Contingent Capital: The Case of COERCs
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Abstract

This paper introduces, analyzes, and values a new form of contingent convertible (CoCo), a Call Option Enhanced Reverse Convertible (COERC). Issued as a bond, it converts to new shareholders’ equity if a bank’s market value of capital falls below a pre-specified trigger. The COERC avoids the problems with market based triggers such as “death spirals” as a result of manipulation or panic. A bank that issues COERCs also has a smaller incentive to choose investments that are subject to large losses. Furthermore, COERCs reduce the problem of “debt overhang,” the disincentive to replenish shareholders’ equity following a decline. The low risk of COERCs should increase their appeal to risk-averse bondholders.
1. Introduction

This paper introduces, analyzes, and values a new security named a Call Option Enhanced Reverse Convertible or COERC. It is a variation of contingent capital that addresses many of the criticisms made against standard forms of contingent capital. Contingent capital, also referred to as contingent convertibles (CoCos), is debt that converts to equity after some triggering event, such as a decline in a bank’s capital below a threshold. The potential benefit of CoCos is that when a bank’s initial equity capital is depleted, the bank automatically recapitalizes, thereby reducing the costs of financial distress and the need for a government bailout. Originally proposed by Flannery (2005), interest in CoCos has grown since the 2007-2009 financial crisis because other debt-like forms of bank capital such as “subordinated debt and hybrid capital largely failed in its original objective of bearing losses” (HM (UK) Treasury (2009)). While in July 2011 the Basel Committee on Banking Supervision (BCBS) (2011) decided that CoCos would not be permitted to fulfil the additional capital required of global systematically important banks (G-SIBs), it continues to review CoCos and does support their use to meet higher national capital requirements. Switzerland has taken the lead by requiring that its two major banks, UBS and Credit Suisse, increase their capital ratios to 19% with up to 9% of this requirement being met with CoCos. A main reason that BCBS (2011) failed to strongly endorse CoCos was uncertainty on how they would perform and how they should best be designed.

For a shareholder value-maximizing bank (or firm), appropriately-designed CoCos can be an attractive financing instrument. Standard capital structure theory views a firm’s choice of debt versus equity as a trade-off between the relative benefit of debt’s corporate tax shield versus its higher costs of financial distress. Prior to conversion a CoCo bond possesses debt’s tax shield, but it avoids direct costs of financial distress (bankruptcy costs) if it automatically converts to equity before the firm’s net worth reaches a
distressed level.\(^1\) In Europe, interest on CoCos is tax deductible, but under current US tax law, the deductibility of interest on CoCos is in question. However, if CoCos are considered as useful capital instruments that reduce the risk of future bail-outs, it is not unlikely that U.S. tax law would be amended. Moreover, because we will show that COERC bondholders will almost always be repaid with cash, rather receive new shares, there is a strong case COERCs are unlike equity and their interest should be tax deductible. But even without tax benefits, CoCos may be beneficial in reducing agency costs. Relative to equity, pre-conversion CoCos obligate a firm to pay coupons that can mitigate managerial agency costs of free cash flow.\(^2\) CoCos may avoid the need for greater equity issuance that reduces managerial ownership and the alignment of interests between managers and shareholders.\(^3\) To the extent that CoCos are less risky than common stock, the issuance of CoCos will avoid the negative signalling effect of equity issues.

However, compared to equity finance, CoCos, as any debt instrument, has higher costs of financial distress than equity. While the automatic conversion of debt into equity reduces direct bankruptcy costs, it may not eliminate the indirect costs of financial distress, i.e. costs arising from conflicts between bondholders and shareholders. This conflict is a result of the fact that debt is default-risky and that shareholders possess limited liability. Myers (1977) identifies two types of costs. First, shareholders have a moral hazard incentive to increase the firm’s risk via investments in excessively (negative NPV) risky assets or higher leverage, as long as the decline in firm value is less than the decline in the value of the debt as a result of the increased default risk. Second, when a firm is in financial distress, total firm value might be increased with a new equity issue that reduces financial distress.\(^4\) However, the “debt overhang” problem is a disincentive for

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\(^1\) Automatic conversion avoids a hold-out problem associated with debt renegotiation where creditors are asked to voluntary exchange risky debt for equity: each individual creditor has an incentive to hold out, although creditors would be better off as a group to accept the restructuring proposal.

\(^2\) Jensen (1986) developed this argument for the advantage of debt. In a banking context, see Kashyap, Rajan, and Stein (2008).

\(^3\) Of course, if the overriding purpose is not to maximize shareholder value nut minimize the probability of default, then obviously forcing banks to issue equity may well be preferred to issue coco bonds (Admati et al (2010)).

\(^4\) Alternatively, the firm could increase its equity-to-debt ratio by paying off debt with a new equity issue.
shareholders to issue new equity if the increase in firm value is smaller than the wealth transfer to the debt holders as a result of the debt’s reduced default risk. Hence a properly-designed CoCo should try to minimize these indirect costs of financial distress as well.

The public policy debate regarding CoCos has spurred significant academic interest. In general, these papers propose different designs for CoCos. The purpose of this paper is to contribute to this literature by proposing a new design, the COERC. We believe that this design has a number of desirable characteristics. First, the trigger is based on market values of capital ratios rather than regulatory capital ratios that are based on book values. Book values are stale and can be manipulated. The goal of CoCos should be to convert into equity while the bank is still a “going concern” that is, at an earlier stage prior to severe financial distress (when the bank becomes a “gone concern”). Conversion to equity at an early stage would likely require a market capital trigger. Second, although based on market values of capital, the design avoids one of the main criticisms of market-based triggers: unjustifiable conversions as a result of manipulation or panic. Our solution is to provide an option to equity holders to buy the shares from the bondholders at the conversion price. In other words, shareholders can prevent dilution by subscribing to a rights issue with a subscription price equal to the conversion price and use the proceeds to repay the debt. This design also preserves the pre-emptive rights of stockholders who may be concerned about losing control to CoCo investors after conversion. Third, by basing the trigger on the market value of capital (defined as equity plus COERCS), divided by senior debt, we avoid the multiple equilibria problem first pointed out by Sundaresan and Wang (2010). Such a trigger requires that the COERCS are sufficiently liquid. Liquidity is enhanced if the COERCS are easy to value and have low risk, even in a realistic environment when bank asset values can suffer sudden losses (as occurs during a financial crisis). We show that by setting the conversion price significantly below the

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trigger price, the COERC is relatively easy to value and has low risk. Indeed, when the conversion price is significantly below the trigger price, shareholders have a large incentive to prevent dilution and repay the debt. This low risk should improve liquidity, minimize costs of financial distress and make it appealing to a large number of risk-averse investors. COERCs’ low risk also derives from the fact that regulators are not involved in the triggering decision, unlike many alternative CoCo proposals. Regulatory involvement makes CoCos difficult to price because of “regulatory risk”. Finally, although the main purpose is to design an instrument that allows banks to avoid financial distress, thereby reducing the likelihood of a public sector (taxpayer) bailout, we also intend this capital to be attractive to the issuing bank or firm. Imposing a security or capital structure that banks find overly burdensome may lead to ‘regulatory arbitrage’ including a shifting of risk to a ‘shadow banking’ sector of the financial system to which taxpayers may still be exposed.

This paper is organised as follows. In Section 2 we provide an overview of other CoCo structures that have been proposed and/or put into practice. In Section 3 we illustrate with a simple numerical example the basic idea behind a COERC and why it addresses some of the problems associated with more classic forms of contingent capital. Section 4 generalizes the framework and values COERCS within the structural framework proposed by Pennacchi (2010). Section 5 summarizes our conclusions and policy implications.

2. Contingent capital: some alternative structures.

By November 2011, three banks had issued securities that might be broadly classified as CoCos, each of them with triggers based on regulatory capital ratios. In November 2009 Lloyds Bank issued Enhanced Capital Notes (ECN). Although the issue was well

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7 An example of a structure where regulators call the shots is proposed by Bhattacharya, Plank, Strobl and Zechner (2002). They assume that regulators audit a bank randomly. If the capital is insufficient, the bank license is lost, the bank is taken over by the regulator and auctioned off to new investors.

8 For example, if equity is tax-disadvantaged relative to debt, a higher equity capital requirement raises banks’ costs of funding and reduces loan supply. Regulatory arbitrage may take the form of excessive off-balance sheet financing (securitization) as shown by Han, Park, and Pennacchi (2010).
received by financial markets, it was an exchange offer. In return for giving up more senior securities, investors in the ECN received an extra 1.5% or 2% additional coupon income. Another CoCo-like security was issued successfully by Rabobank in May of 2010. If the bank’s regulatory capital ratio falls below 7%, the security’s principal is written down by 75% and the remaining 25% is redeemed for cash. This security is not converted to new common equity, so it is not clear that it fits the standard definition of CoCo. The lack of equity conversion is likely due to Rabobank being a cooperative bank without traded common stock. Finally, in February 2011, Credit Suisse, encouraged by the Swiss National Bank, issued SF6 billion of CoCo notes with a 9% coupon rate to two Middle Eastern investors in exchange for existing Tier 1 notes. It also made a separate public CoCo issue for $2 billion at a 7.875% coupon rate, with a common equity Tier 1 capital trigger ratio of 7%, a conversion cap of $20, and a maturity of 30 years. This issue was heavily oversubscribed, perhaps due to the issue’s large credit spread.  

