

Figure 5: **The probability of issuing AT1 CoCos as function of implied Asset volatility**
This figure plots the probability of issuing AT1 CoCos as a function of bank riskiness as measured by the implied asset volatility (a.la Merton (1974)).

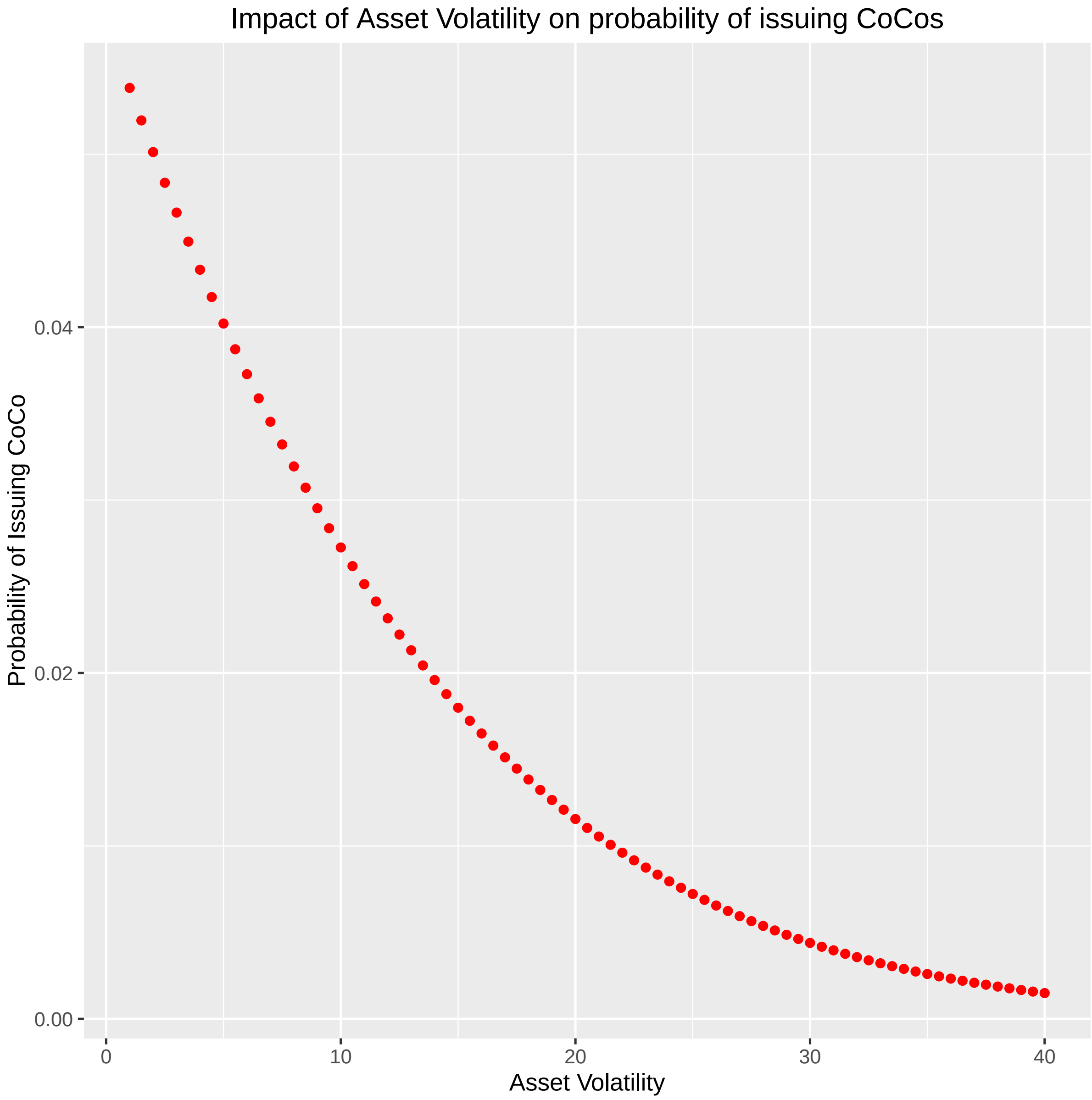

Figure 6: **The probability of issuing AT1 CoCos as function of Equity over Assets**
This figure plots the probability of issuing AT1 CoCos as a function of equity over assets

