Aalto University
School of Business

Determinants of primary market pricing of contingent convertibles

Finance

Master's thesis

Ville Tiainen

2015

Department of Finance
Aalto University
School of Business

Aalto University
School of Business

Aalto University, P.O. BOX 11000, 00076 AALTO
www.aalto.fi

Abstract of master's thesis

Author Ville Tiainen

Title of thesis Determinants of primary market pricing of contingent convertibles

Degree Master of Science

Degree programme Finance

Thesis advisor(s) Markku Kaustia

Year of approval 2015 **Number of pages** 44 **Language** English

Objectives of the study

Contingent convertibles or CoCos are loss absorbing hybrid capital securities issued currently by banks and other financial institutions. CoCos distribute an attractive coupon in return for which investors are willing to carry the risk of having to suffer a loss when the issuing financial institution is in dire straits. CoCo bonds can for example be written down when a capital ratio such as the Core Equity Tier 1 ratio (CET1) of the bank fails to meet a pre-determined level. In this thesis, I study which factors determine the new issue credit spreads for these novel hybrid capital securities.

Data and methodology

My data consists of 112 CoCos which are issued between 2009 and March 2015. Bulk of the CoCos are issued by European banks and financial institutions. I'm also utilizing data from Asia-Pacific region to test the robustness of my findings. To test my hypotheses, I will use a modified version of OLS regression model introduced by Chen et al. (2007). My model incorporates bond specific, firm specific and macroeconomic factors as control variables as I try to find out whether certain CoCo specific factors have significant impact on credit spread at the issuance. Furthermore, I'm using similar OLS regression model to study the determinants of CoCos' credit ratings, specifically whether CoCo specific factors drive bonds' ratings. Here, I derive control variables from Moody's revised bank rating methodology.

Findings of the study

Results of my study generate consistent evidence that, for both fixed and floating rate CoCos', credit spreads are inversely related to the distance between bonds' current CET1 capital ratio and the level of trigger capital ratio. This finding is both economically and statistically significant both Europe and Asia-Pacific & Latin-America regions. Moreover, analysis of public and rated CoCos creates evidence for that investors demand higher credit spread for CoCos which are written down permanently rather than converted into equity. In addition, another main finding of my study is that credit ratings are the single most significant driver both economically and statistically for credit spreads of contingent convertible securities at the issuance. By analyzing determinants of credit ratings I find that credit rating agencies incorporate CoCo-specific factors into them. This explains the multicollinearity between CoCo-specific variables and credit rating.

Keywords Contingent convertibles, CoCos, credit spread determinants, bonds

Table of Contents

List of tables

List of figures

1. Introduction

Financial crisis of 2007-2008 exposed severe flaws in banks’ capital requirements and thereby commenced widespread discussion among regulators how similar crisis could be avoided in the future. Since the crisis, several new regulation entities have been put up by different regulators globally and locally in order to avoid, or at least mitigate, forthcoming banking turmoil. The most notable and exhaustive regulation entity so far has come from the Basel committee on banking supervision, the primary global standard-setter for the prudential regulation of banks, which took steps in that direction by publishing Basel III voluntary regulatory standard.

As part of the revised framework, among other things, banks are required to hold more loss-absorbing capital, namely Tier 1 capital, which consists of Core Equity Tier 1 capital (CET1) and Additional Tier 1 capital (AT1), and Tier 2 capital (T2). According to regulatory standard, from March 31st 2019 on, banks must hold total capital equal to at least 8% of risk-weighted assets (RWA), Tier 1 capital must equal at least 6% of RWA and CET1 must be at least 4.5 % of RWA at all times. In addition, Basel III states single set of criteria that instruments are required to meet before inclusion in the relevant category (Basel Committee on Banking Supervision, 2011). These new criteria for banks’ capital create a situation where older types of hybrid capital, such as lower Tier 2 capital and Tier 3 capital, will no longer be recognized as loss-absorbing instruments by the regulators and are hence already in the process to be replaced by 2019. This transition period creates demand for new types of instruments that help banks to meet the more demanding minimum capital requirements.

Even though several contingent capital instruments exists, the focus in the new regulatory environment is on Contingent convertible capital instruments, or CoCos, which are hybrid capital securities that absorb losses in accordance with their contractual terms when the capital of the issuing bank falls below a certain level (BIS 2013). Consequently, by the definition, all version of CoCos have the common feature of increasing bank capital in adverse states of the world by converting hybrid capital to common equity. Hence the name, contingent convertible.

1.1 Background and motivation

Current academic literature has mainly focused on the design and pricing of contingent convertible securities. My study approaches the topic from the latter standpoint since to the best of my knowledge, there is currently only one paper, by Wilkens and Bethke (2014), which assesses empirically three different pricing models for CoCo bonds. Moreover, given that their results are inconclusive due to the limited number of bonds and comparatively short historical time series, the study settles for outlining three main criteria that are required from suitable pricing model: explicit incorporation of the CoCo bond features, accurate reflection of the CoCo bond as a hybrid equity-credit instrument and practical calibration so that model adapt to the new information.

My study builds on these findings by studying whether structural pricing model introduced by Pennacchi (2010) and evaluated by Wilkens and Bethke (2014) can explain primary market pricing of CoCo bonds. In addition, by empirically studying CoCos issued by European, Latin-American, and Asia-Pacific banks and financial institutions, I aim to show that CoCo-specific factors are important drivers of bonds' primary market pricing.

My results imply that certain CoCo-specific factors have the expected sign and magnitude to credit spreads and that these findings hold throughout different types of contingent convertible securities. In addition, my results show that credit rating agencies incorporate CoCo-specific factors into their ratings which are issued during the issue. This finding underlines the fact, that investors demand compensation for special contingent risks that CoCos entail.

1.2 Objectives and contribution

Besides to structural models (e.g. Pennacchi (2010); Albul et al. (2013); Glasserman and Nouri (2012)), also equity derivative models (De Spiegeleer and Schoutens (2012)) and credit derivative models (De Spiegeleer and Schoutens (2012)) have been introduced for alternative pricing methods for CoCo bonds.

The key contribution of the current paper is to find out whether structural model introduced by Pennacchi (2010) can explain the primary market pricing of banks' CoCo bonds. The reasoning behind this objective is twofold: first, when choosing between above mentioned pricing models, structural model stands out since most of the contingent convertible bonds issued to date have expressed their trigger thresholds in terms of a predetermined capital ratio.

Thus, structural models provide a natural pricing framework that considers the institution's balance sheet structure (i.e. capital ratio) as the main price driver (Wilkens & Bethke, 2014). Second, among structural models, Pennacchi's (2010) model stands out because it is set up as a pricing model and reflects the features of CoCo bonds, thereby establishing practical ground for testing hypotheses.

Considering the aforementioned approach to the topic, I try to find evidence for the following conclusions derived by Pennacchi:

- New issue credit spreads for both fixed and floating rate CoCos' are inversely related to the distance between bonds' current CET1 capital ratio and the level of trigger capital ratio
- New issue credit spreads for both fixed and floating rate CoCos are inversely related to level of trigger capital ratio
- New issue credit spreads for both fixed and floating rate CoCos' are higher for bonds that are written down permanently compared to those that have temporary write down or equity conversion as a loss absorption mechanism
- New issue credit spreads for both fixed and floating rate CoCos' are higher for bonds that are written down temporarily compared to those that have equity conversion as a loss absorption mechanism

Consequently, my study contributes to the existing literature by empirically testing the applicability of Pennacchi's pricing model which fulfills two out three requirements set up by Wilkens and Bethke (2014). Pennacchi's model can be considered as valid starting point for empirical testing since no other model fulfilled more than one requirement.

1.3 Limitations of the study

I acknowledge that study is based on limited set of data and that this could undermine the generalizability of my results. Additionally, my study omits one possibly notable credit spread factor from the regression models, namely combined buffer which is related to issuer's capital core capital structure and its sufficiency. Moreover, since the breach of combined buffer may lead to cancellation or postponement of coupons, it has clear connection to riskiness of a bond and in that way affects to credit spread. Naturally, this could cause omitted variable bias where my regression models compensate for the missing factor by over- or underestimating the effect of one of the other factors. The factor is omitted from the analysis since Bloomberg or any other data vendor is not able to provide reliable data at the moment.

Both the limited data set and possibly important omitted variable bias create obvious incentives for the future research in the field of contingent convertibles.

1.4 Main results

Results of my study generate evidence for H1 which proposes that credit spreads at the issuance for both fixed and floating rate CoCos' are inversely related to the distance between bonds' current CET1 capital ratio and the level of trigger capital ratio. This finding is both economically and statistically significant both Europe and Asia-Pacific & Latin-America regions. Furthermore, my study fails to create statistically significant evidence for other hypotheses.

However, the by-product and other main finding of my study is that credit ratings are the single most significant driver both economically and statistically for credit spreads of contingent convertible securities when they are issued. By analyzing determinants of credit ratings, I find credit rating agencies incorporate CoCo-specific factors into them. This explains the multicollinearity between these variables. To elaborate, volatility adjusted distance to trigger and permanent write-down dummy seem to be the biggest drivers of credit ratings. Consequently, both offer interesting topics for further research.

1.5 Structure of the study

The paper is organized as follows. In Section 2, I will briefly go through the key features and definitions of CoCos. In Section 3, I review the literature related to determinants of credit spreads for both typical corporate bonds and contingent convertible bonds. Section 4 presents the hypotheses of my study. Data is introduced in section 5, methodology in section 6 and results and robustness check in section 7. Section 8 concludes.

2. Key features of contingent convertibles

The brief history of these securities means that CoCo-market is still in a flux and lacks widespread standardization. However, CoCos that are issued so far share three key features which distinguish them from standard senior or subordinated debt securities issued by banks and other financial institutions: host instrument and its key features, the loss absorption mechanism and the trigger that activates loss-absorption mechanism. In addition, certain CoCos have compulsory capital requirements, namely combined buffer requirements, which limit issuers' coupon payments and other discretionary distributions. These features are presented thoroughly next.

2.1 Host instrument

CoCos can currently have two different host instruments, Additional Tier 1 (AT1) and Tier 2 (T2), namely. Both AT1s and T2s satisfy regulatory capital requirements under Basel III[1] and thus share same elements. For example, current Basel III framework requires all AT1 and T2 securities to have point of non-viability (PONV) trigger which effectively gives local banking supervisor a discretionary chance to activate loss-absorption mechanism if they doubt issuing bank's ability to stay solvent. However, T2 CoCos, unlike AT1s, typically have pre-determined mature dates and mandatory coupon payments. Next, I will briefly cover both type of host instruments.

2.1.1 Additional Tier 1 (AT1) contingent convertibles

In Europe, market has converged on AT1 as the predominant host, with a limited role for T2 CoCos[2]. These securities are perpetual by definition and consequently lack any coupon step-ups or incentives to redeem them at a given call-date. Moreover, coupons payments for AT1s are fully optional and can be cancelled or reduced if distribution would decrease issuer's Common Equity Tier 1 (CET1) capital below combined buffer requirement. Additionally, AT1 CoCos have mandatory contractual principal write down as loss absorption mechanism instead of equity conversion. This mechanism has strengthened their popularity among institutional fixed-income investors whose mandates often prevent them from holding equity or securities that can be converted into equity. Finally, to qualify as AT1 capital, a CoCo needs to have trigger level of 5.125 % (CET1 divided by RWA) or higher.

---

[1] See Basel Committee on Banking Supervision (2011) for more information.
[2] Current European Market size for AT1s is €50bn whereas T2s amount to €27bn. Moreover, the expected market size for AT1s is expected to be €200bn and only €40bn for T2s. (Nordea internal report - Understanding European Bank Additional Tier 1 and Contingent Convertibles)

2.1.2 Tier 2 (T2) contingent convertibles

T2 instruments have a few notable differences compared to AT1s. First, T2s typically have contractual maturity date unlike AT1s which, by the definition, are issuer's going-concern capital. Second, T2s normally have mandatory coupons and cancellation of distribution would be considered as a default. Such cancellation would not be considered as a default in the case of AT1s (De Spiegeleer et al. (2015)). Third, in general, T2 CoCos have lower trigger levels than AT1 CoCos. This makes them less likely to be written down or converted into equity when issuer's minimum CET1 ratio is breached. Finally, T2 CoCos are senior to AT1 CoCos in issuers' capital structure.