Few, if any, academic proposals for CoCos advocate triggers based on regulatory capital. While the Basel capital agreements set a uniform approach to defining regulatory capital, basing CoCo conversion on regulatory capital is problematic. First, regulatory capital is an accounting measure that is typically calculated only once every quarter, so it may not provide timely information about a bank’s financial condition for a situation where a the market value of a bank’s capital deteriorates rapidly. Table 1 shows the mean and median Tier 1 common ratios for 50 U.S bank holding companies for each of the four quarters of 2008. It also shows these ratios for some of the largest U.S. banks. These simple statistics show clearly that the variation in these regulatory ratios was too small to be a useful indicator of financial distress. For example, as late as December 2008, investors would only have had access to a ratio calculated on September 30, and even though the September 30 ratio followed the Lehman Brothers bankruptcy on September 15, it was not much different from the ratios reported on March 31 or on June 30. Hence, it is unlikely that CoCos based on a regulatory capital ratio would have been triggered during the worst of the financial crisis.

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9 At the issue date, the 30-year Treasury yield was 4.16%, the AAA corporate bond yield was 5.26%, and the BBB (which was Fitch’s rating of the CoCo) corporate bond yield was 6.14%.
Second, because regulators are aware that capital ratios are stale, they may be tempted to intervene and trigger conversion themselves by influencing reported accounting values (e.g. demanding that assets be written down). This regulatory risk may be difficult to assess, even for major credit rating agencies. Moreover, if regulatory capital ratios lag market ones but regulators forbear in triggering conversion, conversion may be delayed to a point when a bank’s market value of capital is quite low and CoCo investors become more likely to sustain losses. For example, during the recent sovereign debt crisis, from February 2011 (when Credit Suisse issued its CoCo bond) to December 2011, its stock price fell by 50% to $24, approaching the conversion floor of $20. However, its capital ratio of 10% reported in November 2011 stayed well above the conversion trigger of 7%. This payoff structure may be unappealing to risk-averse fixed-income investors unless compensated by a large credit spread. Management may be reluctant to pay such credit risk premiums if it believes the firm’s risk of financial distress is lower than that believed by CoCo investors.

In short, CoCos can be an effective restructuring vehicle if they are designed to convert to equity prior to the onset of severe financial distress. The CoCo issues made thus far by Lloyds Bank, Rabobank, and Credit Suisse are suspect in this regard because their conversion trigger is a regulatory (accounting-based) capital ratio. Rather than being a capital instrument for preventing financial distress, these previous CoCo issues correspond to the Basel III “bail-in” capital standards approved in January 2011. These standards require that for hybrid instruments to qualify for Tier 1 or Tier 2 capital, they must be written-down or converted to equity at the point when a bank becomes “non-viable,” defined as the time when a public sector injection of capital is imminent or regulators deem a write off is necessary. The goal of such bail-in CoCos is loss absorbency when the bank is a “gone concern,” rather than avoiding financial distress in the first place. The CoCos that are the focus of this paper are meant to provide automatic capital restructuring of a bank prior to severe financial distress. Therefore, they are intended to convert at a relatively high market value of capital-to-debt ratio, defined as the sum of the market values of equity and CoCos divided by the book value of the
bank’s deposits and senior debt. The market value of capital at which conversion is triggered might be where a bank is considered adequately capitalized, but not well-capitalized, so conversion would tend to occur when the bank is a going concern rather than a gone concern.

Flannery (2005, 2009a, 2009b) developed the initial proposal for CoCos that specifies a conversion trigger based on the market value of shareholders’ equity. Specifically, conversion would occur if a bank’s stock price hits a pre-specified threshold. His examples assume that when conversion is triggered, CoCo investors receive shares priced at the trigger price equal to the par value of their bonds. As a result, CoCo investors always receive their par value at conversion, so that CoCos are essentially default-free. While the market value trigger avoids the problem of stale regulatory capital ratios and uncertainty regarding regulator discretion, it has been criticized because conversion may be triggered by stock price manipulation or panic. If such market inefficiency allows stock prices to deviate from their fundamental values, conversion can lead to transfers of wealth from shareholders to CoCo investors, which would make the CoCos unappealing to shareholder value maximizing managers. The best way to illustrate this is with a numerical example.

Assume that a highly levered firm (bank) has assets with a value of $A = 1,100$. The firm’s liabilities consist of senior debt (deposits) worth $D = 1,000$, a CoCo bond with par value of $B = 30$, and common shareholders’ equity worth $S \times n_0 = 70$, where $S$ is the stock price per share and $n_0$ is the number of shares outstanding. Let the number of shares outstanding be $n_0 = 7$, so that the stock price is currently $10$. To simplify the example, suppose that prior to conversion, the market value of the CoCo bond, $V$, equals its par value, $B$, so that changes in the firm’s assets affect only the stock price. We relax this assumption later when the CoCo bond’s value, $V$, is permitted to differ from its par value due to possible default losses. For now, with the assumption that $V = B$ prior to conversion, the market value of total capital, $S \times n_0 + V = S \times n_0 + B$, varies only due to

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10 Oswald Grübel, CEO of UBS, states “As soon as you get near these trigger levels – you don’t have to hit them – what do you think shareholders will do? They will get the hell out of that stock.” See “Bankers Fear CoCos Are Another Crisis in the Making” Financial Times March 5, 2011.
stock price movements. Our numerical example assumes that the conversion trigger depends only on the stock price, but later we consider a trigger based on the market value of total capital, $S n_0 + V$.\(^{11}\) Assume also that the CoCo converts when the stock price, $S$, falls to $5$, and the conversion price is also $5$.

Suppose there is an unjustified panic, or a manipulation through short sales initiated by the CoCo investors\(^{12}\), which makes stock price fall to $5$ per share. Hence, the market value of equity drops to $35$. CoCos will convert into 6 shares of common stock, so that the total number of shares increases to 13. However, if CoCo investors understand that the true value of the firm’s assets is still $1,100$, then they know that the combined value of CoCo investors’ and shareholders’ stakes is $100$, which means that the fundamental stock value is $100/13 = 7.69$ per share. The gain to the CoCo investors is now $7.69 \times 6 - 30 = 16.15$ or a gain of 54% relative to the bond’s market value of $30$ before the conversion. This gain, of course, comes at the expense of the original shareholders who now own 7 shares trading at $7.69$ rather than $10$, a loss of $16.15$. Note that we have assumed that the conversion price is equal to the trigger price. This means that the number of shares that bondholders receive at conversion is fixed at 6. In some of the proposed structures, such as Flannery (2009a), the bondholders would receive a contemporaneous market value of shares equal to the bonds’ face value. This means that as the stock price drops, the bondholder receives more shares, a feature that would increase the profits from shorting-and-converting and could create a “death spiral.”

This example illustrates that CoCo investors have an incentive to manipulate stock prices downward through false rumours or through shorting the stock. As McDonald (2010) points out, academics are generally sceptical about legally profitable manipulation, since a speculator who shorts a stock and drives its price down will subsequently drive the

\(^{11}\) As will be discussed and as was first pointed out by Sundaresan and Wang (2010), a conversion trigger based on only the stock price can result in multiple equilibria for the values of $S$ and $V$. Multiple equilibria are avoided when the conversion trigger is based on the sum of equity and CoCo values; that is, the market value of total capital, $S n_0 + V$.

\(^{12}\) Alternatively, short sellers can influence the fundamental value (as opposed to the perceived value) of the firm by shorting and forcing conversion, so that the firm loses its interest tax shields. However that assumes that the company cannot undo this effect by restoring its previous capital structure by borrowing to buy back stock.
stock price up when covering the short. However, in the case of CoCos, the short-seller can cover the short position by shares provided by the issuer after conversion, thereby avoiding buying pressure.

Hillion and Vermaelen (2004) provide empirical evidence consistent with such market inefficiency by analyzing a similar convertible bond known as a “floating-priced convertible” or “death spiral.” These bonds can be converted to equity at a pre-specified total value. Thus, at conversion, a variable number of new shares are issued to bondholders depending on the market price of the stock such that bondholders receive a specific equity value at conversion. Although the investor has the option of deciding when to convert, the non-converted principal plus accrued interest must be converted at maturity. As with CoCos, the motivation for floating-price convertibles is to avoid costs of financial distress by making the bonds default-free, which explains why these securities are typically issued by high growth risky firms. However, Hillion and Vermaelen report that, on average, the stock returns of firms that issue these bonds underperform the market by 85% in the year after issuance. To explain this result, they develop a model of market manipulation where bondholders have an incentive to short stocks and convert afterwards using the shares obtained through conversion to cover their short position. Note that although these bonds typically specify a conversion price that is set at a discount from the market price, even without a discount investors have an incentive to short the stock and force conversion below fair value.

Flannery (2009a) points out that the typical firm in the Hillion-Vermaelen sample is small and risky. Large financial institutions’ equity prices should be less easy to manipulate. Note, however, that even without manipulation, CoCos can create wealth transfers from shareholders to bondholders if stock prices fall for irrational reasons such as false rumours or fears of dilution. So, one does not need a model of manipulation to understand the concerns about market instability. It also remains a fact that the financial industry
justifies its objection to CoCos with market based triggers on the basis of these manipulation/death spiral fears.\textsuperscript{13}

Sunderesan and Wang (2010) point out another problem with triggers based solely on stock prices or the market value of shareholders’ equity: because stock prices and CoCo prices are determined simultaneously, multiple equilibria may exist. Recalling our numerical example, suppose everyone believes the value of the firm is $1,100, the value of the senior debt $1000, the value of equity is $70 (or $10 per share) and the CoCo value is $30. In our example, we have assumed that the trigger price is equal to $5. Sundaresan and Wang (2010) assume a trigger price different from the conversion price, for example, a trigger price of $8 and a conversion price of $5. If investors believe that CoCos will convert into 6 shares, the number of shares will increase to 13, which implies a stock price of $100/13 = $7.69. As the $8 trigger is reached, conversion will take place so that the $10 stock price is no longer a unique equilibrium price. At $7.69, the 6 shares owned by CoCo investors represent a wealth transfer $7.69 \times 6 – $30 = $16.14 at the expense of the original shareholders. It is this value transfer that makes the stock price fall below the trigger price. As a result, there are two possible stock prices: $10 and $7.69. Under the assumptions that interest rates are stochastic and the return on bank assets satisfies a pure diffusion process, Sundaresan and Wang (2010) propose a solution to the multiple equilibria problem where the CoCo bond pays a floating coupon and the number of shares issued at conversion multiplied by the trigger price equals the CoCo bond’s par value. Under these conditions, the CoCos are always worth their par value prior to and at the time of conversion. The absence of a wealth transfer at conversion leads to unique equilibrium values for the stock and CoCos, with CoCos being default-free.

