Contingent Capital: The Case for COERCs

by

George Pennacchi[1], Theo Vermaelen[2] and Christian C.P. Wolff[3]

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Abstract

In this paper we propose a new security, the Call Option Enhanced Reverse Convertible (COERC). The security is a form of contingent capital, i.e. a bond that converts to equity when the market value of equity or capital falls below a certain trigger. The conversion price is set significantly below the trigger price and, at the same time, equity holders have the option to buy back the shares from the bondholders at the conversion price. Compared to other forms of contingent capital proposed in the literature, the COERC is less risky in a world where bank assets can experience sudden, large declines in value. Moreover, the structure eliminates concerns of an equity price "death spiral" 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.

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[1]University of Illinois at Urbana Champaign, Email: gpennacc@illinois.edu [2] INSEAD, Email: theo.VERMAELEN@insead.edu [3]Luxembourg School of Finance, University of Luxembourg and CEPR, Email: Christian.WOLFF@uni.lu

1. Introduction

In this paper we propose a new type of contingent capital, which we baptize COERC, or Call Option Enhanced Reverse Convertible. Contingent capital is debt that converts automatically into equity after some triggering event, such as a decline in the market value of the firm's equity or capital below a threshold level. Hence, when the firm is in financial distress, the company recapitalizes automatically, avoiding a lengthy negotiation process with creditors. The issuance of contingent capital (also called coco bonds) has been proposed as a method to avoid a new financial crisis and avoid government bailouts of banks "too big to fail." Interest in such securities has been made stronger after the observation that "in the recent crisis existing subordinated debt and hybrid capital largely failed in its original objective of bearing losses."[1] The fact is that, in order to save banks that are "too big to fail," governments have bailed out subordinated debt holders. As a result contingent capital is likely to play an important role in the new Basel III agreements. According to some estimates[2], banks may have to issue up to \$ 1 trillion of contingent capital to replace existing securities that will no longer qualify as regulatory capital. The Swiss National bank has taken the lead by requiring that their two major banks, UBS and Credit Suisse, have to increase their capital ratios to 19 % but that up to 9 % of this requirement can be met by issuing contingent capital.

In many ways coco bonds seem like an ideal financing instrument for the shareholder value maximizing firm. Compared to equity, contingent capital securities have tax advantages to the extent that interest is a tax deductible expense. While this is the case in Europe, in the US tax deductibility may be denied if the instrument falls within Section 163 (I) of the tax code.[3] However, as Albul, Jaffee and Tchistyi (2010) point out, if contingent capital would be recognized as a formal component of US prudent capital regulation, it is likely that interest paid by contingent capital instruments would be tax deductible. As long as the debt is not converted, contingent capital also reduces agency

[1] "Risk, Reward and Responsibility : The Financial Sector and Society" (2009), Her Majesty's Treasury.
[2] Standard and Poor's , Mimeo December 3 2010.
[3] "Contingent Capital Discussion", mimeo, Anthony Ragozino and David Seaman, 2010.

costs of free cash flow (Jensen (1986)). Note that these advantages will be relevant when firms are not in financial distress, i.e. they have taxable profits and/or excess cash[4]. Finally, there is a large body of empirical evidence that shows that when a firm announces an equity issue, stock prices fall (E.g. Asquith and Mullins (1986), Loughran and Ritter (1995)). The argument is that as equity is the most risky security in the capital structure, it is also the most likely to be mispriced. As a result managers who care about long term shareholder value would want to avoid issuing equity when the stock is undervalued, but would like to issue equity when shares are overvalued (Myers and Majluf (1984). If the market anticipates such behaviour, equity issues will be interpreted as a negative signal, unlike coco bonds which are less risky and therefore easier to value.

In contrast to equity, issuing contingent capital, as any debt instrument, will increase costs of financial distress. However, in contrast to straight debt, contingent capital will largely eliminate the direct costs of financial distress, i.e. bankruptcy costs. When financial distress becomes large enough to qualify as a triggering event, debt will automatically convert into equity. This automatism will avoid the 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. Dependent on the riskiness of the coco bonds, indirect costs of financial distress will also be smaller than for straight debt. Indirect costs include costs arising from underinvestment in low risk positive net present value projects and overinvestment in high risk negative net present value projects (Myers (1977)). The costs are a result of the fact that debt is risky. If debt is risky an increase (decrease) in firm value as result of investing in a positive (negative) net present value project may be smaller than the increase (decrease) in the value of the debt resulting from the change in default risk. As a result managers may want to make decisions that lower asset values to shift wealth from bondholders to shareholders. If bondholders anticipate such behaviour they will charge shareholders in advance for this

[4] Requiring firms to issue equity in good times as well as bad times is likely to increase agency costs of free cash flow as firms with too much equity in good times will tend to waste it in negative net present value projects (Kashyap, Rajan, and Stein (2008)).

opportunistic behaviour so that ultimately shareholders bear these costs of financial distress.

Hence, it follows that the ideal coco bond should be a bond that has very low risk. If the debt has low risk, not only direct costs of bankruptcy will be avoided (as is the case with all coco bonds) but also indirect costs of financial distress. Moreover, in order to make coco bonds an economically important financing instrument it has also to appeal to bond investors who don't have appetite for high risk debt. The risk of coco bonds is to a large extent the result of the design of the instrument, in particular the trigger, the conversion price and regulatory discretion. For example in February 2011 Credit Suisse issued a coco bond that will convert into equity whenever the firm's core Tier1 capital ratio falls below 7 %. However, the regulator can also force conversion if it sees that Credit Suisse will need 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. One could argue that this bond is risky because of three characteristics. First the trigger is based on capital ratios, which are based on accounting numbers and therefore will be different from market based measures of financial leverage, especially during a financial crisis. Hence, there is no way to predict the stock price at the time of conversion. Second, if the stock price at the time of conversion is less than $ 20 the bondholder will incur a significant loss. Third, the possibility that the regulator can force conversion before the trigger is reached creates an additional risk that is difficult to price. While the bond issue was very successful with retail investors, commentators[5] pointed out that because of the high risk of the instruments the investor base is rather limited. Because of the difficulty in assessing the risks, major rating agencies such as Standard and Poor's and Moody's are refusing to rate coco bonds, which will also limit their marketability. Bolton and Samama (2010) cite a February 2010 report by Moody's that points out that "the unpredictable and non-credit linked elements surrounding these triggering events make the instruments unsuitable for a fixed income rating".