2.2 Trigger

Triggers can be linked to a capital ratio or supervisors' discretion. In the former case, capital ratio is calculated by dividing issuer's CET1 capital with Risk Weighted Assets (RWA). Under Basel III, the minimum trigger level for AT1 CoCos is 5.125%. As a result, there has been a trend towards issuing CoCos with trigger level set exactly to that minimum required level (BIS Quarterly Review, 2013).

Considering the latter case, regulators can activate the loss absorption mechanism if they believe that such action is necessary to prevent issuing bank's insolvency. Current Basel III framework requires all AT1 and T2 eligible securities to have contain discretionary trigger (Basel Committee on Banking Supervision, 2011). Thus, almost all issuers have included regulatory triggers in their bonds (De Spiegeleer et al. (2015)).

It should be noted here that CoCos could, at least in theory, have market-value triggers which could be easily monitored by investors and regulators. In such a case, loss absorption mechanism would be activated as soon as an observable variable such as for example a share price of credit default swap breaches the contractual trigger level. However, CoCos with market-value triggers has not been issued so far.

2.3 Loss absorption mechanism

CoCos can restore issuer's depleted CET1 ratio either by writing down bond's nominal or converting it into equity. As mentioned above, loss absorption mechanism is initiated either when issuer's trigger level is breached or when local banking supervisor decides to use its discretionary power to bolster bank's capital.

First, due to the trigger breach, CoCos can be written down either fully or partially. Moreover, bond nominal can be written down permanently or temporarily. Here the face value of the bond can be restored if the issuing financial institution manages to restore positive financial results and adequate capital ratios. Furthermore, different write down conventions are expected to persist since the design of contingent convertibles is currently driven by local supervisors.

Second, nominal of contingent convertible bond can be converted into equity with rate that can based on the market price of stock at the time the trigger is breached, a pre-specified price, or a combination of these two alternatives. The first option is likely to cause massive dilution of holdings of original shareholders since issuer's stock price is expected to be very low at that time. On the other hand, the second option would lead to a more favorable conversion terms for original shareholders given that the pre-determined conversion price is above the prevailing share price at the trigger event. In the first option, original shareholders would have strong incentive to avoid trigger whereas second option would in turn decrease their motive dodge possible trigger event. Finally, setting the conversion price equal to the prevailing share price at the time of trigger breach, subject to pre-specified price floor, preserves the incentives for existing shareholders to avoid trigger event, while preventing unlimited dilution.

2.4 Combined buffer

The combined buffer is the additional equity-like capital required above the regulatory minimum of 4.5%, below which a bank is insolvent. The combined buffer includes the capital conservation buffer, countercyclical buffer and systemic buffers which are estimated to amount 2.5%, 0.5% and 3% respectively[3]. Thus, the regulatory minimum plus combined buffers is expected to be around 10.5% for large banks by 2018. Combined Buffer is extremely important concept for AT1 CoCos since it establishes a situation when maximum distributable amount (MDA) restrictions apply. MDA in turn equals the maximum amount that bank is allowed to distribute in discretionary distributions (dividends, AT1 coupons and staff bonuses) when it is operating below the Combined Buffer requirement. Breach of the Combined Buffer leads to situation where coupons for AT1 CoCos must be cancelled or reduced due to the MDA restrictions. Consequently, Combined Buffer plays an important role in CoCo valuation alongside with the above mentioned factors. However, the shortage of reliable public time series

[3] Article 141 of CRD IV (Capital requirements regulation and directive)

data about banks' Combined Buffers limits its use as a pricing variable in scientific studies. For the same reason Combined Buffer is excluded from my study.

3. Related literature

This section provides an overview to the existing literature of pricing of corporate bonds and contingent convertible bonds issued by financial institutions. First, I will go through the theoretical literature about pricing of risky corporate debt without any special features. The section is divided into two different topics: structural models and reduced form models. After laying the theoretical groundwork and context for pricing of risky debt, I will move on to the body of literature which discusses about the different pricing models of contingent convertibles, i.e. CoCos. Considering the novelty of the CoCo securities, the discussion in this field has so far concentrated on theoretical papers as empirical papers have been scarce due to the lack of data. Therefore, the main focus is on the theoretical papers.

3.1 Pricing of corporate bonds

There exists a large theoretical body of literature on the pricing of corporate bonds. This literature is usually divided between "structural models" and "reduced form" models. I will first present the earlier related literature of structural models and then go through the main academic literature concentrated on reduced form models.

3.1.1 Structural models

In so-called structural models, a firm is assumed to default when the value of its liabilities exceeds the value of its assets, in which case bondholders assume control of the company in exchange for its residual value. These models build on the original insights of Black and Scholes (1973), who demonstrate that equity and debt can be valued using contingent claims analysis. Besides Black and Scholes (1973), Merton (1974), Ingersoll (1977), Longstaff and Schwartz (1995) and Collin-Dufresne and Goldstein (2001) are some of the classic papers from this area. All of these papers propose a firm value process, and assume that company defaults its debt when its value falls below some threshold. This default threshold is defined as a function of the amount of debt outstanding. This is to say, holding a risky debt instrument can decomposed to a risk-free debt claim and short position of put option which is sold to the equity holders. This put option gives equity holders right to put the firm at the value of the risk-free claim. Besides firm value process, structural models generate predictions for what the theoretical determinants of credit spreads should be. The six common determinants are presented below and written with *italic* font.

First, as pointed out by Longstaff and Schwartz (1995), higher *spot rate* increases the risk neutral of the firm value process. Leland and Toft (1996) arrive at similar conclusion and note that credit spreads decrease as risk-free rate increases. A higher drift, i.e. risk-free rate, reduces the probability of default and thus reduces the credit spread in the structural model. In other words, higher short rate usually implies higher growth of the overall economy which in turn strengthens business performance across the different industries.

Second, the spot rate process itself depends on other factors. Two most important factors driving the term structure of short interest rates are level and *slope of the term structure*. Here, the steepness of the Treasury curve slope (i.e. risk-free rate) reflects the expected evolution of spot rates. Theory predicts that an increase in Treasury yield curve slope will create a decrease in credit spreads. And vice versa, flattening yield curve slope usually implies decelerating overall economy and wider credit spreads.

Third, structural models posit that default is triggered when firm’s leverage ratio equals one. Consequently, it follows that *leverage* drives the demanded credit spread and that increased leverage implies higher demanded credit spread. Among others, Collin-Dufresne and Goldstein have (2001) concluded that firm’s outstanding debt has a significant impact on credit spread of that firm.

Fourth, as mentioned above, contingent-claims approach implies that long position of risky corporate debt can be decomposed into long position of risk-free debt and short position in put option. Since the option value is increasing function of *volatility,* it follows that credit spreads should widen with asset volatility as it increases the probability of default. Zhang et al. (2009) provide empirical evidence on this assertion as their results show that equity volatility and jump effects explain an additional 14% to 18% of the total variation in levels of credit spreads after controlling for rating information and other structural factors. In particular, when all these control variables are included, equity volatility and jumps are still the most significant factors, even more so than the rating dummy variables (Zhang;Zhou;& Zhu, 2009).

Fifth, *the probability or the magnitude of negative downward jump in firm value* increase credit spreads. The rational for the relationship is identical to volatility’s and credit spreads’ relationship described above. Cremers et al. (2008) use a structural jump-diffusion firm value model to assess the level of credit spreads generated by option-implied jump risk premia and find that incorporating option-implied jump risk premia brings predicted credit spread levels much closer to observed levels. The introduction of jumps also helps to improve the fit of the volatility of credit spreads and equity returns. Additionally, Zhang et al. (2009) attempt to explain the credit default swap (CDS) premium, using a novel approach to identify the volatility and jump risks of individual firms from high-frequency equity prices fit of the volatility of credit spreads and equity returns. Their empirical results suggest that the jump risk predicts 19% variation in CDS spread levels, whereas the volatility risk forecasts 48%.

Sixth, *business climate* also plays a role in structural models. This is based on the notion that even if the probability of default remains constant for a firm, changes in credit spreads can occur due to changes in expected recovery rate which in turn should be a function of business climate (Collin-Dufresne & Goldstein, 2001). Moreover, Altman and Kishore (1996) find that recovery rates are time-varying due to different business cycles or climates. They also note that the original rating of a bond issue as investment grade or below investment grade has virtually no effect on recoveries once seniority is accounted for. Additionally, neither the size of the issue nor the time to default from its original date of issuance has any association with the recovery rate

3.1.2 Reduced form models

A difficulty with structural models is that investment-grade corporate bonds very rarely default. For example, Elton et al. (2001) conclude that only a small part of the spread between corporate and treasuries and the difference in spreads on bonds with different ratings is explained by the expected default loss. They point out that 46.17 percent of difference between 10 year corporate and treasury yields is unexplained by taxes or expected default and show that the vast majority of that difference is compensation for systematic risk and is affected by the same influences that affect systematic risks in the stock market.

Reduced form models, by contrast, assume exogenous stochastic processes for the default and the recovery rate. These models are usually fit econometrically to data on swap spreads and corporate bond yields (Campbell & Taksler, 2003). There are several papers which employ a less structured econometric analysis and ask what observable variables are correlated with bond yields cross-sectionally and over time.

Collin-Dufresne et al. (2001) investigate changes in credit spreads on individual bonds and find that most of the variation in credit spreads is explained by the an aggregate factor common to all corporate bonds, whereas the factors suggested by traditional models of default risk explain only about one-quarter of the variation in the credit spreads as measured by adjusted R-squared. In their study, they try to explain credit spread changes by traditional structural model factors that were described on the previous sub-section.

Furthermore, as Collin-Dufresne et al. (2001), Campbell and Taksler (2003) employ relatively unstructured econometric approach to explore the effect of equity volatility on the corporate bond spreads. After controlling typical credit spread determinants, they conclude that equity volatility can explain as much cross-sectional variation in yields as can credit ratings, and that volatility contributes explanatory power even in the presence of credit ratings. Furthermore, authors note that the effect appears to be much stronger than can be explained by the standard structural model of Merton (1974).

Finally, Chen et al. (2007) examine the association between corporate bond liquidity and credit spreads. After using similar methods and credit spread determinants as Collin-Dufresne et al. (2001) and Campbell and Taksler (2003) they document that liquidity is priced in credit spreads. Furthermore, liquidity is a key determinant in credit spreads, explaining as much as half of the cross-sectional variation in credit spread levels and as much as twice the cross-sectional variation in credit spread changes than is explained by credit rating effects alone. Results hold for both investment-grade and speculative-grade bonds.

3.2 Pricing of contingent convertible bonds

The pricing models for CoCo securities that are proposed in the literature can be broadly grouped in three different categories: structural models, credit derivative models and equity derivative models. Since my work is based on structural model, this section reviews the most prominent papers that consider the issuing institution’s balance sheet structure as the main price driver CoCo bond.

Because most of the contingent convertible bonds issued to date have expressed their trigger thresholds in terms of a predetermined capital ratio, structural models provide a natural pricing framework for this new type of convertible security. First, Pennacchi (2010) assumes the bank's total asset value to follow a Wiener process while the value of deposit, subordinated bond and equity capital tranches are modeled depending on the asset value. In addition, he integrates jump-diffusion processes, which reflect the possibility of sudden large losses in asset value. In the model, triggering of the CoCo depends on the asset value or some book value to asset value ratio. Determining the corresponding factors in practice may be extremely difficult. This issue is not addressed in detail in the paper.

