NBER WORKING PAPER SERIES

COCO ISSUANCE AND BANK FRAGILITY

Stefan Avdjiev
Bilyana Bogdanova
Patrick Bolton
Wei Jiang
Anastasia Kartasheva

Working Paper 23999
http://www.nber.org/papers/w23999

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
November 2017

The study has benefited from discussions by Felipe Cortes, Mark Flannery, Florian Heider, George Pennacchi, Klaus Schaeck, Theo Vermaelen, and comments from Ruth Doubleday, Louise Eggett, Ingo Fender, Ulf Lewrick, Noel Reynolds, and Kostas Tsatsaronis, as well as seminar participants at the American Economic Association, Bank for International Settlements, Deutsche Bundesbank, the Committee on the Global Financial System workshop on contingent capital instruments, Conference on Financial Regulation at the University of Chicago, De Nederlandsche Bank, European Finance Association, European Winter Finance Conference, Imperial College of London, NBER Risks of Financial Institutions, Research Task Force of the Basel Committee on Banking Supervision, Western Finance Association, University of Geneva, and University of St. Gallen. We thank Minchen Zheng (Columbia) for excellent research assistance. The views expressed in the paper are those of the authors and do not necessarily represent the views of the Bank for International Settlements or the National Bureau of Economic Research.

CoCo Issuance and Bank Fragility
Stefan Avdjiev, Bilyana Bogdanova, Patrick Bolton, Wei Jiang, and Anastasia Kartasheva
NBER Working Paper No. 23999
November 2017
JEL No. G01,G21,G28,G32

ABSTRACT

The promise of contingent convertible capital securities (CoCos) as a "bail-in" solution has been the subject of considerable theoretical analysis and debate, but little is known about their effects in practice. In this paper, we undertake the first comprehensive empirical analysis of bank CoCo issues, a market segment that comprises over 730 instruments totaling $521 billion. Four main findings emerge: 1) The propensity to issue a CoCo is higher for larger and better-capitalized banks; 2) CoCo issues result in statistically significant declines in issuers' CDS spreads, indicating that they generate risk-reduction benefits and lower costs of debt. This is especially true for CoCos that: i) convert into equity, ii) have mechanical triggers, iii) are classified as Additional Tier 1 instruments; 3) CoCos with only discretionary triggers do not have a significant impact on CDS spreads; 4) CoCo issues have no statistically significant impact on stock prices, except for principal write-down CoCos with a high trigger level, which have a positive effect.

Stefan Avdjiev
Bank for International Settlements
Centralbahnplatz 2
Basel 4002, Switzerland
stefan.avdjiev@bis.org

Bilyana Bogdanova
Bank for International Settlements
Centralbahnplatz 2
4002 Basel
Switzerland
bilyana.bogdanova@bis.org

Patrick Bolton
Columbia Business School
804 Uris Hall
New York, NY 10027
and NBER
pb2208@columbia.edu

Wei Jiang
Graduate School of Business
Columbia University
3022 Broadway, Uris Hall 803
New York, NY 10027
and NBER
wj2006@columbia.edu

Anastasia Kartasheva
Bank for International Settlements
Centralbahnplatz 2
4002 Basel
Switzerland
Anastasia.Kartasheva@bis.org

1 Introduction

If there is one term that epitomizes the infamy of the Global Financial Crisis of 2007-09 it is "too big to fail". Even when they sought to impose financial discipline on banks that had assumed excessive levels of leverage, financial regulators were more often than not forced to accept bailouts as the only possible stabilizing intervention because the alternative of putting the failed banks through some form of resolution and imposing losses on depositors and other bank creditors was seen to be too dangerous in the middle of the crisis. It is not surprising, therefore, that a major priority of regulators following the crisis, on top of significantly tightened bank capital and liquidity regulations, was to create new instruments to facilitate the write-down of the debt of distressed institutions. In short, the priority became to make sure that, in the event of another crisis, *bail-ins* would be a credible alternative to *bailouts*.

One way of bringing about a swift and seamless bail-in is through the conversion of contingent convertible capital securities (CoCos) previously issued by the bank. The automatic loss absorption by CoCos when a pre-specified trigger has been breached was the main appeal of these securities according to the early proponents, in particular, Flannery (2005, 2016); Raviv (2004); Duffie (2009); McDonald (2013); Coffee (2011); Pennacchi, Vermaelen and Wolff (2014); and the Squam Lake Working Group (2010). These advocates of CoCos disagreed on the design of CoCos, in particular on whether the trigger should be a stock price floor or a minimum equity-capital ratio, and their proposals were criticized by other commentators, most notably Admati, DeMarzo, Hellwig and Pfleiderer (2013) and Sundaresan and Wang (2015), who argued that CoCos were excessively complex and their conversion could have destabilizing effects.

In the immediate aftermath of the Global Financial Crisis, these debates among academics were mirrored by differences in opinions and preferences among national bank regulators. Nevertheless, the introduction of the Basel III framework, which allows banks to meet part of their regulatory capital requirements with CoCo instruments, created strong incentives for banks to seriously explore the possibilities for issuing CoCos. Furthermore, the inclusion of specific contingent capital elements in the Basel III framework brought some homogeneity in CoCo design across jurisdictions. As the number of jurisdictions implementing Basel III grew, banks responded by raising a substantial amount of capital in the form of CoCo issues. Between January 2009 and December 2015, banks around the world issued a total of $521 billion in CoCos through 731 different issues.

The market for bank CoCos is now large enough to undertake a systematic empirical analysis of bank CoCo issuance. We do this by assembling the first comprehensive data set of all CoCo issues by banks between 2009 and 2015. Beyond providing an overview of the main characteristics of CoCos and their issuers, our study seeks to address two fundamental questions: What drives bank CoCo issuance decisions? And how do CoCo issues affect issuers' balance sheets?

To determine the factors driving CoCo issuance, we perform a duration analysis and estimate which bank characteristics are associated with a higher propensity to issue a CoCo. Our first main broad finding is that larger banks and banks with relatively strong balance sheets, were among the first wave of CoCo issuers. But banks with impaired balance sheets that were in greater need of recapitalization were less likely to issue CoCos. Even though this result is surprising at first sight, it is consistent with the predictions of our simple theoretical model (presented in Appendix B). Issuance decisions are made with shareholder interests in mind; and shareholders may pass on a CoCo issue if it does not enhance shareholder value. As our theoretical model predicts, a CoCo issue by a bank with an impaired balance sheet mostly benefits the bank's senior unsecured debt holders (a version of the classic "debt overhang" problem). Viewed in this light, our result is less surprising. Consistent with this interpretation, we also find that statistical significance is greater for CoCos that specify a principal write-down when the trigger is breached rather than a conversion of debt into equity. Principal write-down CoCos are, in effect, junior to equity in distress states and, therefore, particularly attractive to shareholders.

We also conduct an event study to evaluate the impact of CoCo issuance on the issuer's balance sheet. In particular, we estimate the announcement effect of a CoCo issue on the issuer's CDS spreads and equity prices, breaking the effect down by key issuer characteristics and CoCo contract features. Several striking results emerge from this analysis. First, the overall impact of a CoCo issue on the issuer's CDS spread is negative and strongly statistically significant, indicating that, according to market participants, a CoCo issue unambiguously strengthens the issuer's balance sheet. When we break down the effect by CoCo loss absorption mechanism, we find that the impact on CDS spreads of CoCos that convert into equity is much stronger than the respective impact of principal write-down CoCos. This latter result is again consistent with the predictions of our simple model. As we show, a

CoCo that converts into equity disciplines risk-taking by shareholders because conversion may dilute existing equity holders' claims. In contrast, risk-taking is rewarded at the conversion margin when CoCos absorb losses via a principal write-down. This explains why the net reduction in credit risk following the issue of a principal write-down CoCos is lower.

When we further separate the announcement effects by the type of trigger mechanism, we strikingly find that the presence of a mechanical trigger makes all the difference. More concretely, only CoCos that have a mechanical trigger (in addition to a discretionary trigger) have a significant negative impact on the issuer's CDS spread. In other words, the issuance of a CoCo with only a discretionary trigger is seen to have no significant effect on the bank's credit risk by the market. The most likely explanation for this market reaction is that these CoCos are pure "gone concern" instruments, with a lot of uncertainty surrounding the regulator's conversion decision. CoCos that also have a mechanical trigger combine both "gone concern" and "going concern" features. The market reaction to the announcement of CoCo issues with a mechanical trigger suggests that the triggering event for these CoCos is more predictable, at least for the "going concern" part.

We also find that the level of the mechanical trigger matters. The impact of high-trigger CoCos on CDS spreads is stronger than that for low-trigger CoCos. These results shed light on an important controversy around banks' true motivation for issuing CoCos. Ever since the first CoCo issue by Lloyd's in November 2009, which specified a low trigger, the concern was raised that the contingent component of these instruments was purely theoretical and that regulatory intervention to save the issuer would take place long before the low trigger level would be breached (see Alessandri and Haldane, 2009 and Glasserman and Perotti, 2017). Our results only partially confirm these concerns and indicate that, at least for high-trigger CoCos, market expectations do factor in a significant probability of conversion. It is also worth noting that these results also partially dispel another myth about CoCos: that investors were only focused on the high yields and entirely ignored the risk of conversion.

All in all, we find that CoCo issuance has generally contributed to reducing bank fragility. But not all instruments are equal in this regard. The CoCos that have the strongest strengthening effect on bank balance sheets are the ones that absorb losses by converting to equity as well as those that have a mechanical trigger and an Additional Tier 1 (AT1) designation.[1]

We also look at the announcement effects on bank equity prices and find that for the full sample there is no significant impact of CoCo issuance on the issuer's stock price. This is again consistent with the predictions of our theoretical model and reflects the fact that while a CoCo issue may strengthen a bank's balance sheet it may do so at the behest of shareholders. Interestingly, however, the one type of CoCo whose main design features are most beneficial to shareholders – a principal write-down CoCo with a high trigger – does have a positive and statistically significant impact on the issuer's equity price.

Our paper contributes to the wider literature of empirical studies of financial contracts (see Roberts and Sufi, 2009, for a survey). Because our financial contracts are publicly traded we are able to shed light on market reactions to particular designs, which is typically not possible for venture capital contracts and syndicated bank loans.

[1]The implicit assumption behind the above conclusions (and throughout our analysis) is that CoCo issuance is not substituting for CET1 issuance, i.e. that CoCos are issued on top of (rather than instead of) CET1.

None of the CoCos in our sample have converted or been in danger of converting during our sample period. We therefore cannot investigate the effects of conversion.[2] However, the study by Vallee (2015) of hybrid bonds issued by European banks between 1998 and 2012, which have similar features to CoCos structured as reverse convertible bonds, shows how conversion can provide a capital cushion to issuing banks in a crisis. Vallee studies the effects of the ex-post conversion of these hybrid bonds during the financial crisis of 2007-09 and finds that conversion had the intended effects predicted by CoCo theories.

The remainder of the paper is organized as follows. Section 2 provides the institutional background, describes the current state of CoCo issuance, and presents an overview of the sample. Section 3 describes the post-crisis policy debates around bank regulatory reform. It also summarizes the predictions derived from the theoretical framework developed in Appendix B. Section 4 presents the empirical analyses. Section 4.1 contains several duration analyses on the propensity of a bank to issue a CoCo. Section 4.2 reports the estimates of the impact of CoCo issuance on the CDS spread and the stock price of the issuing bank, as well as the differential effects of the main CoCo contract features. Section 5 discusses open questions about the future design of CoCos and offers concluding comments.

[2] Outside our sample period, there has been one episode in which coupon suspension was feared for Deutsche Bank's CoCos in February 2016, and another episode in which conversion of Banco Popular's CoCos was triggered by the regulator in June 2017.

2 Institutional Background and Sample Overview

2.1 The CoCo market

CoCos have two defining features – a trigger modifying the debt repayment terms and a loss-absorption mechanism. We describe the different forms these features can take in Figure 1.

A CoCo can have one or more triggers. In case of multiple triggers, the loss absorption mechanism is activated when any trigger is breached. All CoCos are required to have a discretionary trigger under Basel III. This trigger type allows regulators to activate the loss absorption mechanism if they decide that the issuer has reached the point of non-viability. In addition, some CoCos also have a mechanical trigger, which is defined relative to the capital of the CoCo-issuing bank. In theory, the capital measure could be based on book values or market values. In practice, however, the mechanical triggers of all the CoCos that have been issued so far are book-value based. In most cases, those are defined in terms of the ratio of the issuing bank's Common Equity Tier 1 (CET1) capital to its risk-weighted assets (RWA).

[Insert Figure 1 here.]

The loss-absorbing mechanism is the second key characteristic of a CoCo. Recapitalization through conversion can occur in two ways. A mandatory conversion-into-equity (MC) CoCo increases CET1 capital by converting the CoCo debt into equity at a pre-defined conversion rate. The conversion rate can be based on the market price of the stock at the time the trigger is breached, a pre-specified price (e.g. the stock price at issuance), or a combination of the two prices. Principal write-down (PWD) CoCos repair the bank's balance sheet by writing down the CoCo's principal amount, either permanently or temporarily.[3]

Basel III framework contains two key contingent capital elements (Figure 2).[4] First, all (AT1 and T2) CoCos must include a discretionary trigger, also known as a point of non-viability (PONV) trigger. Second, all AT1 CoCos classified as liabilities must have a mechanical trigger, with a minimum trigger level of 5.125% (in terms of CET1/RWA).[5] However, the Basel III framework does not specify a particular loss absorption mechanism, implicitly treating PWD CoCos and MC CoCos in a symmetric fashion.[6]

[Insert Figure 2 here.]

More recently, two other regulatory changes have further expanded the potential market footprint of bank CoCos. The first change is the upcoming Total Loss Absorption Capacity (TLAC) resolution requirements rules for global systemically important banks (G-SIBs). The new TLAC requirements can be (at least partially) satisfied through the issuance of CoCos as well as through the issuance of other (non-CoCo) "bail-inable" debt.[7] The second change was introduced by the European Bank Recovery and Resolution Directive (BRRD), which includes the Minimum Requirement for Own Funds and Eligible Liabilities (MREL)

[3] Avdjiev, Kartasheva, and Bogdanova (2013) provide further details on CoCo contract features and bank capital regulations related to CoCos.

[4] As illustrated in Figure 2, the regulatory minimum capital requirements under the Basel III framework are (RWA-based) ratios of 4.5% for CET1, 6% for Tier 1 capital (CET1 + AT1), and of 8% for total capital (CET1 + AT1 + T2). All instruments other than those in CET1 are optional – i.e. banks have the option to meet all their capital requirements using only CET1.

[5] The latter requirement does not apply to AT1 CoCos classified as equity (i.e. preferred shares.)

[6] In some jurisdictions (e.g., Switzerland), national supervisors supplement the Basel III minimum capital levels by requiring G-SIB banks to have additional capital layers, filled with CoCos. See FINMA (2015).