[5] "Bankers fear that cocos are just another crisis in the making" by Patrick Jenkins, Financial times,March 5, 2011

So, the ideal coco bond should be a bond that is essentially risk-free. In this paper we propose such a bond, a Call Option Enhanced Reverse Convertible, or COERC. In contrast to the Credit Suisse coco bond, the trigger is based on market value based leverage ratios, which are forward looking, rather than backward looking, measures of financial distress. It also means that at the time of the triggering event the stock price is known, unlike in the case of coco bonds with accounting based capital ratio triggers. As the trigger is driven by the market and not by regulators, regulatory risk is avoided. The conversion price is set at a large discount from the market price at the time of conversion, which means that conversion would generate massive shareholder dilution. However, in order to prevent this dilution, shareholders have an option to buy back the shares from the bondholders at the conversion price. In practice, what will happen is that when the trigger is reached, the company will announce a rights issue with an issue price equal to the conversion price and use the proceeds to repay the debt. As a result, the debt will be (almost) risk-free. In our simulations, we show that it is possible to design a COERC in such a way that the fair credit spread is 20 basis points above the risk-free rate. So although the shareholders are *coerced* to repay the debt, the benefit from this coercion is reflected in the low cost of debt as well as the elimination of all direct and indirect costs of financial distress. Although at the time of the trigger, the company will announce an equity issue, there is no negative signal associated with the issuance as the issue is the automatic result of reaching a pre-defined trigger.

Market based triggers are generally criticised because they create instability: bond holders have an incentive to short the stock and trigger conversion. Moreover, the fear of dilution may encourage shareholders to sell their shares so that the company ends up in a self-fulfilling death spiral. However, because in a COERC shareholders have pre-emptive rights in buying the shares from the bondholders, they can undo any conversion that is result of manipulation or unjustified panic. Moreover, because bondholders will generally be repaid, they have no incentive to hedge their investment by shorting the stock when the leverage ratio approaches the trigger, unlike the case of coco bonds where bondholders will become shareholders after the triggering event. The design of the contract also discourages manipulation by other bondholders. Bolton and Samama (2010) argue that other bond-holders may want to short the stock to trigger conversion, in order to improve their seniority. However, because the COERCs will be repaid in these circumstances such activity will not improve other bondholder's seniority.

Throughout this paper we are assuming that the goal of the bank (or a firm in general) is to maximize shareholder value. So our approach is different from Admati et al (2010) who want regulators to force banks to issue equity, to limit dividend payments or make interest payments on debt issued by banks non tax deductible. If bank regulators only want to minimize financial distress costs, they should simply focus on increasing bank equity capital requirements or force companies to issue equity when they are in financial distress (Duffie (2010) Hart and Zingales (2009)). Our objective is to propose an alternative, an instrument that a value maximizing manager would like to issue, without being forced by regulators. Companies are coerced to issue equity and repay debt by fear of dilution, not by the decision of a regulator. Imposing regulation against the interest of the bank's shareholders will encourage regulatory arbitrage and may also reduce economic growth.[6] If bankers, on the other hand, can be convinced that issuing contingent capital increases shareholder value, then any regulatory "encouragement" to issue these securities will be welcomed. Our proposal is therefore more consistent with a free market solution to the general problem that debt overhang discourages firms from recapitalizing when they are in financial distress. Hence the COERC should be of interest to any corporation where costs of financial distress are potentially important.

This paper is organised as follows. In Section 2 we provide an overview of other reverse convertible structures proposed in the literature and/or implemented in 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.

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[6] 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).

2. Contingent capital: some alternative structures.

In order to reduce banks' default risk, Raviv (2004) proposes that debt be converted into equity whenever the bank's regulatory capital ratio falls below a certain threshold.[7] There are two potential problems with this "reverse-convertible" or "contingent capital" structure. First, regulatory capital is an accounting measure that is typically calculated only once every quarter. Such a mechanism will not work in a situation where a bank's capital structure deteriorates rapidly. For example, Citibank had a Tier 1 capital ratio that was measured at 11.8% in December 2008, at the height of the financial crisis (Duffie (2010))[8]. Second, because regulators are aware that capital ratios are stale, they may be tempted to intervene and pull the trigger themselves and this regulatory risk may be difficult to assess, even for major credit rating agencies. Third, there is an issue about the marketability of such debt. If capital ratios lag true measures of financial distress bondholders will take significant losses when eventually the trigger is reached. This payoff structure may not appeal to a large number of risk-averse investors, unless compensated by a large credit spread. Management may be reluctant to pay such risk premiums if it believes the firm's risk of financial distress is lower than that expected by the reverse convertible bond investors.

By March 2011 three banks had issued securities that might be broadly classified as contingent capital with triggers based on capital ratios. In November 2009 Lloyds Bank issued Enhanced Capital Notes (ECN). Although the issue was well received by financial markets, it should be pointed out that this 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. Other contingent securities with a capital ratio trigger were issued

[7] Though Raviv (2004) proposes a regulatory capital trigger, his model actually assumes a trigger that is based on the market value of a bank's assets. Raviv (2004) developed his proposal as a modification of Flannery (2005) which first appeared as a working paper in 2002 and which is discussed shortly. More recently, Glasserman and Behzad (2010) propose a convertible with a trigger based on book values of regulatory capital and where conversion would take place gradually over time.