Building partly on Pennacchi's work, Buergi (2013) presents straight-forward structural approach to value CoCo bonds. Similar to earlier structural models, author assumes that issuer's total asset value follows a geometric Brownian motion and that there exists a certain relationship between the actual value of assets and its disclosed counterpart. In addition, it is assumed that the actual asset value equals the sum of the firm's market capitalization and its actual value of liabilities (following Pennacchi), the equity and the TIER-1 ratio are in a linear relationship and that the worse the financial condition of the firm is, the more the actual and the disclosed value of assets converge.

By applying these assumptions, Buergi (2013) concludes that his model allows to clearly picture the basic mechanics of CoCo pricing and simultaneously introduces three major problems which are inherent for TIER-1 ratio triggered CoCos. First, the determination of the TIER-1 ratio depends on certain guidelines given by the national regulators. They usually leave some leeway for discretionary decisions. Correspondingly, modeling their relationship to straight-forward book ratios such as the equity ratio may be very difficult and require detailed information on the issuer's asset structure. Second, defining probability of TIER-1 ratio breach is difficult due the fact that actual asset values cannot be observed directly and thus one has to rely on implied asset values derived either from equity or credit markets. Finally, for those CoCos that convert to equity after trigger event, the stock price at the conversion plays naturally important role from the valuation perspective. Even though issuers TIER-1 ratio should be reflected in the market value, determining the prevalent share price at the conversion is troublesome.

Alongside structural models, current academic literature leans on equity and credit derivative models for contingent convertible valuation. De Spiegeleer and Schoutens (2012) present examples for both of aforementioned approaches.

Equity derivatives approach basically is a payoff replication where CoCo bond is divided in three separate parts: a zero coupon bond, the coupon payments and the block of shares received if converted. Each part is valued separately. Whereas the valuation of the corporate bond part is rather simple, coupon payments are modeled as multiple binary-down-in options and the block of shares as a knock-in forward. The binary down-and-in options reflect the cancellation of the coupon payments after the conversion has taken place. The knock-in forward represents the trigger event, when the CoCo bondholder exchanges the bond for shares at a predetermined strike price. Provided that triggering relies on a stock price trigger, the valuation of all parts is unproblematic. But in practice triggering usually depends on an equity or TIER-1 ratio as mentioned earlier on description of structural models. De Spiegeleer and Schoutens (2012) bypass this issue by replacing the equity ratio trigger level by a representative stock price level. This generally implies positive relationship between company's share price and TIER-1 equity ratio. In their empirical analysis, Wilkes and Bethke (2014) conclude that given the straightforward parameterization, the equity derivatives model is most promising approach for practical implementation for hedging CoCo risk.

Furthermore, Spiegeleer and Schoutens (2012) have also presented a credit derivatives approach for CoCo pricing. Since the main distinctive feature of CoCo is the conversion or write-off in the case of financial distress and consequent trigger event, the bond price should closely reflect the financial health and default probability of the issuer. Thus, they calculate the triggering probability and the expected loss in case of conversion. This results in a certain credit spread, which is necessary to cover the corresponding investment risks. A central problem with their approach is the stream of future coupon payments that the holder of the CoCo bond forfeits at conversion.

Above mentioned challenges are also mentioned by Wilkens and Bethke (2014) in their empirical analysis of current CoCo pricing methods. Authors note that structural model reflects the features and dynamics of CoCo bonds in terms of its specification but that model's performance strongly depends on an accurate estimation of the asset value, whose proxying via the market share price can lead to deviations from the actual capital ratios. In addition, other models suffer also from different biases. Consequently, their study states that unambiguous "ranking" of the approaches is not possible at this stage leading them to just outline three main criteria for CoCo pricing models:

1. Explicit incorporation of the CoCo bond features, such as the capital ratio trigger, into a pricing model
2. Accurate reflection of the CoCo bond as a hybrid equity–credit instrument
3. Possibility to calibrate the model to observable market parameters

Finally, Wilkens and Bethke (2014) conclude none of the tested pricing models fulfill all these criteria. However, Pennacchi's model is the only one that fulfills two out three criteria and can be hence considered less biased model also for primary market pricing of CoCo bonds.

4. Hypotheses

This section presents the hypotheses of this study which are based on the previous literature and research questions of this study. Related theoretical framework and reasoning are presented after each hypothesis. Furthermore, whereas the first two hypotheses are related to the probability of conversion and its effect on the required credit spread, the third and fourth hypotheses study the interdependence of conversion fraction, i.e. the amount converted to equity, to credit spread respectively. In other words, H1 and H2 are focused on the CoCo characteristics that define the probability of trigger event whereas H3 and H4 are designed to test how post-trigger event characteristics affect the primary market pricing of contingent convertible bonds.

H1: New issue credit spreads for both fixed and floating rate CoCos' are inversely related to the distance between bonds' current CET1 capital ratio and the level of trigger capital ratio

With a bigger "equity cushion" between issuer's current CET1 level and conversion threshold (i.e. level of trigger capital ratio), there is a smaller change that sudden drop in banks assets would create conversion of contingent capital to equity or lead to write down of bond nominal. Thus, "equity cushion" protects CoCo-investors from possible losses. This hypothesis is based on the structural credit risk model of a bank that issues deposits, share-holders equity, and fixed or floating coupon bonds in the form of contingent capital or subordinated debt. The return on the bank's assets follows a jump-diffusion process, and default-free interest rates are stochastic (Pennacchi, 2010).

H2: *New issue credit spreads for both fixed and floating rate CoCos are inversely related to level of trigger capital ratio*

The second hypothesis proposes that the level of contingent convertibles' trigger capital ratio is inversely related to the demanded yield spread at the issuance. H2 is based on

Pennacchi’s conclusion that delaying conversion to a point when the value of original shareholders’ equity is low raises the new issue yields on contingent capital since smaller equity cushion makes it more likely that a downward jump in asset value can occur and prevent full conversion to equity.

H3: New issue credit spreads for both fixed and floating rate CoCos’ are higher for bonds that are written down permanently compared to those that have temporary write down or equity conversion as a loss absorption mechanism

The third hypothesis to be tested assumes that, ceteris paribus, investors of contingent capital bond demand compensation for possible permanent write-downs of nominal capital. Naturally, given that temporary write-down is always preferable over permanent write down (ceteris paribus) and that equity has always non-negative value, bond investors will demand higher expected yield for those contingent convertibles with permanent write down as loss absorption mechanism. This hypothesis is based on Pennacchi’s (2010) conclusion that contingent capital investors will require higher new issue credit spreads, even in the absence of jump risk in structural model, if the conversion terms specify a discount to par value of bond since losses occur at conversion

H4: *New issue credit spreads for both fixed and floating rate CoCos’ are higher for bonds that are written down temporarily compared to those that have equity conversion as a loss absorption mechanism*

Related to third hypothesis, CoCo investors bond demand compensation for possible temporary write-downs of nominal capital. Naturally, given that equity has always non-negative value, bond investors will demand higher expected yield for those contingent convertibles with temporary write down than for those that convert to equity at the trigger event. As mentioned before, both H3 and H4 are based on Pennacchi’s conclusion that contingent capital investors will require higher new-issue credit spreads, even in the absence of jump risk, if the conversion terms specify a discount to par value since losses occur at conversion (Pennacchi, 2010).

5. Description of Data

The bond data used in this study consists of CoCo bonds issued by different financial institutions during the time period of 2009 – March 2015. The cross sectional bond data is obtained from Bloomberg Professional and it contains bulk of the required information about the bonds. Studies like Buergi (2013), De Spiegeleer and Schoutens (2012) and Wilkens and Bethke (2014) have used similar data source to get both quantitative and qualitative data on CoCos. Moreover, Bloomberg is to my knowledge the most comprehensive source for necessary data since all the CoCo issuances are documented there. In addition to Bloomberg, I'm utilizing issuers' financial statements and Moody's private data on CoCos to verify issuers' CET1-ratios at the issuance. This is done because Bloomberg's CET1-capital data is to some extent inaccurate due to various calculation methods. Thus, the first source for this data is issuer's latest financial statement before the issuance. If the appropriate data is not disclosed there, then Moody's CoCo-report is utilized. Bloomberg's database is the last source for this data.

Bloomberg search function returns 221 different ISINs when "Is Capital Contingent" -criteria is applied for bond search. After excluding duplicates (i.e. equivalent bonds with different ISINs due to different documentation), bonds without English documentation and/or reliable accounting data from the issuance data, the sample size amounts to 112. Table 1 summarizes this data.

As the table shows, the growth of contingent convertible market has accelerated steadily from 2009 to 2015. Consequently, the bulk of the data used in this study comes from time period

Table 1 Global primary market CoCo transactions from 2009 to 2015

This table illustrates the global issuance volume of contingent convertible bonds in terms of number of issuers, number of different bonds and total transaction volume. Year 2015 includes only those CoCos that are issued before end of March. First column presents the number distinct issuers in a given year. Second column shows the number of bonds that these issuers have issued during that year. Finally, the third column presents the total transaction volume of these issues in USD billions.

Year	Number of issuers	Number of bonds issued	Total transaction volume ($bn)
2009	1	1	0.2
2010	2	2	2.0
2011	2	2	4.3
2012	10	12	14.0
2013	16	23	25.0
2014	35	58	106.1
1-3/2015	10	14	12.6
Total		112	164.3

2012-2014. This period contains 93 bonds (out of the total 112) and 61 issuers. The total transaction volume from the same period amounts to $145.1 billion which is more than 88 % of the total transaction volume during the whole sample period. First three years contain only 5 different transactions and total transaction volume amounts to $6.5 billion. Furthermore, my data set includes also 14 bonds also from present year. Thus, the sample period spans from 2009 to March 2015.

Figure 1 presents the geographical distribution of CoCo issuers in dataset. As can be seen from the figure, to date, most of the issuers come from continental Europe, namely 43.8%. Furthermore, within continental Europe, more than half of CoCos are issued by Swiss institutions such as UBS and Credit Suisse which are defined as global systematically important banks, i.e. G-SIBS. Continental Europe and UK CoCos represent 26.8 % of my sample. Scandinavian issues amount to 16.1 % of the data whereas bonds issued outside of the three aforementioned regions comprise 13.4 % of the sample.

Figure 2 illustrates how the popularity of different loss-absorption mechanisms has evolved during the sample period. As the figure shows, CoCos with write-down as loss absorption mechanism dominate the bond sample. From the included 112 CoCos, 74 are written down either temporarily or permanently if bond’s trigger level is breached. Moreover, as can be seen from the figure, popularity of write down has grown over time.

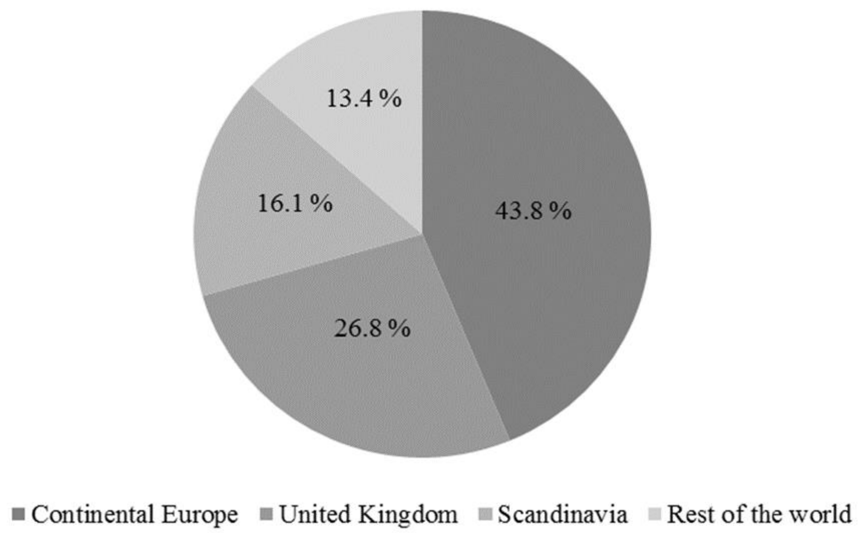

Figure 1 Geographical distribution of CoCo issuances

This figure represents the geographical distribution of CoCo issuers in my dataset. Issuer’s home country equals country of domicile defined by Bloomberg. As can be seen from the figure, more than two fifths of the CoCos included in to the sample are issued by continental European banks and financial institutions. Issuers from United Kingdom represent the second largest issuer group whereas Scandinavian issuers represent are third biggest group. Rest of the world equals mainly Russian and Chinese issuers.