[7] The TLAC standard defines a minimum requirement for the instruments and liabilities that should be "bailin-able" (i.e. readily available for bail-in within resolution) at G-SIBs. See FSB (2015).

stipulating that a sufficient fraction of bank debt liabilities be bail-inable.[8]

Nearly as important as bank regulations are institutional investors' constraints and issuer incentives to create notable clientele effects on CoCo design. In particular, the persistently low interest rates in the post-financial crisis environment incentivized fixed income investors to invest in high-yield instruments. However, fixed income investors are often restricted by mandate from investing in instruments that have a non-negligible probability of converting to equity or face higher compliance costs for these instruments. In contrast, PWD instruments typically do not fall under such restrictions.

2.2 Sample overview

Our data set is compiled using information from Bloomberg and Dealogic. We have manually augmented the data set with additional information from supplementary sources. The sample that we use in our benchmark analysis consists exclusively of CoCos issued by banks and excludes those issued by insurance companies and other non-bank financial institutions. Furthermore, we focus on CoCos that have at least one (mechanical or discretionary) contractual trigger.[9]

The data comprises the main elements of CoCo term sheets, their regulatory classification, and key issuer characteristics. We collect information in the most important CoCo contractual terms - the loss absorption mechanism (principal write-down or mandatory conversion to equity), the trigger type (mechanical or discretionary), and the trigger level (for

[8] See EBA (2016).

[9] In this paper, we focus on loss absorption mechanism triggers and we do not analyze coupon cancellation triggers. Also we do not include CoCos that have only a statutory trigger.

CoCos that have a mechanical trigger). In addition, we also collect the following variables: maturity; issued amount; currency of denomination; regulatory capital classification (AT1 or T2); issue date; price and yield at issuance; coupon rate; and payment rank classification (subordinated debt, preferred equity, etc.).

As for issuer characteristics, we collect daily data on issuer equity prices and CDS spreads (for senior unsecured debt). We construct benchmark indices in which banks are grouped based on their country/region of operations – "Australia and New Zealand," "Canada", "Europe," and "Japan." For equity prices, we use market capitalization-weighted Datastream bank country/regional equity indices. For CDS spreads, we calculate equally-weighted averages of the CDS spreads of banks operating in the respective county/regions. In order to obtain a more representative set of banks included in each country/regional CDS index, we augment the constituents of the MARKIT iTraxx and CDX indices with additional banks, which (i) operate in the respective CoCo-issuing jurisdictions and (ii) have liquid CDS for senior unsecured debt.[10]

For the empirical exercise on the determinants of CoCo issuance, we take the universe of potential CoCo issuers to be the top 500 banks (by total assets in 2009) in CoCo-issuing advanced economies. This sample encompasses both those banks who eventually do issue one or more CoCo securities and those banks for which CoCo is a potential option, but choose not to issue. We obtain annual data of the major balance-sheet variables for the actual and

[10] All the additional banks that we include in our augmented country/regional CDS indices have (senior unsecured debt) CDS spreads reported by Markit on at least 75% of the business days in our sample. In our benchmark empirical exercises, we use the values of each country/regional CDS index on a given date only if a CDS spread is reported for at least 75% of the banks included in the respective country/region on that date.

potential CoCo issuers from Bankscope.

An overview of the CoCo market through the end of 2015 is presented in Table 1. Between 2009 and 2015, there have been 731 CoCo issuances for a combined issuing volume of $521 billion. The size of the average CoCo issue is $713 million. Nevertheless, that figure conceals a wide variation in individual CoCo issue sizes, which range from $2 million to $7 billion.

[Insert Table 1 here.]

The last column of Table 1 provides a break-down of CoCo issuance by region. European issuers account for 39% of the CoCo market. Another 14% of CoCo issuance has come from banks from non-European advanced economies. Following a period of rapid growth in CoCo issuance in the last years, emerging market economies account for over 46% of the CoCo market by the end of 2015.

The left-hand panel of Figure 3 displays the geographical distribution of CoCo issuance by individual countries. In the early years of our sample, CoCo issuance was heavily concentrated in advanced European countries; issuers headquartered in the UK and Switzerland were particularly active. In the later years of our sample, CoCo issuance in non-European advanced economies (Australia, Japan, and Canada) gradually picked up in tandem with the implementation of Basel III. Issuance by banks in emerging market economies (EMEs) remained relatively low until the last couple of years in our sample, when Chinese banks became particularly active issuers of CoCos. One notable absence from the list of CoCo-issuing jurisdictions is the United States, where banks have issued AT1 and T2 instruments that have only statutory (as opposed to contractual) triggers [11].

[Insert Figure 3 here.]

Banks tend to issue CoCos either in their respective home currency or in US dollars (Figure 3, right-hand panel). Virtually all CoCos denominated in British pounds, Australian dollars, Japanese yen, Canadian dollars, and Chinese yuan were issued by banks from the respective currency-issuing jurisdictions. Also, roughly two thirds of the $84 billion in euro-denominated CoCos were issued by banks from the Euro area. The US dollars denominated issuance totaled $148 billion and accounted for 28% of global issuance.

The majority of the CoCos in our sample have a mechanical trigger in addition to the discretionary trigger (present in all CoCos in our sample). The total volume of CoCos with a mechanical trigger is $292 billion (or 56% of the global aggregate), and the amount of CoCos with only a discretionary trigger is $229 billion (or 44% of the global aggregate). The majority of CoCos issued by banks in advanced economies tend to have mechanical triggers.

The majority ($205 billion) of the CoCos with a mechanical trigger have trigger levels that do not exceed 5.125%, which is the minimum trigger level (in terms of CET1/RWA) required for a CoCo classified as a liability to qualify as AT1 capital under Basel III. About $87 billion worth of CoCos have a mechanical trigger level that is higher than 5.125%.[12]

Slightly more than half (55%) of all CoCos are classified as AT1 capital. The rest are

[11] We have not included the AT1 preferred shares and the T2 subordinated debt instruments issued by US banks since all of them have only *statutory* triggers. As discussed above, we focus on contingent convertible capital instruments with at least one *contractual* trigger.

[12] Another potentially relevant critical capitalization level is the Capital Conservation Buffer Requirement (CBR). When an issuer's capital buffer falls below the CBR, it is constrained in its ability to continue its existing dividend and coupon payouts.

classified as T2 capital. AT1 CoCo issuance has dominated in most advanced economies, where nearly three quarters of the CoCos are classified as AT1 capital. The only exceptions are Switzerland and Canada (where issuance has been roughly evenly split between AT1 and T2 CoCos) and Japan (where T2 CoCos have accounted for two thirds of all issuance). In contrast, EME banks have issued mostly T2 CoCos, which represent 63% of their total CoCo issuance so far.

Figure 4 tracks the evolution of the CoCo market between 2009 and 2015. It shows that the volume of CoCo issuance has grown rapidly since 2009. The left-hand panel of Figure 4 reveals that, in the early years, issuance of AT1 instruments was slightly more prevalent than that of T2 instruments. As issuance by EME banks picked up in 2014 and 2015, so too did the share of T2 CoCos.

[Insert Figure 4 here.]

The right-hand panel of Figure 4 breaks down the evolution of CoCo issuance by the loss-absorption mechanism. Even though MC CoCos dominated in the early years, the issuance of PWD instruments picked up over time. Growing demand by fixed income investors for CoCos and shareholder incentives to issue PWD CoCos could be important factors that contributed to this trend.

3 Policy debates and hypotheses

For most advocates, the main case for CoCos is the quick and simple bail-in mechanism they provide. Early critics of CoCos have argued, however, that an even better and simpler bail-inable instrument is equity (Admati, DeMarzo, Hellwig, and Pfleiderer, 2013). Another early concern was that the design of some types of CoCos could result in destabilizing bail-ins (Sundaresan and Wang, 2015). These observations, and others we discuss below, have been at the heart of policy debates around CoCos. Our analysis focuses on how the design of CoCos matters for the overall costs and benefits from issuing such instruments.

3.1 Market-based or accounting-based triggers?

While CoCo issuance reduces the issuing bank's probability of failure, it also changes the distribution of payoffs over different claims in states of distress. As a result, the CoCo trigger may be subject to gaming by bank managers, regulators, and investors. Different designs give rise to strategic gaming problems. One prominent issue that has been widely discussed in the literature is the pros and cons of book-value versus market-value triggers in terms of the promptness and accuracy of conversion.

The responsiveness of book-value triggers depends on the frequency with which book values are reassessed and disclosed. It also depends on the accuracy and robustness of the internal risk models that are used to measure the risk exposure of bank balance sheets. These factors reduce the ability for CoCos with accounting-based triggers to respond in a timely way to the onset of a sudden crisis. In contrast, market-value triggers, as Flannery (2005,

2009) and Calomiris and Herring (2013) have argued, are that they immediately respond to news about realized or prospective bank losses. In addition, they are somewhat more immune to accounting obfuscation.[13]

However, a potential shortcoming of market-based triggers is that they are exposed to price volatility generated by noise trading. Moreover, they may invite stock price manipulation or speculative attacks. For example, market-based triggers may be vulnerable to strategic short-selling for the purposes of forcing the conversion of a CoCo and thereby transferring value from equity holders to CoCo investors, as Hillion and Vermaelen (2004) have argued. A broader concern with using market prices for regulatory purposes is that this can distort the information content of prices (see Faure-Grimaud 2002, and Bond, Goldstein and Prescott 2010). For CoCos specifically, when a market price triggers conversion, the share price reflects both the value of the issuer's total assets and the redistribution of value among initial shareholders and CoCo investors, as discussed in Glassermann and Nouri (2016) and Berg and Kaserer (2015).

There are several proposals that address these latter concerns, including: i) inducing gradual conversion into shares (Bulow and Klemperer, 2014); ii) fixing the number of new shares at conversion (Flannery, 2009); iii) letting the trigger be based on a historical moving average of stock prices (Duffie, 2009, and Calomiris and Herring, 2013); and, iv) fixing the conversion price below the share value at conversion, with an option for initial shareholders to purchase the new shares at the lower price (Pennacchi, Vermaelen, and Wolff, 2013).

[13] As we have already noted, all AT1 and T2 CoCos must include a discretionary trigger. Such triggers potentially have regulatory forbearance problems, and generate excessive sensitivity of the market to regulatory announcements.

Another important feature of CoCos is their maturity. As Pennacchi and Tchistyi (2016a) have argued, CoCos with infinite maturity are much more robust to price manipulation. They show that when CoCos are perpetuities, the multiple equilibrium problem identified by Sundaresan and Wang (2015) disappears and equilibrium is unique regardless of other CoCo features.

3.2 Loss absorption and risk taking incentives

The effect of CoCo issuance on risk-taking incentives of the issuing bank is an important aspect of CoCo design. In theory, PWD CoCos could encourage excess risk-taking around the conversion trigger, whereas MC CoCos that dilute existing shareholders upon conversion could encourage accounting manipulation to delay conversion. Moreover, CoCos with conversion terms that transfer value to equity holders upon conversion are likely to encourage additional risk-taking. Indeed, Berg and Kaserer (2015) analyze the conversion price of CoCos issued by Lloyds in an option-pricing context and show that those bonds create perverse risk incentives for banks' equity holders.

Excess risk-taking incentives associated with PWD CoCos can be mitigated by exposing bank executive compensation to CoCo price risk (Bolton, Mehran, and Shapiro, 2015 and Hilscher and Raviv, 2014). Approaches to address the concerns regarding MC CoCos have been more diverse. Flannery (2005) and Calomiris and Herring (2013) urge that the design of CoCos should take the form of MC CoCos that are dilutive to preexisting equityholders and that convert well before the bank faces insolvency. Similarly, Martynova and Perotti

(2016) show that CoCos lower bank risk-taking in equilibrium only when they take the form of high-trigger MC CoCos. But the problem with these CoCo designs is that bank equityholders have little incentives to issue such CoCos, because doing so mostly benefits outstanding unsecured creditors with higher seniority in the event of a bankruptcy state. In other words, bank equityholders may face a “debt overhang” problem with respect to high-trigger, dilutive, MC-CoCos. However, Chen, Glasserman, Nouri, and Pelger (2013) and Albul, Jaffee, and Tchistyi (2012) have shown that equityholders can have a positive incentive to issue CoCos to the extent that they also benefit when the issuer has a lower default risk (for example, via lower costs of debt rollovers).

In summary, the literature highlights that CoCo contract features affect bank risk-taking incentives. Though CoCo contract-design could be influenced by regulators, the reality is that issuing banks have substantial leeway in selecting the contract features they want. Hence it is important to understand the effects of CoCo designs on bank incentives in order to induce CoCo contracts that are desirable from the perspective of financial stability.

3.3 CoCos as a macroprudential tool

Several proposals of CoCo design have focused on the question of how CoCos should be modified to deal with a systemic risk event. The essence of these proposals is that the CoCo trigger should be contingent on some measure of systemic risk. However, this contract design could paradoxically lead to higher systemic risk because it would increase moral hazard frictions. That said, CoCos whose conversion is triggered by a systemic event do offer the desirable property that they deliver a bail-in only when it is needed, in a crisis when restructuring a bank's liabilities and raising new capital is difficult.

One early such proposal came from Kashyap, Rajan, and Stein (2008), who suggest that banks purchase capital insurance, with a trigger that is based on a systemic event. Similarly, the Squam Lake Working Group (2009) proposes that CoCos convert to equity under two conditions: (i) a breach of a trigger based on an accounting capital ratio; and (ii) a declaration by regulators that there is a systemic crisis. Caballero and Kurlat (2008) have also proposed that the central bank could issue tradable insurance credits that entitle the holder to attach a central bank guarantee to assets on its balance sheet during a systemic crisis. Their proposal eliminates the need to make the trigger contingent on a specific event, which they argue is a better way of dealing with a surprise shock.

CoCos can also be a macroprudential tool if they implement counter-cyclical equity buffers. One way of achieving this, suggested by Bolton and Samama (2012), is to do away with automatic triggers altogether and design the CoCos as reverse convertible bonds granting the issuer the option to convert the bond into equity. Issuers would only convert when the put option embedded in the CoCo is in the money, which is more likely to be the case in recessions or in a financial crisis. When the issuer exercises the option, the bank is effectively recapitalized at more favorable terms than available in the market. A CoCo structured as a reverse convertible bond would be equivalent to giving the issuer a commitment to augment its equity capital at will, and at favorable terms, in recessions, thus implementing a form of counter-cyclical equity buffer. Vallee (2013) shows that European banks that had issued hybrid debt before the crisis took advantage of the convertibility option to convert the debt issues in the middle of the crisis of 2007-09, which enabled them to partially recapitalize their stressed balance sheets. Finally, Zeng (2013) also derives optimal countercyclical bank capital requirements, and shows that they can be implemented using CoCo instruments.

3.4 Hypotheses

Our empirical analysis focuses on two key questions. What bank characteristics determine whether a bank issues a CoCo of a given design? And, what is the impact of CoCo issuance on the market price of other claims on the issuing bank? To guide our empirical analysis, we develop a simple theoretical model (presented in Appendix B) that generates several predictions on these two questions. The model considers a bank issuer with assets and liabilities in place that currently satisfy regulatory capital requirements, but risks violating these requirements in a future crisis state in which it incurs a loss. The decision the issuer faces is whether to issue a CoCo now, so as to buttress its balance sheet sufficiently to be able to withstand a loss without violating its capital requirements, or to risk having to go through a costly recapitalization in the crisis state. As a trade-off to fire-sale recapitalization costs in a crisis, the issuer faces CoCo issuance costs. These issuance costs include underwriting fees and dilution costs due to asymmetric information.