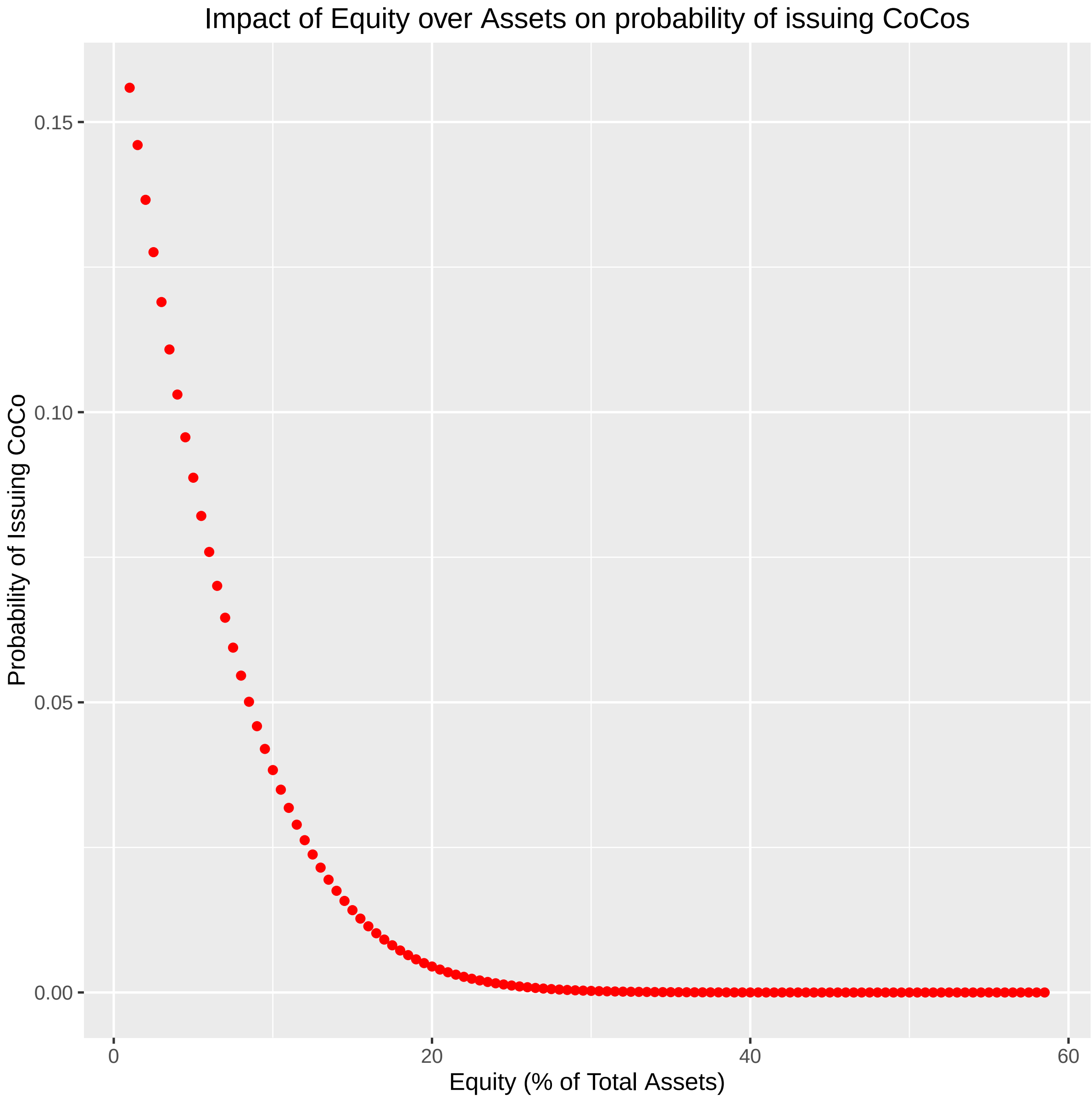

Figure 7: **The partial effect of volatility on capital structure**
This figure plots the partial effect of implied asset volatility on the average of the fraction of contingent capital in the capital structure of banks as a function of equity over assets.