However, the Sundaresan and Wang (2010) solution to the multiple equilibrium problem is sensitive to their assumption that the value of bank assets follows a continuous diffusion process without any discontinuities. Their solution to the multiple equilibrium problem when a trigger is tied solely to the stock price does not hold in a more general

\textsuperscript{13} For example, see “Contingent capital: possibilities, problems and opportunities,” Goldman Sachs mimeo, February 16, 2011, and “CoCos,” Lex column, \textit{Financial Times} July 21, 2011.
model where bank asset values follow a mixed jump-diffusion process. Such an environment is modelled by Pennacchi (2010), and the possibility that bank assets may suddenly decline in value (jump) can have qualitatively distinct effects on the value of CoCos and bank equity. In general, when discontinuous declines in bank asset values are possible, it may be impossible to design CoCos (or any other bank liability) that is completely default-free. In turn, if CoCos are not always valued at par, there can be wealth transfers at conversion and the multiple equilibrium problem re-emerges.

Figure 1 shows the percentage of banks among the 100 largest U.S. bank holding companies that experienced stock price declines of larger than 10% in a single day over the period from January 1, 2007 until December 31, 2008. These jumps in bank equity values suggest that any realistic model for pricing CoCos should allow for jumps in bank asset values. As a result, it is unlikely that a CoCo can be designed to be completely default free, and when conversion is based solely on the bank’s stock price, multiple equilibria may always exist.

Kashyap, Rajan and Stein (2008) propose that, rather than increasing capital requirements ex ante, firms buy contingent capital insurance: insurance that inserts capital in the bank when it gets into trouble, which essentially is analogous to the firm buying put options on its own stock. Their solution requires the existence of default-free entities that sell such insurance. As Duffie (2010) points out, if the source of distress is a general financial crisis, the put seller may itself be distressed and unable to honour its commitments. Bolton and Samama (2010) propose that banks buy puts from long-term investors such as Sovereign Wealth Funds and other large institutional investors.

The COERC trigger we propose in this paper is issuer specific. Kashyap, Rajan and Stein (2008) propose a trigger mechanism based on aggregate bank losses. McDonald (2010) proposes a dual price trigger: conversion would be mandatory if the stock price falls below a trigger value and the value of a financial institutions stock index falls below another trigger. These proposals allow all financial institutions to recapitalize during a widespread financial crisis, but permit an individual institution to fail during normal
times. A similar dual trigger mechanism is proposed by the Squam Lake Working Group (2009) proposal: banks would issue debt and the debt would convert into equity when a regulator declares that there is a systematic crisis and the issuer would violate covenants. These approaches assume that the main purpose of CoCos is to mitigate the consequences of a major financial crisis, and because they assume that a regulator ultimately decides when conversion takes place these CoCos would be hard to value. Moreover, the goal of the current paper is more general: to design a security that has the benefits of debt financing over equity financing but with lower financial distress costs than other debt securities. As a consequence, a COERC may be beneficial to any bank that wants to reduce the costs of financial distress. These costs are more difficult to measure than direct bankruptcy costs but could be more substantial. Specifically, if other stakeholders feel that a bank or a company will go under, they will respond so that default becomes a self-fulfilling prophecy, in particular for banks which face, in no particular order (1) loss of their short-term wholesale funding base, including interbank, repo, and short-term paper (2) the (partial) loss of their retail deposit base, regardless of deposit protection arrangements that might be in place (3) the loss of significant parts of their derivatives business (4) significantly increased collateral requirements (5) the loss of their most valued employees.

3. An alternative security: call option enhanced reverse convertible (COERC)

In this paper, we introduce an alternative CoCo structure that achieves the following objectives. First, the instrument does not encourage manipulation by short-sellers nor does it transfer wealth from shareholders to bondholders during a market panic. Second, it has less credit risk than other proposed CoCos, making it more attractive to risk-averse fixed-income investors. Third, as no regulators are involved, uncertainty due to regulatory discretion is avoided. Fourth, with the appropriate trigger mechanism, multiple equilibria are avoided. Finally, existing bank shareholders preserve their pre-emptive rights over bondholders, something which may be important for control reasons.
COERCs have two main features that distinguish them from other CoCo designs, and these two characteristics address criticisms of standard CoCos with market value triggers. First, if conversion is triggered by a decline in the market value of the bank’s capital, a relatively large number of new shares would be issued to COERC investors such that the bank’s existing shareholders would likely be heavily diluted. In other words, the market value of new shares issued to the holders of COERC bonds would likely exceed their bonds’ par value, giving them a capital gain and the bank’s existing shareholders a capital loss. However, the second main feature of COERCs allows existing shareholders to avoid this dilution because they are given the right (option) to purchase the newly issued shares at an exercise price equal to the COERC bonds’ par value.

What incentives are created by these two features? Because the effective share price at which conversion is triggered is intentionally set higher than exercise price needed to repay the par value of the COERC bonds, the existing shareholders will almost always have an incentive to exercise their option to purchase the shares issued to COERC investors. They will be coerced into repaying the COERC investors to avoid being heavily diluted. Moreover, rather than becoming shareholders when conversion is triggered, COERC investors end up receiving their bonds’ par value in cash. This will, in turn, reduce the credit risk of CoCos, thereby enhancing their marketability with fixed income investors. Note that CoCos are often criticized for being hard to value, which makes them unattractive to traditional fixed-income investors and makes credit rating agencies reluctant to rate them.14 These investors may shy away from them because they do not wish to become bank shareholders, especially when the bank is in financial distress. If capital markets are segmented between fixed-income and equity investors, there may be little demand for CoCos, raising their cost to banks that issue them. This criticism applies most to CoCos with triggers based on regulatory capital ratios and/or regulator discretion: banks can manipulate regulatory accounting and regulators’

14 See e.g. “Credit Suisse CoCo Investors Uncertain How to Value Notes,” The Financial Times April 15, 2011. The Credit Suisse CoCo issue was rated BBB by Fitch, but Moody’s and Standard & Poor’s have yet to rate a CoCo, citing uncertainty over these bonds’ potential losses.
decisions are subject to political pressure. But while CoCos with market value triggers are less exposed to regulatory risk, investors have complained that the likelihood of losses at conversion is still hard to predict. However, because COERCs are designed to be nearly default-free, it is relatively easy to value them. Even if the timing of conversion is hard to predict, the fact that CoCo investors almost always receive their bonds’ par value in cash should qualify them for a very high quality credit rating. It should also qualify them for favourable tax treatment since the main argument against the tax deductibility of interest payments is that CoCos are quasi-equity, i.e. they are typically converted, not repaid.

Moreover, COERCs are designed to prevent all undesirable conversions because the initial shareholders have pre-emptive rights to buy all new shares issued to COERC investors. Hence, shareholders can undo any conversion that is the result of manipulation or an unjustified panic. COERC investors would receive their bonds’ par value in cash, not shares. Moreover, COERC investors would have little incentive to hedge their investment by shorting the bank’s shares when the market value of capital approaches the trigger, unlike investors in standard CoCos who become shareholders after the triggering event. The design of the contract also discourages manipulation by the bank’s other bondholders. Bolton and Samama (2010) argue that other bondholders may want to short the bank’s stock to trigger conversion and improve their seniority. However, because COERC investors are repaid in these circumstances, such activity would not improve other bondholders’ seniority.

3.1 Numerical example

For example, Credit Suisse’s CoCo, issued in February 2011, converts to equity if the bank’s core Tier1 capital ratio falls below 7%. However, the Swiss regulator, FINMA, can also force conversion if it sees that Credit Suisse needs public funds to avoid insolvency. The conversion price is the minimum of $20 and the volume weighted average stock price five days before the conversion notice. Arguably, there are three reasons why this CoCo is risky. First the trigger is based on regulatory accounting capital ratios so that the stock price at the time of conversion is unpredictable. Second, if the stock price at the time of conversion is less than $20, CoCo investors can incur a significant loss. Third, the ability of FINMA to force conversion before the trigger is reached creates additional risk that is difficult to price.
This section illustrates the basic features of a COERC with a numerical example. In the next section, we show how COERCs would be valued using the framework of Pennacchi (2010). Similar to the previous numerical example, let the COERC’s par value equal $30 and the trigger stock price be $5. However, when conversion is triggered 30 new shares, rather than 6, are issued to COERC investors. Thus, the implied conversion price is set significantly below the trigger price: it will be $1 rather than $5. Now suppose that the stock price is manipulated down to $5 and COERCs are converted into 30 new shares. Together with the 7 shares owned by the initial shareholders, the total number of shares outstanding is now 37, which translates into a fundamental (non-manipulated) share value of $100/37 = $2.70. Obviously, considering that shareholders have the right to buy back these shares at $1 so that their total payment to COERC investors is $30, they will do so. If they did not, their wealth would fall from 7×$10 = $70 to 7×$2.70 = $18.9, a loss of $51.1. They can recover this loss on their old shares by buying back the 30 shares at $1 from the bondholders (which, at the fundamental value of $2.70 per share, represents a gain of $51). As a result, the COERC investors end up being paid their bonds’ par value.