[8] For some evidence on the stickiness of capital ratio based triggers versus market based triggers see De Martiono et al (2010). Specifically, their simulation results show that over the 1994-2009 period, Tier1 capital ratio triggers would almost never have gone off for contingent capital issued by US, Canadian or UK institutions.

successfully by Rabobank in May of 2010. Whenever the bank's capital ratio falls below 7%, the security's principal is written down by 75% and the remaining 25% is redeemed for cash. Note that this contingent debt is not converted to new common equity, so it is not clear that it fits the definition of contingent capital. The lack of conversion possibility is a result of the fact that Rabobank is a cooperative bank without traded common stock. Finally, in February 2011, Credit Suisse, encouraged by the Swiss National Bank, issued 6 billion Swiss Frances of contingent capital notes to two Middle Eastern investors in exchange for existing Tier 1 notes. While these securities had coupons of 9 %, it also made a separate public issue for $ 2 billion at a 7.875 % interest 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, suggesting that there exists a demand for these securities, provided banks are willing to pay significant credit spreads.

Flannery (2005, 2009a, 2009b), proposes issuing contingent capital certificates. His idea is similar to Raviv (2004) but now conversion takes place when the stock price hits a certain level, i.e. when the *market* value of equity over the book value of debt falls below a certain threshold. This trigger price is also the conversion price, so that the coco bonds are essentially riskless. While it avoids the problem of stale accounting data, it also relies on equity market efficiency. Market efficiency can fail due to stock price manipulation or panic. Such market inefficiency may lead to transfers of wealth from shareholders to contingent capital investors, which would make the security 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 secured debt (deposits) worth D = \$1,000, a contingent capital 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 contingent capital 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 contingent capital 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 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, $S \times n_0 + V$.[9] Assume also that contingent capital 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 contingent capital investors, which makes stock price fall to \$5 per share. Hence, the market value of equity drops to \$35. Contingent capital will convert into 6 shares of common stock, so that the total number of shares increases to 13. However, if contingent capital investors understand that the true value of the assets is still \$1,100, then they know that the combined value of contingent capital holders' and equity holders' stake is \$100, which means that the true stock price is \$100/13 = \$7.69 per share. The gain to the contingent capital investors is now \$7.69×6 – \$30 = \$16.15 or a gain of 54% relative to the 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 contingent capital 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 legal profitable manipulation as anyone who shorts a stock and drives the price down will subsequently

[9] As will be discussed, a conversion trigger based on only the stock price would 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 bond values; that is, the market value of total capital, $S \times n_0 + V$.

drive the stock price up when covering the short. However, in the case of contingent capital, the short-seller can cover the short position by shares provided by the issuer after conversion, thereby avoiding buying pressure. Hillion and Vermaelen (2004) examine floating priced convertibles which are bonds that can be converted at a discount from the market price. Although the investor has the option to convert, the non-converted principal plus accrued interest has to be converted at maturity. As with contingent capital, the idea is also here to avoid costs of financial distress by making the bonds risk-free, which explains why these securities are typically issued by high growth risky firms. However, Hillion and Vermaelen report that, on average, companies that issue these bonds underperform the market by 85 % in the year after issuance. In order 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.

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, contingent capital notes 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 market based triggers in contingent capital on the basis of these manipulation/death spiral fears.[10]

Sunderesan and Wang (2010) point out another problem with triggers based on stock prices or market values of equity: because stock prices and convertible prices are determined simultaneously, multiple equilibria may exist. Going back to our numerical example, suppose everyone believes the value of the firm is $1,100, the value of the senior debt $1000, the value of the equity is $70 (or $10 per share) and the value of the contingent capital is $30. In our example, we have assumed that the trigger price is equal

[10] See for example "Contingent capital : possibilities, problems and opportunities", Goldman Sachs mimeo, February 16 2011.

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 contingent capital 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 the contingent capital investors represent a wealth transfer \$7.69×6 – \$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 we have 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 contingent capital bond pays a floating coupon and the number of shares issued at conversion multiplied by the trigger price equals the contingent capital bond's par value. Under these conditions, the contingent capital bonds are always worth their par value prior to and at the time of conversion. The absence of a wealth transfer at conversion leads to a unique equilibrium value for the stock and the contingent capital bonds, with the bonds essentially being default-free.

Pennacchi (2010) makes the point that pricing contingent capital issued by a bank requires simultaneously valuing deposits, shareholders' equity, and contingent capital bonds. Moreover, by assuming the return on bank assets satisfies a mixed jump-diffusion process, his model captures the realistic possibility that bank assets may suddenly decline in value, which requires that contingent capital sometimes convert at below its par value. Figure 1 shows the percentage of banks of the largest 100 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. It shows that any realistic model for pricing contingent capital should allow for jumps in value. As a result, it may not be possible to structure the contingent capital contract so that it is default-free and always sells at its par value, as suggested by Sundaresan and Wang (2010). An implication is that it may not be possible to avoid wealth transfers between shareholders and bondholders at conversion due to contingent capital's credit risk. Thus, when conversion is based solely on the bank's stock price, multiple equilibria may always exist.

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

In this paper, we propose an alternative contingent capital 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 is less risky than other "classic" contingent capital securities that have been proposed in the literature. As a result it will generate lower levels of financial distress and be marketable to risk-averse investors. Third, as no regulators are involved, uncertainty due to regulatory discretion is avoided. Fourth, with the appropriate trigger mechanism, multiple equilibria are avoided and finally, shareholders preserve their pre-emptive rights over bondholders, something which may be important for control reasons.

There are two main contractual features of a COERC bond. The first is that the conversion price is set significantly below the trigger price. The second is that it gives the shareholders an option (warrant) to buy the shares back from the bondholders after conversion at this same low conversion price. This call option ensures that shareholders can "undo" any wealth transfer to bondholders created by manipulation or panic. The fact that the conversion price is set significantly below the trigger price gives a strong incentive for shareholders to exercise the call option and repay the bonds at their par value. This will in turn reduce the risk of the bonds, thereby enhancing their marketability with fixed income investors.

3.1 Numerical example

This section illustrates the basic features of a COERC bond with a numerical example. In the next section, we will show how a COERC bond would be valued using the framework of Pennacchi (2010). Let the COERC's trigger price be $5 and its conversion price be $1. Suppose now the stock price gets manipulated down to $5 and bondholders convert their $30 of bonds into 30 new shares. The new number of shares outstanding is now 37, which translates into a true (non-manipulated) fair value of \$100/37 = \$2.70. Obviously, considering that shareholders have the right to buy back these shares at \$1 per share, they will do so. If they did not, their wealth would fall from \$7×10 = \$70 to \$7×2.70 = \$18.92, a loss of \$51.08. They can recover this loss on their old shares by buying back the 30 shares at \$1 from the bondholders (which, at a fair value of \$2.70 per share, represents a gain of \$51). As a result, the COERC bonds end up being paid their par value.