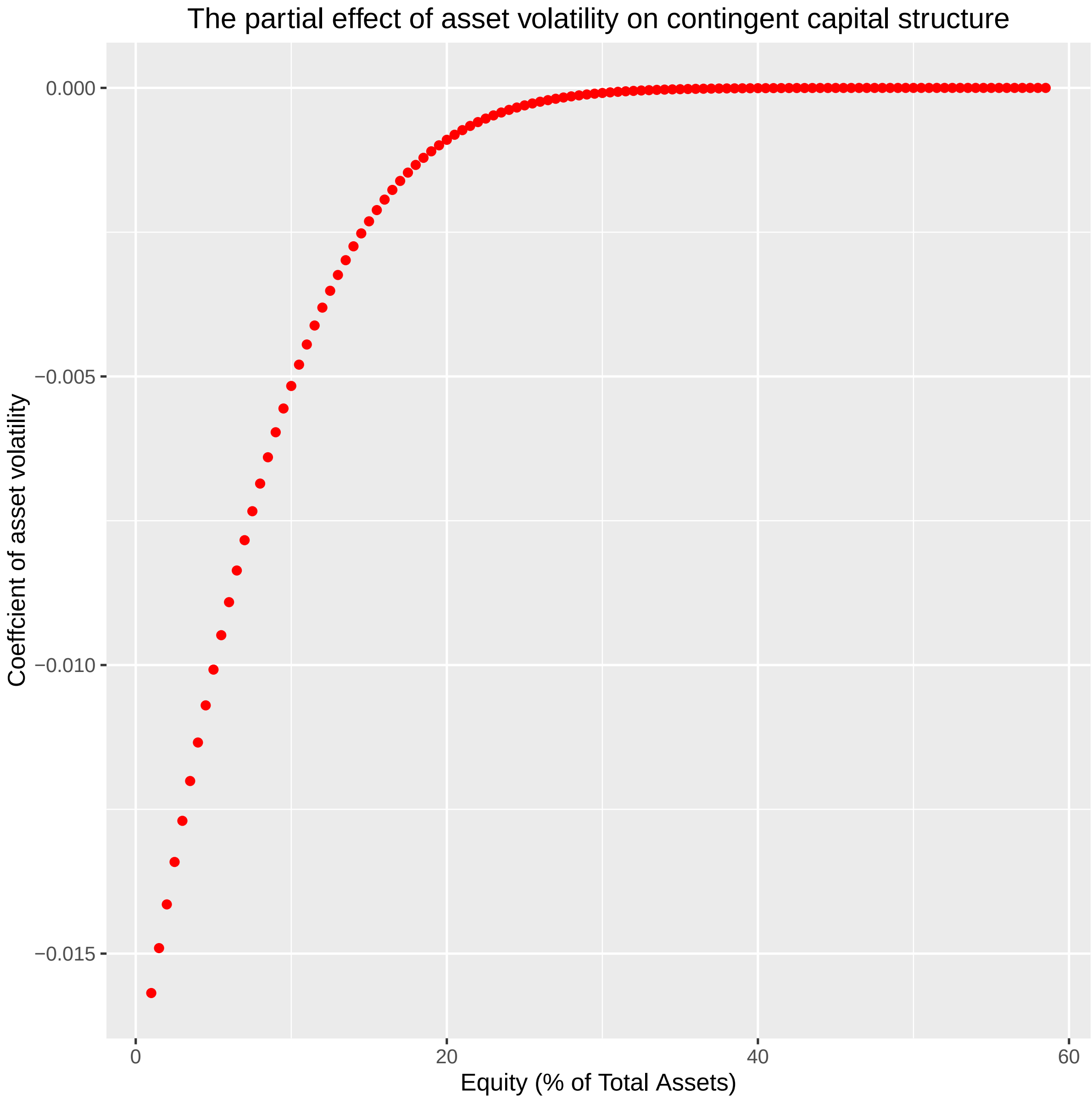

Table 1: **Summary Statistics of AT1 CoCos**
This table provides the summary statistics of the AT1 CoCos issued across the world. Panel A lists the summary statistics of all the CoCos issued in the regio. Panel B provides the summary statistics of Temporary Write Down CoCos, Panel C of Permanent Write Down CoCos and Panel D of CoCos which get converted to equity when the trigger is breached. The COCO Trigger Level is set on the Common Equity Tier 1 (as a % of RWA) of the bank.