Suppose instead there was justified, fundamental decline in the bank’s stock price to $5 per share (implying a fall in market value of equity from $70 to $35). COERC bondholders will convert into 30 shares. The fully diluted value per share is now $(30+35)/37 = $1.76 per share. Each shareholder will, again, exercise the option to buy the shares back at $1, so that COERC investors continue to receive their bonds’ par value.

It can be shown that shareholders will always repay the COERC bonds until the fully diluted stock price is equal to $1. This will be the case when the combined value of the COERC bonds and the initial shareholders’ equity equals $37. As COERCs are repaid $30, the equity will be worth $7. Note that at this point the total value of the assets will be $1,037. In other words, as long as the total value of the firm remains above $1,037, the COERC investors are repaid their par value.

Now it becomes clear why a larger proportion of shares are issued to COERC investors makes them less credit-risky. Suppose, instead, that only 6 shares were issued to COERC
investors at conversion, so that the conversion and trigger prices are both $5. Shareholders would not purchase the 6 shares from COERC investors for a total sum of $30 unless the fully diluted stock price was $5. For this to be the case, the total firm asset value must be $1,000 + 13×$5 = $1,065. If the asset value falls anywhere below $1,065, the shareholders will no longer exercise their option. COERC investors will be left with 6 shares worth less than $5, so they experience a loss from their bonds’ par value. In contrast, with a $1 conversion price so that 30 shares are issued to COERC investors, they would become shareholders only if firm value falls below $1,037. Lowering the conversion price clearly reduces a COERC’s credit risk. As we will show, low risk COERCs may not only make them attractive to fixed-income investors but also reduce shareholder – bondholder conflicts related to moral hazard and debt overhang.

3.2 Graphical illustration

Figure 2 illustrates our analysis, assuming that conversion and the repurchase option can only occur at the COERC bond’s maturity. It shows the payoffs of the bond (with par value of $30) and the payoffs to shareholders as a function of total asset value of the firm at the bonds’ maturity date. Note that because the firm has $1,000 of senior debt, all other claims become worthless if firm value falls below $1,000. The solid line shows the payoffs when bonds are not convertible, while the interrupted line shows the case of COERCs.

If the bonds were not convertible, their value, V, would be worth $30 as long as the total firm asset value, A, is higher than $1,030. If A falls below $1,030 but above $1,000, the shareholders are wiped out and the bondholders receive A - $1,000. Note that in this case we get the classic hockey stick graph for the value of equity, equal to \( \text{Max}[A - 1030, 0] \).

If we make the bonds convertible, with a conversion price of $1 whenever the stock price hits $5 or whenever firm value falls below $1,065, equity holders will exercise their call option and repay the bonds at par as long as the fully diluted stock price exceeds $1, or as long as total firm value is larger than $1,037. So until that point, nothing changes compared to the case where the debt was not convertible.
However, when the firm’s value falls below $1,037, shareholders will not bail out the COERC bondholders, who now end up with $30/37 of $Max[A−1000,0]$ which is less than $30. Shareholders obtain the residual, equal to $7/37$ of $Max[A−1000,0]$. Note the fundamental change: shareholders are now interested in preserving firm value between $1,000$ and $1,037. This interest is a direct result of the fact that the COERC investors have to share the value of the firm with the equity holders whenever the value of the firm is in the $1,000$-$1,037$ range.

Note that by putting the conversion price very low (at $1$) COERC bondholders’ risk is only marginally higher than that of non-convertible bonds. If we had put the conversion and trigger price at $5$, the shareholders would have refused to repay the debt when firm value falls below $1,065$, not $1,037$. In that case, the risk of the bondholders would have been higher$^{16}$. Some basic valuation insights can be obtained from Figure 2. At the maturity of the COERC, its value will be the minimum of its par value of $B$ and $\alpha(A-1000)$, where $\alpha$ is equal to the number of shares obtained by COERC investors after conversion ($n_1$) divided by the total number of shares outstanding after the conversion ($n_0+n_1$). In our numerical example, $n_0 = 7$ and $n_1 = 30$, so that $\alpha = 81.1\%$. Let us redefine $Max[A−1000,0]$ as $A^*$; that is, the combined value owned by the COERC investors and initial shareholders. It is straightforward to show that $\text{Min}[B, \alpha A^*] = B − \text{Max}[B − \alpha A^*, 0]$. In words, the COERC is a portfolio of a default-free bond and a short put that allows shareholders to sell back a fraction of the firm, $\alpha A^*$, to the COERC investors at an exercise price of $B$. The shareholders will exercise the option when $B > \alpha A^*$; that is, when the value of the firm owned by the COERC investors following conversion is less than the par value of the COERCs.

$^{16}$ Note that the figure is somewhat oversimplified: if the COERC is more risky than a non-convertible bond, the par value should be higher than 30. As the default risk of a bond increases, its promised par value should increase. However, as shown in the next section, when conversion can occur prior to maturity, COERCs can be less risky than non-convertible bonds.
As mentioned earlier, Sundaresan and Wang (2010) argue that a conversion price based solely on the firm’s stock price leads to multiple equilibria in that there are not individually unique market values for the stock, $S$, and the CoCo bond, $V$. The intuition is that the stock price depends on the conversion decision and vice versa. The simple solution to this multiple equilibrium problem is to make the trigger a function of the sum of the value of shareholders’ equity and the value of COERCs, rather than only the value of shareholders’ equity or just the stock price.\textsuperscript{17} In other words, there is a unique equilibrium when the conversion trigger is based on the sum of the market values of shareholders’ equity and COERCs; that is, the market value of total capital equal to $S \times n_0 + V = A - D$.\textsuperscript{18} Such a trigger is a natural market-value counterpart to the regulatory capital triggers seen in CoCos that have been issued thus far. Note that such a trigger would also reduce the incentives for COERC holders to manipulate the stock. If the value of the COERCs reflects the benefits from this manipulation, the sum of the market value of COERCs and equity will not change and conversion cannot be triggered.

Of course, the viability of a trigger based on a market value of total capital ratio, equal to the sum of the market values of equity plus COERCs, divided by the par value of senior debt (deposits), will depend on the availability of information on senior debt and the liquidity of COERCs. Large U.S. banks must already report their senior debt to the Federal Reserve on a weekly basis.\textsuperscript{19} In addition, while many corporate bonds are not very liquid, subordinated debt issued by large banks is: based on data from TRACE, we find that subordinated debt issued by large U.S. banks (of which contingent capital should be a special case) trade, on average, 30 times per day. Moreover, a bond’s liquidity will be negatively correlated with its risk, and COERCs will have low risk as the only

\textsuperscript{17} Equity equals $30 and COERCs equal $30 in the first equilibrium and equity equals $51 and COERCs equal $9 in the second equilibrium.

\textsuperscript{18} We are grateful to Stewart Myers for first suggesting this approach.

\textsuperscript{19} Banks report the amounts of their deposits and other non-capital liabilities in form FR 2644 Weekly Report of Selected Assets and Liabilities of Domestically Chartered Commercial Banks and U.S. Branches and Agencies of Foreign Banks.
instance where existing shareholders would decline exercising their right to repurchase the COERC investors’ shares would be if a sudden, massive loss in the bank’s capital triggered conversion but also left the large proportion of shares issued to COERC investors to be worth less than their bonds’ par value. Only for such an extraordinary event would the COERC investors become shareholders and suffer a loss. As we will show using reasonable parameter values, COERC bonds might require a 20 basis point credit spread to cover the value of such potential losses.

3.4 Discussion

As long as the fully diluted stock price is above $1 in our example, the shares obtained by COERC investors after conversion are assumed to be sold to initial shareholders at $1 when they exercise their rights. In practice, the shares obtained through conversion will not be issued to COERC investors until the rights issue is completed, perhaps several weeks later. Once the rights issue is completed, the funds will be used to repay the debt. By not issuing the shares directly to COERC investors, the firm avoids a private stock repurchase. In many countries the percentage of shares that can be repurchased is limited, which would prevent the large repurchase in our example. Other countries impose corporate taxes when companies buy back stock. Structuring the COERC contract so that it does not involve a share buyback seems necessary to make it practical. In other words, as soon as the conversion trigger is hit, the company announces a rights issue. If the rights issue is successful, COERC investors are repaid. If not, COERC investors become shareholders as in a standard CoCo.

For the conversion to take place at very low stock prices, shareholders will need to approve a significant increase in the number of authorised shares. Note that after the conversion, the number of shares (and stock price) can be restored through a reverse stock split. In general, shareholders are reluctant to authorise such a large dilution as it can lead to a loss of control. However, since the COERC structure allows shareholders to preserve their pre-emptive rights (again a unique feature relative to other CoCos), control by the initial shareholders’ can be maintained.
One potential concern about CoCos in general is the effect on fully diluted earnings per share (EPS).\(^{20}\) Although diluted EPS may not be economically meaningful, in practice many investors focus on this financial ratio. According to US GAAP “Potentially issuable shares are included in diluted EPS using the ‘if-converted’ method if one or more contingencies relate to the entity’s share price.” As the COERC trigger is based on a market capital ratio, not a stock price, it is unclear whether a firm issuing a COERC would have to report a heavily reduced EPS, particularly since shareholders have purchase rights. Under IFRS “potentially issuable shares are considered ‘contingently issuable’ and are included in diluted EPS using the if-converted method only if the contingencies are satisfied at the end of the reporting period.” This rule would appear to lead to dilution only if conversion is triggered, which of course makes sense.

Although COERCs undermine the limited liability of shareholders, it should be noted that shareholders who are reluctant to contribute more funding to the firm can sell their rights to other investors who rationally will exercise the option. If no one exercises the call option, CoCo investors would realize a large windfall gain: in the example where the combined value of equity and COERCs falls to $65, COERC investors would end up with $52.70, a profit of $22.70 on an investment of $30.