Suppose instead there was *justified*, true financial distress making the stock price fall 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. The shareholder will exercise his option to buy the shares back at \$1 so that the COERC bonds are again repaid their par value.

It can be shown that the equity holders 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 bonds and the common stock equals \$37. As the bonds 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 bondholders will be repaid their par value.*

Now, it is easier to understand why we want to set the conversion price significantly below the default trigger price. If, for example, we had set both prices at \$5, the equity holders would not repay the bonds if the fully diluted stock price is less than \$5. When the conversion price is \$5, there are 6 new shares issued, or 13 shares outstanding. The combined value of both securities (assuming repayment of the bonds after conversion) will be again \$65, leading to a fully diluted stock price of \$5. Note that at this point in time, the total firm's asset value will be \$1,000+ \$65 = \$1,065. If the asset value falls below \$1,065 the shareholders will no longer exercise their option and the excess value of the total firm above the senior debt will now have to be shared between bondholders and shareholders.

So with the $1 conversion price, bondholders become shareholders when the value falls below $1,037. With the $5 conversion price, they will become shareholders if firm value falls below $1,065. By lowering the conversion price we clearly have reduced the riskiness of the convertible debt, which lowers costs of financial distress and makes the security more marketable to fixed income investors.

3.2 Graphic illustration

Figure 2 illustrates our analysis, assuming that all options (the conversion option and the call option) are exercised at the maturity date of the bonds. It shows the payoffs of the bond (with par value of $30) and the payoffs to equity holders 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 equity holders 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 $\mathrm{Max}\left[A-1030,0\right]$. 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 $\mathrm{Max}\left[A-1000,0\right]$ which is less than $30. Shareholders obtain the residual, equal to 7/37 of $\mathrm{Max}\left[A-1000,0\right]$. Note the fundamental change: equity holders 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 bondholders 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. Graphically, the blue line in Figure 2 would start going down when the asset value reaches $1,065.[11]

Some basic valuation insights can be obtained from Figure 2. At the maturity of the COERC bond, its value will be the minimum of its par value of B and $\alpha(A\text{-}1000)$, where α is equal to the number of shares obtained by the bondholders 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 $\text{Max}\left[A-1000,0\right]$ as A^*, i.e. the combined value owned by the COERC bondholders and the equity holders. It is straightforward to show that $\text{Min}\left[B,\alpha A^*\right]$ = B - $\text{Max}\left[B-\alpha A^*,0\right]$. In words, the COERC is a portfolio of a riskless bond and a short put. The put option allows the equity holders to sell back a fraction of the firm, αA^*, to the bondholders at an exercise price of B. The equity holders will exercise the option when $B > \alpha A^*$; that is, when the value of the firm owned by the bond holders after conversion is less than the par value of the bonds.

3.3 COERCS and multiple equilibria

[11] Note that the figure is somewhat oversimplified: if the COERC bond 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, COERC bonds 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 may lead to multiple equilibria such that there is not a determinant value for the market values of the stock, *S*, and the contingent capital bond, *V*. The intuition is that the stock price depends on the conversion decision and vice versa. With our security design, there is a unique equilibrium if conversion can only take place at maturity and the bonds trade at par. For example, assume that at maturity the asset value is $ 1,100 and the value of the senior debt is $1000. If investors believe that bondholders will convert the $30 COERC into 30 shares the fully diluted stock price will be $(1100 – 1000 – 30)/37 which is $2.70. On the other hand if investors believed the COERC would be repaid, the stock price would be $ (1100 – 1000 – 30) / 7 = $10. The logic of Sundaresan and Wang (2010) predicts that stock prices can either be $10 or $2.70. However, because of the call option embedded in the COERC bonds, the shareholders will undo the conversion by repaying the bonds, so that the stock price (market value of equity) will always be $10 ($70). So if conversion can only take place at maturity there is a unique equilibrium stock price.

However, when conversion can take place before maturity, this is no longer guaranteed. This can best be illustrated by a numerical example provided by Sundaresan and Wang[12]. Assume we are one period before maturity and assume a trinomial tree as shown in figure 3. Specifically, the banks total assets are today worth $ 1030 and the senior debt trades at $ 970. The valuations reflect that there is a 1/3 probability that, at maturity, assets are worth $ 1200, a 1/3 probability that assets are worth $ 1000 and a 1/3 probability that assets are worth $ 900. Note that now there is a 2/3 probability that the equity becomes worthless. If the market expects that the bondholders will convert today the bond into 30 shares at a $ 1 conversion price, the COERC will be worth $ 30. Figure 3 shows that this also means that the equity will be worth $ 30 as well: $ 60 minus the cost of buying back the 30 shares at $ 1. With 7 shares remaining this implies a stock price of $ 4.28 which is below the trigger price of $ 5 and this scenario therefore is a possible equilibrium. But assume that the market expects that the debt holders will not convert their debt today but only at maturity, if possible. Figure 3 shows that in this case the COERC is worth $ 9 and

[12] We are grateful to Sundaresan and Wang for this example.

the equity $ 51. This scenario is also an equilibrium as the stock price of $ 51/7 = $ 7.28 is above the trigger price.

The solution to this multiple equilibrium problem is to make the trigger a function of the sum of the value of the common stock and COERCs rather than the stock price. Note that in both equilibria, that sum is equal to $ 60. If we had specified a contract that conversion is mandatory whenever the value of this capital is below $ 65 (which is equivalent to a $ 5 stock price), we would have a unique equilibrium. One period before maturity conversion would have taken place with a unique equilibrium stock price of $ 4.28. In short, conversion will not be triggered not by the stock price but by the **sum** of the market values of equity and COERCS; that is, the market value of total capital equal to $S\times n_0 + V = A - D$.[13] With conversion triggered by the market value of total capital, A - D, the multiple equilibria problem is avoided. Such a trigger is natural from a regulatory point of view because it is the market value equivalent of the book value of regulatory capital.