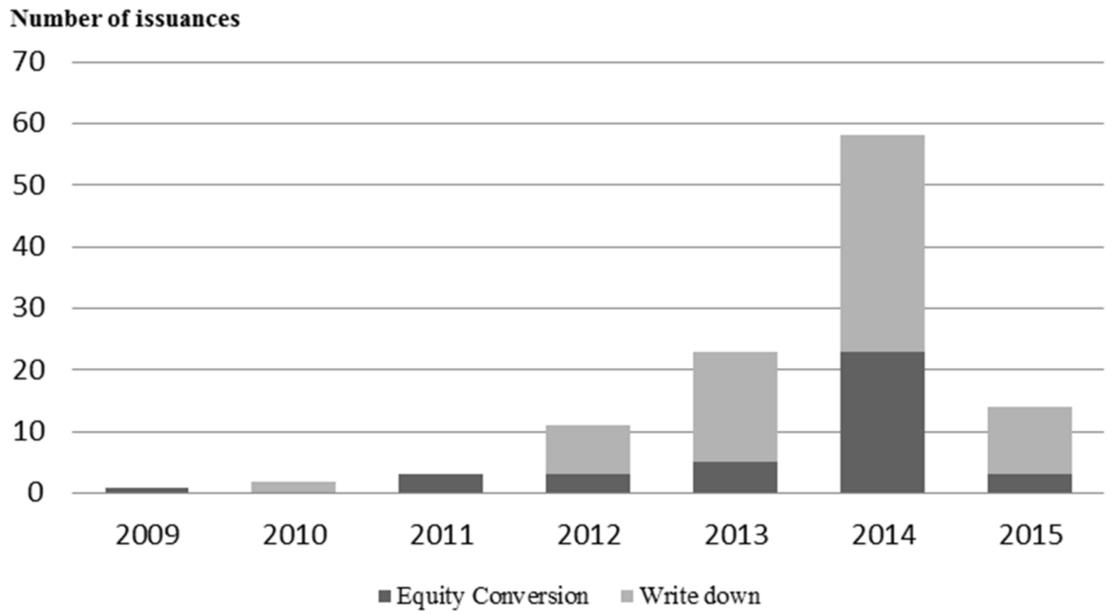

Figure 2 Distribution of loss-absorption mechanism of CoCos
This figure presents the popularity of different loss-absorption mechanisms among CoCo sample during the period of 2009-March 2015. The dark part of the column represents equity conversion CoCos whereas the grey part depicts CoCos that are written down either completely or partially if trigger level is breached. As can be seen from the columns, write down feature has gained popularity over the time.

Alongside CoCo-specific data, Bloomberg also provides all the relevant data for different control variables such as issue size, bond maturity, rating, volatility of issuer's equity, risk-free rate, steepness of the risk-free yield curve and TED-spread[4]. Moreover, I also retrieve treasury rates data for different currencies from Bloomberg to calculate the credit spread at the issuance.

Finally, Table 2 contains summary statistics classified by aggregated credit ratings. Here, aggregated credit rating equals the average credit rating that bond has received from Moody's, S&P and/or Fitch. If only one rating agency has rated the bond then the aggregate rating equals that rating. Several observations are apparent. First, Table 2 shows that credit spreads and credit ratings seem to have, unsurprisingly, negative correlation. Moreover, on average, first call date for rated CoCos is set 5 to 8 years from the issue (maturity). Interestingly, all the eight BBB-rated bonds have permanent write down feature for loss-absorption mechanism. This might reflect one of rating agencies' prerequisites for BBB or BBB+ ratings. The rationale behind this prerequisite is that CoCos that are written down permanently after trigger level breach are much

[4] In this case, the TED spread is the difference between the 3 month Euribor-rate and on short-term German Treasury bills, Bubills.

Table 2 Description of rated CoCo sample

This table presents summary statistics for rated contingent convertible bonds which are included in the sample data. Aggregated rating equals the average credit rating that bond has received from Moody's, S&P and/or Fitch. If only one rating agency has rated the bond then the aggregate rating equals that rating. All values excluding different trigger breach actions presented in table are average values per each rating category. First row reports the number of bonds per each rating category. Credit spread and trigger level are reported in basis points. Maturity depicts the difference between bonds' issue date and first call date.

	Aggregate credit rating								
	CCC+	B	B+	BB-	BB	BB+	BBB-	BBB	BBB+
N of bonds	1	-	5	18	23	16	16	8	-
Credit spread at the issue (bp)	834.9	-	683.2	582.3	546.7	566.9	455.1	424.6	-
Maturity (year)	7.0	-	6.1	7.4	7.1	6.5	6.0	7.6	-
Amount itssued (million USD)	333	-	635	1733	1499	1206	1056	1967	-
Trigger level (bp)	200.0	-	343.0	615.0	512.5	556.3	594.5	525.0	-
Equity conversion	0	-	0	11	5	6	6	0	-
Temporary write-down	1	-	1	7	12	5	7	0	-
Permanen write-down	0	-	4	0	6	5	3	8	

more straightforward to valuate compared to those that are written down only temporarily or converted to equity.

6. Methodology

In this section, I will present OLS regression model which is used to confirm/refute my research hypotheses. The model is adopted from the Chen et al. (2007) paper with few modifications. Modifications are mainly due the fact, that the original paper studies determinants of yield spreads of ordinary corporate bonds whereas I'm concentrating on contingent convertible bonds issued by banks and other financial institutions. Moreover, Chen et al. (2007) apply US secondary market data in their study while my data consists of European primary market contingent convertible transactions.

6.1 OLS regression model for credit spread analysis

Earlier literature shows that spread in rates between corporate and government bonds cannot be solely explained by expected default loss or tax premiums, which are typical for the former bond class. For example, Elton et al. (2001) point out that even after accounting for the impact of default and taxes, a large part of differential between corporate and treasury bonds remains unexplained. Authors show that the vast majority of this difference is compensation for systemic risk which is affected by the same dynamics that affect systematic risks in the stock market. Number of studies continued their work by showing that rate spreads can be also explained by bond liquidity (e.g. Chen et al. (2007)) and idiosyncratic equity risk (e.g. Campbell and Taksler (2003)).

I will use a modified version of regression model of Chen et al. (2007) to test my hypotheses. The modifications that I will make to the model are as following: First, I add the relevant CoCo factors to the model. Second, I remove the firm specific factors (Pretax coverage dummy, Operating income per sales, Debt to sales, and Debt to capitalization) from the model since these are reflected in the credit ratings that are issued after a given bond transaction is announced . Third, I will measure liquidity by the size of the issue instead of bid-ask spread, proportion of zero returns or the LOT estimate. This modification is needed because I'm using only primary market data. Consequently, the "amount outstanding" factor is excluded from the model and it's replaced with liquidity. Fourth, I will exclude coupon variable from the regression since its purpose in the original study of Elton et al. (2001) was to show that lighter taxation of government bonds compared to corporate bonds in US results in positive yield spread for corporate bonds. Given that my dataset contains bonds from different tax jurisdictions, utilization of coupon percentage as a control variable would be dubious. Finally, I am using the following regression model to study different contingent convertible features' effect to yield spread on primary market transactions:

$$\begin{aligned} Credit\ spread_i &= \alpha_i + \beta_1 Distance\ to\ Trigger_i + \beta_2 Trigger\ capital\ ratio\ _i \\ &+ \beta_3 Permanent\ Write\ Down\ Dummy_i \\ &+ \beta_4 Temporary\ Write\ Down\ Dummy_i + \beta_5 Bond\ rating_i + \beta_6 Liquidity_i \\ &+ \beta_7 Maturity_i + \beta_8 Volatility_i + \beta_9 Treasury\ rate_{it} \\ &+ \beta_{10} 10Yr - 2Yr\ Treasury\ rate_{it} + \beta_{11} EuroDollar_{it} \\ &- 3\ month\ Treasury\ bill_{it} + \varepsilon_i \end{aligned}$$

Here, the first explanatory variable refers to difference between bank's CET1 capital ratio at the issuance date and the trigger level which initiates the loss absorption mechanism if breached. Naturally, this coefficient is supposed to tell if distance to trigger and new issue credit spreads are inversely correlated, in other words, whether H1 holds. Second factor is in included to the model to see if the trigger capital ratio levels and credit spreads are negatively correlated.

The sign of the coefficient tells us if H2 can be accepted. Third factor is dummy variable which tells whether investors of contingent capital bonds demand compensation for possible permanent write-down of nominal capital instead of temporary write-down or equity conversion. Thus, this coefficient sheds light on H3. Furthermore, model's fourth factor is also a dummy variable which illustrates whether investors demand higher yield spreads for CoCos which nominal is written off temporarily rather than converted to equity. In general, the first two factors are related to probability of the loss absorption mechanism being activated and its effect on primary market pricing of contingent convertible bonds. Additionally, third and fourth factor are included into the model to see how post-breach features of CoCos affect their primary market pricing.

The control variables can be divided into bond-specific, firm-specific and market specific variables. First, regarding to bond-specific control variables, rating variable controls the effect of issuers' credit risk profile to the yield spread. I will use the average of Fitch, Moody's and Standard & Poor's rating whenever possible[5]. If only one rating agency has rated the issue, I consider that agency's rating. In contrast to studies like Campbell and Taksler (2003) and Chen et al. (2007), I don't couple rating variable with accounting variables since one can assume that ratings incorporate and reflect all the relevant accounting ratios when they are issued simultaneously with a given bond. Second, to proxy differences in corporate bond liquidity, I include issue size (in USD) in the regression. If bond's issue currency is other than USD, issue date's end-of-day mid quote is used to convert issue size in US dollars. Third, maturity variable is included in the model to control interest rate risk's effect on bonds' yield spread. Here, maturity is defined as a year fraction between issue date and the next call date.

Campbell and Taksler (2003) provide evidence that equity volatility is directly related to the cost of borrowing for corporate issuers. Thus, In addition to bond-specific features, I will include equity volatility as a firm-specific control variable to my regression model. For each bond, I consider the equity data for the 180 days prior to issue date.

Finally, in addition to afore mentioned bond- and firm-specific information I'm including three market wide control variables to the model. These are the 1 year swap rate, the difference between the 10-year and 2-year swap rates and the difference between 30 day Eurodollar rate

[5] Credit ratings range from 1-9 (S&P and Fitch: from B- to BBB+ and for Moody's from B3 to Baa1). If more than one rating agency has rated the bond, the value of a given bond's rating is the average of these ratings. If only one rating agency has rated the bond, then bond's rating equals that value.

and treasury rate to control current short rate environment, steepness of the risk-free yield curve and potential liquidity effects on corporate bonds over Treasury bonds respectively.