Note that, in general, COERCs will be repaid rather than converted, as there is no reason to assume that the issuance of this type of convertible will communicate a negative signal (Brennan and Kraus (1987)). Companies that feel that they are overvalued would prefer to issue equity, not COERCs, as they would be forced to repay the debt when the market becomes more efficient.

Calomiris and Herring (2011) propose a structure were the fear of dilution encourages banks to issue equity pre-emptively, to prevent that a very dilutive trigger based on equity market value will be reached. Such an equity issue is very likely to provide a very negative signal of the bank’s prospects, possibly revealing that insiders believe the bank’s

\(^{20}\) See Bolton and Samama (2010, p.39).
stock is overvalued. In our case the issuance of equity does not provide a negative signal as the issuance is a result of changes in market values, not managerial decisions. Calomiris and Herring (2011) want to prevent death spirals by outlawing short sales of bank stocks, but even with short sale restrictions a death spiral can be a result of investor panic.

One caveat: our numerical examples have assumed that senior debts, such as deposits, are not withdrawn as the bank’s financial condition worsens. Therefore, it may still be necessary for banks to have deposit insurance or access to government liquidity (as via a central bank “discount window”) to protect against a panic. A COERC should not be viewed as the sole instrument that prevents financial collapse, especially considering that the conversion of COERCs into equity does not infuse new funds into the bank. It simply “cleans up” the balance sheet by reducing the debt overhang problem. This overhang problem is mitigated, but possibly not completely eliminated, if the bank has other senior debt or over-the-counter derivative counterparties. However, since COERCs are subordinated to these other senior liabilities, the larger the proportion of COERCs to these liabilities, the greater will be the reduction in debt overhang. In addition, when conversion occurs at an early stage of financial distress, the resulting higher level of equity decreases any disincentive to issue additional equity or new COERCs.

4. Valuation

This section analyzes how the contractual features of COERCs and the risk of the bank that issues them affect the fair credit spread that COERC investors would require. Credit spreads, or new issue yields, for COERCs are also compared to those for standard CoCos and non-convertible bonds. We also analyze a bank’s risk-shifting incentives and its debt overhang problem when it issues COERCs versus other forms of convertible and non-convertible bonds. The setting for valuing these bonds is the structural model of Pennacchi (2010). Here we summarize the model’s assumptions and refer the reader to the original paper for details.
Because our focus is on how contractual terms affect the losses that COERC and CoCo investors will suffer and the credit spreads that these investors will require, like other structural models, such as Merton (1974), we assume a Modigliani-Miller setting where a bank’s mix of liabilities does not change the total value of the firm. That is, the value of the bank does not incorporate the value of debt’s tax shields or its bankruptcy costs.\textsuperscript{21} While these characteristics of debt would be important if one wished to determine a firm’s optimal capital structure, they would have second-order importance in a comparison of different forms of convertible bank debt. Moreover, the capital structure of banks is largely determined by regulation, at least more so than other types of firms. In addition, neglecting factors such as costs of bankruptcy and financial distress would understate the benefits of COERCs since we show they can be nearly default-free. Furthermore, two types of costs of financial distress, namely, costs arising from underinvestment and risk shifting, are lower for a properly designed COERC than for other types of CoCo bonds or non-convertible debt. So, although we don’t develop a full model of optimal capital structure, our analysis shows that, ceteris paribus, COERCs can reduce the likelihood of distress and bankruptcy. Whether COERCs will strictly dominate other forms of debt may depend on the tax status of their interest payments. However, as argued earlier, COERC investors are almost always repaid in cash, rather than equity, which should justify their treatment as debt.

The model assumes that a bank issues short-maturity deposits (senior debt), shareholders’ equity, and longer-maturity bonds in the form of COERCs, standard CoCos, or non-convertible subordinated debt. To account for the conditions that arise during a financial crisis, we model bank assets with a stochastic process that allows their value to experience sudden jumps. As a consequence, the bank’s stock price (as well as its bond’s value) can also experience the sudden large changes in value that are evident in Figure 1. Denote the date \( t \) value of the bank’s assets as \( A_t \). The change in the bank’s assets equals the asset’s return plus changes due to the bank’s cash inflows less cash outflows. Using

\textsuperscript{21} Albul et al. (2010) and Barucci and Del Viva (2011) consider a firm’s optimal issuance of CoCos, senior debt, and equity using Leland (1994) style models that include taxes and bankruptcy costs. However, these models may not be the most appropriate for modelling banks because they assume all firm debt has a perpetual maturity and the firm’s shareholders, not regulators, determine when the firm becomes bankrupt.
the superscript * to distinguish asset changes solely due to their rate of return, these assets’ risk-neutral rate of return, \( \frac{dA^*_t}{A^*_t} \), satisfies the jump – diffusion process:

\[
\frac{dA^*_t}{A^*_t} = \left( r_t - \lambda k \right) dt + \sigma dz + (Y_{q_t} - 1) dq_t
\]

(1)

where \( dz \) is a Brownian motion, \( q_t \) is a Poisson counting process that increases by 1 with probability \( \lambda dt \),

\[
\ln \left( Y_{q_t} \right) \sim N \left( \mu_y, \sigma^2_y \right)
\]

(2)

and \( k = E^Q \left[ Y_{q_t} - 1 \right] = \exp \left[ \mu_y + \frac{1}{2} \sigma^2_y \right] - 1 \) is the risk-neutral expected value of a jump. In equation (1), \( \sigma \) is the standard deviation of the continuous diffusion movements in the bank’s assets while the parameter \( \lambda \) measures the probability of a jump in the assets’ value. Equation (2) specifies that the jump size is lognormally distributed, where the parameter \( \mu_y \) controls the mean jump size and \( \sigma_y \) is the jump size’s standard deviation.

Because interest rates change in an uncertain manner, especially during a financial crisis, we permit the default-free interest rate (e.g., Treasury bill rate), \( r_t \), to be stochastic. It follows the process of the well-known model of Cox, Ingersoll, and Ross (1985).

Our model assumes bank deposits have a very short maturity, but are default-risky and pay a fair, competitive interest rate. This assumption fits many large “money-center” banks which tend to rely on short-term, wholesale sources of funds, such as large-denomination deposits paying LIBOR. Assuming deposits have a short maturity also simplifies our analysis because the conversion of CoCos or COERCs does not affect the current value or yield on deposits because conversion does not change the total amount of claims junior to deposits. It only changes the composition.

\[
\text{Modeling the “risk-neutral” or “Q-measure” processes for the bank’s assets allows us to value the bank’s liabilities in a general way that accounts for the assets’ risks. The risk-neutral expectations operator is denoted } E^Q \left[ \cdot \right].
\]

\[
\text{Because conversion can change the bank’s cash outflows due to a reduction in coupon payments, it will, in general, change future interest rates on deposits. The model accounts for this fact.}
\]
Thus, let $D_t$ be the date $t$ quantity of bank deposits which are assumed to have an instantaneous (e.g., overnight) maturity and to pay an interest rate of $r_t + h_t$, where $h_t$ is their fair credit spread. Another realistic assumption of the model is that the bank attempts to target a capital ratio or asset-to-deposit ratio, so that leverage tends to be mean-reverting. Much empirical evidence, including Flannery and Rangan (2008), Adrian and Shin (2010), and Memmel and Raupach (2010), finds that deposit growth expands (contracts) when banks have an excess (a shortage) of capital. This is modeled by defining $x_t = A_t/D_t$ as the date $t$ asset-to-deposit ratio which the bank targets by adjusting deposit growth according to:

$$\frac{dD_t}{D_t} = g(x_t - \hat{x}) \, dt$$  \hspace{1cm} (3)$$

where the positive constant $g$ measures the strength of mean-reversion and $\hat{x} > 1$ is the bank’s target asset-to-deposit ratio.

The bank is assumed to fail (be closed by regulators) when assets fall to, or below, the par value of deposits (plus any non-convertible bonds). If failure occurs, total losses to depositors are $D_t - A_t$. While deposits are default-risky, prior to failure their value always equals their par value $D_t$ since their short maturity allows their credit spread $h_t$ to continually adjust to its fair value. This assumption simplifies the valuation of the bank’s other liabilities since they always sum to total capital worth $A_t - D_t$. Moreover, it can be shown that this fair credit spread equals

$$h_t = \lambda \left[ N(-d_1) - x_t \exp\left(\mu_y + \frac{1}{2} \sigma_y^2\right) N(-d_2) \right]$$  \hspace{1cm} (4)$$

where $d_1 = \ln(x_t) + \mu_y / \sigma_y$ and $d_2 = d_1 + \sigma_y$. Note that $h_t$ is a strictly decreasing, convex function of the bank’s asset to deposit ratio, $x_t = A_t/D_t$.

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24 Another structural model of a firm with mean-reverting leverage is Collin-Dufresne and Goldstein (2001). They show that allowing leverage to mean-revert is necessary for matching the credit spreads of corporate bonds. Given empirical evidence that bank leverage displays even stronger mean-reversion than that of non-financial corporations, modeling this phenomenon appears particularly important for accurately valuing bank bonds.

25 Note that this credit spread depends only on the bank’s current asset-to-deposit ratio and the parameters of the asset jump process. Only jumps that wipe out the bank’s capital can impose losses on depositors.
In addition to deposits, at date 0 the bank issues subordinated bonds having a par value of $B$ and a finite maturity date of $T > 0$. Prior to maturity or conversion, the bonds pay a continuous coupon per unit time, $c_t dt$. Since, in reality, banks issue both fixed- and floating-coupon bonds, our model considers each of these cases. If coupons are fixed, then $c_t = c$, while if coupons are floating, then $c_t = r_t + s$ where $s$ is a fixed credit spread over the short-term default-free rate. In general, the value of fixed-coupon bonds is exposed to both interest rate risk and credit risk whereas the value of floating-coupon bonds is sensitive only to credit risk. At date 0, the fixed coupon rate, $c$, or fixed spread, $s$, is set such that the bond sells (is issued) at its par value, $B$. The method of determining this new issue coupon rate (yield) or coupon spread will be discussed shortly.