Sundaresan and Wang (2010) propose an alternative solution to the multiple equilibrium problem: allow the coupon rate of the contingent capital bonds to float such that the bonds always trade at par. However, such a solution only works if firm asset values, and hence stock prices, follow a pure diffusion process. When asset values can experience sudden, large losses (jumps), as Figure 1 suggests, one needs an alternative design to avoid multiple equilibria. This will be further illustrated in section 4 of this paper.

3.4 Some caveats

As long as the fully diluted stock price is above $1 in our example, the shares obtained by the bondholders after conversion are assumed to be sold to the equity holders at $1 when they exercise their rights. In practice the shares obtained through conversion will not be issued to convertible bond investors until the rights issue is completed, perhaps several

[13] We are grateful to Stewart Myers for first suggesting this approach.

weeks later. Once the rights issue is completed, the funds will be used to repay the debt. In other words, once the trigger is hit, the firm has an option to deliver the shares or to repay the debt. By not issuing the shares to the bondholders, 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 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, bondholders are repaid. If not, they become equity holders as in a normal cocobond.

In order for the conversion to take place at very low stock prices, common stock holders have 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. Shareholders are generally reluctant to authorise such large dilution as they are concerned about a loss of control. However, as the COERC structure allows equity holders to preserve their pre-emptive rights (again a unique feature relative to other coco bond structures) the dilution does not impair the shareholder's control rights.

One potential concern about convertible bonds in general is the effect on fully diluted earnings per share[14]. Although economically speaking, fully diluted earnings per share are not very meaningful, it is a fact that many investors pay a lot of attention to this number. 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 our trigger is based on a market leverage ratio, not a stock price, it is not obvious whether under US GAAP the issuer would have to report a heavily reduced EPS number as it is not obvious to determine, ex-ante, the number of shares that will be issued when the trigger is hit. Under IFRS "potentially issuable shares are considered "contingently issuable" and are included in diluted EPS using the if-converted only if the

[14] See Bolton and Samama (2010), pp

contingencies are satisfied at the end of the reporting period". It seems this rule would only lead to dilution if the effective trigger is reached, which of course makes sense.

Although some may see this structure as a way to undermine the limited liability of shareholders, it should be noted that shareholders who are reluctant to put more money in the firm can sell their rights to other investors who rationally will exercise the option. If no one exercises the call option, bondholders would realize a large windfall gain: in the case where the combined value of equity and debt falls to $65 the bondholders would end up with 30/37 = 81% of this value or $52.70, a profit of $22.70 on an investment of $30.

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. This essentially boils down to buying put options on your own stock. Their solution requires the existence of default proof 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 othr large institutional investotrs.

Our trigger 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 index falls below a trigger value. This essentially allows all issuing financial institutions to recapitalize during a financial crisis, but permits a bank 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 contingent capital is to mitigate the consequences of major financial crisis. The purpose of this 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, we believe that a COERC can be beneficial to any corporation that wants to reduce the costs of financial distress resulting from the debt overhang problem first described by Myers (1977).

We have assumed here that conversion is driven by market prices, not by a regulator. This will avoid regulatory risk, a source of risk that is difficult to estimate. If the trigger is based on a pre-specified market value of equity plus COERCs, divided by senior debt (deposits) then of course the trigger stock price will depend on the available information about senior debt and the liquidity of COERCs. As COERCs will be largely risk free, we expect that they will be very liquid. Hart and Zingales (2009) propose a trigger based on CDS prices. For example, if the CDS price of the bank's debt exceeds a certain threshold, the trigger price will be the market price of the stock at that time. The conversion price of the COERCs (and the issue price in the subsequent rights issue) will then be equal to 80% of the market price. Note that in this case "default" in credit default swaps must correspond to the triggering event, although, strictly speaking, the coco bond is designed to avoid default.

Note also that, in our analysis we assumed that the secured debt, which can be interpreted as deposits, is safe. So, we still need to have a system of deposit insurance to avoid bank runs created by panic. In no way can the COERC can be considered as the ultimate instrument to save the world from financial collapse, especially considering that the conversion of COERC bonds into equity does not bring in net new funds to the firm. It simply "cleans up" the balance sheet by reducing the debt overhang problem. This overhang problem is mitigated, but possibly not eliminated if the bank has other short-term debt or over-the-counter derivative counterparties. Only when the conversion occurs before a major liquidity crisis is likely to begin can the bank issue additional equity (beyond the amount necessary to repay the bonds) or new COERCs.

4. Valuation

This section calculates values of COERCs and compares them to standard contingent capital and non-convertible bonds. It also analyzes 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. Note that we assume that the issuance of COERCs or other securities does not change the total value of the firm. In this section we are mainly concerned by comparing the risks of the various bonds. However, as the costs of financial distress are positively related to credit risk, it follows that the lower the risk of the debt, the higher the value of the assets.

It is assumed that a bank issues short-maturity deposits, shareholders' equity, and longer-maturity bonds in the form of COERCs, standard contingent capital or (non-convertible) subordinated debt.

To realistically 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. These assets' risk-neutral rate of return, dA_t^* / A_t^*, satisfies the jump – diffusion process:[15]

$$\frac{dA_t^*}{A_t^*} = \left(r_t - \lambda k\right)dt + \sigma dz + (Y_{q_{t^-}} - 1)dq_t \tag{1}$$

where dz is a Brownian motion, q_t is a Poisson counting process that increases by 1 with probability λdt,

$$\ln\left(Y_{q_{t^-}}\right) \sim N\left(\mu_y, \sigma_y^2\right) \tag{2}$$

[15] 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 $E^Q\left[\cdot\right]$.

and $k \equiv E^Q\left[Y_{q_{t^-}} - 1\right] = \exp\left[\mu_y + \frac{1}{2}\sigma_y^2\right] - 1$ is the risk-neutral expected value of a jump. In equation (1), σ is the standard deviation of the continuous diffusion movements in the bank's assets while the parameter λ measures the probability of a jump in the assets' value. Equation (2) specifies that the jump size is log normally distributed, where the parameter μ_y controls the mean jump size and σ_y is the standard deviation of the jump size.