The model assumes that the decision whether to issue a CoCo or not rests with the shareholders of the issuing bank, who evaluate the relative costs of CoCo issuance today versus contingent recapitalization tomorrow, with the goal of shareholder value maximization. The analysis implies that issuing a CoCo is more attractive to shareholders, the less the CoCo issue is underpriced by the market, the lower the fraction of equity promised to CoCo investors upon conversion, and the higher the asset sales discount in a crisis.

Accordingly, there are two important differences between an MC CoCo and a PWD CoCo for a bank issuer. First, the conversion of the PWD CoCo always increases the value of equity, while the conversion of an MC CoCo could result in dilution of equity holders. Second, PWD CoCos are less likely to be underpriced by the market, because the loss upon conversion is contractually specified and is therefore less likely to be overestimated by investors. Moreover, PWD CoCos are 100% fixed income securities, which are more straightforward to value and which have greater appeal to institutional investors specializing in fixed income securities.

The key predictions of the model about banks' propensities to issue CoCos are as follows. There is an inverse U-shaped relation between the issuing bank's incentives to issue a CoCo and the bank's equity capitalization. When the bank's capitalization is very low, its shareholders have little incentive to issue CoCos, especially MC CoCos, since most of the benefits of the CoCo issue go to senior unsecured debt holders and not equity holders. When the bank's capitalization is very high, it has no need to raise costly equity, whether in the form of CoCos or common stock. It is mostly for intermediate equity capitalization levels that equity holders have an incentive to issue CoCos, for then equity holders, along with senior unsecured debt holders, benefit from the CoCo issue by avoiding a future costly recapitalization in a crisis.

The model analysis also delivers the following predictions about CoCo-issuing banks' incentives to engage in excess risk taking.[14] A sufficiently dilutive MC-CoCo contract mitigates bank shareholders' incentives to engage in excess risk-taking, as they would bear a cost as a result of CoCo conversion following the realization of a loss. This effect is stronger for CoCos with higher conversion triggers. In contrast, PWD-CoCos encourage bank excess risk-taking by decreasing the size of the losses for bank shareholders in the crisis state.

Finally, the model delivers key predictions about the effect of CoCo issuance on the value of the bank's other claims. First, CoCo issuance, whatever its design, should increase the recovery value of senior unsecured debt, and therefore lower the bank's CDS spreads. However, there is no such clear prediction for the issuing bank's share price. The reason is that the decision to issue a CoCo conveys a "mixed" signal about the health of the issuer's balance sheet. If the market prior is that the issuer has a very strong balance sheet, then the issuance of a CoCo is bad news, but if the market prior is that the bank is undercapitalized, then the issuance of a CoCo is good news. The formal analysis considers a situation where the issuer may be of three different types: (i) poorly capitalized banks that become insolvent upon the realization of a loss, (ii) adequately capitalized banks that require recapitalization upon the realization of a loss, and (iii) well capitalized banks that do not require a recapitalization upon the realization of a loss. As we pointed out above, our model predicts that poorly and well capitalized banks should have no incentives to issue a CoCo. Thus, an announcement of a CoCo issue can trigger a positive or a negative stock price reaction, depending on the prior beliefs about the distribution of bank types in the economy.

[14] Our analysis on risk-taking incentives aligns with the literature reviewed in Section 3.2.

4 Empirical Analyses

We conduct two main sets of empirical exercises. First, we perform duration analyses in order to investigate the main determinants of the propensity of a bank to issue a CoCo. Second, we estimate of the impact of CoCo issuance on the CDS spread and the stock price of the issuing bank, as well as the differential effects of the main CoCo contract features.

In both of our benchmark empirical analyses, we focus on CoCos classified as liabilities and issued by banks from advanced economies. We do not include CoCos issued by banks from EMEs since the considerable degree of heterogeneity in the timing of the Basel III implementation among EME jurisdictions could introduce a significant amount of noise in the empirical analyses. We do not include CoCos classified as preferred shares in our benchmark empirical analyses for a couple of reasons. First, as discussed above, CoCos that are classified as preferred shares are exempt from the requirement to have a mechanical trigger with a minimum level of 5.125% in order to be eligible to qualify as AT1 capital. This makes such CoCos considerably different from AT1 CoCos classified as liabilities. Second, CoCos classified as preferred shares are concentrated in a very small number of jurisdictions and represent a tiny fraction of our overall sample.

4.1 Determinants of CoCo Issuance

The first question we analyze concerns banks' propensity to issue CoCos. We focus on an "unconditional" sample of banks that could be potential CoCo issuers. We restrict the sample to the top 500 banks (ranked by total assets in 2009) in the set of CoCo-issuing advanced economies, plus all the CoCo issuers from advanced economies that are not among the top 500. The resulting sample includes a total of 523 banks.

We take January 2009 as the beginning of our sample period and track CoCo issuance of all the banks in our sample until December 2015.[15] For our first question, we estimate the expected duration from January 2009 until the time when a bank with given characteristics issues a CoCo for the first time. We perform several duration analyses that are reported in Table 2. The first set of results, reported in Panel A, is from a two-sided Tobit regression of *time to issue* in the cross-section, the number of months from January 2009 to the time of the first CoCo issue, as a function of key bank balance sheet characteristics. The duration, by construction, is bounded from below at zero. For the non-issuers, the time of the first CoCo issue is coded as being censored at the end of the sample period.

[Insert Table 2 here.]

The independent variables we focus on are: (i) *total assets* (in logs); (ii) *Tier 1* (Tier-1 capital); (iii) *G-SIB* (a dummy variable for G-SIB status); (iv) *gross loans*; (v) *deposits*; (vi) *trading Securities;* and (vii) *long-term funding.* All variables, except *total assets,* are scaled by total assets and expressed as percentage points. All bank characteristics are measured at the beginning of the sample period, in January 2009. We break down *deposits* into *customer deposits* and *bank deposits* on the grounds that the risk profile of banks with mostly customer deposits is likely to be significantly different from that of banks with mostly bank deposits. We also track interbank lending on both the liability and asset sides through the variables

[15] CoCos were only beginning to be considered as a financing option by banks in 2009.

interbank borrowing and *interbank assets.*

Our main findings are as follows. First, the coefficient on *total assets* is negative and significant for all specifications. Note that a positive coefficient indicates a longer delay to issuance, or a *low* propensity to issue, so that our first result implies that larger banks are quicker to issue CoCos over our sample period. This confirms the anecdotal evidence that smaller banks take longer to test the market for new financing vehicles.[16]

Second, the coefficient on *Tier 1* is negative and statistically significant in most specifications. Recall that our theoretical prediction is that inadequately capitalized banks are less likely to issue CoCos. Based on the coefficient in column (1), a one-percentage-point increase in Tier 1 capital (including CET1 and AT1, with an average ratio of 7.0% in 2009) is associated with a 3.8-month shortening in the time to issuance, out of a sample average of *55.7* months (from January 2009) for all issuers. To take into account the potential non-monotonicity in the relation, we add the square of the variable *Tier 1* (or $Tier$ 1 ˆ 2), in specification (3). Although the coefficient on the squared term is negative, it is insignificant. This is likely due to the fact that the increasing regulatory benchmark during our benchmark window implied issuance needs for most banks. As a consequence, hardly any banks in our sample were in an "extremely well funded" state, which prevented the non-monotonicity in the theoretical model from taking effect.

Third, on the asset side of bank balance sheets, the coefficients on both *gross loans* and *trading securities* are negative and significant. A higher value of the *trading securities* variable is typically interpreted as an indication of greater risk-taking by a bank (Roengpitya

[16] See, e.g., "Coco bonds: Mass conversion," *Economist,* September 13th, 2014.

et al, 2014). Every percentage point increase in *trading securities* (with an average of 17.8%) predicts a 0.9 months shortening of the expected duration to first issuance.

Fourth, on the liability side, deposits are commonly considered to be a reliable and sticky source of bank financing, as opposed to wholesale funding which is more sensitive to changes in interest rates and more prone to "runs" in response to negative information about bank profitability. Indeed, Huang and Ratnovski (2011) suggest that wholesale funding was one of the major sources of bank vulnerability during the financial crisis. Consistent with their analysis, we find that banks that are predominantly financed by deposits are significantly (at the 5% level) less likely to issue CoCos. The coefficient of 0.810 for *deposits* suggests that for every 10-percentage point increase in deposits relative to total assets, a bank waits on average 8.1 more months before issuing its first CoCo. Further breaking down *deposits* into *customer deposits* and *bank deposits,* we observe that both elements are highly significant.

Finally, column (5) in Panel A shows that an increase in *interbank assets* has no significant effect, but that banks more reliant on *interbank borrowing* are significantly less likely to issue CoCos. In the interbank market, a few banks tend to play the role of market makers by channeling the excess deposits of, usually smaller, banks that do not have access to lending opportunities to medium-sized and larger banks that have ample lending opportunities (Fecht et al., 2011).

Panel B of Table 2 reports the estimates of a Cox (1972) proportional hazards analysis of banks' propensity to issue CoCos in each month during our sample period of January 2009 to December 2015. Here a higher coefficient means a higher probability of issuing a first CoCo in a given month, conditional on no-issuance until the previous month. Each coefficient, once exponentiated, could be interpreted as an "odds ratio" of issuance by a bank in a given month.

The results of the Cox hazards analysis mostly reinforce those reported in Panel A: larger banks, as well as banks with more loans and marketable securities are more likely to issue a CoCo. The opposite is true for banks with more deposits and more interbank borrowing. Note, however, that Tier 1 capital adequacy no longer matters at the monthly frequency, except when both *Tier 1* and (*Tier 1)^2,* are included as regressors, suggesting that the negative relation between core capital and propensity of CoCo issuance is most prominent among banks with low levels of *Tier 1* capital.

Panels C and D of Table 2 break down CoCo issuance into PWD CoCo and MC CoCo issues at the bank-month level using the Fine and Gray (1999) competing risk model. Under this model, the first issue of a CoCo with a particular loss-absorbing mechanism (PWD or MC) is considered the realization of one type of risk, with the other possible form of loss-absorbing mechanism interpreted as a "competing risk." Accordingly, this model estimates the propensity to issue a particular type of CoCo instrument, taking into account that another type of CoCo is also available in the issuer's choice set.

A finding that emerges from this analysis is that *total assets* and *Tier 1* tend to be more consistently significant for PWD CoCos. This finding is consistent with our theoretical prediction that CoCos are issued when they primarily benefit shareholders, but not when they primarily benefit senior unsecured debt investors. The larger banks, and the better capitalized banks, are likely to be more resilient in a crisis. For these banks there is therefore a low credit risk associated with their senior unsecured debt, and hence a low debt overhang problem. In other words, most of the potential benefits of a CoCo issue go to incumbent shareholders, who tend to benefit more from a PWD CoCo issue than from an MC CoCo issue, since the latter has the potential to dilute the value of their shares upon conversion.

4.2 Impact of CoCo Issuance on Senior Unsecured Debt and Equity

4.2.1 Empirical set-up

The issuance of a CoCo can affect the CDS spread of the issuing bank through two main channels. First, it reduces the probability of default by providing an additional layer of loss-absorbing capacity.[17] Second, issuing a CoCo affects the risk-taking incentives of the bank's management and equity holders, which can alter the probability of default and thereby have an impact on the riskiness of senior debt. While the second effect could go in either direction depending on the main CoCo design features, the first effect should be weakly beneficial for banks' senior debt holders. Overall, CoCo issuance is expected to lower CDS spreads, as our theoretical analysis suggests.

As we explain in Section 3.4, the effect of issuing a CoCo on the issuer's stock price is more difficult to determine, a priori. However, the relative effect of different CoCo designs on the issuer's stock price is easier to pin down. Given that PWD CoCos do not have any

[17] As discussed in the Introduction, our analysis is based on the implicit assumption that CoCos are issued on top of (rather than instead of) CET1.

negative equity dilution effects, we expect to see a more positive stock price response to the issuance announcement of a PWD CoCo than to an MC CoCo.

We assess the announcement effect of issuing CoCos on CDS spreads and equity prices using two different empirical approaches. First, we follow the estimation methodology used in James (1987) to determine the impact of CoCo issuance. In addition to assessing the overall effect, we also examine how it depends on the main CoCo contract features (loss absorption mechanism, trigger type, trigger level, etc.) and on issuer characteristics (size, capital cushion over trigger level, G-SIB status, geographical location, etc.).[18] Second, we estimate the impact of CoCo issuance on CDS spreads and equity prices in a standard cross-sectional regression framework.

The event date for CoCo issuance is not always clearly defined. Unlike in other event studies, where all relevant information is simultaneously announced to all market participants at a clearly defined point in time, for CoCo issues there is no single point in time when an upcoming issue is publicly announced. Instead, information about an upcoming issue spreads among market participants in a diffusion-like process. According to market participants, the information about the intention of a bank to issue a CoCo is revealed to a small group of potential buyers over the two weeks prior to the date of the issuance. As the book is built, the information is likely to diffuse to a wider set of investors and to be incorporated into equity prices and CDS spreads prior to the actual date of the issue. Still, the issue date often reveals additional value-relevant information, such as the over-subscription status of the issue.

[18] Appendix A contains a detailed description of the estimation methodology.

Due to the above reasons, we adopt a conservative approach in selecting the event date and the window size for our benchmark exercise. More concretely, when measuring the impact of CoCo issuance on CDS spreads, we select an 11-day window (in units of trading days), which starts ten business days before the issuance date (t-10) and ends at the issuance date (t): [t-10, t]. When measuring the impact on equity prices, we select a shorter, six-day window, which starts five business days before the issuance date (t-5) and ends at the issuance date (t): [t-5, t]. We select a shorter event window for equity prices than for CDS spreads since the former tend to be more informationally sensitive than the latter. As a result, equity prices are more likely than CDS spreads to have their reaction to CoCo issuance be "contaminated" by other information that is revealed during the event window.[19]

4.2.2 Impact on bank CDS spreads

We estimate the change in issuers' CDS spreads (on senior unsecured debt) around CoCo issuance dates. Table 3 reports the results of this estimation.

[Insert Table 3 here.]

Our main finding is that the overall impact of CoCo issuance on the CDS spread of the issuing bank is negative and strongly statistically significant. The z-value (□2.70) indicates that the cumulative change vis-à-vis the benchmark during the 11-day event window is negative and statistically significant at the 1% level.[20]

[19] We also conduct robustness checks, in which we explore a number of alternative window sizes and event dates. While we do not report those results in the paper due to space constraints, all of them are available upon request.

[20] The second statistic we examine is the proportion of negative prediction errors. It has a value of 57% and is statistically significant at the 5% level by the Wilcoxon signed rank statistic.

The economic significance is also meaningful. The average prediction error (APE) for the full sample is approximately 3 bps. Once prediction errors are weighted by the (US dollar) volume of each issue, the estimated impact increases to 5 bps. This implies that issuing a CoCo reduces the annual interest costs associated with each $10 billion of (non-CoCo) bank debt by $5 million. Furthermore, the estimated economic impact varies considerably across CoCo sub-groups, ranging from 2 to 22 bps.