6.2 OLS regression model for credit rating analysis

To test whether CoCo-specific variables affect ratings, I employ a regression models which incorporate them with the traditional credit metrics used by Moody's. The models are as follows:

$$
\begin{aligned}
Credit\ Rating_i & \\
= \ & \alpha_i + \beta_1 Distance\ to\ Trigger_i + \beta_2 Trigger\ capital\ \ ratio_i \\
& + \beta_3 Permanent\ write\ down\ dummy_i \\
& + \beta_4 Temporary\ write\ down\ dummy_i + \beta_5 Equity\ Volatility_i \\
& + \beta_6 Capital_i + \beta_7 Profitability_i + \beta_8 Asset\ liquidity_i \\
& + \beta_9 Bloomberg\ ESG\ score_i + \varepsilon_i
\end{aligned}
$$

$$
\begin{aligned}
Credit\ Rating_i & \\
= \ & \alpha_i + \beta_1 Volatility\ adjusted\ distance\ to\ trigger_i \\
& + \beta_2 Trigger\ capital\ \ ratio_i + \beta_3 Permanent\ write\ down\ dummy_i \\
& + \beta_4 Temporary\ write\ down\ dummy_i + \beta_5 Capital_i + \beta_6 Profitability_i \\
& + \beta_7 Asset\ liquidity_i + \beta_8 Bloomberg\ ESG\ score_i + \varepsilon_i
\end{aligned}
$$

As can be noted instantly, the only difference between the two models is the fact that first model has distance to trigger and equity volatility as separate variables whereas the second one couples these two together. As mentioned earlier, linking the value or credit spread of the CoCo solely to the distance to trigger is similar to valuing an option on the difference between the strike and the current value of the underlying security. Thus, I will follow the idea of De Spiegeleer et al. (2015) and create equity volatility adjusted distance to trigger variable for the second regression model. The variable equals bond's distance to trigger divided by the issuer's annual volatility measured by the price changes for the 180 most recent trading days prior issue date. Other CoCo-specific factors are unchanged from the earlier tests.

Furthermore, other explanatory variables can be grouped on three categories: solvency related (capital and profitability), liquidity (asset liquidity) and qualitative adjustments

(Bloomberg ESG score). Here, the control variables are adapted from Moody's (2015) updated credit rating methodology for banks which centers on core characteristics of solvency and liquidity. Regarding solvency, capital is measured by dividing tangible common equity by risk-weighted assets (RWA) whereas profitability equals issuer's net income divided by tangible assets. Liquidity is defined as liquid assets per total assets. The values of the aforementioned ratios are based on issuers' latest financial statements before issue date. The data is collected from the Bloomberg.

Additionally, Moody's has identified three additional factors beyond traditional financial ratios that are important qualitative contributors to the soundness of a financial institution but which are either: (1) nonfinancial in nature; or (2) financial, but which we cannot readily assess via a common standard ratio. From these three qualitative factors corporate behavior is included in my model and it's measured by Bloomberg's ESG disclosure score which is based on the extent of a company's Environmental, Social, and Governance (ESG) disclosure. The score ranges from 0.1 for companies that disclose a minimum amount of ESG data to 100 for those that disclose every data point collected by Bloomberg. Each data point is weighted in terms of importance, with data such as Greenhouse Gas Emissions carrying greater weight than other disclosures. The score is also tailored to different industry sectors. In this way, each company is only evaluated in terms of the data that is relevant to its industry sector.

7. Results

In this section I will present the empirical findings of empirical study which is conducted with cross-sectional data consisting of 112 contingent convertible primary market transactions. First, I present and comment results of the OLS regression which includes all the aforementioned explanatory variables. Second, I go through separate regressions with, bond-specific, firm-specific and interest rate-specific control variables. My results don't create statistically significant and consistent evidence for H2, H3, and H4 - thus for each of them, H0 can't be rejected. However, my findings show that new issue credit spreads for CoCos' are inversely related to the distance between bonds' current CET1 capital ratio and the level of trigger capital ratio, thus creating support for H1. This is especially true when bond rating is excluded from the regression model since the "CET1 buffer" and bond's credit rating experience notable multicollinearity. Additionally, the second main finding of my study is that credit ratings are the single most significant driver both economically and statistically for credit spreads of contingent convertible securities when they are issued. By analyzing determinants of credit ratings, I find that credit rating agencies incorporate CoCo-specific factors into them. This explains the multicollinearity between these variables. To elaborate, volatility adjusted distance to trigger and permanent write-down dummy seem to be the biggest drivers of credit ratings.

7.1 Full sample analysis

Table 3 illustrates the determinants of new issue credit spreads, respective regression coefficients, and related *t*-statistics. First column of the table presents regression results for the whole sample of 112 observations. Here, “rating” and “volatility” variables are excluded from the regression since some bonds are either unrated, issued by private company, or both. Moreover, the regression includes three qualitative variables which are all linked to CoCos’ loss absorption mechanism: equity conversion, temporary write-down, and permanent write-down. From the aforementioned variables equity conversion is selected as a reference category whereas write-down mechanisms are depicted as dummy variables.

The most interesting finding from the first column is the value of distance to trigger variable. The interpretation of the coefficient is as follows: on average, one basis points increase in the distance between the issuer’s CET1 ratio and the level of trigger capital ratio decreases the new issue credit spread demanded by investors by 0.21 basis points. In other words, 100 basis point increase in CET1 buffer (*ceteris paribus*) should lower the credit spread by 21 basis point at the issue date. Thus, H1 is accepted on 1 % confidence level and I can interpret that new issue credit spreads are inversely related to distance between issuer’s CET1 ratio at the issuance and the level of trigger capital ratio. Among other recent empirical studies, De Spiegeleer et al. (2015) report similar relationship. However, they note that equity volatility adjusted distance to trigger yields substantially higher R-squared figure and conclude that distance to trigger is a static picture which doesn’t reflect information about the business risk of a particular financial institution. De Spiegeleer et al. (2015) also remark that linking the value of the CoCo bond solely to the distance to trigger is similar to valuing an option on the difference between the strike and the value of the underlying security. Thus, future empirical studies should control volatility by taking equity volatility adjusted distance to trigger into consideration. Here, equity volatility is taken into account as a separate explanatory variable.

Table 3 Credit spread determinants: linear variables

This table presents the new issue credit spread determinants for different samples. All determinants presented in this table are linear. Determinants are grouped into CoCo-specific effects (distance to trigger, trigger capital ratio, permanent write down dummy, and temporary write down dummy), bond-specific effects (liquidity, maturity, and rating), firm-specific effects (volatility), and market-specific effects (1 year risk-free rate, difference between 10 year risk-free rate and 2 year risk-free rate, and the difference between 3 month Euribor rate and Germany 3 month government bill yield). All values are reported on basis points. Unit of liquidity is one million US dollar, maturity is reported in years whereas values for the rating-variable ranges between 1 and 9 (numeric values are converted from the actual credit ratings, from B- to BBB+, namely).

Variable	Whole Sample (n=112)	Public (n=86)	Rated (n=88)	Public and Rated (n=75)
Intercept	**938.92*** **	**755.02*** **	**1016.39*** **	**764.09*** **
	(8.32)	(7.44)	(10.21)	(7.30)
CoCo-specific				
Distance to Trigger	**-0.21*** **	**-0.16*** **	**-0.10** **	**-0.02**
	(-3.72)	(-3.07)	(-1.95)	(-0.35)
Trigger Capital Ratio	**-0.15**	**-0.07**	**-0.06**	**0.02**
	(-1.39)	(-0.66)	(-0.60)	(0.19)
Permanent Writedown	**-57.74**	**-49.84**	**16.71**	**0.92**
	(-1.27)	(-1.25)	(0.45)	(0.02)
Temporary Writedown	**-67.92**	**-52.25**	**-32.36**	**-41.15**
	(-1.54)	(-1.36)	(-0.93)	(-1.17)
Bond-specific				
Liquidity	**-0.07*** **	**-0.03**	**-0.02**	**0.00**
	(-3.22)	(-1.45)	(-1.12)	-0.2
Maturity	**-21.64*** **	**-14.25** **	**-17.42*** **	**-12.32** **
	(-2.61)	(-2.16)	(-2.94)	(-2.35)
Rating	-	-	**-49.22*** **	**-44.56*** **
			(-5.29)	(-4.74)
Firm-specific				
Volatility	-	**0.05*** **	-	**0.08*** **
		(3.82)		(3.44)
Market-specific				
1y Risk Free Rate	**-0.31**	**-0.58** **	**-0.59**	**-0.68**
	(-0.79)	(-1.88)	(-1.10)	(-1.41)
10y-2y Risk Free Rate	**0.43**	**-0.05**	**-0.09**	**-0.15**
	(1.39)	(-0.17)	(-0.36)	(-0.66)
3mo Euribor - 3mo Bubill	**2.21** **	**1.63** **	**3.14*** **	**2.32*** **
	(2.24)	(1.78)	(3.55)	(2.92)
Adjusted R^2	0.28	0.41	0.47	0.51

Significant at 1% (***), 5% (**), and 10% (*) levels.

Based on the above, my results about distance to trigger reflect the “intrinsic value” of CoCo bond and simultaneously establish ground for forthcoming research.

In addition, it should be noted that new issue credit spreads are higher for bonds that are written down permanently compared to those that have temporary write down as a loss absorption mechanism. Put differently, CoCos with temporary write-down feature seem have higher credit spread discount than CoCos with permanent write-down feature. However, this finding is not statistically significant. Consequently, H3 and H4 can't be accepted.

Both liquidity and maturity are statistically significant on 1 percentage level. Moreover, the latter has also notable impact on credit spread: one year extension of bond's maturity decreases the demanded credit spread by 21.64 basis points. The inverse relationship between credit spread and bond's maturity is not a completely surprising result. For example, results of Pennacchi's (2010) structural model show that when capital is low and the likelihood of conversion losses are high, contingent capital bonds' spreads over their respective default-free Treasury yields are a decreasing function of maturity. Earlier theoretical studies such as Jarrow et al. (1997) and Longstaff and Schwartz (1995) have also found the similar downward sloping or hump-shaped credit spread curves for speculative-grade issuers. Furthermore, Helwege and Turner (1999) have showed that inverse relationship between maturity and credit spreads results from the fact that the safer high-yield issuers in a given rating category tend to have longer term bonds, leading to a sample selection bias in regression estimates.

Second column includes regression results for the 86 contingent convertible bonds which are issued by publicly traded companies (i.e. companies that have equity volatility data on Bloomberg. These CoCos are referred as "public"). First, including equity volatility to regression model raises the adjusted R-squared almost by 13 percentage points compared to first column's regression. Second interesting finding is the dramatic decline of the intercept variable. Compared to whole sample, publicly traded CoCo issuers pay on average 183 basis points less for their contingent convertible capital than their non-publicly traded peers. Another interesting finding is that the inclusion of equity volatility variable reduces the effect of CoCo-specific factors on new issue credit spreads. However, distance to trigger factor remains statistically significant on 1 percent confidence level. Thirdly, the volatility factor itself is positively correlated with new issue credit spreads. The interpretation of the coefficient is that one basis point increase in annual volatility of issuer's stock price increases credit spread by 0.05 basis points on average. Thus, increase of 1 percentage point in stock's excess volatility predicts 5 basis point increase of the credit spread. These findings are in line with Campbell and Taksler (2003) and Chen et al. (2007) who document both statistically and economically significant effect of equity volatility on bond credit spreads.

Third column presents regression results for the rated sample of 88 CoCos. First, including rating variable to regression model raises the adjusted R-squared more than 18 percentage points compared to first column's regression and 5 percentage points second column's regression. As in earlier regressions, the intercept variable is statistically different from zero on the 1 percent level and amounts to 1016.39 basis points. Furthermore, rating is clearly correlated with CoCo-specific factors since their magnitude and significance decrease notably compared to the whole sample. Same effect can be observed with maturity factor. Multicollinearity between these factors gives evidence that rating agencies incorporate these CoCo- and bond-specific factors, among other variables, in their analyses of new contingent convertible issues. This finding is in line with Campbell and Taksler (2003) who note that credit ratings are designed to contain information outside the basic accounting data. The rating itself is predominantly negatively correlated with new issue credit spread: on average, one notch upgrade on credit rating[6] results in 49 basis points decrease in demanded credit spread. The coefficient is statistically significant on 1 percent level. The effects of CoCo- and bond-specific factors to credit rating are explored later on this study.