The bank’s shareholders’ equity equals the bank’s residual asset value when the bond matures or is converted, and it equals zero if the bank fails. Now suppose that the bond is convertible, so that it is either a standard CoCo or a COERC. We can define a post-conversion original shareholders’ equity to deposit ratio at which conversion is triggered as

$$
\bar{e} = \frac{A_t - D_t - B}{D_t}
$$

(5)

In the example of the previous Sections 2 and 3, $D_0 = 1000$, $B = 30$, and conversion is triggered when $\bar{e} = 3.5\%$.\(^{26}\) If there are $n_0$ shares of equity outstanding and the current level of deposits is $D_t$, then the post-conversion trigger stock price can be expressed as $\bar{e}D_t / n_0 = (\bar{a}_t - D_t - B) / n_0$, where $\bar{a}_t$ is the value of $A_t$ that satisfies equation (5).

Note that equation (5) can be rewritten as

$$
\frac{A_t - D_t}{D_t} = \frac{S_t \times n_0 + V_t}{D_t} = \bar{e} + \frac{B}{D_t}
$$

(6)

\(^{26}\) Note that the trigger ratio in equation (5) allows for the (realistic) possibility that the quantity of deposits can change over time. Alternatively, one could specify the trigger stock price to be fixed. But if the bank changes its asset value by issuing or reducing deposits, then the ratio of equity to deposits (senior debt) will not always be the same at the trigger stock price. From a regulatory viewpoint, it might be preferable to make the trigger a fixed market value equity to deposit ratio. But this requires the trigger stock price (assuming the number of shares are constant) to be proportional to deposits. More generally, one might wish to allow the bank to issue or repurchase shares, in which case the stock price again will need to be adjusted so that the trigger continues to reflect a fixed equity to deposit ratio.
Hence our trigger is based on the combined value of equity and CoCos (or COERCs) relative to deposits. In other words the equity trigger of 3.5% of deposits is equivalent to a trigger of $S_n n_0 + V_t = 3.5\% + 3\% = A_t - D_t = 6.5\%$ of capital to deposits. As discussed earlier, this trigger mechanism, rather than a trigger based solely on stock prices, eliminates the multiple equilibria discussed by Sundaresan and Wang (2010).

Furthermore, since the market value capital ratio in equation (6) is $(A_t - D_t)/D_t = x_t - 1$, the bank’s asset to deposit ratio, $x_t$, can be viewed as the “state” variable triggering the conversion event.

Let us now consider the specific case in which the convertible bond is a COERC. Let $n_1$ be the total number of new shares offered to COERC investors for converting to common equity, where $n_1 = B / (\bar{\varepsilon} D_t / n_0)$; that is, the price per share at which COERC investors can purchase stock is $B / n_1 \leq \bar{\varepsilon} D_t / n_0$, so that it is much less than the trigger price.\(^ {27}\) If conversion is triggered, say at date $t_c$, because $A_{t_c} \leq B + D_{t_c} (1 + \bar{\varepsilon})$, then we can think of a rights offering being completed at date $t_r > t_c$ where, for example, $t_r = t_c + 20$ trading days if it takes approximately one month for a rights offering to be completed. As before, define $\alpha = n_1 / (n_0 + n_1)$. Then assuming shareholders optimally exercise their right to purchase the stock at the conversion price, the value of the COERC bond at the rights offering date, say $V_{t_r}$, will be

$$V_{t_r} = \begin{cases} B & \text{if } B \leq \alpha (A_{t_r} - D_{t_r}) \\ \alpha (A_{t_r} - D_{t_r}) & \text{if } 0 < \alpha (A_{t_r} - D_{t_r}) < B \\ 0 & \text{if } A_{t_r} - D_{t_r} \leq 0 \end{cases}$$

Using a Monte Carlo valuation technique that simulates the risk-neutral processes for the bank’s asset-to-deposit ratio, $x_t$, and the instantaneous-maturity interest rate, $r_t$, new issue yields, $c$, for fixed-coupon COERCs or new issue spreads, $s$, for floating-coupon COERCs can be computed. This is done by computing the COERC’s date 0 value, $V_0$, for a given coupon rate or spread. Then, the COERC’s fair new issue yield, $c^*$, or fair new

\(^ {27}\) While the trigger price depends on $D_t$, the variation in $D_t$ relative to $D_0$ is likely to be sufficiently small so that the inequality will hold.
credit spread, \(s^*\), is determined by varying \(c\) or \(s\) until \(V_0 = B\); that is, until the COERC initially sells for its par value.

New issue yields for fixed-coupon COERC bonds are graphed in Figures 3 to 6. The parameter assumptions regarding the term structure of interest rates, the bank’s jump-diffusion risk parameters, capital targeting behavior, and deposit growth are the same as the benchmark parameters listed in Pennacchi (2010).\(^{28}\) The bank is assumed to target a total capital-to-deposit ratio of 10%. In addition, COERC bonds are assumed to have a five-year maturity and an initial par value equal to 3% of deposits (as in our earlier numerical examples); that is \(B/D_0 = 3\%). \(^{29}\) Following a triggered conversion, it is assumed to take 20 trading days for a rights offering.

The horizontal axis in the figures gives the initial percent of total bank capital per deposits, \((A_0 - D_0)/D_0\), at the time of the bond issue. The vertical axis is the fixed-coupon new issue yield (par yield), in percent. In each figure, the dashed, horizontal line at the bottom is the par yield on a five-year maturity, default-free Treasury bond, equal to 4.23%.

In Figure 3, conversion is assumed to be triggered when the post-conversion equity value equals 3.5% of deposits; that is, \(\tau = 3.5\%). Thus, with COERCs equaling 3% of deposits, this implies conversion at a capital-to-deposits ratio of about 6.5%. The lower blue schedule gives new issue yields for various initial capital levels under the assumption that \(\alpha = n_1/(n_0 + n_1) = 30/37\). It shows that new issue yields are higher when the bank’s initial capital is lower. The reason is that when capital is low, conversion becomes more likely. Given the assumption of a jump-diffusion process for bank asset returns, it is possible that conversion may occur following a sudden loss in capital where the original bank shareholders will no longer wish to buy back the converted COERCs shares at par

\(^{28}\) The initial instantaneous default-free interest rate, \(r_0\), is assumed to be 3.5% and the Cox, Ingersoll, and Ross term structure parameters are such that the initial par yield on a five-year default-free (Treasury) coupon bond is 4.23%. The parameters describing the asset jump-diffusion process and the capital targeting process are \(\sigma = 2\%, \lambda = 1, \mu = -1\%, \sigma_y = 2\%, g = \frac{1}{2}, \) and \(\hat{\lambda} = 1.10\).

\(^{29}\) Thus, the targeted level of shareholders’ equity to deposits is 7%.
because equilibrium share values will have decreased to less than par. This is the case of the second or third line in the COERC payoff in equation (7) above.

The upper, red schedule in Figure 3 is similar except that the ratio of COERC shares to total shares at conversion is specified to be $\alpha \equiv n_1/(n_0 + n_1) = 20/27$. New issue yields are higher compared to the previous schedule for each initial capital level. The intuition for this result is that when $\alpha$ is lower, so that the number of shares issued to COERC investors is less, it would take a smaller sudden decline in bank capital before the original equity holders would no longer wish to buy back the new COERC shares at par.\(^{30}\) Consequently, there is a greater possibility that COERC investors will suffer a loss in value at conversion.

The lower, blue schedule in Figure 4 repeats the schedule in Figure 3; that is $\alpha \equiv n_1/(n_0 + n_1) = 30/37$ and conversion is triggered when the post-conversion equity-to-deposit ratio is $\bar{e} = 3.5\%$. The upper, red schedule in Figure 4 assumes the same parameter values except that conversion is triggered when the post-conversion equity-to-deposit ratio is $\bar{e} = 2.0\%$. This implies that conversion occurs when the capital-to-deposit ratio is approximately 5\%, rather than 6.5\%, and is the reason why this schedule is graphed for capital-to-deposit ratios as low as 5.5\%. For each initial level of capital, new issue yields are higher compared to the blue schedule because with a smaller amount of original shareholders’ equity, a smaller downward jump in the bank’s asset value is sufficient to dissuade the original shareholders from buying back the newly issued COERC shares at par.

For comparison, we next consider the value of a standard CoCo bond that is assumed to have the same general structure as the COERC. The CoCo is assumed to convert at the same trigger value, equation (4), but receive a different number of shares, $n_1$, upon conversion to common equity. It is assumed that this number of shares equals that which

\(^{30}\) In other words, the first line of the COERC payoff in equation (7) becomes less likely.
converts the CoCo to equal its par value if the post-conversion stock price equals the trigger price:\(^\text{31}\)

\[ n_1 = B \frac{1}{(\bar{D}_t / n_0)} \]  

This is the conversion method advocated by Flannery (2010) and Sundaresan and Wang (2010). If, as before, we define \( \alpha \equiv n_1/(n_0 + n_1) \) as the ratio of the number of shares issued to contingent capital investors as a proportion of total shares if conversion occurs, then for this case

\[ \alpha = \frac{B}{B + \bar{D}_t} \]

In other words, if conversion happens where the post-conversion stock price exactly equals the trigger price, then contingent capital will be worth its par value (e.g., 3\%) and original shareholders’ equity equals its value at the trigger stock price (e.g., 3.5\%).