We next break down the full sample into subsamples sorted by the most important CoCo contract terms and issuer characteristics. Our first sorting variable is the loss absorption mechanism (mandatory conversion or principal write-down). In line with the predictions of Section 3.4, the impact of mandatory conversion (MC) CoCos on CDS spreads tends to be considerably stronger than the impact of principal write-down (PWD) CoCos. The estimated impact of MC CoCo issuance is negative and statistically significant at the 1% level (with a z-value of -3.07). Roughly two-thirds (63%) of the prediction errors in the MC CoCo subsample have a negative sign and the Wilcoxon signed rank statistic is statistically significant at the 1% level. The coefficient for the impact of PWD CoCo issuance has the right (negative) sign, but it is not statistically significant (according to both, the z-statistic and the Wilcoxon signed rank statistic).

In economic terms, the size of the estimated impact of MC CoCo issuance on CDS spreads is also considerably larger than the impact of PWD CoCo issuance. The simple average prediction error for MC CoCos (-5.0 bps) is roughly three and a half times higher than that for PWD CoCos (-1.4 bps). When we weight prediction errors by the size of each respective CoCo issue, the estimated impact of issuing MC CoCos is -8.4 bps, whereas the impact of issuing PWD CoCos is -2.4 bps.

The significant differences between the estimated impacts of issuing MC CoCos and PWD CoCos on the CDS spread of the issuing bank points in particular to the potential importance of the loss absorption mechanism for banks' risk-taking incentives. The MC feature increases the cost of risk-taking for current shareholders and management due to the threat of equity dilution. But, no such costs are imposed by PWD CoCos. On the contrary, PWD CoCos actually increase the risk-taking incentives of shareholders, as PWD CoCo holders could absorb losses ahead of shareholders. Thus, in the case of PWD CoCos, the risk-taking incentive effect works in the opposite direction of the loss absorption effect (which has a negative impact on CDS spreads for both loss absorption mechanisms). In contrast, the two effects reinforce each other in the case of MC CoCos.

A second major finding is that the presence of a mechanical trigger in CoCo term sheets plays a very important role. The estimated impact of issuing a CoCo with a mechanical trigger is negative and statistically significant at the 5% level (with a z-value of -2.22). That subsample of CoCos has an average prediction error of -3.3 bps and weighted average prediction error of -4.8 bps. In contrast, the estimated impact of issuing a CoCo that only has a discretionary trigger, while also negative, is not statistically significant.

There are a number of explanations for this key finding. CoCos with only a discretionary trigger are more akin to pure "gone concern" instruments and inherit all the uncertainties associated with regulatory intervention in a bank resolution. At what point will the CoCo be triggered? What happens in resolution? Will the CoCo be totally or partially wiped out? Will it be the only debt instrument to be bailed in? All of these uncertainties compound to make the valuation of the CoCo and assessing the impact of the CoCo issue on the value of senior unsecured debt very difficult. In contrast, CoCos that also have a mechanical trigger combine features of both "gone concern" and "going concern" instruments. As a consequence, such CoCos are likely to absorb losses earlier, which is desirable from the perspective of senior unsecured bondholders.

The level of the mechanical trigger is also important for the CDS market reaction. The estimated impact of issuing CoCos with a high trigger (above the minimum trigger for AT1 classification of 5.125%) on CDS spreads is negative and statistically significant at the 10% level. The estimated impact of CoCos with a low trigger (less than or equal to 5.125%) is also negative, but is not statistically significant. CoCos with a high trigger are closer to "going concern" CoCos, as they are more likely to convert before the PONV than low-trigger CoCos. Thus, they provide higher-quality protection to unsecured bondholders of the CoCo-issuing bank.

A third major result is that the impact of CoCo issuance on CDS spreads is affected by the interaction of the main CoCo design features. Namely, MC CoCos with a mechanical trigger have a negative and statistically significant impact, whose magnitude (-6.2 bps) is greater than those of the respective one-dimensional subcategories (MC CoCos and CoCos with a mechanical trigger). This implies that the above two characteristics interact with each other to boost the impact of CoCos on CDS spreads. Intuitively, the combination of reduced risk-taking incentives (associated with the MC feature) and automatic loss absorption (associated with the mechanical trigger feature) provide the greatest degree of protection for senior unsecured debt holders. Meanwhile, the impact of MC CoCos with a discretionary trigger is also negative, but it is only statistically significant at the 10% level and its magnitude (−1.5 bps) is considerably smaller.

A fourth important finding is that the size of the CoCo issue (as a share of RWA) also matters. Large CoCo issues have a negative and statistically significant (at the 5% level) impact on CDS spreads, but small issues have no statistically significant effect. The weighted average impact on the issuing bank's CDS spread is considerably higher for relatively larger issues (−7.2 bps) than for relatively smaller issues (−1.7 bps). This is not surprising. The larger the issue, the thicker the layer of protection that CoCos provide to the senior unsecured bondholders. Moreover, the fact that the bank was able to place a relatively large issue in itself reveals that investors have confidence in the overall healthiness of the bank.

The regulatory classification of CoCo instruments also plays an important role. AT1 CoCos have a negative and highly significant (at the 1% level) impact on CDS spreads. In contrast, the impact of T2 CoCos is insignificant. The weighted average prediction error for AT1 CoCos is −6.7 bps, whereas that for T2 CoCos is only −0.4 bps. Intuitively, the enhanced design features associated with the higher quality AT1 capital instruments provide better protection for the senior creditors of the issuing bank.

Our results also suggest that CoCo issuance tends to have a bigger effect on the CDS spreads of relatively smaller issuers. The impact of CoCos issued by banks with *total assets* of less than \$1 trillion is negative and statistically significant at the 1% level. In contrast, the impact of CoCo issuance on CDS spreads tends to be insignificant for banks whose *total assets* exceed \$1 trillion. Splitting banks according to their G-SIB classification generates similar results.[21] That is, the impact of CoCos issued by banks that are not classified as G-SIBs is highly significant while the impact of CoCos issued by G-SIBs is not statistically significant. This latter finding could be interpreted as indicating that market participants believe that only G-SIBs benefit from an implicit government guarantee.

We turn next to the results of our cross-sectional regression analysis of the impact of CoCo issuance on CDS spreads. These results, reported in Table 4, are in line with the results obtained using the James (1987) methodology.

[Insert Table 4 here.]

The first set of cross-sectional regressions examines the effect of the loss absorption mechanism (Table 4, Panel A). In line with the results obtained using the James (1987) methodology, the main finding is that the impact of MC CoCo on CDS spreads is much more negative and significant than that of PWD CoCos (specification (1)). In the baseline specification, the impact of MC CoCos is negative and statistically significant at the 5% level. Once additional dummy controls are included, the impact of MC CoCos is still negative and statistically significant at the 5% level for AT1 instruments (specification (2)) and for repeat issuers (specification (4)). In contrast, the estimated impact of PWD CoCos is not

[21] For the latter data split, we classify CoCo-issuing banks according to their G-SIB status at the time of CoCo issuance (for G-SIB lists by year, see FSB (2016)).

statistically significant in any of the examined specifications.

The second set of results provides insights into the impact of the trigger type (Table 4, Panel B). In line with the results obtained using the James (1987) methodology, the impact of CoCos with mechanical triggers is negative and statistically significant at the 5% level (Column 1). In contrast, the impact of CoCos that only have a discretionary trigger is not statistically significant. The negative impact of mechanical-trigger CoCos appears to be stronger for non-G-SIBs (Column 2) and for repeat issuers (Column 3). In sum, CoCos are most likely to be beneficial to senior unsecured bondholders if their automatic loss-absorption feature is combined with a thicker layer of protection (as in the case of repeat issuers) or with an issuer that is not systemically important (as in the case of non-G-SIBs). The last regression in Panel B examines two-dimensional splits of the main CoCo design features (Column 4). They indicate that the impact of MC CoCos with a mechanical trigger (MC/MT CoCos) is negative and statistically significant at the 5% level. The impacts of the other three CoCo types (MC/DT, PWD/MT, PWD/MT) are also negative, but not statistically significant.

The third set of regressions investigates the effect of changing the level of the mechanical trigger (Table 4, Panel C). The estimates from the baseline specification indicate that both high-trigger and low-trigger CoCos have a negative impact, which is statistically significant at the 10% level (Column 1). The specifications with additional dummy controls reveal that the high-trigger CoCos of repeat issuers have a negative and strongly statistically significant (at the 1% level) impact (Column 3). In contrast, the impact of repeat issuers' low-trigger

CoCos is statistically significant only at the 10% level. Interestingly, the impact of first-time issuers' CoCos is not statistically significant, regardless of the trigger level. One possible explanation for these results is that the early loss absorption feature of high-trigger CoCos has a larger impact for repeat issuers, since they increase the size of the already existing layer of protection that CoCos provide for senior unsecured debt, making CoCos a more potent loss absorption tool. This hypothesis is further supported by the fact that the coefficient on the issued CoCo amount (as a share of RWA) in the same regression specification is negative and statistically significant.

4.2.3 Impact on bank equity prices

Our theoretical analysis does not yield clear-cut predictions on the effects of CoCo issuance on equity prices. That said, we should expect PWD CoCos to have a more positive effect on stock price than MC Cocos, all else equal, because they are more protective of shareholders.

Table 5 reports the results using the same methodologies as in Table 3, but replacing CDS spreads with stock prices as an independent variable. For the overall sample, the impact of CoCo issuance is not statistically significant. This most likely reflects the same ambiguity that we discuss in our theoretical predictions. The results for the one-dimensional subsample splits along the main CoCo design features (loss absorption mechanism, trigger type, trigger level) are also insignificant.

[Insert Table 5 here.]

The two-dimensional subsample splits generate the most interesting results for the impact of CoCo issuance on equity prices. The most important finding is that issuing a PWD CoCo with a high trigger has a positive and statistically significant (at the 5% level) impact on the equity price of the issuing bank. The combination of (i) the early loss absorption feature associated with high-trigger CoCos and (ii) the fact that PWD CoCo holders absorb losses ahead of equity holders appears to explain this result. Conversely, the impact of high-trigger MC CoCos on equity prices is negative, albeit not statistically significant. A likely explanation for this result is that the effect of possible dilution of equity holders may be (partially) offset by the effect of owning shares in a bank that is better capitalized and more stable as a result of the CoCo issuance. The fact that the estimated impact of high-trigger MC CoCos goes in the opposite direction to that of high-trigger PWD CoCos also explains why the overall impact of high-trigger CoCos (from the one-dimensional sample splits) is insignificant.

Finally, we examine the impact of CoCo issuance on equity prices in cross-sectional regressions. The main results, which are presented in Table 6, are in line with the ones obtained using the James (1987) methodology. When examined on a stand-alone basis, the main CoCo design features (loss absorption mechanism, trigger type, trigger level) do not have a statistically significant impact on equity prices.

[Insert Table 6 here.]

The regression specifications that include two-dimensional (CoCo design feature) dummies generate the most interesting and statistically significant results (Columns 1-3). Just as for the estimates generated using the James (1987) methodology, the cross-sectional regression coefficients imply that the impact of PWD CoCos with a high trigger on equity prices is positive and statistically significant (at the 5% level). Furthermore, the impact of PWD CoCos with a mechanical trigger is also positive and statistically significant (Columns 4-5). However, its estimated magnitude is somewhat smaller than the one for PWD CoCos with a high trigger. Thus, the positive impact of PWD CoCos on stock prices appears to be present for all PWD CoCos with a mechanical trigger. Nevertheless, it is stronger for high-trigger PWD CoCos (which absorb losses relatively early) than for low-trigger PWD CoCo (which absorb losses relatively late).

5 Conclusion

Overall, our analysis indicates that CoCos can contribute to reducing bank fragility. The CoCo market is no longer a small niche market. Although CoCos are deemed to be complex by many commentators, possibly too complex for retail investors, there appears to be a sufficiently large institutional investor clientele that stands ready to hold them. One reason why CoCos are perceived to be so complex is that there is a great variety of CoCo designs, as we have shown. What is more, the designs that have been chosen by issuers are quite different from those recommended by the large theoretical literature on CoCos (e.g., Albul et al (2016), Chen et al (2017), Glasserman and Nouri (2016), Pennacchi and Tchistyi (2016a, 2016b), Chan and van Wijnbergen (2016)).

The change in the mix of CoCo designs is primarily driven by a combination of experimentation, issuer incentives and investor demand. Now that the CoCo market is reaching maturity, it is important to find out which designs are desirable and which ones are not from a financial stability point of view, as well as where CoCo design can possibly be simplified with a view to standardizing this market.

Our study provides a first set of answers to these questions. One of our important findings is the shift over time from MC to PWD CoCos. Our other results suggest that this shift is driven by shareholder preferences, as the announcement effect of PWD CoCos on stock price is positive. This shift is also driven by fixed income investor clienteles, who prefer to hold pure fixed income products rather than hybrids, other things equal.

But is this a desirable development from a financial stability perspective? We have shown that the issuance of MC CoCos has a stronger impact on CDS spreads, which may suggest that MC CoCos have a superior design from the point of view of reducing bank fragility. However, we have also shown that shareholder risk-taking incentives tend to be stronger for instruments with PWD features. This points to a trade-off in terms of the combined effects of contractual features and overall issuance volumes for financial stability that any efforts to standardize CoCo instruments would have to take into account. Other potential avenues for standardization include: (i) reconsidering the benefits of CoCos with only discretionary triggers; (ii) requiring higher triggers, so that CoCos are more like "going concern" than "gone concern" instruments; (iii) revisiting the merits of T2 CoCos; (iv) considering whether to increase CoCo requirements with the goal of increasing their overall loss-absorbing capacity.

We have explored only a subset of questions on the effects of CoCos on issuing banks' balance sheets. An important open question for the immediate future concerns the investor clientele of CoCos. Unfortunately, the lack of information on the buy side makes it difficult to know the distribution of CoCo holdings and assess whether CoCos reduce rather than redistribute risks in the banking system. CoCos would enhance the stability of issuing banks and the banking system at large only if the holders of CoCos were long-term investors unconnected to the banking system.

References

[1] Admati, Anat, Peter DeMarzo, Martin Hellwig, and Paul Pfleiderer, 2013. Fallacies, irrelevant facts and myths in the discussion of capital regulation: Why bank equity is not expensive. Unpublished working paper.

[2] Albul, Boris, Dwight M. Jaffee, and Alexei Tchistyi, 2016. Contingent convertible bonds and capital structure decisions. Unpublished working paper.

[3] Alessandri, Piergiorgio, and Andrew Haldane, 2009. Banking on the State. Bank of England, 9 November 2009.

[4] Avdjiev, Stefan, Anastasia Kartasheva, and Bilyana Bogdanova, 2013. CoCo: A primer. BIS Quarterly Review, September.

[5] Basel Committee on Banking Supervision, 2011. Basel III: A global regulatory framework for more resilient banks and banking systems, June 2011.