Fourth column from Table 3 presents regression results for the public and rated CoCos. First, including both volatility and rating variable to the regression model raise the adjusted R-squared to 0.5117 which equals almost 5 percentage point increase compared to regression on the third column. However, the most notable finding from this regression is the fact that inclusion of both rating and volatility factor decrease the impact and statistical significance of CoCo-specific factors substantially. The effect of maturity remains more or less invariable and statistically significant.

Finally, regarding market specific variables only the "TED spread" (3mo Euribor – 3mo Bubill) has statistically significant correlation with new issue credit spreads on 1 % level. Irrespective of the sample, the coefficient for this variable is positive, as a wider spread indicates a flight to quality or liquidity, which will increase the required compensation for holding risky bonds. Longstaff (2004) and Campbell and Taksler (2003) have documented similar results.

Furthermore, Table 4 presents results of OLS regressions with modified variables. Here, new issue credit spread (dependent variable), distance to trigger, liquidity and excess volatility are converted to natural logarithms of their original values. Additionally, maturity is squared. As can be seen from the Table 3, the non-linear variables don't change regression outputs

[6] Credit ratings range from 1-9 (S&P and Fitch: from B- to BBB+ and for Moody's from B3 to Baa1). If more than one rating agency has rated the bond, the value of a given bond's rating is the average of these ratings. If only one rating agency has rated the bond, then bond's rating equals that value.

Table 4 Credit spread determinants: linear and non-linear variables

This table presents the new issue credit spread determinants for different samples. Table contains both linear and non-linear variables. Determinants are grouped into CoCo-specific effects (natural logarithm of distance to trigger, trigger capital ratio, permanent write down dummy, and temporary write down dummy), bond-specific effects (natural logarithm of liquidity, maturity raised to second order, and rating), firm-specific effects (natural logarithm of volatility), and market-specific effects (1 year risk-free rate, difference between 10 year risk-free rate and 2 year risk-free rate, and the difference between 3 month Euribor rate and Germany 3 month government bill yield). All linear values are reported on basis points. Unit of liquidity is natural logarithm of amount issued in USD millions , maturity is reported in years raised to second order whereas values for the rating-variable range between 1 and 9 (numeric values are converted from the actual credit ratings, from B- to BBB+, namely).

Variable	Whole Sample (n=112)	Public (n=86)	Rated (n=88)	Public and Rated (n=75)
Ln Intercept	**8.28*** **	**6.07*** **	**7.86*** **	**5.56*** **
	(15.46)	(8.58)	(14.34)	(6.80)
CoCo-specific				
Ln Distance to Trigger	**-0.23*** **	**-0.13***	**-0.12***	**-0.01**
	(3.34)	(1.80)	(1.94)	(0.09)
Trigger Capital Ratio	**0.00**	**0.00**	**0.00**	**0.00**
	(1.3)	(1.12)	(0.09)	(0.96)
Permanent Writedown	**-0.16** **	**-0.21** **	**0.00**	**0.12**
	(1.99)	(2.62)	(0.01)	(0.14)
Temporary Writedown	**-0.11**	**-0.12***	**-0.03**	**-0.08**
	(1.34)	(1.69)	(0.52)	(1.10)
Bond-specific				
Ln Liquidity	**-0.06** **	**-0.01**	**-0.05**	**0.03**
	(2.11)	(0.38)	(1.20)	(0.76)
Maturity^2	**-0.002*** **	**-0.002***	**-0.002*** **	**-0.002** **
	(2.61)	(1.95)	(2.99)	(2.48)
Rating	-	-	**-0.09*** **	**-0.09*** **
			(5.03)	(4.93)
Firm-specific				
Ln (Volatility)	-	**0.20*** **	-	**0.12** **
		(4.59)		(2.16)
Market-specific				
1y Risk Free Rate	**-0.001** **	**-0.001** **	**-0.001***	**-0.001***
	(2.23)	(2.29)	(1.97)	(0.67)
10y-2y Risk Free Rate	**0.001**	**0.00**	**0.00**	**0.00**
	(1.50)	(0.54)	(0.07)	(0.83)
3mo Euribor - 3mo Bubill	**0.004** **	**0.004** **	**0.005*** **	**0.005*** **
	(2.19)	(2.08)	(3.11)	(3.14)
Adjusted R^2	0.25	0.42	0.43	0.49

Significant at 1% (***), 5% (**), and 10% (*) levels.

notably. Variables that were significant on with linear regressions remain significant with non-linear values. The values of adjusted R-squared decrease to some extent when non-linear variables are used.

7.2 Subsample analysis: public and rated contingent convertibles

Table 5 reports the results of OLS regressions which are based on the data of public and rated CoCos. Here I'm analyzing the effect of including different variables sequentially (i.e.

Table 5 Credit spread determinants: public and rated CoCos

This table presents the new issue credit spread determinants for public and rated CoCos. All determinants presented in this table are linear. Determinants are grouped into CoCo-specific effects (distance to trigger, trigger capital ratio, permanent write down dummy, and temporary write down dummy), bond-specific effects (liquidity and maturity), market-specific effects (1 year risk-free rate, difference between 10 year risk-free rate and 2 year risk-free rate, and the difference between 3 month Euribor rate and Germany 3 month government bill yield) and rating and volatility. All values are reported on basis points. Unit of liquidity is one million US dollar, maturity is reported in years whereas values for the rating-variable range between 1 and 9 (numeric values are converted from the actual credit ratings, from B- to BBB+, namely).

Variable	Public and Rated CoCos (n=75)				
Intercept	**585.47*** **	**780.91*** **	**753.66*** **	**805.37*** **	**764.09*** **
	(5.65)	(6.97)	(5.94)	(7.17)	(7.30)
CoCo-specific					
Distance to Trigger	**-0.17*** **	**-0.22*** **	**-0.20*** **	**-0.09***	**-0.02**
	(3.06)	(4.03)	(3.61)	(1.70)	(0.35)
Trigger Capital Ratio	**0.09**	**0.06**	**0.04**	**0.17**	**0.02**
	(0.61)	(0.48)	(0.31)	(1.47)	(0.19)
Permanent Writedown	**12.95**	**16.60**	**11.56**	**71.49***	**0.92**
	(0.29)	(0.39)	(0.28)	(1.82)	(0.02)
Temporary Writedown	**-9.20**	**-10.27**	**-20.27**	**-5.68**	**-41.15**
	(0.23)	(0.25)	(0.49)	(0.16)	(-1.17)
Bond-specific					
Liquidity	-	**-0.04*** **	**-0.03**	**-0.01**	**0.00**
		(2.08)	(1.45)	(0.41)	-0.2
Maturity	-	**-14.04*** **	**-13.40*** **	**-15.51*** **	**-12.32*** **
		(2.27)	(2.12)	(2.78)	(-2.35)
Market-specific					
1y Risk Free Rate	-	-	**-0.06**	**-0.62**	**-0.68**
			(0.10)	(1.20)	(-1.41)
10y-2y Risk Free Rate	-	-	**-0.20**	**-0.12**	**-0.15**
			(0.69)	(0.48)	(-0.66)
3mo Euribor - 3mo Bubill	-	-	**2.21*** **	**2.80*** **	**2.32*** **
			(2.34)	(3.33)	(2.92)
Rating and Volatility					
Rating	-	-	-	**-45.22*** **	**-44.56*** **
				(4.44)	(4.74)
Volatility	-	-	-	-	**0.08*** **
					(3.44)
Adjusted R^2	0.11	0.23	0.26	0.43	0.51

Significant at 1% (***), 5% (**), and 10% (*) levels.

CoCo-, bond-, firm- and market-specific variables) to the regression model. Thus, I am breaking down the incremental effects of different variables from the fourth column of Table 2. The results of this sequential analysis are more or less in line with those presented above. That is to say, the magnitude and sign of different variables don’t change dramatically.

Again, distance to trigger is negatively correlated with the new issue credit spreads. Correlation is statistically significant to the point when rating variable is included into regression model as an explanatory variable. Consequently, subsample analysis creates more evidence for H1. Moreover, the significance of the variable ranges from -0.22 basis points to -0.02 basis points depending on the number of explanatory variables included.

Like with the broader sample, the level of trigger capital ratio seems to be irrelevant for credit spread demanded by investors. This is somewhat intuitive since linking the spread of the CoCo bond solely to the level of trigger capital ratio is similar to valuing an option based on the level of strike price. Like with options, one needs naturally take the distance to trigger and the volatility of the capital ratio into account when estimating appropriate credit spread for a given CoCo. In this framework, it is not surprising that also subsample analysis fails to create evidence for H2.

Furthermore, the coefficient for permanent write-down dummy is positive when only public and rated CoCos are analyzed. Even though coefficients are not statistically significant they show that new issue credit spreads are higher for CoCos that are written down permanently compared to those that have temporary write-down or equity conversion as a loss absorption mechanism. Aforementioned builds support for H3 in this subsample.

The fourth column clearly implies multicollinearity between CoCos' distance to trigger and credit rating variable: the statistical and economical significance of the former declines notably when latter is added to the regression model. The significance of the distance to trigger variable declines even more when volatility variable is included (fifth column). In addition, rating variable increases improves model's fit notably. The value of adjusted R-square jumps from 0.26 to 0.43. Model's adjusted R-square increases to 0.58 when volatility variable is also included.

Finally, the economical and statistical significance of bond- and market-specific variables stays somewhat unchanged with the subsample of public and rated CoCos. Bonds' maturity is still has statistically significant negative correlation with new issue credit spread whereas the "TED spread" (3mo Euribor – 3mo Bubill) has the opposite effect on spreads. As mentioned above, both of these findings are in line with the earlier literature.

The coefficients of non-linear variables for public and rated CoCos are presented in Table 6. Again, dependent variable and distance to trigger, liquidity and volatility are converted to natural logarithms. Additionally, rating variable is squared. As with the whole sample, non-linear variables don't change the relative significance of coefficients notably. The effects on adjusted R-squared are mixed. However, linear variables result to better fit when volatility and rating are included as an explanatory variables.

Table 6 Credit spread determinants: public and rated CoCos, non-linear variables

This table presents the new issue credit spread determinants. Table contains both linear and non-linear variables. Determinants are grouped into CoCo-specific effects (natural logarithm of distance to trigger, trigger capital ratio, permanent write down dummy, and temporary write down dummy), bond-specific effects (natural logarithm of liquidity, maturity raised to second order, and rating), market-specific effects (1 year risk-free rate, difference between 10 year risk-free rate and 2 year risk-free rate, and the difference between 3 month Euribor rate and Germany 3 month government bill yield), rating and volatility (natural logarithm). All linear values are reported on basis points. Unit of liquidity is natural logarithm of amount issued in USD millions , maturity is reported in years raised to second order whereas values for the rating-variable range between 1 and 9 (numeric values are converted from the actual credit ratings, from B- to BBB+, namely).

Variable	Public and Rated CoCos (n=75)				
Ln Intercept	**7.31*** **	**8.26*** **	**7.89*** **	**6.78*** **	**5.63*** **
	(14.31)	(12.81)	(11.42)	(10.90)	(7.26)
CoCo-specific					
Ln Distance to Trigger	**-0.19*** **	**-0.25*** **	**-0.22*** **	**-0.06**	**-0.01**
	(2.79)	(3.64)	(2.99)	(0.90)	(0.10)
Trigger Capital Ratio	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	(0.87)	(0.94)	(0.80)	(0.76)	(1.25)
Permanent Writedown	**-0.02**	**-0.008**	**-0.03**	**0.12***	**0.02**
	(0.15)	(0.10)	(0.34)	(1.67)	(0.29)
Temporary Writedown	**-0.01**	**0.002**	**-0.02**	**0.00**	**-0.05**
	(0.15)	(0.04)	(0.27)	(0.07)	(0.84)
Bond-specific					
Ln Liquidity	-	**-0.07**	**-0.05**	**0.01**	**0.02**
		(1.55)	(0.99)	(0.21)	(0.48)
Maturity^2	-	**-0.001*** **	**-0.001***	**-0.002*** **	**-0.002*** **
		(2.01)	(1.90)	(2.75)	(2.58)
Market-specific					
1y Risk Free Rate	-	-	**-0.001**	**-0.002*** **	**-0.002*** **
			(1.05)	(2.06)	(2.08)
10y-2y Risk Free Rate	-	-	**0.00**	**0.00**	**0.00**
			(0.43)	(0.26)	(0.55)
3mo Euribor - 3mo Bubill	-	-	**0.004*** **	**0.005*** **	**0.005*** **
			(2.02)	(3.33)	(3.24)
Rating and Volatility					
Rating	-	-	-	**-0.10*** **	**-0.09*** **
				(5.17)	(4.86)
Ln Volatility	-	-	-		**0.13*** **
					(2.33)
Adjusted R^2	0.12	0.20	0.23	0.45	0.49

Significant at 1% (***), 5% (**), and 10% (*) levels.