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, 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 and pay a 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. 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.[16] This is modeled by defining $x_t \equiv A_t/D_t$ as the date t asset-to-deposit ratio which the bank targets by adjusting deposit growth according to:

$$\frac{dD_t}{D_t} = g\left(x_t - \hat{x}\right)dt \tag{3}$$

where $g > 0$ measures the strength of mean-reversion and $\hat{x} > 1$ is the bank's target asset-to-deposit ratio.

[16] 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.

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 $D_t - A_t$.[17] 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 modeling assumption simplifies the valuation of the bank's other liabilities since they will always sum to total capital worth $A_t - D_t$.

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 will be exposed to both interest rate risk and credit risk whereas the value of floating-coupon bonds will be 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 contingent capital bond or a COERC. We can define a post-conversion original shareholders' equity to deposit ratio at which conversion is triggered as

$$\overline{e} = \frac{A_t - B - D_t}{D_t} \tag{4}$$

[17] Under these assumptions, the fair credit spread on deposits equals $h_t = \lambda\left[N\left(-d_1\right) - x_t \exp\left(\mu_y + \tfrac{1}{2}\sigma_y^2\right) N\left(-d_2\right)\right]$ where $d_1 = \left[\ln\left(x_t\right) + \mu_y\right] / \sigma_y$ and $d_2 = d_1 + \sigma_y$. Note that this credit spread depends only on the bank's current asset-to-deposit ratio and the parameters of the asset jump process. The reason is that only jumps that wipe out the bank's capital can impose losses on depositors.

In the example of the previous Sections 2 and 3, D_0 = 1000, B = 30, and conversion is triggered when $\bar{e}$ = 3.5%.[18] If there are n_0 shares of equity outstanding and the current level of deposits is D_t, then the trigger, post-conversion stock price can be expressed as $\bar{e}D_t / n_0 = \left(\bar{a}_t - B - D_t\right) / n_0$, where $\bar{a}_t$ is the value of A_t that satisfies equation (4).

Note that equation (4) can be rewritten as

$$\frac{A_t - D_t}{D_t} = \frac{S_t \times n_0 + V_t}{D_t} = \bar{e} + \frac{B}{D_t} \tag{5}$$

Hence our trigger is based on the combined value of equity and COERCs relative to deposits. In other words the equity trigger of 3.5 % of deposits is equivalent to a trigger of $S_t \times n_0 + V_t$ = 3.5% + 3% = $A_t - D_t$ = 6.5% of capital to deposits. Note that this trigger mechanism, rather than a trigger based on stock prices, eliminates the concerns about multiple equilibria discussed by Sundaresan and Wang (2010).

Next, let us 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 $n_1 \gg B / \left(\bar{e}D_t / n_0\right)$; that is, the price per share at which COERC investors can purchase stock is $B / n_1 \ll \bar{e}D_t / n_0$, so that it is much less than the trigger price.[19] If conversion is triggered, say at date t_c, because $A_{t_c} \leq B + D_{t_c}\left(1 + \bar{e}\right)$, 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 $\alpha \equiv n_1/(n_0 + n_1)$. Then assuming shareholders optimally exercise their right to

[18] Note that the trigger ratio in equation (4) 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 point of view, it might be preferable to make the trigger to be a fixed market value equity to deposit ratio. But this will require 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 will need to again be adjusted so that the trigger continues to reflect a fixed equity to deposit ratio.

[19] 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.

purchase the stock at the conversion price, the value of the COERC bond at the rights offering date, say V_{t_r} , will be

$$V_{t_r} = \begin{cases} B & \text{if } B \leq \alpha\left(A_{t_r} - D_{t_r}\right) \\ \alpha\left(A_{t_r} - D_{t_r}\right) & \text{if } 0 < \alpha\left(A_{t_r} - D_{t_r}\right) < B \\ 0 & \text{if } A_{t_r} - D_{t_r} \leq 0 \end{cases} \tag{6}$$

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 compute 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 credit spread, s^*, is determined by varying c or s until $V_0 = B$; that is, the COERC initially sells for its par value.

New issue yields for fixed-coupon COERC bonds are graphed in Figures 3 to 5. 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).[20] 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%. 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, pink horizontal line at the bottom is the par yield on a five-year maturity, default-free Treasury bond, equal to 4.23%.

[20] 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 σ = 2%, λ=1, μ_y = -1%, σ_y = 2%, b = ½, and $\hat{x} = 1.10$.

In Figure 3, conversion is assumed to be triggered when the post-conversion equity value equals 3.5 % of deposits; that is, $\bar{e} = 3.5\%$. Thus, with COERCs equaling 3% of deposits, this implies conversion at a capital-to-deposits ratio of about 6.5%. The blue schedule gives new issue yields for various initial capital levels under the assumption that $\alpha \equiv n_1/(n_0 + n_1) = 30/37$. 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 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 (5) above.

The red schedule 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 blue schedule for each initial capital level. The intuition for this result is that when α 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.[21] Consequently, there is a greater possibility that COERC investors will suffer a loss in value at conversion.

The blue schedule in Figure 4 repeats the blue 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 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 red schedule is graphed for capital-to-deposit ratios as low as 5.5%. The rationale for why new issue yields are higher compared to the blue schedule for each initial capital level is that with a smaller amount of original shareholders' equity, a smaller downward jump in the bank's asset value is

[21] In other words, the first line of the COERC payoff in equation (2) becomes less likely.

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 contingent capital bond that is assumed to have the same general structure as the COERC. The contingent capital bond 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 converts the contingent capital to equal its par value if the post-conversion stock price equals the trigger price:[22]

$$n_1 = B / \left(\overline{e} D_t / n_0 \right) \tag{7}$$

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

$$\alpha = \frac{B / \left(\overline{e} D_t / n_0 \right)}{B / \left(\overline{e} D_t / n_0 \right) + n_0} = \frac{B}{B + \overline{e} D_t} \tag{8}$$

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 $A_{t_c} \leq B + D_{t_c} \left(1 + \overline{e} \right)$, then the value of the contingent capital bond at conversion, say V_{t_c}, will be

$$V_{t_c} = \begin{cases} \alpha \left(A_{t_c} - D_{t_r} \right) & \text{if } 0 < \alpha \left(A_{t_c} - D_{t_c} \right) \leq B \\ 0 & \text{if } A_{t_c} - D_{t_c} \leq 0 \end{cases} \tag{9}$$

Note from equation (4) that if $A_{t_c} = \overline{e} D_{t_c} + B + D_{t_c}$, so that conversion occurs smoothly at an asset value that leaves the ex-post conversion value of equity exactly equal to $\overline{e} D_{t_c}$,

[22] Note that the trigger price depends on D_t.