[6] Bolton, Patrick, and Frederic Samama, 2012. Capital access bonds: Contingent capital with option to convert, Economic Policy 27, 275-317.

[7] Bolton,Patrick, Hamid Mehran, Joel Shapiro, 2015. Executive compensation and risk taking. Review of Financial Studies 6, 2139–2181.

[8] Bond, Philip, Itay Goldstein and Edward Simpson Prescott 2010. Market-based corrective actions. Review of Financial Studies 23, 781–820.

[9] Bulow, Jeremy and Paul Klemperer, 2014. Equity recourse notes: Creating countercyclical bank bapital. Unpublished working paper.

[10] Caballero, Ricardo and Pablo Kurlat, 2008. The Surprising' Origin and Nature of Financial Crises: A Macroeconomic Policy Proposal. 2008 Economic Symposium, "Maintaining Stability in a Changing Financial System." Federal Reserve Bank of Kansas City.

[11] Calomiris, Charles W., and Richard J. Herring, 2011. Why and how to design a contingent convertible debt requirement. Unpublished working paper.

[12] Chan, Stephanie, and Sweder van Wijnbergen, 2016. Coco Design, Risk Shifting and Financial Fragility. Unpublished working paper.

[13] Chen, Nan, Paul Glasserman, Behzad Nouri, and Markus Pelger, 2017. Contingent capital, tail risk, and debt-induced collapse. Review of Financial Studies, forthcoming.

[14] Coffee Jr, John C, 2011. Systemic risk after Dodd-Frank: Contingent capital and the need for regulatory strategies beyond oversight. Columbia Law Review 111, 795–1878.

[15] Glasserman, Paul, and Behzad Nouri, 2016. Market-Triggered Changes in Capital Structure: Equilibrium Price Dynamics. Econometrica 84, 2113-2153.

[16] Cox, D. R., 1972. Regression Models and Life Tables. Journal of the Royal Statistical Society, Ser. B, 34, 187-220.

[17] Duffie, Darrel, 2009. Contractual methods for out-of-court restructuring of systemically important financial institutions. Submission requested by the US Treasury Working Group on Bank Capital, November 9.

[18] European Banking Authority (EBA), 2016. Report on the implementation and design of MREL framework, 14 December 2016.

[19] Faure-Grimaud, Antoine, 2002. Using Stock Price Information to Regulate Firms. Review of Economic Studies 69, 169 - 190.

[20] Fecht, Falko, Kjell G. Nyborg, and Jorg Rocholl, 2011. The price of liquidity: The effects of market conditions and bank characteristics. Journal of Financial Economics 102, 344-362.

[21] Financial Stability Board, 2016. 2016 list of global systemically important banks (G-SIBs), 21 November 2016.

[22] Financial Stability Board, 2015. Principles of loss-absorbing and recapitalization capacity of G-SIBs in resolution, 9 November 2015.

[23] Fine, J. and Gray, R., 1999. A Proportional Hazards Model for the Subdistribution of a Competing Risk. Journal of the American Statistical Association 94, 496–509.

[24] FINMA, 2015, New "too big to fail" capital requirements for global systemically important banks in Switzerland, Swiss Financial Market Supervisory Authority, October 21, 2015

[25] Flannery, Mark J., 2005. No pain, no gain? Effecting market discipline via reverse convertible debentures. In: Hal S. Scott (Ed.), Capital Adequacy Beyond Basel: Banking, Securities, and Insurance.

[26] Flannery, Mark J., 2016. Stabilizing large financial institutions with contingent capital certificates. Quarterly Journal of Finance 6, 1-26.

[27] Hillion, Pierre and Theo Vermaelen, 2004. Death spiral convertibles. Journal of Financial Economics 71, 381-415.

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

[29] Huang, Rocco, and Lev Ratnovski, 2011, The dark side of bank wholesale funding. Journal of Financial Intermediation 20, 248-263.

[30] James, Christopher, 1987. Some evidence on the uniqueness of bank loans. Journal of Financial Economics 19, 217-235.

[31] Kashyap, Anil K, Raghuram G Rajan, and Jeremy C Stein. 2008. Rethinking Capital Regulation. 2008 Economic Symposium, "Maintaining Stability in a Changing Financial System." Federal Reserve Bank of Kansas City.

[32] Martynova, Natalya, and Enrico Perotti, 2016. Convertible bond and bank risk-taking. Unpublished working paper.

[33] McDonald, R. 2013. Contingent capital with dual price trigger. Journal of Financial Stability 9, 230-241.

[34] Pennacchi, George, Theo Vermaelen, and Christian C.P. Wolff, 2014. Contingent Capital: The case of COERCs. Journal of Financial and Quantitative Analysis 49, 541–574.

[35] Pennacchi, George, and Alexei Tchistyi, 2016a. A Reexamination of contingent convertibles with stock price triggers. Unpublished working paper.

[36] Pennacchi, George, and Alexei Tchistyi, 2016b. On equilibrium when contingent capital has a market trigger: A correction to Sundaresan and Wang Journal of Finance (2015). Unpublished working paper.

[37] Perroti, Enrico, and Paul Glasserman, 2017. The uncovered CoCo bonds. Unpublished working paper.

[38] Raviv, Arthur, 2004. Bank stability and market discipline: debt-for-equity swap versus subordinated notes. Unpublished working paper.

[39] Roberts, Michael R. and Amir Sufi, 2009. Financial Contracting: A Survey of Empirical Research and Future Directions. Annual Review of Financial Economics 1, 207-226.

[40] Roengpitya, Rungporn, Nikola Tarashev, and Kostas Tsatsaronis, 2014. Bank business models. BIS Quarterly Review, December.

[41] Sundaresan, Suresh, and Zhenyu Wang, 2015. On the design of contingent capital with a market trigger. Journal of Finance 70, 881–920.

[42] Squam Lake Working Group on Financial Regulation (2010). An expedited resolution mechanisms for distressed financial firms: regulatory hybrid securities. Squam Lake working group, Council on Foreign Relations, April.

[43] Vallee, Boris, 2015. Contingent Capital Trigger Effects: Evidence from Liability Management Exercises. Unpublished working paper.

[44] Zeng, Jing, 2013. Contingent Capital Structure. Unpublished working paper.

6 Appendix A: Impact of CoCo Issuance - Empirical Methodology

We conduct our empirical analysis of the impact of CoCo issuance on CDS spreads and equity prices in two steps.

In the first part, we employ the event methodology used in James (1987). The prediction error associated with CoCo instrument j on day t is defined as:

$$PE_{jt} = R_{jt} - (\alpha_j + \beta_j R_{mt}),$$

where R_{jt} is the equity return or the change in the CDS spread on day t of the bank that has issued CoCo instrument j; R_{mt} is the return on the benchmark equity or CDS index on day t; α_j and β_j are the estimated coefficients from a CAPM over an estimation period of 200 business days that excludes the 40 business days centered around the event date.

The cumulative prediction error (CPE) of CoCo instrument j over an event window $(t_0 - T, t_0)$ is given by:

$$CPE_j = \sum_{t=t_0-T}^{t_0} PE_{jt},$$

and the average cumulative prediction error (ACPE) over a sample of CoCo instruments of size N is:

$$ACPE = \frac{1}{N}\sum_{j=1}^{N} CPE_j.$$

Tests of statistical significance are based on cumulative standardized prediction errors

(CSPE) over the event window $(t_0 \square T, t_0)$ that account for the number of days in the estimation period and the length of the event window so as to control for the increase in variance from prediction outside the estimation period. The cumulative standardized prediction error for bank j over the event window $(t_0 \square T, t_0)$ is defined as:

$$CSPE_j = \sum_{t=t_0 \square T}^{t_0} \frac{PE_{jt}}{S_{jt}},$$

where

$$S_{jt} = \left[TV_j^2 \left[1 + \frac{1}{M} + \frac{(R_{mt} \square \bar{R}_m)^2}{\sum_{i=1}^{M} (R_{mi} \square \bar{R}_m)^2} \right] \right]^{\frac{1}{2}}$$

and M is the number of business days in the CAPM estimation, V_j^2 is the variance of the residual in CoCo instrument j's CAPM regression and $\bar{R}_m$ is the mean market return over the estimation period.

The average cumulative standardized prediction error (ACSPE) over the event window $(t_0 \square T, t_0)$ is:

$$ACSPE = \frac{1}{N} \sum_{j=1}^{N} CSPE_j.$$

Assuming the individual prediction errors are independent across instruments, the Z statistic

$$Z = \sqrt{N}(ACSPE)$$

is distributed as $N(0, 1)$ under the null hypothesis that the average cumulative standardized prediction error equals 0.

In the second part of our empirical examination of the impact of CoCo issuance on CDS spreads and equity prices, we estimate multivariate cross-sectional regressions. More precisely, we focus on the following specification:

$$CPE_j = \alpha_j + \beta_j X_j, +u_j,$$

where CPE_j are the cumulative prediction errors (defined above) over the event window $(t_0 \square T, t_0)$ and X_j is a set of characteristics of the instrument and the issuing bank. More concretely, we focus on the main CoCo contractual features such as the loss absorption mechanism, the trigger type, and the trigger level. In order to properly account for multiple issuance by a single bank over the sample period, we use clustered regressions, assuming that the errors are independent across banks, but allowing them to be correlated within banks.

Appendix B: A simple analytical framework

The model

It is helpful to consider the incentives of a bank to issue a CoCo in a simple formal analytical framework. The formal analysis can also clarify the effects of the CoCo issuance on the value of other bank's claims and its incentives to take risk.

We take as given the balance sheet of the bank at date 0, and we consider a two-period model. On the asset side, the bank has assets in place with book value A. Except for an aggregate risk exposure with two states of the world–a crisis state and a boon state–these are well diversified assets. They yield positive earnings π at $t = 1$ in the boon state, which occurs with probability $(1 - \theta)$, and a positive loss l in the crisis state with probability θ. Under risk-neutral preferences (or probabilities) the ex-ante market value of the bank's assets is then

$$A[1 + \pi - \theta(l + \pi)].$$

On the liability side, the bank has deposits with face value D and senior unsecured debt with face value B. The bank's equity is therefore given by $E = A[1 + \pi - \theta(l + \pi)] - D - B$, and its equity to capital ratio is

$$\kappa_0 = \frac{E}{A[1 + \pi - \theta(l + \pi)]}.$$

We denote the required capital ratio by $\overline{\kappa}$ and take it that $\kappa_0 \geq \overline{\kappa}$, but that, following a loss at date 1, the bank may be in a situation where $\kappa_1 < \overline{\kappa}$.

At date 0, the bank can issue a CoCo instrument with face value C and a capital-ratio trigger $\tilde{\kappa}$, with $\overline{\kappa} \leq \tilde{\kappa} < \kappa_0$. Should the bank's equity-capital ratio fall below a trigger $\tilde{\kappa}$, the CoCo instrument reduces bank debt and improves the bank's equity-capital ratio by either converting into equity or through a principal write-down.

Consider first how conversion to equity CoCos (*MC-CoCos*) work. These instruments stipulate that the investor gets a fraction $\alpha > 0$ of the bank's equity when the bank's equity-capital ratio falls below $\tilde{\kappa}$, and receives the coupon payment P when the capital ratio is above $\tilde{\kappa}$. We shall restrict attention to situations where the CoCo trigger may be breached only if the bank incurs a loss at date 1. In that state of the world the *pre-conversion equity value* is given by

$$E_l = A(1 - l) - (D + B + C)$$

and conversion is triggered if

$$\frac{E_l}{A(1 - l)} < \tilde{\kappa}.$$

Post conversion equity value is

$$E_{1c} = \max\{0, A(1 - l) - (D + B)\},$$

and CoCo holders receive a fraction α of this value. Old equity holders are *diluted* upon conversion by CoCo holders if and only if $E_{1c} > 0$ and

$$\alpha > \alpha_c = \frac{C}{E_{1c}}.$$

Note that if the terms of the MC-CoCo are such that equity holders are diluted, $\alpha > \alpha_c$, then the price of the MC-CoCo at date 0 is greater than the par value C.

In contrast, if $\alpha < \alpha_c$ then equity holders benefit from the conversion of CoCos, and CoCo-holders are negatively affected by conversion triggered by the loss l. In that case, the date 0 price of the MC-CoCo is less than the par value C.

Consider next principal write-down CoCos (*PWD-CoCos*). These instruments stipulate a principal and a coupon payment P as long as the bank's equity-capital ratio is above $\tilde{\kappa}$. Should the trigger $\tilde{\kappa}$ be breached, however, then the repayment terms are reduced to ηC, where $1 > \eta \geq 0$. By design, shareholders cannot be *diluted* by conversion of PWD-CoCo holders. On the contrary, shareholder value always increases upon conversion of a PWD-CoCo, and it is decreasing in η. Therefore, the price of a PWD-CoCo at date 0 is always less than the par value C. Note that PWD-CoCos can be viewed as a special case of MC-CoCos with $\alpha = 0$.

Determinants of CoCo issuance

The leading regulatory motivation for CoCos is the bail-in mechanism: conversion of a CoCo avoids a costly recapitalization at date 1, following the realization of the loss l. Consider this capital strengthening motivation for CoCos and suppose that

$$\frac{A(1-l)-(D+B)}{A(1-l)} < \overline{\kappa}.$$

Following the realization of a loss at date 1, the bank must then either be recapitalized or some of debt must be '*bailed in*'.

Going-concern CoCos and the recapitalization of a well-capitalized bank. First, we consider the case when the loss l is small enough that:

$$A(1-l)-(D+B) > 0.$$

That is, the bank can be recapitalized without any bail-in (as the *point of non-viability* or PONV has not yet been reached). To reduce the number of cases to consider, we also assume that B is large enough that

$$\frac{A(1-l)-D}{A(1-l)} > \overline{\kappa}.$$

Recapitalization of a bank that has not reached the PONV can be done by either (i) shrinking the bank's balance sheet, (ii) reducing debt or (iii) raising new equity. Suppose that the bank issues a CoCo in order to be able to reduce its senior unsecured debt in the loss state to the point $\hat{B}$ such that

$$\frac{A(1-l)-(D+\hat{B})}{A(1-l)} = \overline{\kappa}.$$

Let F denote the amount raised by the bank issuing an MC-CoCo at date 0, and suppose without loss of generality that the bank uses these proceeds to reduce its senior unsecured debt from B to $\hat{B} = B - F$, so that it is just able to meet its capital requirements following a loss in the crisis state.