7.3 Credit rating analysis

My results have so far presented consistent evidence mainly for the hypothesis that credit spreads for CoCos' are inversely related to the distance between issuers current CET1 capital ratio and the level of trigger capital ratio (H1). For other three hypotheses, regression results generate mixed evidence. However, besides hypotheses validity, both full and subsample analysis revealed economically and statistically negative correlation between credit spreads and credit rating. This is not surprising since, as found in the literature and supported in this article, credit ratings are the most important single source of information on credit risk overall (see, e.g., Hand et al. (1992), Hite and Warga (1997), Daniel and Jensen (2005)).

Moreover, especially the subsample analysis showed multicollinearity between CoCo-specific variables and credit rating. Thus, based on the above, one could hypothesize that credit rating agencies include distinct features of contingent convertible bonds, among other traditional credit metrics, into ratings for these hybrid securities. If so, one could argue further that these features play role in primary market pricing of CoCos since credit rating itself has significant impact on credit spreads, as depicted above.

Table 7 reports the coefficient estimates for the first OLS regression model introduced earlier. Again, I include different control variables sequentially to the regression model. Starting from the first column, one can see that every variable except temporary write-down has statistically significant effect on credit rating. Like earlier, distance to trigger and trigger capital ratio are presented in basis points. Thus, for example, 100 basis point improvement to distance to trigger should increase the credit rating by 0.01 notches7. Contrary to earlier results, in addition to intercept and distance to trigger variables, both trigger capital ratio and permanent write-down variables are both economically and statistically significant.

Second, quite surprisingly, equity volatility solely doesn’t seem to have significant effect on credit rating (second column). Result might be indication that volatility, as mentioned before, should be coupled with distance to trigger variable. This argument is investigated with the second regression model later on.

Third, similar to volatility variable, neither capital nor profitability seem to have economically or statistically significant effect on a given CoCo’s credit rating. Introduction of the solvency variables has most notable effect on intercept variable which jumps from 2.79 to 4.21. One possible reason behind the jump is the data sampling issue since eight issuers lack the relevant solvency data on Bloomberg.

[7]Like earlier, values for the rating-variable range between 1 and 9 (numeric values are converted from the actual credit ratings, from B- to BBB+, namely) based on the average of credit rating given by S&P, Moody’s and Fitch.

Table 7 Credit rating determinants for CoCos

This table presents credit rating determinants for rated CoCos. All determinants presented in this table are linear. Determinants are grouped into CoCo-specific effects (distance to trigger, trigger capital ratio, permanent write down dummy, and temporary write down dummy), volatility (annualized volatility of issuer's equity is computed from the last 180 trading days), solvency-specific effects (capital which is total common equity divided by risk weighted assets and profitability which is annual return divided by total assets), liquidity-specific effects (asset liquidity which is liquid assets divided by total assets) and qualitative adjustments (Bloomberg's ESG score which ranges from 0.1 to 100) . All the loading factors for independent variables, except dummies and Bloomberg's ESG Score, are sensitivities per one basis point change in the variable. The dependent variable, namely the aggregated credit rating score, can have values from 1 to 9.

Variable	Public and Rated CoCos (n=75)				
Intercept	**2.04****	**2.79****	**4.21*****	**5.7****	**5.56***
	(2.40)	(2.24)	(2.72)	(2.72)	(1.66)
CoCo-specific					
Distance to Trigger	**0.001*****	**0.002*****	**0.001****	**0.00**	**0.001***
	(3.02)	(3.02)	(2.13)	(0.70)	(1.73)
Trigger Capital Ratio	**0.004*****	**0.003****	**0.00**	**0.00**	**-0.003**
	(3.44)	(2.09)	(0.11)	(0.18)	(1.02)
Permanent Writedown	**1.30*****	**1.58*****	**1.11****	**1.72****	**1.57****
	(3.14)	(3.00)	(2.00)	(2.35)	(2.51)
Temporary Writedown	**0.21**	**0.18**	**-0.15**	**0.88**	**0.89***
	(0.55)	(0.40)	(0.32)	(1.53)	(1.84)
Volatility					
Equity Volatility	-	**0.00**	**0.00**	**0.00**	**0.00**
		(0.75)	(0.07)	(0.73)	(0.55)
Solvency					
Capital (TCE per RWA)	-	-	**0.00**	**0.00**	**0.00**
			(1.21)	(0.19)	(0.05)
Profitability (Return on TA)	-	-	**0.004**	**0.02*****	**0.01*****
			(1.4)	(3.62)	(3.11)
Liquidity					
Asset Liquidity (LA per TA)	-	-	-	**0.00**	**0.00**
				(0.28)	(0.35)
Qualitative Adjustments					
Bloomberg ESG Score	-	-	-	-	**0.01**
					(0.26)
Adjusted R^2	0.21	0.23	0.33	0.51	0.67

Finally, fourth and fifth column on Table 7 show that asset liquidity and company's corporate behavior measured by Bloomberg's ESG score don't seem to be related on CoCos' credit rating in this sample. The most notable finding from the credit rating analysis is the significance of permanent write-down dummy which seems to increase the credit rating more than one notch. The reason behind this might be the fact that all three credit rating agencies have been rating CoCos only since 2013. Among other uncertainties, the existence of discretionary triggers and equity conversion created valuation uncertainties, which have further complicated the ratings process (BIS Quarterly Review, 2013). At least partly based on this, permanent write-down as a loss-absorption mechanism has become more common in CoCos that have been issued during or after 2013 since it reduces valuation uncertainty. This might be one possible explanation why permanent write-down feature seems to improve bond's rating compared to one that has equity conversion as a loss absorption mechanism. However, this argument is definitely proper subject for future research as amount of data expands.

Table 8 presents reports the coefficient estimates for the second OLS regression model which incorporates equity volatility adjusted distance to trigger variable. Otherwise results on Tables 7 and 8 are fully comparable.

First, the factor loadings for the CoCo-specific factors (column 1) are in line with the earlier regression which included distance to trigger and equity volatility as separate independent variables. However, the most notable finding from Table 7 is the factor loading of volatility adjusted distance trigger which amounts to 4.34 on 1 % percent confidence level. The interpretation of the aforementioned variable is as follows: if annual volatility of issuer's equity equals distance to trigger, the variable gets value of 1 and credit rating should increase 4.34 notches on average. As described earlier, volatility adjusted distance to trigger is received by dividing distance to trigger by annual volatility of issuer's equity. The factor loading remains both economically and statistically significant even when traditional credit metric variables are included into the regression model (columns 2-4).

Second, the addition of solvency variables has similar effects as with first credit rating regression: intercept, volatility adjusted distance to trigger and permanent write-down dummy have the most prominent effect on the credit rating.

Third, after adding liquidity and quality adjustment variables the significance of profitability increases notably. However, the effect of profitability to credit rating is somewhat constrained here since values of the variable range between -244 and 219 basis points where as the factor loading is only 0.01 per one basis point increase or decrease. Thus, intercept, volatility adjusted distance to trigger and both dummy variables remain the most significant explanatory variables for credit ratings. This finding holds for both above depicted regression models. Additionally, the economical and statistical significance of volatility adjusted distance to trigger variable induces interesting questions for the future research of contingent convertibles securities.

Table 8 Credit rating determinants for CoCos

This table presents credit rating determinants for rated CoCos. All determinants presented in this table are linear. Determinants are grouped into CoCo-specific effects (volatility adjusted distance to trigger which is distance to trigger divided by annual volatility of issuers equity computed from the last 180 trading days, trigger capital ratio, permanent write down dummy, and temporary write down dummy), solvency-specific effects (capital which is total common equity divided by risk weighted assets and profitability which is annual return divided by total assets), liquidity-specific effects (asset liquidity which is liquid assets divided by total assets) and qualitative adjustments (Bloomberg's ESG score which ranges from 0.1 to 100) . The loading factors for the following independent variables are sensitivities per one basis point change in the variable: trigger capital ratio, capital, profitability and asset liquidity. Volatility adjusted distance to trigger is ratio which is calculated by dividing distance to trigger by annual volatility of issuer's equity. Bloomberg ESG score ranges from 0.1 to 100. The dependent variable, namely the aggregated credit rating score, can have values from 1 to 9.

Variable	Public and Rated CoCos (n=75)			
Intercept	**1.96***	**4.01*****	**4.64****	**6.64****
	(1.82)	(2.95)	(2.30)	(2.57)
CoCo-specific				
Volatility adjusted Distance to Trigger	**4.34*****	**3.32*****	**2.21***	**2.16****
	(4.63)	(3.03)	(1.88)	(2.14)
Trigger Capital Ratio	**0.004****	**0.00**	**0.00**	**0.00**
	(2.48)	(0.17)	(0.04)	(0.95)
Permanent Writedown	**1.72*****	**1.46*****	**1.80*****	**1.95*****
	(3.82)	(2.83)	(2.67)	(3.47)
Temporary Writedown	**0.17**	**-0.07**	**0.77**	**1.03****
	(0.42)	(0.18)	(1.51)	(2.34)
Solvency				
Capital (TCE per RWA)	-	**0.00**	**0.00**	**0.00**
		(0.65)	(0.46)	(0.33)
Profitability (Return on TA)	-	**0.003**	**0.01*****	**0.01****
		(1.10)	(3.47)	(2.74)
Liquidity				
Asset Liquidity (LA per TA)	-	-	**0.00**	**0.00**
			(0.54)	(0.34)
Qualitative Adjustments				
Bloomberg ESG Score	-	-	-	**-0.02**
				(0.75)
Adjusted R^2	0.32	0.38	0.55	0.70

Significant at 1% (***), 5% (**), and 10% (*) levels.

7.4 Robustness check

To test robustness of my results, I will run similar regression as presented in Table 3 with another dataset which consists of bonds issued in Asia-Pacific and Latin-America regions (i.e. non-European issuers). Though the dataset consists of only 30 CoCos, the results are in line with the earlier presented findings and thus corroborate them.

The reason why this small set of data is excluded from the main dataset is that these bonds have considerably more idiosyncratic features which deviate from their European counterparts. First of all, Asia-Pacific and Latin-America CoCos have various discretionary triggers, or point of non-viability (PONV) triggers, which are activated based on local supervisors' judgment about the issuing bank's solvency prospects. Second, basically all AT1 CoCos issued by Australian banks have scheduled mandatory conversion on predetermined date under certain market conditions. This feature is stark contrast to European AT1s which, by the definition, don't have any predetermined mandatory conversion or redemption date. Third, Moody's defines these instruments either as non-cumulative preferred shares or subordinated debt even though they have distinct CoCo-features (predefined trigger level and loss-absorption mechanisms, namely). Based on the above mentioned differences I will examine this dataset separately.

Table 9 reports the new issue credit spreads factors, respective factor loadings, and related t-statistics. Several interesting results stand out from the table. First, excluding the public sample (second column), sign and significance of distance to trigger variable is in line with the results presented earlier. That is to say, my first hypothesis that new issue credit spreads for CoCos' are inversely related to the distance between bonds' current CET1 capital ratio and the level of trigger capital ratio receives more backing.