Thus, if conversion is triggered, say at date \( t_c \), because \( A_{t_c} \leq B + D_{t_c} (1 + \bar{D}_{t_c}) \), then the value of the CoCo at conversion, say \( V_{t_c} \), will be

\[ V_{t_c} = \begin{cases} 
\alpha (A_{t_c} - D_{t_c}) & \text{if } 0 < \alpha (A_{t_c} - D_{t_c}) \leq B \\
0 & \text{if } A_{t_c} - D_{t_c} \leq 0
\end{cases} \]

Note from equation (5) that if \( A_{t_c} = \bar{D}_{t_c} + B + D_{t_c} \), so that conversion occurs smoothly at an asset value that leaves the ex-post conversion value of equity exactly equal to \( \bar{D}_{t_c} \), then the conversion value of contingent capital is exactly par, \( V_{t_c} = B \). Instead, if conversion occurs following a downward jump in asset value such that \( A_{t_c} < \bar{D}_{t_c} + B + D_{t_c} \), then the CoCo’s conversion value is strictly less than its par value.

This is the conversion method for standard CoCos that is assumed in Figures 5 and 6.

Figure 5 shows that the new issue yields for fixed-coupon CoCos (without the call option enhancement) is always larger than those for comparable COERCs. For a given level of capital, yields increase as \( \alpha \), the ratio of shares issued to COERC investors to total shares,

\(^{31}\) Note that the trigger price depends on \( D_t \).
declines. For standard CoCos, this ratio is at its minimum, \( \alpha = B / (B + eD) = 6/13 \), which is where shareholders have no incentive to repurchase the newly issued shares.

Figure 6 makes the same comparison but where both COERCs and standard CoCos pay floating, rather than fixed, coupons. It also considers floating-coupon, non-convertible subordinated debt that has the same par value \((B = 3\% \times D_0)\) and maturity \((T = 5\text{ years})\) as the COERCs and standard CoCos. What is graphed are these three bonds’ new-issue credit spreads (in basis points) over the short-term default-free interest rate \(r_t\). This is done for various initial capital to deposit ratios. Note that new-issue credit spreads for non-convertible subordinated debt are calculated for capital as low as 3.5\% of deposits while credit spreads for COERCs and standard contingent capital are calculated at capital only as low as 7\% of deposits because they convert at a 6.5\% capital threshold.

Similar to Figure 5, Figure 6 shows that the greater number of shares issued to COERC investors, together with shareholders’ call option to buy them back, leads to more states of the world where bondholders are paid back at par, thereby reducing the COERC’s new issue credit spread relative to that of standard CoCos. Moreover, Figure 6 shows that COERCs can be less risky than even non-convertible subordinated bonds.\(^{32}\) While non-convertible bonds would not default until total bank capital falls below 3\% of deposits, if it does, they are certain to suffer losses. COERCs could suffer losses at higher levels of capital, since shareholders would not repurchase COERC shares at par if capital suddenly falls below \(3\% / \alpha = 3\% / (30/37) = 3.7\%\) of deposits when it was just before above 6.5\% of deposits. However, there are many states of the world when capital breaches the 6.5\% threshold (but stays above 3.7\%) where COERCs are repaid at par. In these situations, COERC investors are better off because, unlike non-convertible bondholders, they no longer face the threat of losses due to further declines in capital.

\(^{32}\) In general, COERCs can have smaller or larger new-issue credit spreads relative to comparable non-convertible subordinated debt. If the COERC to total share ratio, \(\alpha\), is low, credit spreads on COERCs can exceed those for non-convertible debt. This can be seen in Figure 6 where CoCos without a call option have higher credit spreads than non-convertible subordinated debt. Recall that standard CoCos can be interpreted as a COERC where \(\alpha\) is at a minimum (trigger and conversion prices are equal), which in this example is \(\alpha = 6/13\).
The design features that reduce the default risk of COERCs relative to that of standard CoCos (and in some cases, non-convertible debt) have implications for a bank’s risk-shifting incentives. As pointed out by Merton (1974), shareholders’ equity of a levered, limited-liability firm is comparable to a call option written on the firm’s assets with a strike price equal to the promised payment on the firm’s debt. By raising the risk of the firm’s assets, the shareholders can increase the volatility and, in turn, the value of their call option at the expense of the firm’s debt value. This moral hazard incentive to transfer value from debt holders to equity holders tends to rise as the firm becomes more levered.

The risk-shifting incentives of banks that issue COERCs, standard CoCos, and non-convertible bonds can be analyzed in the context of our model. We calculate the change in the value of the bank’s shareholders’ equity, \( \partial E \), which equals minus the change in the value of the bank’s bonds, \(-\partial V\), following an increase in one of the bank’s risk parameters.\(^33\) Unlike most models such as Merton (1974) that have only one asset risk parameter controlling the volatility of diffusion risk, \( \sigma \), our model has three additional parameters determining jump risks: the frequency of jumps, \( \lambda \); the volatility of the size of jumps, \( \sigma_y \); and the mean jump size, \( \mu_y \). Considering the risk from possible jumps in asset values is critical, because without it all of the bonds that we analyze would be default-free and have zero credit spreads; that is, they would always be paid their par values at maturity, conversion, or the bank’s failure.\(^34\)

Figures 7 to 10 illustrate the change in the value of shareholders’ equity following a 25% increase in one of these parameters from its benchmark level. In each figure, the calculation is made for current bank capital levels ranging from 7% to 15% of deposits. These calculations assume that the bonds issued by the bank pay floating coupons and were issued at a fair credit spread when the bank had total capital equal to 10% of deposits.

\(^33\) Because deposits have a very short (instantaneous) maturity and their fair credit spread immediately adjusts, a change in one of the bank’s asset risk parameters does not affect the value of deposits.

\(^34\) With only diffusion (Brownian motion) risk, asset values follow a continuous sample path and, given the par-value triggers that we assume, the bonds are always be paid their par values at conversion. This is the case for the models of Sunderesan and Wang (2010) and Albul, Jaffee and Tchistyi (2010) where only diffusion risk affects asset returns. Furthermore, since we assume the bank is closed whenever capital falls to or below the par value of deposits plus any non-convertible bonds, a pure diffusion process for assets implies that non-convertible subordinated debtholders are repaid at par when the bank fails.
deposits, and bonds are 3% of deposits. Note that bonds could be COERCs, CoCos, or non-convertible subordinated debt. As in our previous examples, the conversion threshold for COERCs and standard CoCos is assumed to be at a total capital value of 6.5% of deposits.

Figure 7 shows that the value of shareholders’ equity increases following a rise in the frequency of jumps, $\lambda$. The change tends to be greater as the bank’s capital declines, except for convertible bonds at capital levels near the conversion threshold. However, the most important finding is that the increase in equity is greater when the bank issues a standard CoCo or a non-convertible, subordinated bond than when it issues a COERC. A bank that issues COERCs has a smaller incentive to engage in activities or make investments that would increase the frequency of large changes in the value of the bank’s assets. The relatively greater number of shares that COERC investors receive at conversion better protects the par value of their investment compared to investors in standard CoCos. Furthermore, because COERCs have a high probability of being converted at par, they benefit from the ability to exit the bank earlier than non-convertible bond investors.

The same qualitative finding occurs in Figure 8 which solves for the change in the value of shareholders equity following a rise in the volatility of jump sizes, $\sigma$. For any level of capital, the moral hazard problem of choosing activities or investments that produce potentially large profits or losses is reduced with COERCs relative to standard CoCos or non-convertible bonds. A similar result emerges in Figure 9 which computes the rise in the value of equity following a decline in the mean jump size, $\mu$. A bank that issues COERCs, rather than standard CoCos or subordinated debt, has a smaller incentive to choose investments or activities that are subject to large losses.

35 For convertible bonds near the conversion threshold, it can be relatively more likely that the threshold will be hit exactly (due to diffusion movements in asset values) which would result in repayment at par. Furthermore, at low levels of capital, the market value of equity is also low, so that its absolute increase from greater risk will tend not to be as great, though it can be greater as a proportion of equity.

36 The figure shows the change in the value of equity when $\mu$ declines from -1% to -1.25%.
As noted earlier, in our model non-convertible bonds, standard CoCos (with a par-conversion trigger), and COERCs are default-free if jump risk is absent and only diffusion risk affects bank asset values. Thus, increasing diffusion risk could not change the value of equity or these three bonds. However, when both jump and diffusion risks are present, risk-shifting incentives are influenced by diffusion risk. We now assume our model’s jump risk parameters are at their benchmark levels and consider a rise in the diffusion risk parameter, $\sigma$. Figure 10 shows that for high capital levels, greater diffusion risk is qualitatively similar to greater jump risk in that it makes capital depletion more likely. However, the reverse occurs for convertible bonds at low levels of capital where increases in diffusion risk can hurt shareholders. The intuition for this result is that greater diffusion risk increases the likelihood that assets decline to the trigger threshold continuously, making conversion occur exactly at par. Thus, greater diffusion risk could counteract jump risks which create the possibility of conversion at less than par.

Our final comparison between non-convertible bonds, standard CoCos, and COERCs is with respect to the debt overhang problem of their issuing bank. In general, when bank debt is subject to possible losses from default, issuing new equity will make debt’s default losses less likely and increase its value. Given that investors pay a fair price for the new equity issue, the increase in the debt’s value must come at the expense of the bank’s pre-existing shareholders’ equity. Such a loss in shareholder value creates a disincentive for the bank to replenish its equity following a decline in the bank’s capital, which is the Myers (1977) debt overhang problem.