Under Modigliani-Miller assumptions this MC-CoCo is worth

$$F = (1 - \theta)C + \theta\alpha[A(1 - l) - (D + B - F)],$$

or

$$F = \frac{(1 - \theta)C + \theta\alpha[A(1 - l) - (D + B)]}{1 - \theta\alpha}.$$

And (C, α) are such that

$$(D + B) - (1 - \theta)C = A(1 - l)(1 - \overline{\kappa}(1 - \theta\alpha)).$$

In a Modigliani-Miller world there are no issuance costs, so that all banks at risk of a future recapitalization would weakly prefer to issue a CoCo. In practice, however, banks face CoCo issuance costs that are given by a combination of underwriting fees and negative financial market reaction to the CoCo issue (the market may interpret issuance of a CoCo as a signal of financial weakness of the issuing bank). This can be modeled in a simple way by assuming that investors overestimate the true size of potential losses: When true losses are l, they believe the losses to be equal to Φl, where $\Phi > 1$. A CoCo issuer will then incur an expected issuance cost of:

$$\theta\alpha Al(\Phi - 1).$$

The bank compares the expected issuance costs of a CoCo to the alternative of recapitalizing the bank following a loss (to meet its minimum equity-capital constraint) through asset sales. The bank then sells Δ of its assets at a discounted (fire-sale) price $\lambda\Delta$, where $\lambda < 1$ and uses the proceeds to retire some of its senior unsecured debt B, so that its new equity-capital ratio becomes

$$\frac{A(1 - l) - (D + B - \lambda\Delta)}{A(1 - l) - \Delta} \geq \overline{\kappa}.$$

Such a recapitalization is also costly for shareholders, as they incur the fire-sale cost $(1-\lambda)\Delta$. The ex ante expected fire-sale costs are

$$\theta(1 - \lambda)\Delta,$$

where Δ is given by

$$\Delta = \frac{D + B - A(1 - l)(1 - \overline{\kappa})}{\lambda + \overline{\kappa}}.$$

The CoCo issuance cost is set against the expected benefit of avoiding a costly recapitalization in a crisis. Thus, shareholders of a well-capitalized bank are better off issuing a CoCo if:

$$\alpha Al(\Phi - 1) < (1 - \lambda)\left[\frac{D + B - A(1 - l)(1 - \overline{\kappa})}{\lambda + \overline{\kappa}}\right].$$

Issuing a CoCo is more attractive to shareholders, the less the CoCo issue is underpriced by the market, the lower the fraction of equity promised to CoCo investors upon conversion, and the higher the asset sales discount at the time of financial distress.

These predictions are broadly robust to the design of the CoCo instrument and also apply to PWD-CoCos. An important difference between an MC-CoCo and a PWD-CoCo for a bank issuer is that the latter is less likely to be undervalued by the market. First, the loss upon conversion is contractually specified and, therefore, less likely to be overestimated by investors. Second, a PWD-CoCo is a 100% fixed income security, which is more straightforward to value and which has greater appeal to institutional investors specializing in fixed income investments.

Gone-concern CoCos and recapitalization of a PONV bank. Next, we consider the case when the loss l is such that shareholders anticipate to be wiped out in the crisis state,

$$A(1 - l) - (D + B) \leq 0.$$

We assume that the restructuring then involves bail-in of the senior unsecured debt. In practice, there are many different ways of restructuring a PONV bank. Moreover, the restructuring burden will not necessarily be entirely borne by senior unsecured debt. Much of our analysis, however, is not affected by how a PONV bank is restructured. When shareholders anticipate a large loss l that wipes them out in the crisis state then they do not benefit from a CoCo issue. However, CoCo issuance may benefit the holders of senior unsecured debt.

The empirical predictions of the model about a bank's propensity to issue CoCos then depend on the design of the CoCo contract, and the ex-ante probability that the bank's losses are low enough that the bank remains a going concern, or that they are so high that the bank is a gone concern following the realization of the loss l. The better capitalized a bank is, the lower the probability that it could become a gone concern, and the stronger its shareholders' incentives to issue a CoCo, especially a PWD-CoCo. Shareholders of banks that anticipate reaching a PONV following the realization of the loss l, however, have no incentives to issue a CoCo.

CoCo issuance and bank's risk-taking incentives

Next we analyze how CoCo issuance affects banks incentives to engage in risk-taking activities. Consider the bank's incentive post CoCo issuance to invest in a project that has a mean return of zero but provides a positive return ρ in the boon state and a negative return $-$ in the crisis state,

$$\rho(1 - \theta) - \theta = 0.$$

Suppose that the loss $\hat{l}$ in the crisis state is such that

$$\frac{A(1 - \hat{l}) - (D + B)}{A(1 - \hat{l})} \geq \overline{\kappa}.$$

Would the CoCo issuer have an incentive to make the same bet as above if it now means that

$$\frac{A(1 - \hat{l} - \ ) - (D + B)}{A(1 - \hat{l})} < \overline{\kappa}?$$

Under an MC-CoCo the bank shareholders would have no incentive to take this risk if the CoCo is sufficiently dilutive. Furthermore, the incentives to engage in risk taking will be lower the higher is the trigger ratio at which the MC-CoCo converts into equity. In contrast, under a PWD-CoCo, the shareholders would have a strict incentive to take this bet as it would allow them to gain something both in the boon state (ρ) and in the crisis state ($B - \hat{B}$).

CoCo issuance and the value of other bank claims

The effect of a CoCo issue should be to lower credit default swap spreads, given that the probability of the worst outcome of a haircut imposed on senior unsecured debt is decreased by the CoCo issuance. It should also result in a (weak) increase in the value of senior unsecured bonds, given that the bank is better capitalized after the CoCo issue.

The predicted stock price reaction, however, is harder to pin down. CoCo issuance induces both a positive effect on the expected value of the bank (due to the lower risk of recapitalization at fire-sale prices) and a negative signaling impact about potential losses (when there is asymmetric information about the size of potential losses between the bank's managers and investors).

Consider the situation in which the bank may face three types of losses in a crisis, $l \in \{l_L, l_H, l_{HH}\}$. If expected losses in the crisis state are low, l_L, then the bank remains robustly capitalized even after incurring these losses

$$\frac{A(1 - l_L) - (D + B)}{A(1 - l_L)} \geq \overline{\kappa}.$$

If the losses are larger, l_H, then the bank will need to recapitalize in the midst of the crisis but its PONV is not reached,

$$0 < \frac{A(1 - l_H) - (D + B)}{A(1 - l_H)} < \overline{\kappa}.$$

And if the losses are very large, l_{HH},

$$\frac{A(1 - l_{HH}) - (D + B)}{A(1 - \hat{l})} < 0,$$

then the bank reaches the PONV.

Suppose that the bank is privately informed about its losses in the crisis, but investors do not know the true size of losses $l \in \{l_L, l_H, l_{HH}\}$. Investor beliefs are given by $p_L = \Pr(l = l_L)$, $p_H = \Pr(l = l_H)$, and $p_{HH} = \Pr(l = l_{HH})$. In addition, investors believe the losses to be equal to Φl, where $\Phi > 1$, when in fact they are only equal to l. The bank's managers do know the true value of l. The managers' remuneration is tied to the future share value of the bank so that their objective is to maximize the date 1 value of the bank's equity.

In this situation, the bank with losses l_{HH} or l_L has no incentives to issue a CoCo. In the former case, the CoCo issuance only benefits senior unsecured bondholders and has no value for shareholders, as their equity is wiped out in the crisis state. In the latter case, the bank does not face a risk of recapitalization in the crisis and would avoid a costly CoCo issuance.

A partially separating equilibrium may then be obtained at date 0 in which a bank-type with losses l_H issues a CoCo and bank-types l_L and l_{HH} do not. The announcement of the

CoCo can then trigger a positive or a negative stock price reaction depending on prior beliefs p_L and p_{HH}. If p_{HH} is large then the announcement of a CoCo issue is good news. The CoCo issuance signals that the bank's potential losses are smaller than originally expected,

$$l_H < \bar{l} = p_L l_L + p_H l_H + p_{HH} l_{HH}.$$

As a result, CoCo issuance triggers a positive stock price reaction. In contrast, if p_L is large and

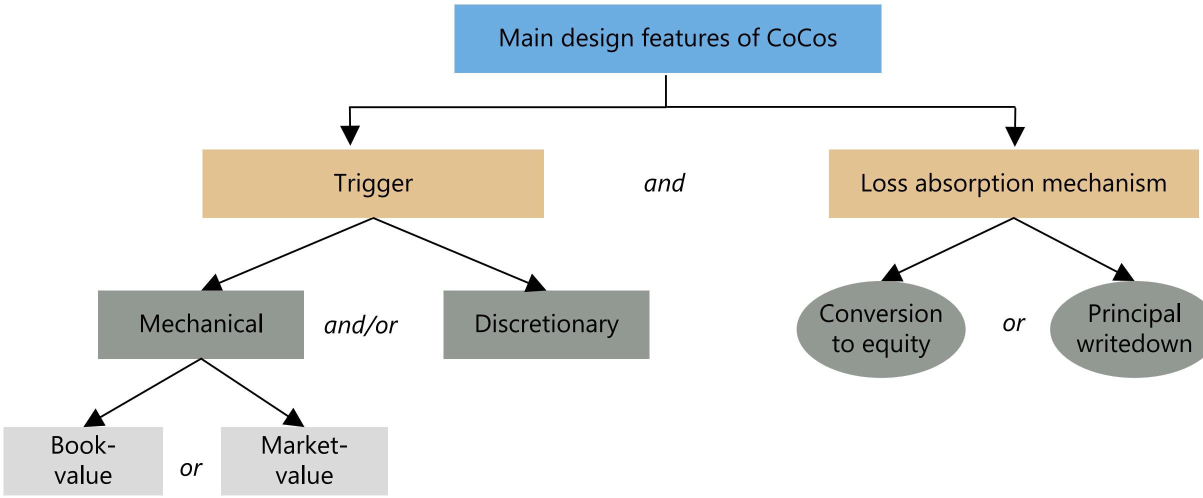
$$l_H > \bar{l},$$

then CoCo issuance is bad news. The announcement of the CoCo then triggers a negative stock price reaction, as losses in the crisis are revealed to be higher than expected. Note that in either case, the bank l_H has incentives to issue a CoCo to avoid a costly recapitalization.

To summarize, the announcement of a CoCo issue induces a positive reaction in credit markets. It reduces the bank's credit default spread and increases the value of senior unsecured debt. The impact of CoCo issuance on the stock price is indeterminate. A CoCo issue benefits banks with medium-sized losses and is not favored by banks with large or small losses. The stock price reaction can be either positive or negative depending on the prior distribution of losses for potential CoCo issuers.

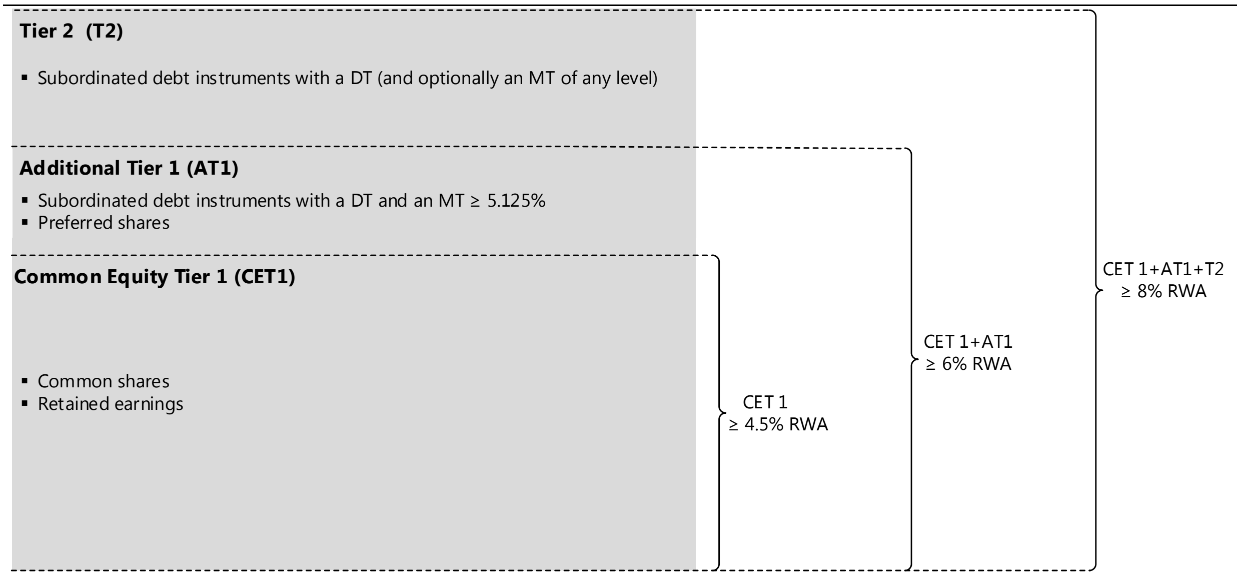
Structure of CoCos

Figure 1



CoCos' Position in Basel III Capital Requirements[1]

Figure 2

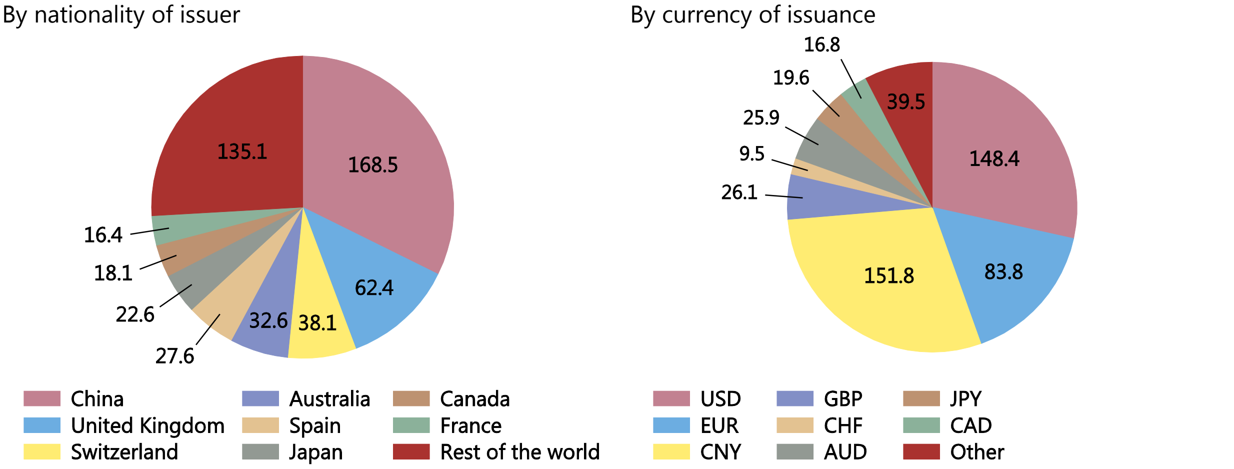


DT = discretionary trigger; MT = mechanical trigger.

[1] The list of instruments in this graph is not exhaustive and is included solely for illustrative purposes. For a complete list of instruments and the associated criteria for inclusion in each of the three capital buckets, see Basel Committee on Banking Supervision (2011). The above shares of risk-weighted assets (RWA) represent the bare minimum capital requirements and do not account for any add-ons, such as the capital conservation buffer, the countercyclical buffer, and the systemically important financial institution (SIFI) surcharge. All instruments other than those in CET1 are optional – the inclusion of an instrument in one of the above three capital buckets implies that banks have the option (but not the requirement) to use that instrument to meet the respective minimum capital requirement (i.e. banks have the option to meet all their capital requirements using only CET1).