Panel A: All AT1 CoCos issued

Statistic	N	Mean	St. Dev.	Min	Median	Max
Amount Issued ($ Million)	236	1,079	1,186	1,956	927	7,045
Coupon (%)	236	6.63	1.98	2.25	6.38	12.5
COCO Trigger Level	234	5.67	0.86	5.0	5.125	9.00

Panel B: AT1 CoCos issued in the EEA

Statistic	N	Mean	St. Dev.	Min	Median	Max
Amount Issued ($ Million)	177	921	793	2	1,000	3,795
Coupon (%)	177	6.39	1.82	2.25	6.38	11.88
COCO Trigger Level	176	5.8	0.95	5.0	5.125	9.0

Panel C: Temporary Write Down CoCos - EEA

Statistic	N	Mean	St. Dev.	Min	Median	Max
Amount Issued ($ Million)	84	721	651	3	600	2,382
Coupon	84	6.32	1.66	2.63	6.19	10.46
COCO Trigger Level	83	5.31	0.57	5.0	5.125	7.125

Panel D: Permanent Write Down CoCos - EEA

Statistic	N	Mean	St. Dev.	Min	Median	Max
Amount Issued ($ Million)	36	839	838	2	353	2,500
Coupon (%)	36	5.69	1.49	2.88	5.96	8.4
COCO Trigger Level	36	5.99	0.99	5.125	5.125	8.0

Panel E: Equity Conversion CoCos - EEA

Statistic	N	Mean	St. Dev.	Min	Median	Max
Amount Issued ($ Million)	50	1,421	791	21	1,500	3,795
Coupon (%)	50	7.41	1.66	2.85	7.19	11.88
COCO Trigger Level	50	6.54	0.94	5.125	7.0	9.0

Table 2: **Summary Statistics of Listed Banks**
This table provides the summary statistics of the publicly listed banks in our sample. The summary statistics are calculated over bank-year observations from 2010 - 2015. Asset volatility and probability of default are calculated as <paper>. All variables are winsorized at the 1st and 99th percentile.

Panel A: Banks which issued AT1 CoCos

Statistic	N	Mean	St. Dev.	Min	Median	Max
Log(Assets)	310	18.29	2.52	13.12	18.82	21.76
Equity/Assets (%)	310	6.83	3.60	2.13	6.47	54.61
CET1(%)	297	12.81	3.60	4.00	12.18	40.41
Tier 1 (%)	301	14.21	3.76	4.90	13.70	40.27
Loans/Assets (%)	309	62.06	18.96	4.29	65.44	91.12
Deposits/Assets (%)	310	50.46	17.57	7.32	52.54	89.90
Cash/Assets (%)	310	0.09	0.07	0.01	0.08	0.64
ROA (%)	310	0.36	0.82	−6.92	0.42	3.37
Asset Volatility	278	2.98	4.18	0.03	1.81	33.19
Stock Volatility	290	33.88	20.52	4.01	30.32	148.63
Prob of Default	278	0.01	0.05	0.00	0.0000	0.52

Panel B: Banks which did not issue AT1 CoCos

Statistic	N	Mean	St. Dev.	Min	Median	Max
Log(Assets)	939	15.31	1.98	10.14	15.26	20.73
Equity/Assets (%)	939	11.58	10.16	1.17	8.73	58.61
CET1(%)	836	14.27	6.19	4.00	13.11	40.41
Tier 1 (%)	880	14.86	5.89	4.90	14.00	40.27
Loans/Assets (%)	881	63.84	21.39	4.29	69.55	92.52
Deposits/Assets (%)	938	60.63	20.73	0.28	64.48	89.90
Cash/Assets (%)	939	0.14	0.13	0.01	0.09	0.64
ROA (%)	939	0.40	2.32	−8.86	0.49	9.23
Asset Volatility	745	4.87	7.42	0.03	2.40	43.96
Stock Volatility	773	36.42	24.84	4.01	30.48	148.63
Prob of Default	745	0.02	0.07	0.00	0.0000	0.52

Table 3: **Determinants of Contingent Capital Structure**

This table reports the results of a panel Tobit regression of the additional tier 1 contingent capital bonds (CoCos) outstanding (as a fraction of lagged total Assets) on leverage ratio (equity over assets) and proxies for bank riskiness. The control variables include size (*log(assets)*), loans over assets, deposits over assets, common equity Tier 1 ratio (*CET1*), cash over assets, return on assets (*ROA*) and a dummy indicating whether the bank is a globally systemically important bank (*GSIB*). Columns (1) and (2) use implied asset volatility as a measure of firm riskiness (a.la Merton (1974)). Columns (3) and (4) use probability of default as a measure of riskiness & columns (5) and (6) use one year stock volatility as a measure of bank riskiness. All regressors are one year lagged values. Standard errors are clustered at the firm level.