We quantify debt overhang by calculating the change in the value of the bank’s shareholders’ equity, $\partial E$, following a new equity issue that increases the bank’s assets by $\partial A$. Since new equity is assumed to be fairly priced, the change in the value of the pre-existing shareholders’ equity is $\partial E/\partial A - 1$. A negative value for this quantity indicates debt overhang. Similar to previous figures that analyzed risk-shifting incentives, Figure 11 shows calculations of $\partial E/\partial A - 1$ for a bank that issued either a non-convertible subordinated bond, standard CoCos, or a COERC. In each case the bonds were assumed to be issued at a fair floating-coupon credit spread when the bank had total capital equal
to 10% of deposits, with 3% of it in the form of the bonds. As before, the conversion threshold for COERCs and standard CoCos is assumed to be when total capital equals 6.5% of deposits. The calculations assume the amount of new equity, \( \partial A \), equals 0.125% (one-eighth of a percent) of deposits.

Relative to non-convertible subordinated debt, Figure 11 shows that COERCs reduce the debt overhang problem for any level of bank capital. In addition, for most capital levels the debt overhang problem also is smaller for a bank that issues COERCs relative to one that issues standard CoCos. The only exception occurs at low capital levels where the two bonds are close to their conversion thresholds. There we see that \( \partial E/\partial A - 1 \) actually turns positive. The intuition for this result is that conversion due to a diffusion movement in asset value becomes more likely when capital is close to the threshold, an event that would pay the bondholders’ their par values and which the shareholders would wish to avoid. However, taken as a whole, our analysis indicates that COERCs mitigate debt overhang and could improve financial stability by removing much of the bank’s disincentive to replenish capital following an expected loss.

5. Summary

In this paper we introduce and value a new security, the Call Option Enhanced Reverse Convertible (COERC), that reduces the probability of default and hence the associated costs of financial distress. The security design modifies the CoCo proposal of Flannery (2005, 2009a) to deal with three fundamental issues. First, the security should not be an instrument to manipulate the issuing firm’s stock price or put its stock in a “death spiral” tailspin due to fears of massive dilution. COERCs avoid this problem by giving shareholders an option to buy back the shares from the COERC investors at the conversion price. Second, one cannot expect that there will be a very active market for CoCos if their investors are exposed to large risks. One way to reduce these investors’ risks is to design their security in such a way that it forces shareholders to pay them back when financial distress becomes significant. This is achieved with COERCs by setting the conversion price very low, below the stock price that will trigger the conversion. Not
paying back the COERC investors would massively dilute shareholders and transfer wealth to COERC investors. This, in turn, lowers the credit risk of COERCs. Third, the security should be designed to rule out the problem of multiple equilibria pointed out by Sundaresan and Wang (2010). Basing the conversion trigger on market value of total capital to senior debt ratio, rather than the stock price, eliminates multiple equilibria.

Because COERCs have low credit risk, they can lower not only the direct, but also the indirect, costs of financial distress. Relative to standard CoCos, or even non-convertible bonds, COERCs’ lower default risk mitigates the excessive risk-taking incentives that are typically present in a levered firm. The COERC design that reduces the possibility of wealth transfers between their investors and shareholders also helps solve the ‘debt overhang’ problem of high leverage described by Myers (1977). This reduction in agency costs should make the COERC design relevant for corporations in general.

Finally, unlike some other CoCos, with COERCs involvement by government regulatory authorities is not required. For example, Duffie (2010) proposes that regulators force a bank to make a deep discount rights issue whenever they consider it necessary. The COERC design also “forces” equityholders to repay debt in order to avoid dilution, but because this commitment is anticipated, it will benefit shareholders through lower yields on COERCs. Of course, in order to make a COERC interesting for issuers, interest should be tax deductible. It would be ironic if government policy handicapped debt that reduces the likelihood of a financial crisis while favouring standard debt that does not. Considering the fact that COERC investors are almost always repaid in cash, the tax authorities should look more favourably at a COERC than at a normal CoCo that converts to equity in times of financial distress.
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Table I

Mean and median 2008 Tier 1 Common ratios of major US Banks

Panel A : Mean and Median 2008 Tier 1 Common Ratios of 50 Major U.S. Banks

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<th>March 31</th>
<th>June 30</th>
<th>Sept 30</th>
<th>Dec 31</th>
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<tr>
<td>Mean</td>
<td>8.07</td>
<td>8.14</td>
<td>8.16</td>
<td>9.12</td>
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<tr>
<td>Median</td>
<td>7.88</td>
<td>7.92</td>
<td>7.89</td>
<td>9.14</td>
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Panel B : 2008 Tier 1 Common Ratios of Selected Large Banks

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<th>March 31</th>
<th>June 30</th>
<th>Sept 30</th>
<th>Dec 31</th>
</tr>
</thead>
<tbody>
<tr>
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<td>6.08</td>
<td>6.80</td>
<td>6.10</td>
<td>7.47</td>
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<tr>
<td>Bank of NY Mellon Corp</td>
<td>7.44</td>
<td>7.94</td>
<td>8.00</td>
<td>11.90</td>
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<td>Capital One FC</td>
<td>9.48</td>
<td>9.90</td>
<td>10.58</td>
<td>12.46</td>
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<tr>
<td>Citigroup</td>
<td>5.83</td>
<td>6.79</td>
<td>6.14</td>
<td>9.48</td>
</tr>
<tr>
<td>JP Morgan Chase &amp; Co</td>
<td>7.01</td>
<td>6.86</td>
<td>6.91</td>
<td>8.94</td>
</tr>
<tr>
<td>Wells Fargo &amp; Co</td>
<td>6.69</td>
<td>6.53</td>
<td>6.45</td>
<td>5.98</td>
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Note: The Tier 1 common ratio is defined as Tier 1 capital minus qualifying minority interest in consolidated subsidiaries minus qualified preferred stock minus other deductions divided by risk weighted assets. Data source: Y-9C Bank Holding Company Reports obtained from the Federal Reserve Bank of Chicago.
Figure 1

Percentage of 100 Largest U.S. Banks with a Daily Stock Return less than -10%
Figure 2. COERC versus straight debt

Payoff diagrams to shareholders and bondholders when debt is not convertible.

Payoff to shareholders and bondholders when debt is convertible

\[ V = \text{Subordinated Bonds} \]

\[ E = \text{Shareholders' Equity} \]

\[ A = \text{Total firm value} \]
New Issue Yields on Fixed-Coupon COERCs
For Different Numbers of Shares Issued

Five-Year Maturity, Initial COERC Value = 3% of Deposits,
Conversion Triggered when Total Capital = 6.5% of Deposits
Dashed Line is Five-Year Default Free Treasury Yield

COERC shares to total shares ratio $\alpha = 20/27$

COERC shares to total shares ratio $\alpha = 30/37$
New Issue Yields on Fixed-Coupon COERCs
For Different Equity Trigger Thresholds

Five-Year Maturity, Initial COERC Value = 3% of Deposits,
COERC Shares to Total Shares Ratio $\alpha = \frac{30}{37}$
Dashed Line is Five-Year Default Free Treasury Yield

Conversion Triggered when Total Capital = 5.0% of Deposits
Conversion Triggered when Total Capital = 6.5% of Deposits
New Issue Yields on Fixed-Coupon COERCs versus Contingent Capital without Call Option

Five-Year Maturity, Initial Bond Value = 3% of Deposits, Conversion Triggered when Total Capital = 6.5% of Deposits

α = COERC Shares to Total Shares Ratio

Dashed Line is Five-Year Default Free Treasury Yield

Contingent Capital without Call Option

COERC \(\alpha = \frac{10}{17}\)

COERC \(\alpha = \frac{20}{27}\)

COERC \(\alpha = \frac{30}{37}\)
Figure 6

New Issue Credit Spreads on Floating-Coupon COERCs, Contingent Capital, and Subordinated Debt

Five-Year Maturity, Initial Bond Value = 3% of Deposits, Conversion Triggered when Total Capital = 6.5% of Deposits

\( \alpha = \text{COERC Shares to Total Shares Ratio} \)
Figure 7

Change in the Value of Shareholders’ Equity per Deposit
For a 25% Increase in Frequency of Jumps ($\lambda$)

Five-Year Maturity, Initial Bond Value = 3% of Deposits,
Conversion Triggered when Total Capital = 6.5% of Deposits

$\alpha = \text{COERC Shares to Total Shares Ratio}$

Contingent Capital without Call Option
Non-convertible Subordinated Debt
COERC $\alpha = 30/37$
Figure 8

Change in the Value of Shareholders’ Equity per Deposit For a 25% Increase in the Volatility of Jumps (σₚ)

Five-Year Maturity, Initial Bond Value = 3% of Deposits, Conversion Triggered when Total Capital = 6.5% of Deposits
α = COERC Shares to Total Shares Ratio

Contingent Capital without Call Option
Non-convertible Subordinated Debt
COERC α = 30/37

Capital to Deposits (%)
Figure 9

Change in the Value of Shareholders’ Equity per Deposit
For a 25% Decline in the Mean Jump Size (\( \mu_y \))

Five-Year Maturity, Initial Bond Value = 3% of Deposits,
Conversion Triggered when Total Capital = 6.5% of Deposits
\( \alpha = \text{COERC Shares to Total Shares Ratio} \)

Contingent Capital without Call Option
Non-convertible Subordinated Debt
COERC \( \alpha = 30/37 \)
Change in the Value of Shareholders’ Equity per Deposit
For a 25% Increase in Diffusion Volatility ($\sigma$)

Five-Year Maturity, Initial Bond Value = 3% of Deposits,
Conversion Triggered when Total Capital = 6.5% of Deposits
$\alpha = \text{COERC Shares to Total Shares Ratio}$

- Non-convertible Subordinated Debt
- Contingent Capital without Call Option

$\frac{\partial (E/D)}{\partial \sigma}$

Capital to Deposits (%)
Figure 11

Change in the Value of Existing Shareholders’ Equity Following an Increase in New Equity of 0.125% of Deposits

Five-Year Maturity, Initial Bond Value = 3% of Deposits, Conversion Triggered when Total Capital = 6.5% of Deposits

\[ \alpha = \text{COERC Shares to Total Shares Ratio} \]