CoCo Issuance

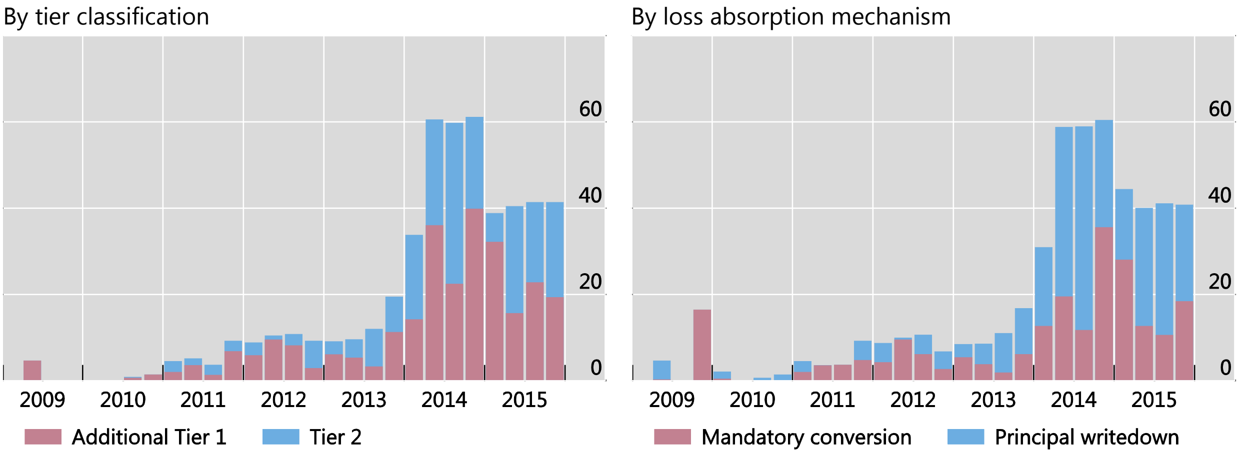
Issued amount, 2009–15, in USD billions Figure 3



Sources: Bloomberg; Dealogic; authors' calculations.

The Evolution of the CoCo Market

Issued amount, in USD billions Figure 4



Note: In some periods, there are minor differences between the quarterly issued amounts in the left- and right-hand panels due to incomplete information (on tier classification or loss absorption mechanism) for a small number of CoCos issued in the respective periods.

Sources: Bloomberg; Dealogic; authors' calculations.

Table 1. CoCo Issuance, 2009–15

This table reports the amount issued (in billions of US dollars) of CoCos that (i) were issued by banks between January 2009 and December 2015 and (ii) have at least one (mechanical or discretionary) contractual trigger. The number of issues is indicated in parentheses. Individual subcategories do not always add up to the respective reported totals due to missing data and/or rounding. The G-SIB designation refers to a global systemically important bank. The trigger threshold of 5.125% is the minimum required for a CoCo to qualify as additional tier 1 (AT1) capital under Basel III. Sources: Bloomberg; Dealogic.

	GSIB designation		Loss absorption mechanism		Trigger				Tier classification		Total
	GSIB	Non-GSIB	Principal write-down	Mandatory conversion	Mechanical All levels	Mechanical <=5.125	Mechanical >5.125	Discretionary only	AT 1	Tier 2	
Advanced economies	124.4 (108)	155.6 (277)	124.3 (182)	154.7 (194)	206.7 (243)	125.7 (174)	81.0 (69)	73.3 (142)	188.3 (228)	73.2 (117)	280.0 (385)
Euro area	36.7 (32)	48.8 (67)	43.6 (56)	41.7 (41)	73.1 (83)	55.2 (61)	17.9 (22)	12.5 (16)	75.7 (83)	8.1 (15)	85.6 (99)
Non-euro area Europe	69.3 (43)	50.6 (115)	58.1 (84)	61.2 (68)	111.9 (136)	48.7 (89)	63.1 (47)	8.1 (22)	75.6 (86)	27.6 (33)	111.9 (158)
Switzerland	33.6 (18)	4.5 (16)	29.4 (28)	8.4 (4)	33.8 (30)	24.9 (22)	8.9 (8)	4.3 (4)	19.2 (20)	18.9 (14)	38.1 (34)
United Kingdom	32.7 (19)	29.7 (47)	10.7 (6)	51.7 (60)	62.4 (66)	16.9 (37)	45.5 (29)	0 (0)	41.5 (27)	4.2 (3)	62.4 (66)
Other	3.0 (6)	16.4 (52)	18.0 (50)	1.0 (4)	15.7 (40)	6.9 (30)	8.7 (10)	3.7 (18)	14.9 (39)	4.5 (16)	19.4 (58)
Non-European AEs	18.4 (33)	56.1 (95)	22.6 (42)	51.8 (85)	21.8 (24)	21.8 (24)	0 (0)	52.7 (104)	37.0 (59)	37.5 (69)	74.5 (128)
Emerging market economies	69.4 (24)	172.0 (322)	158.6 (258)	65.1 (26)	85.6 (72)	79.5 (53)	6.1 (19)	155.9 (274)	86.6 (75)	147.8 (264)	241.5 (346)
Emerging Asia	69.1 (18)	129.7 (225)	130.0 (193)	62.2 (20)	64.7 (32)	62.5 (19)	2.2 (13)	134.1 (211)	68.7 (53)	123.5 (188)	198.8 (243)
Other EMEs	0.4 (6)	42.3 (97)	28.6 (65)	2.9 (6)	20.9 (40)	16.9 (34)	3.9 (6)	21.8 (63)	17.9 (22)	24.2 (76)	42.7 (103)
Total	193.8 (132)	327.7 (599)	282.9 (440)	219.8 (220)	292.3 (315)	205.2 (227)	87.1 (88)	229.2 (416)	274.9 (303)	221.0 (381)	521.5 (731)

Table 2. Propensity to Issue CoCos: Duration Analyses

This table analyses the propensity of banks to issue CoCos using duration analysis. The sample consists of "potential" issuers, defined as the 500 banks with the highest total assets in CoCo-issuing advanced economy jurisdictions, plus the advanced economy CoCo issuers in our sample that are not among the top 500. The sample is from January 2009 through December 2015. Panel A presents results from regressions using a Tobit regression where the dependent variable is *Time to Issue* (in months from January 2009). Panel B presents results from the Cox (1972) proportional hazards model using time-varying covariates at the bank-month level. Panel C (D) presents results from the Fine and Gray (1999) competing risk hazards model, at the bank-month level, where the issuance of any principal write-down (mandatory conversion) CoCos is the "main risk" and the issuance of any mandatory conversion (principal write-down) CoCos is the "competing risk." For Panels B–D, observations drop out of the sample right after a bank issues any CoCo for the first time. Banks without any issuance are treated as being censored at the end of the sample period. All dependent variables except *Total assets* and *G-SIB* are scaled by total assets, expressed in percentage points. The independent variables are as follows: *Total assets* (in logarithm), *Tier 1* (Tier 1 capital), *G-SIB* (indicating a global systemically important bank), *Gross loans*, *Trading Securities*, *Long-term funding*, *Deposits* (the sum of bank deposits and customer deposits), *Tier 1 ^ 2* (the square of Tier 1), *Customer deposits*, *Bank deposits*, *Interbank borrowing* (the sum of deposits from banks, repos, and cash collateral), and *Interbank assets* (the sum of loans and advances to banks, reverse repos, and cash collateral). The t-statistics are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Duration to First CoCo Issuance

	(1)	(2)	(3)	(4)	(5)
Total assets	-11.019***	-14.317***	-10.844***	-9.641**	-16.537***
	(-4.36)	(-4.63)	(-3.53)	(-3.22)	(-4.65)
Tier 1	-3.760**	-3.834**	2.821	-2.974*	-2.682
	(-2.29)	(-2.26)	(0.57)	(-1.79)	(-1.44)
G-SIB		-14.859	-13.531	-19.052*	-12.933
		(-1.33)	(-1.22)	(-1.71)	(-1.14)
Gross loans		-0.605**	-0.885***	-0.853***	-0.663**
		(-2.78)	(-3.60)	(-3.46)	(-2.59)
Trading securities		-0.873**	-0.732*	-0.942**	-1.225**
		(-2.28)	(-1.90)	(-2.32)	(-2.89)
Long-term funding		-0.156	0.378	0.312	-0.114
		(-0.79)	(1.42)	(1.21)	(-0.56)
Deposits			0.810**		
(Bank+Customer)			(3.30)		
Tier 1 ^ 2			-0.385		
			(-1.24)		
Customer deposits				0.684**	
				(2.92)	
Bank deposits				2.025***	
				(4.14)	
Interbank borrowing					0.833**
					(2.44)
Interbank assets					-0.154
					(-0.45)
Number of observations	512	510	510	510	506

Panel B: Hazards to First CoCo Issuance					
	(1)	(2)	(3)	(4)	(5)
Total assets	0.449***	0.530***	0.515***	0.429***	0.581***
	(6.19)	(6.10)	(5.16)	(4.59)	(5.94)
Tier 1	0.002	0.002	0.461*	0.002	0.048
	(0.29)	(0.34)	(1.91)	(0.36)	(0.88)
G-SIB		0.330	0.355	0.285	0.253
		(1.06)	(1.13)	(0.89)	(0.80)
Gross loans		0.018***	0.032***	0.034***	0.022***
		(3.92)	(4.38)	(4.33)	(2.81)
Trading securities		0.037***	0.033**	0.040***	0.055***
		(3.02)	(2.48)	(2.66)	(3.92)
Long-term funding		0.013**	-0.004	-0.004	0.009
		(2.16)	(-0.47)	(-0.52)	(1.45)
Deposits			-0.026***		
(Bank+Customer)			(-3.86)		
Tier 1 ^ 2			-0.026		
			(-1.52)		
Customer deposits				-0.018***	
				(-2.68)	
Bank deposits				-0.117***	
				(-4.94)	
Interbank borrowing					-0.036***
					(-2.98)
Interbank assets					-0.017
					(-1.35)
Number of observations	3323	3323	3323	3323	3296

Panel C: Hazards to First Principal Write-Down Issuance (with Mandatory Conversion as Competing Risk)					
	(1)	(2)	(3)	(4)	(5)
Total assets	0.419***	0.473***	0.495***	0.350**	0.588***
	(3.49)	(3.30)	(3.27)	(2.27)	(4.48)
Tier 1	0.002**	0.002**	0.461**	0.002**	0.097**
	(2.05)	(2.36)	(2.28)	(2.51)	(2.04)
G-SIB		0.580	0.633*	0.591	0.505
		(1.55)	(1.65)	(1.51)	(1.29)
Gross loans		0.016***	0.026***	0.028***	0.015*
		(3.23)	(3.21)	(3.21)	(1.71)
Trading securities		0.036***	0.032**	0.038***	0.046***
		(3.54)	(2.51)	(2.58)	(3.28)
Long-term funding		0.019***	0.006	0.004	0.020***
		(3.47)	(0.76)	(0.54)	(3.03)
Deposits			-0.025***		
(Bank+Customer)			(-3.74)		
Tier 1 ^ 2			-0.020*		
			(-1.95)		
Customer deposits				-0.017***	
				(-2.69)	
Bank deposits				-0.103***	
				(-4.07)	
Interbank borrowing					-0.023**
					(-2.11)
Interbank assets					-0.018
					(-1.63)
Number of observations	3323	3323	3323	3323	3296

Panel D: Hazards to Mandatory Conversion Issuance (with Principal Write-Down as Competing Risk)					
	(1)	(2)	(3)	(4)	(5)
Total assets	0.399***	0.505***	0.396**	0.423**	0.482**
	(2.98)	(2.83)	(2.04)	(2.08)	(2.33)
Tier 1	-0.002	-0.019	1.160	-0.022	-0.034
	(-0.04)	(-0.22)	(1.62)	(-0.31)	(-0.36)
G-SIB		-0.303	-0.241	-0.304	-0.216
		(-0.51)	(-0.40)	(-0.50)	(-0.36)
Gross loans		0.019***	0.038***	0.041***	0.031**
		(3.92)	(4.07)	(2.98)	(2.12)
Trading securities		0.035**	0.031	0.037*	0.061***
		(2.18)	(1.55)	(1.71)	(3.23)
Long-term funding		-0.002	-0.028***	-0.022**	-0.009
		(-0.30)	(-2.76)	(-2.15)	(-1.17)
Deposits			-0.030***		
(Bank+Customer)			(-4.18)		
Tier 1 ^ 2			-0.103*		
			(-1.76)		
Customer deposits				-0.019***	
				(-2.75)	
Bank deposits				-0.122***	
				(-3.06)	
Interbank borrowing					-0.053**
					(-2.33)
Interbank assets					-0.011
					(-0.57)
Number of observations	3323	3323	3323	3323	3296

Table 3. Impact of CoCo Issuance on Issuers' CDS Spreads: Cumulative Prediction Error (CPE) Analyses

This table examines the impact of CoCo issuance on issuing banks' CDS spreads using the methodology of James (1987). The average cumulative prediction errors (ACPE) for each category are calculated as equally-weighted averages of the cumulative prediction errors (CPEj) for the set of CoCo instruments that belong to each category. The weighted average cumulative prediction errors (WACPE) are calculated as issued, amount-weighted averages of the CPE for the set of CoCo instruments that belong to each category. For each CoCo instrument j, CPE_j is defined as the cumulative prediction error (derived from a CAPM model, estimated over a period of 200 business days, excluding the 40 business days centered around the event date) of its issuer's CDS spread over the event window, which starts 10 business days before the issuance date (t-10) and ends on the issuance date (t). The "Z-value" is defined as Z = √N (ACSPE), where ACSPE is the average cumulative standardized prediction error and N is the sample size. "Proportion negative" is the proportion of negative CPE_j. The test statistic is a Wilcoxon signed rank statistic. The null hypothesis is that the proportion of negative prediction errors equals 0.5. The trigger threshold of 5.125% is the minimum required for a CoCo to qualify as additional tier 1 (AT1) capital under Basel III. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample covers CoCo instruments issued by banks in advanced economies between January 2009 and December 2015.