	Dependent variable:					
	AT1 Outstanding					
	(1)	(2)	(3)	(4)	(5)	(6)
$(Equity/Assets)_{t-1}$	-0.105^{*}	-0.127^{**}	-0.108^{*}	-0.126^{**}	-0.104^{*}	-0.124^{**}
	(0.059)	(0.063)	(0.059)	(0.062)	(0.057)	(0.061)
$assvol_{t-1}$	-0.062^{***}	-0.052^{**}				
	(0.022)	(0.021)				
$probd_{t-1}$			-4.253^{**}	-3.521^{*}		
			(2.063)	(1.851)		
$StockVol_{t-1}$					-0.014^{**}	-0.010^{*}
					(0.006)	(0.006)
$(Loans/Assets)_{t-1}$	0.023^{**}	0.018^{*}	0.024^{***}	0.018^{**}	0.023^{***}	0.018^{**}
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
$(Deposits/Assets)_{t-1}$	0.015	0.010	0.015	0.010	0.014	0.009
	(0.014)	(0.013)	(0.014)	(0.014)	(0.014)	(0.013)
$Log(Assets_{t-1})$	0.307^{**}	0.269^{**}	0.306^{**}	0.270^{**}	0.298^{**}	0.263^{**}
	(0.127)	(0.131)	(0.124)	(0.127)	(0.122)	(0.125)
ROA_{t-1}	0.080	0.052	0.084	0.056	0.043	0.040
	(0.145)	(0.123)	(0.135)	(0.112)	(0.130)	(0.106)
$CET1_{t-1}$	0.088^{***}	0.020	0.095^{***}	0.025	0.086^{***}	0.020
	(0.030)	(0.037)	(0.031)	(0.038)	(0.030)	(0.037)
GSIB	0.768^{*}	0.632	0.842^{**}	0.690	0.870^{**}	0.680
	(0.409)	(0.438)	(0.414)	(0.437)	(0.403)	(0.425)
Constant	-9.723^{***}		-9.972^{***}		-9.215^{***}	
	(3.077)		(3.018)		(3.165)	
Time Dummies	No	Yes	No	Yes	No	Yes
Observations	938	938	938	938	957	957
Note:						*p<0.1; **p<0.05; ***p<0.01

Table 4: **Contingent capital bond pricing and bank riskiness.**
This table reports the results of a panel OLS regression of the spread between the coupons of the CoCo bonds and the yield on the comparable government bond on the difference between the common equity tier 1 ratio and the CoCo trigger level(*TriggerBuffer*) & proxies of bank riskiness. The control variables include size (*log(assets)*), loans over assets, deposits over assets, cash over assets, return on assets (*ROA*), equity over assets and a dummy indicating whether the bank is a globally systemically important bank (*GSIB*). Columns (1) and (2) use implied asset volatility as a measure of firm riskiness (a.la Merton (1974)). Columns (3) and (4) use probability of default as a measure of riskiness & columns (5) and (6) use one year stock volatility as a measure of bank riskiness. All regressors are one year lagged values. Standard errors are clustered at the bank level.

	Dependent variable:					
	spread					
	(1)	(2)	(3)	(4)	(5)	(6)
$TriggerBuffer$	−0.185***	−0.152**	−0.187***	−0.151**	−0.160***	−0.139**
	(0.060)	(0.065)	(0.061)	(0.065)	(0.054)	(0.063)
$assvol_{t-1}$	0.297***	0.204**				
	(0.101)	(0.097)				
$probd_{t-1}$			23.431***	14.384***		
			(4.347)	(3.606)		
$StockVol_{t-1}$					0.050***	0.041***
					(0.014)	(0.011)
GSIB		−1.140**		−1.215**		−1.074**
		(0.569)		(0.598)		(0.509)
$(Loans/Assets)_{t-1}$		−0.020*		−0.022**		−0.017
		(0.011)		(0.011)		(0.010)
$(Deposits/Assets)_{t-1}$		−0.010		−0.011		−0.008
		(0.017)		(0.016)		(0.013)
$Log(Assets_{t-1})$		−0.085		−0.089		−0.050
		(0.181)		(0.185)		(0.151)
ROA_{t-1}		−0.941**		−1.001**		−0.748*
		(0.386)		(0.404)		(0.423)
$(Equity/Assets)_{t-1}$		0.252**		0.267**		0.267**
		(0.117)		(0.121)		(0.110)
Constant	5.481***	8.282**	5.878***	8.763**	4.294***	6.101*
	(0.523)	(4.157)	(0.525)	(4.056)	(0.607)	(3.418)
Observations	121	121	121	121	124	124
Adjusted R^2	0.291	0.413	0.256	0.392	0.329	0.449
Note:						*p<0.1; **p<0.05; ***p<0.01

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