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 $A_{t_c} < \overline{e}D_{t_c} + B + D_{t_c}$, then the conversion value of contingent capital is strictly less than its par value.

This is the conversion method for standard contingent capital that is assumed in Figures 5 and 6. Figure 5 shows that the new issue yields for fixed-coupon contingent capital (without the call option enhancement) is always larger than those for comparable COERCs. For a given level of capital, yields increase as α, the ratio of shares issue to COERC investors to total shares, declines. For standard contingent capital, this ratio is at its minimum, $\alpha = B/\left(B + \overline{e}D_t\right) = 6/13$, 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 contingent capital pay floating, rather than fixed, coupons. It also considers floating-coupon, non-convertible subordinated debt that has the same par value (B = 3%×D_0) and maturity (T = 5 years) as the COERCs and standard contingent capital. 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 contingent capital. Moreover, Figure 6 shows that COERCs can be less risky than even non-convertible subordinated bonds.[23]

[23] 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, α, is low, credit spreads on COERCs can exceed those for non-convertible debt. This can be seen in Figure 6 where contingent capital without a call

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%÷α = 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.

The design features that reduce the default risk of COERCs relative to that of standard contingent capital (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 contingent capital, 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, ∂E, which equals minus the change in the value of the bank's bonds, -∂V, following an increase in one of the bank's risk parameters.[24] Unlike most models such as Merton (1974) that have only one asset risk parameter controlling the volatility of diffusion risk, σ, our model has three additional parameters determining jump risks: the frequency of jumps, λ; the volatility of the size of jumps, σ_y; and the mean jump size, μ_y. Considering the risk from possible

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option has higher credit spreads than non-convertible subordinated debt. Recall that standard contingent capital can be interpreted as a COERC where α is at a minimum (trigger and conversion prices are equal), which in this example is α = 6/13.

[24] 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.

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.[25]

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, with 3% of it in the form of the bonds (COERCs, contingent capital, or non-convertible subordinated debt). As in our previous examples, the conversion threshold for COERCs and standard contingent capital 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, λ. The change tends to be greater as the bank's capital declines, except for convertible bonds at capital levels near the conversion threshold.[26] However, the most important finding is that the increase in equity is greater then the bank issues a standard contingent capital bond or a non-convertible, subordinated bond relative to 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 contingent capital. Furthermore, because COERCs have a high

[25] 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.

[26] 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.

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, σ_y. 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 contingent capital 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, μ_y.[27] A bank that issues COERCs, rather than standard contingent capital or subordinated debt, has a smaller incentive to choose investments or activities that are subject to large losses.

As noted earlier, in our model non-convertible bonds, standard contingent capital (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, σ. 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 contingent capital, 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

[27] The figure shows the change in the value of equity when μ_y declines from -1% to -1.25%.

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, ∂E, following a new equity issue that increases the bank's assets by ∂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 contingent capital, 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 contingent capital is assumed to be when total capital equals 6.5% of deposits. The calculations assume the amount of new equity, ∂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 contingent capital. 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 propose a new security, the Call Option Enhanced Reverse Convertible (COERC), in order to reduce the probability of default and hence the associated costs of financial distress. The security design is a modification of the proposal of Flannery (2005, 2009a) to deal with three fundamental issues. First, the security should not be an instrument to manipulate the stock price or put the stock in a "death spiral" tailspin because of fear of massive dilution. This is avoided by giving the shareholders a warrant to buy back the shares from the bondholders at the conversion price. Second, one cannot expect that there will be a very active market if bondholders are exposed to large risks. One way to reduce the risks for the bondholders is to design the security in such a way that it forces equity holders to pay them back when financial distress becomes significant. This is achieved by setting the conversion price very low, below the stock price that will trigger the conversion. Not paying back the bondholders will result in massive shareholder dilution and a large wealth transfer to the bondholders. This in turn will lower the risk of the bonds. Third, the security design should be such that it does not generate multiple equilibria that make the value indeterminate as suggested by Sundaresan and Wang (2010). Making the trigger a function of the market value of capital relative to senior debt , rather than the stock price, eliminates the multiple equilibrium problem. .

Because COERCs are a debt instrument with low risk, it becomes attractive as it lowers not only the directs but also indirect costs of financial distress. Relative to standard contingent capital, or even non-convertible bonds, the lower default risk of COERCs 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: because of the limited liability of equity, firms will tend to refuse to replenish their capital, even when it is in the interest of total firm value maximization.

Although this paper focused on the problems of banks, we argue that COERCs could be useful for corporations in general, to lower their costs of financial distress. Note also that the government or regulatory authorities are not involved in the process, other than through the tax treatment of interest deductions generated by COERCs. Obviously it would be ironic if the government would discriminate against debt that reduces the likelihood of a financial crisis. So if, in general, interest remains a tax deductible expense, interest on COERCS should also be tax deductible at the corporate level.