		ACPE	Z-value	Proportion negative	WACPE	Sample size
All CoCos		-2.66***	-2.70	0.57**	-4.81	136
Loss absorption						
Principal write-down (PWD)		-1.35	-1.07	0.54	-2.40	87
Mandatory conversion (MC)		-4.97***	-3.07	0.63***	-8.37	49
Trigger						
Mechanical trigger		-3.25**	-2.22	0.55**	-4.80	83
<=5.125		-3.36	-1.38	0.60	-5.57	50
>5.125		-3.08*	-1.83	0.48	-3.91	33
Discretionary trigger only		-1.08	-1.15	0.58	-2.14	50
PWD and mechanical trigger		-1.61	-1.18	0.55	-2.36	53
PWD and trigger<=5.125		-0.82	-0.63	0.57	-0.67	37
PWD and trigger>5.125		-3.42	-1.20	0.50	-6.38	16
PWD and discretionary trigger only		-0.89	-0.22	0.52	-2.51	33
MC and mechanical trigger		-6.15**	-2.13	0.57*	-8.26	30
MC and trigger<=5.125		-10.58	-1.64	0.69	-21.71	13
MC and trigger>5.125		-2.76	-1.39	0.47	-2.43	17
MC and discretionary trigger only		-1.46*	-1.66	0.71*	-1.24	17
Additional Tier 1		-4.17***	-2.63	0.57**	-6.69	75
Tier 2		-0.67	-1.00	0.57	-0.35	60
CoCo issue size	<median	-1.76	-1.46	0.58*	-1.66	79
(amount issued/ RWA)	>=median	-4.36**	-2.56	0.57*	-7.21	54
Issuer size	<$1000bn	-4.04***	-2.63	0.62***	-8.97	68
(total assets)	>=$1000bn	-1.54	-1.25	0.54	-2.18	65
Issuer	G-SIB	-1.53	-1.15	0.53	-2.03	72
	Non-G-SIB	-3.93***	-2.72	0.63***	-9.74	64
European issuance		-3.15**	-2.20	0.55*	-5.33	93
Non-European issuance		-1.59	-1.58	0.63	-2.38	43
Distance to trigger	<median	-5.78	-1.37	0.55	-9.13	31
(Regulatory T1 capital/RWA)	>=median	-2.13*	-1.84	0.57*	-1.83	49
First-time issuer		-2.90	-0.40	0.48	-6.17	40
Repeat issuer		-2.55***	-2.93	0.61***	-4.01	94

Table 4. Impact of Coco Issuance on Issuers' CDS Spreads: Cross-Sectional Regression Analyses

This table examines the impact of CoCo issuance on issuing banks' CDS spreads using multivariate, cross-sectional regression analysis. The dependent variable (CPEj) in all specifications is the cumulative prediction error (derived from a CAPM model, estimated over a period of 200 business days, excluding the 40 business days centerred around the event date) of the CDS spread of the issuer of the CoCo instrument j over the event window, which starts 10 business days before the issuance date (t-10) and ends on the issuance date (t). The independent variables are: a dummy variable for CoCos with a principal write-down (PWD) loss absorption mechanism; a dummy variable for CoCos with a high trigger (HT), defined as a mechanical trigger>5.125, the minimum for a CoCo to quality as Tier 1 capital; a dummy variable for CoCos with a low trigger (LT), defined as a mechanical trigger<=5.125; a dummy variable for CoCos with only a discretionary trigger (DT); a dummy variable for CoCos classified as Tier 1 instruments (Tier 1); a dummy variable for CoCos issued by a globally systemically important bank (G-SIB); a dummy variable for CoCos issued by a bank with no prior CoCo issuances (first-time issuer); CoCo issue size (defined as the CoCo amount issued/the risk-weighted assets of the issuing bank) and the Tier 1 ratio, leverage ratio and size of the issuing bank (measured by the log of total assets)). All continuous variables are demeaned. *, ** and *** indicate significance at 10%, 5% and 1%, respectively, based on a standard t-test for individual coefficients and on a Wald test for the sums of coefficients; t-statistics (in parentheses) are clustered by issuing bank. The sample covers CoCo instruments issued by banks in advanced economies between January 2009 and December 2015.

Panel A: Loss Absorption Mechanism

	(1)	(2) DC: Tier 1	(3) DC: G-SIB	(4) DC: First-time issuer
Constant	-5.60**	-2.40*	-5.04*	-5.61**
	(-2.40)	(-1.86)	(-1.88)	(-2.51)
Principal write-down (PWD)	3.87	1.28	3.09	3.83
	(1.34)	(0.60)	(0.96)	(1.25)
Tier 1/ RWA	0.15	0.19	0.19	0.15
	(0.42)	(0.53)	(0.49)	(0.41)
Amount issued/ RWA	-2.35	-1.21	-2.54	-2.21
	(-0.85)	(-0.45)	(-0.92)	(-0.77)
Log (total assets)	-0.02	0.64	-1.45	0.08
	(-0.01)	(0.46)	(-0.87)	(0.06)
Leverage ratio	0.28	0.53	0.56	0.35
	(0.20)	(0.37)	(0.40)	(0.26)
Dummy control (DC)		-6.50	2.81	-0.47
		(-1.60)	(0.70)	(-0.07)
PWD*DC		4.55	1.23	0.56
		(0.97)	(0.29)	(0.08)
Overall impacts				
PWD	-1.73			
MC	-5.60**			
PWD; DC=0		-1.11	-1.95	-1.78
MC; DC=0		-2.40*	-5.04*	-5.61**
PWD; DC=1		-3.07	2.09	-1.69
MC; DC=1		-8.90**	-2.23	-6.08
Number of observations	133	132	133	131

Panel B: Trigger Type

	(1)	(2) DC: G-SIB	(3) DC: First-time issuer	(4) DC: PWD
Constant	-4.80**	-5.60**	-6.09**	-8.07**
	(-2.13)	(-2.13)	(-2.46)	(-2.21)
Discretionary trigger only (DT)	1.81	3.83	3.38	5.35
	(0.84)	(1.37)	(1.51)	(1.36)
Tier 1/ RWA	0.63	0.62	0.72*	0.52
	(1.62)	(1.54)	(1.89)	(1.33)
Amount issued/ RWA	-5.06	-4.44	-6.06*	-5.10
	(-1.41)	(-1.26)	(-1.71)	(-1.35)
Log (total assets)	0.16	-1.66	0.09	0.24
	(1.42)	(1.69)	(1.40)	(1.49)
Leverage ratio	-0.06	0.28	-0.08	0.30
	(-0.05)	(0.21)	(-0.06)	(0.22)
Dummy control (DC)		5.77**	3.43	5.31
		(2.33)	(1.29)	(1.54)
DT*DC		-1.86	-6.08	-5.87
		(-0.58)	(-1.47)	(-1.41)
Overall impacts				
DT	-3.00			
Mechanical trigger (MT)	-4.80**			
DT; DC=0		-1.77	-2.71	
MT; DC=0		-5.60**	-6.09**	
DT; DC=1		2.14	-5.36	
MT; DC=1		0.17	-2.66	
PWD;MT				-2.75
MC;MT				-8.07**
PWD;DT				-3.28
MC;DT				-2.72
Number of observations	130	130	129	130

Panel C: Trigger Level

	(1)	(2) DC: G-SIB	(3) DC: First-time issuer
Constant	-4.20*	-2.39	-7.44***
	(-1.72)	(-0.95)	(-2.60)
Low trigger (LT)	-0.97	-6.00	2.02
	(-0.29)	(-1.12)	(0.68)
Discretionary trigger only (DT)	1.22	0.92	4.77
	(0.55)	(0.38)	(1.62)
Tier 1/ RWA	0.63*	0.64	0.81*
	(1.65)	(1.62)	(1.93)
Amount issued/ RWA	-5.16	-4.65	-6.31*
	(-1.38)	(-1.27)	(-1.70)
Log (total assets)	0.10	-2.08	0.03
	(0.07)	(-1.08)	(0.02)
Leverage ratio	-0.12	0.56	-0.05
	(-0.08)	(0.39)	(-0.04)
Dummy control (DC)		3.33	6.93*
		(0.82)	(1.95)
LT*DC		6.40	-6.42
		(1.09)	(-0.96)
DT*DC		1.26	-9.54**
		(0.29)	(-2.03)
Overall impacts			
LT	-5.16*		
DT	-2.98		
HT	-4.20*		
LT; DC=0		-8.38*	-5.42*
DT; DC=0		-1.46	-2.67
HT; DC=0		-2.39	-7.44***
LT; DC=1		1.35	-4.91
DT; DC=1		3.13	-5.28
HT; DC=1		0.94	-0.51
Number of observations	130	130	129

Table 5. Impact of CoCo Issuance on Issuers' Equity Prices: Cumulative Prediction Error (CPE) Analyses

This table examines the impact of CoCo issuance on issuing banks' equity prices using the methodology of James (1987). The average cumulative prediction errors (ACPE) for each category are calculated as equally-weighted averages of the cumulative prediction errors (CPE_j) for the set of CoCo instruments that belong to each category. The weighted average cumulative prediction errors (WACPE) are calculated as issued amount-weighted averages of the CPE for the set of CoCo instruments that belongs to each category. For each CoCo instrument j, CPE_j is defined as the cumulative prediction error (derived from a CAPM model, estimated over a period of 200 business days, excluding the 40 business days centered around the event date) of its issuer's equity price over the event window, which starts 5 business days before the issuance date (t-5) and ends on the issuance date (t). The "Z-value" is defined as Z = √N (ACSPE), where ACSPE is the average cumulative standardized prediction error and N is the sample size. "Proportion negative" is the proportion of negative CPE_j. The test statistic is a Wilcoxon signed rank statistic. The null hypothesis is that the proportion of negative prediction errors equals 0.5. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample covers CoCo instruments issued by banks in advanced economies between January 2009 and December 2015.

		ACPE	Z-value	Proportion negative	WACPE	Sample size
All CoCos		0.15	0.76	0.35	0.27	170
Loss absorption						
Principal write-down (PWD)		0.27	1.03	0.29	1.16	103
Mandatory conversion (MC)		-0.04	-0.07	0.88	-0.74	67
Trigger						
Mechanical trigger		0.40	1.02	0.23	0.60	97
<=5.125		-0.17	0.73	0.29	0.04	65
>5.125		1.55	0.73	0.55	1.32	32
Discretionary trigger only		-0.24	-0.07	0.95	-0.38	67
PWD and mechanical trigger		0.69	1.56	0.15	1.91	60
PWD and trigger<=5.125		-0.19	0.66	0.36	0.20	47
PWD and trigger>5.125		3.87**	2.10	0.22	7.33	13
PWD and discretionary trigger only		-0.44	-0.44	0.69	-0.57	39
MC and mechanical trigger		-0.08	-0.35	0.92	-0.82	37
MC and trigger<=5.125		-0.12	0.32	0.65	-0.34	18
MC and trigger>5.125		-0.04	-0.80	0.66	-1.07	19
MC and discretionary trigger only		0.04	0.41	0.86	-0.11	28
Additional Tier 1		0.23	0.71	0.26	0.35	92
Tier 2		0.06	0.35	0.79	0.13	78
CoCo issue size	<median	0.33	1.44	0.12	0.14	92
(amount issued/ RWA)	>=median	0.37	-0.17	0.99	0.43	69
Issuer size	<$1000bn	0.65	1.30	0.27	1.75	96
(total assets)	>=$1000bn	-0.04	0.09	0.85	-0.74	67
Issuer	G-SIB	0.06	0.35	0.79	-0.27	74
	Non-G-SIB	0.22	0.70	0.48	1.13	96
European issuance		0.17	0.37	0.58	0.43	111
Non-European issuance		0.11	0.78	0.46	-0.24	59
Distance to trigger	<median	1.40*	1.65	0.19	1.66	40
(Regulatory T1 capital/RWA)	>=median	0.29	0.50	0.38	-0.26	51
First-time issuer		0.76	1.62	0.10	1.36	57
Repeat issuer		-0.23	-0.45	0.78	-0.41	108

Table 6. Impact of Coco Issuance on Issuers' Equity Prices: Cross-Sectional Regression Analyses

This table examines the impact of CoCo issuance on issuing banks' equity prices using multivariate, cross-sectional regression analysis. The dependent variable (CPEj) in all specifications is the cumulative prediction error (derived from a CAPM model, estimated over a period of 200 business days, excluding the 40 business days centered around the event date) of the equity price of the issuer of CoCo instrument j over the event window, which starts 5 business days before the issuance date (t-5) and ends on the issuance date (t). The independent variables are: a dummy variable for CoCos with a principal write-down (PWD) loss absorption mechanism; a dummy variable for CoCos with a high trigger (HT), defined as a mechanical trigger>5.125, the minimum for a CoCo to qualify as Tier 1 capital; a dummy variable for CoCos with a low trigger (LT), defined as a mechanical trigger<=5.125; a dummy variable for CoCos with only a discretionary (DT); a dummy variable for CoCos classified as Tier 1 instruments (Tier 1); a dummy variable for CoCos issued by a globally systemically important bank (G-SIB); a dummy variable for CoCos issued by a bank with no prior CoCo issuances (first-time issuer); CoCo issue size (defined as CoCo amount issued/ risk-weighted assets of the issuing bank) and the Tier 1 ratio, leverage ratio and size of the issuing bank (measured by the log of total assets)). All continuous variables are de-meaned. *, ** and *** indicate significance at 10%, 5% and 1%, respectively, based on a standard t-test for individual coefficients and on a Wald test for sums of coefficients; t-statistics (in parentheses) are clustered by issuing bank. The sample covers CoCo instruments issued by banks in advanced economies between January 2009 and December 2015.

Loss Absorption Mechanism and Trigger Level

	(1)	(2) DC: G-SIB	(3) DC: First-time issuer	(4)	(5) DC: G-SIB	(6) DC: First-time issuer
Constant	-0.44	-0.71	-0.63	0.40	0.98	-0.05
	(-0.77)	(-1.07)	(-1.06)	(0.55)	(1.3)	(-0.05)
Principal write-down (PWD)	-0.10	0.50	-0.28	1.07	1.32	1.08
	(-0.16)	(0.59)	(-0.41)	(1.02)	(1.16)	(1.04)
High trigger (HT)	0.61	1.38	0.37			
	(0.63)	(1.01)	(0.37)			
Low trigger (LT)	1.05	1.59*	0.92			
	(1.37)	(1.88)	(1.18)			
Discretionary trigger only (DT)				-0.78	-1.78*	-0.55
				(-0.98)	(-1.75)	(-0.66)
Tier 1/ RWA	-0.27*	-0.28	-0.24	-0.28*	-0.29	-0.24
	(-1.71)	(-1.58)	(-1.59)	(-1.69)	(-1.51)	(-1.58)
Amount issued/ RWA	-0.28	-0.40	-0.46	-0.29	-0.44	-0.49
	(-0.23)	(-0.32)	(-0.38)	(-0.21)	(-0.34)	(-0.38)
Log (total assets)	-0.36	-0.16	-0.34	-0.42	-0.10	-0.40
	(-0.96)	(-0.33)	(-0.87)	(-1.03)	(-0.18)	(-0.95)
Leverage ratio	-0.51*	-0.52*	-0.55*	-0.60*	-0.60**	-0.64**
	(-1.81)	(-1.88)	(-1.92)	(-1.92)	(-2.03)	(-2.04)
Dummy control (DC)		-1.11	0.83		-1.68	0.96
		(-1.07)	(1.18)		(-1.44)	(1.4)
PWD*LT	0.15	-0.10	0.29			
	(0.16)	(-0.10)	(0.3)			
PWD*HT	4.09**	3.33*	4.24**			
	(2.07)	(1.67)	(2.04)			
PWD*DT				-1.22	-0.56	-1.44
				(-1.11)	(-0.49)	(-1.23)

Overall impacts						
PWD*HT	4.16**	4.51**	3.71**			
MC*HT	0.17	0.67	-0.26			
PWD*LT	0.66	1.28*	0.30			
MC*LT	0.62	0.88	0.29			
PWD*DT	-0.54	-0.21	-0.91	-0.53	-0.04	-0.95
MC*DT	-0.44	-0.71	-0.63	-0.38	-0.80	-0.59
PWD*MT				1.47**	2.30**	1.04
MC*MT				0.40	0.98	-0.05
Number of observations	155	155	154	155	155	154