Second, regarding to bond specific factors, same factors stand out as with the European data. The effect of maturity is again significant both economically and statistically. This finding is in line with results of Helwege and Turner (1999) which show, that for speculative grade bonds, better quality firms are able to issue bonds with longer maturity. This causes a negative relation between the yield spread and maturity for these bonds. In addition to maturity, also rating has significantly negative effect on new issue credit spreads. Again, the sign and loading of this factor are in line results derived from the European data.

Third, the signs and loadings of all the market specific factors are also consistent with my main results and earlier literature. First of all, as pointed out by Longstaff and Schwartz (1995), higher spot rate increases risk-neutral drift of the firm value process. A higher drift reduces the probability of default, and in turn, reduces the credit spread. Duffee (1998) has also provided similar evidence of negative relation between changes in credit spreads and interest rates. Additionally, the sign for flight to quality factor (3m Euribor -3m Bubill) is as expected. The expected coefficient of this variable is positive, as wider spread indicates a flight to quality or

Table 9 Credit spread determinants for Asian-Pacific and Latin-American CoCos

This table presents the new issue credit spread determinants for CoCos issued by Asia-Pacific and Latin-American banks and financial institutions. All determinants presented in this table are linear. Determinants are grouped into CoCo-specific effects (distance to trigger, permanent write down dummy, and temporary write down dummy), bond-specific effects (liquidity, maturity, and rating), firm-specific effects (volatility), and market-specific effects (1 year risk-free rate, difference between 10 year risk-free rate and 2 year risk-free rate, and the difference between 3 month Euribor rate and Germany 3 month government bill yield). All values are reported on basis points. Unit of liquidity is one million US dollar, maturity is reported in years whereas values for the rating-variable ranges between 1 and 9 (numeric values are converted from the actual credit ratings, from B- to BBB+, namely).

Variable	Whole Sample (n=29)	Public (n=25)	Rated (n=19)	Public and Rated (n=15)
Intercept	**1319.16*** **	**855.18** **	**1465.99*** **	**1496.53*** **
	(6.17)	(2.33)	(6.80)	(4.75)
CoCo-specific				
Distance to Trigger	**-0.29***	**0.03**	**-0.25***	**-0.10**
	(1.89)	(0.13)	(2.05)	(0.81)
Permanent Writedown	**63.74**	**136.45**	**75.01**	**257.43***
	(0.79)	(0.84)	(1.21)	(2.43)
Temporary Writedown	**168.55**	**196.98**	**-126.31**	**30.79**
	(1.19)	(1.11)	(1.03)	(0.28)
Bond-specific				
Liquidity	**0.00**	**0.01**	**0.03**	**-0.03**
	(0.23)	(0.47)	(1.56)	(1.93)
Maturity	**-72.22*** **	**-29.82**	**-45.84** **	**-37.52**
	(3.52)	(0.91)	(2.56)	(1.75)
Rating	-	-	**-83.60*** **	**-100.02*** **
			(3.82)	5.94)
Firm-specific				
Volatility	**-**	**0.41**	**-**	**-0.04**
		(0.45)		(0.58)
Market-specific				
1y Risk Free Rate	**-1.68*** **	**-1.22*** **	**-0.81** **	**-0.59** **
	(4.99)	(3.14)	(2.65)	(2.97)
10y-2y Risk Free Rate	**-0.83**	**-1.48***	**-0.71**	**-1.23** **
	(1.19)	(1.94)	(1.26)	(3.33)
3mo Euribor - 3mo Bubill	**1.91***	**1.05**	**5.36*** **	**3.26***
	(1.78)	(1.05)	(4.12)	(2.72)
Adjusted R^2	0.62	0.50	0.82	0.92

Significant at 1% (***), 5% (**), and 10% (*) levels.

liquidity, which will increase the required compensation for holding corporate bonds (Longstaff F. A., 2004). Furthermore, it's somewhat surprising to see that European flight to quality factor works has significant effect also on Asia-Pacific and Latin-America data.

To conclude, even though the dataset utilized for robustness check is limited, the results are in line with the main results throughout the different factors. As earlier, the coefficient of distance to trigger factor strengthens the main results of this study and thus creates more evidence for my H1. Both write-down dummies have expected signs, though coefficients are not statistically significant throughout different regression models. Consequently, the data fails to create solid evidence for H3 and H4. Trigger capital ratio factor is omitted here because all except two bonds have the same trigger capital ratio (5.125%). Thus, H2 can't be tested here. Finally, as mentioned above, results are consistent with earlier credit spread literature.

8. Conclusions

This study examines the determinants of new issue credit spreads of novel hybrid bank capital called contingent convertibles, or CoCos. The key contribution of the current paper is to find out whether credit spread determinants introduced by Pennacchi (2010) can explain the primary market pricing of banks' CoCo bonds. Utilizing CoCo issuance data from 2009 to March 2015 and controlling all the relevant credit spread determinants my results bring partial evidence for Pennacchi's (2010) predictions. Main analyses are conducted with European data whereas Asian-Pacific and Latin-America data is used to tests robustness of the European results. In addition to credit spread determinants, I'm also studying whether rating agencies incorporate different CoCo-specific factors into their ratings.

Results of my study generate consistent evidence for H1 which proposes that credit spreads at the issuance for both fixed and floating rate CoCos' are inversely related to the distance between bonds' current CET1 capital ratio and the level of trigger capital ratio. This finding is both economically and statistically significant both Europe and Asia-Pacific & Latin-America regions. Moreover, analysis of public and rated CoCos creates evidence for my third hypothesis, which was meant to test whether investors demand higher credit spread for CoCos which are written down permanently rather than converted into equity. Similar results arise from Asian-Pacific and Latin-America data which is used for robustness check. However, the factor coefficients for permanent write down dummies are not consistently statistically significant so H3 can't be accepted.

Concerning H2 and H4, my analysis fails to create consistent evidence to them. That is to say, trigger capital ratio itself doesn't have meaningful effect on new issue credit spreads of contingent convertible bonds. Furthermore, temporary write down feature seems to have opposite effect to credit spreads as expected as it generally decreases the demanded credit spread compared to CoCos with equity conversion as loss absorption mechanism. However, given that issuers are increasingly adopting write down features to CoCos, the comparison between equity conversion vs. nominal write down features might become redundant in the future.

The by-product and other main finding of my study is that credit ratings are the single most significant driver both economically and statistically for credit spreads of contingent convertible securities when they are issued. By analyzing determinants of credit ratings, I find that credit rating agencies incorporate CoCo-specific factors into them. This explains the multicollinearity between these variables. To elaborate, volatility adjusted distance to trigger and permanent write-down dummy seem to be the biggest drivers of credit ratings. The positive and significant effect of permanent write down feature might reflect rating agencies' inclination towards transparent and calculable loss-absorption features. Either way, both offer interesting topics for further research.

Finally, although this study is motivated by testing the predictions of structural model of contingent capital, there is clear demand for research which takes idiosyncrasies of CoCos more broadly into consideration and tries to explain the observed credit spreads and credit ratings with expanded list of CoCo-specific features. For example, typically coupons of CoCos are to be cancelled if issuer's capital slides below Combined Buffer which consists of minimum CET1 capital, capital conservation buffer, GSIB buffer and countercyclical buffer. Thus, distance to Combined Buffer could be relevant factor behind credit spreads of CoCos and thereby interesting object for future exploration alongside volatility adjusted distance to trigger and different write-down dummies.

9. References

Albul, B., Jaffee, D., Tchistyi, A., 2013. Contingent convertible bonds and capital structure decisions. Unpublished working paper. University of California, Berkeley.

Altman, E. I., Kishore, V. M., 1996. Almost everything you wanted to know about recoveries on defauited bonds. Financial Analysts Journal 52, 57-64.

Altman, E., Saunders, A., 1998. Credit risk measurement: Developments over the last 20. Journal of Banking & Finance 21, 1721-1742.

Ammann, M., Kind, A., Wilde, C., 2008. Simulation Based Pricing of Convertible Bonds. Journal of Empirical Finance 15, 310-331.

Basel Committee on Banking Supervision, 2011. Basel III: A Global Regulatory Framework for More Resilient Banks and Banking Systems.

BIS Quarterly Review, 2013. CoCos: a primer.

Black, F., Scholes, M., 1973. The pricing of options and corporate liabilities. Journal of Political Economy 81, 637-654.

Buergi, M., P., 2013. Pricing contingent convertibles: A general gramework for application in practice. Financial Markets and Portfolio Management 27, 31-63.

Campbell, J., Y., Taksler, G., B., 2003. Equity Volatiliy and Corporate Bond Yields. The Journal of Finance 58, 2321-2349.

Chen, L., Lesmond, D., Wei, J., 2007. Corporate yield spreads and bond liquidity. Journal of Finance 62, 119-149.

Collin-Dufresne, P., Goldstein, R., S., 2001. Do credit spreads reflect stationary leverage ratios? Journal of Finance 56, 1926-1957.

Cremers, M., K., Driessen, J., Maenhout, P., 2008. Explaining the level of credit spreads: option-implied jump risk premia in a firm value model. Review of Financial Studies 21, 2209-2242.

Daniels, K., N., Jensen, M., S., 2005. The effect of credit ratings on credit default swap spreads and credit spreads. Journal of Fixed Income 15, 16-33.

De Spiegeleer, J., Schoutens, W., 2012. Pricing contingent convertibles: A derivatives approach. Journal of Derivatives, 27-36.

De Spiegeleer, J., Marquet, I., Schoutens, W., 2015. CoCo Bonds and Implied CET1 Volatility. Unpublished working paper. Department of Mathematics KU Leuwen.

Duffee, G., R., 1998. The relation between treasury yields and and corporate bond yield spreads. Journal of Finance 53, 2225-2241.

Elton, E. J., Gruber, M., J., Agrawal, D., Mann, C., 2001. Explaining the Rate Spreads on Corporate Bonds. The Journal of Finance 56, 247-277.

Glasserman, P., Nouri, B., 2012. Contingent capital with a capital-ratio trigger. Management Science, 1816-1833.

Hand, J., R., Holthausen, R., W., Leftwich, R., W., 1992. The effect of bond rating agency announcements on bond and stock prices. Journal of Finance 47, 733-752.

Helwege, J., Turner, C., 1999. The Slope of the credit yield curve for speculative-grade issuers. Journal of Finance 54, 1869-1884.

Hite, G., Warga, A., 1997. The effect of bond rating changes on bond price performance. Financial Analysts Journal 53, 33-51.

Ingersoll, J., 1977. A contingent claim valuation of convertible securities. Journal of Financial Economics 4, 289-322.

Jarrow, R., A.. Lando, D., Turnbull, S., M., 1997. A Markov model for the term structure of credit risk spreads. Review of Financial Studies 10, 481-522.

Leland, H., E., Toft, K., B., 1996. Optimal capital structure, endogenous bankruptcy, and term structure of credit spreads. Journal of Finance 3, 987-1019.

Lewis, C., M., 1991. Convertible debt: valuation and conversion in complex capital structures. Journal of Banking and Finance 15, 665-682.

Longstaff, F., A., 2004. The Flight-to-Liquidity premium on U.S. Treasury bond prices. Journall of Business 77, 511-526.

Longstaff, F., A., Schwartz, E., 1995. A simple approach to valuing risky fixed and floating rate debt. Journal of Finance 50, 789-821.

Merton, R., 1974. On the pricing of corporate debt: The risk structure of interest rates. Journal of Finance 29, 449-470.

Moody's, 2015. *Moody's investor service: Rating Methodology for Banks*.

Pennacchi, G., 2010. A structural model of contingent bank capital. Unpublished working paper. University of Illinois.

Wilkens, S., Bethke, N., 2014. A contingent convertible (CoCo) bonds: a first empirical assessment of selected pricing models. Financial Analyst Journal 70, 59-77.

Zhang, B., Zhou, H., Zhu, H., 2009. Explaining credit default swap spreads with the equity volatility and jump risks of individual firms. The Review of Financial Studies 12, 5099-5131.