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Figure 1

Percentage of 100 Largest U.S. Banks with a Daily Stock Return less than -10%

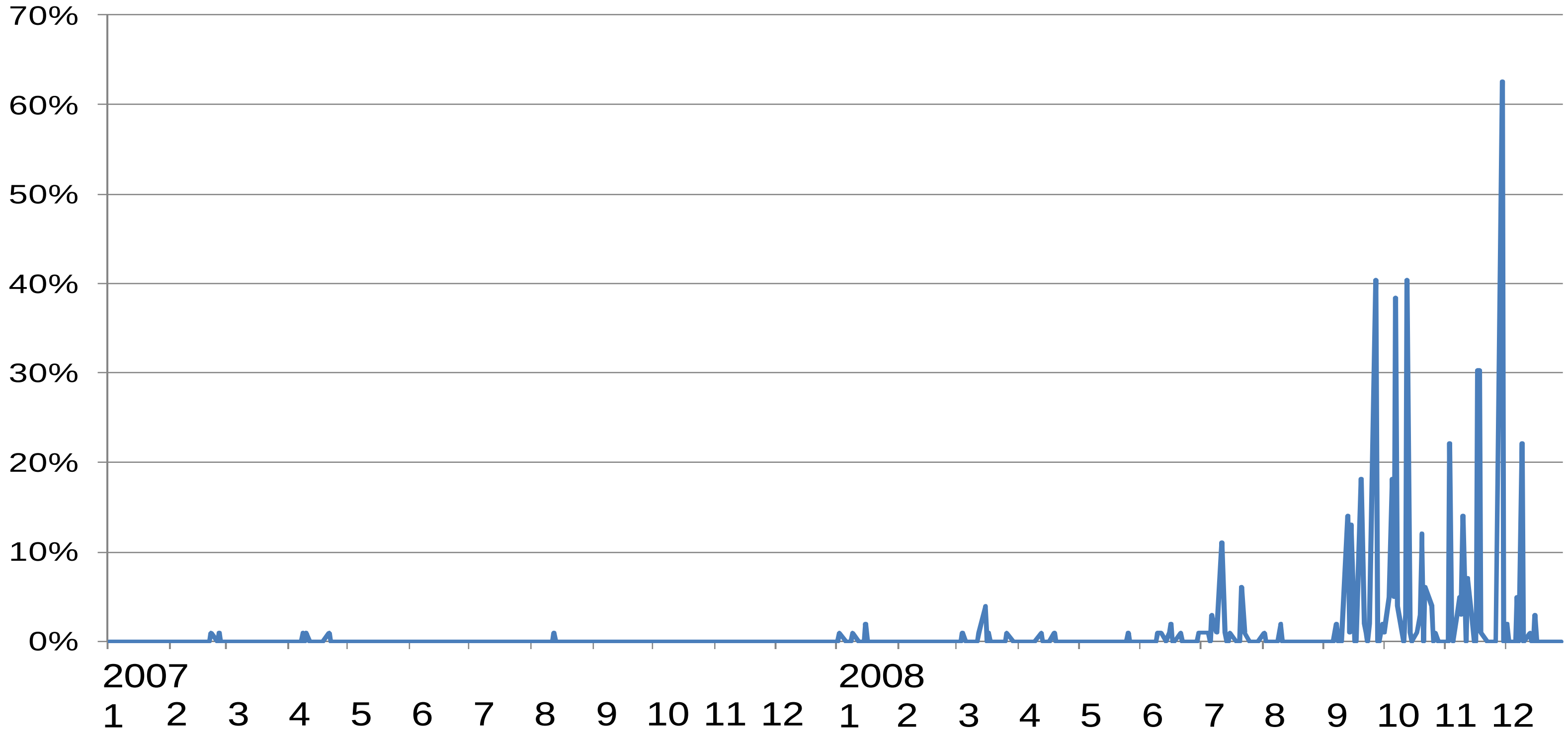
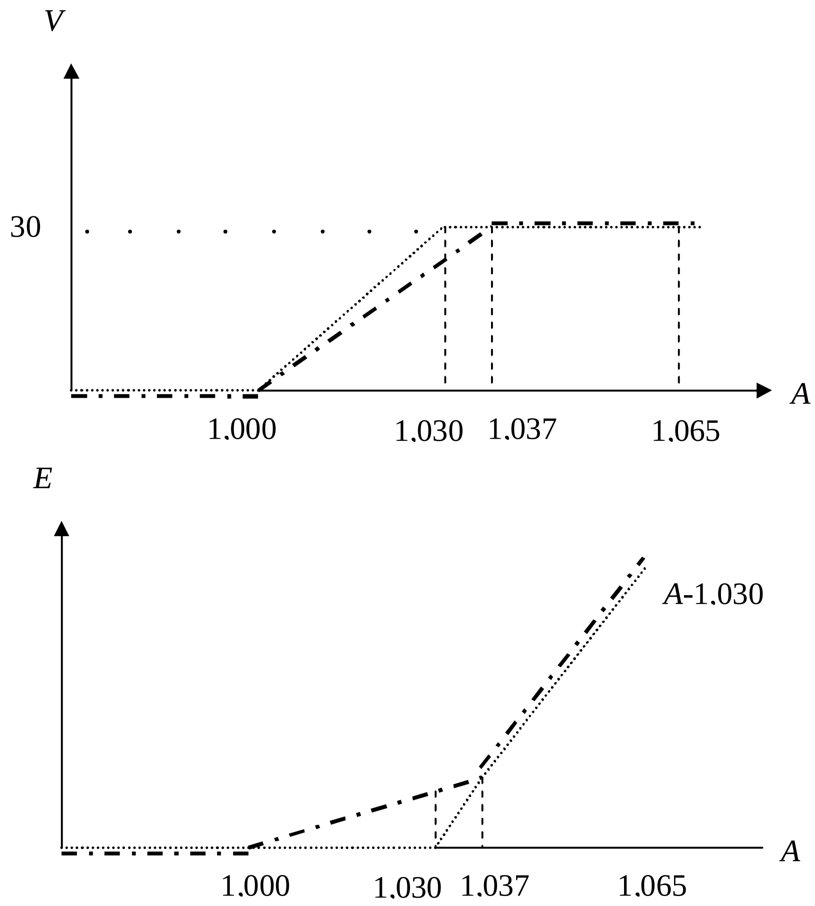


Figure 2 COERC versus Straight Debt



.... Payoff diagrams to equity holders and bondholders when debt is not convertible.
– · – Payoff to equity holders and bondholders when debt is convertible

V = Subordinated Bonds; E = Equity; A = Total firm value

Figure 3 Multiple equilibria

Conversion ratio m = 30 guarantees no multiple equilibrium at maturity, but cannot guarantee this *before* maturity

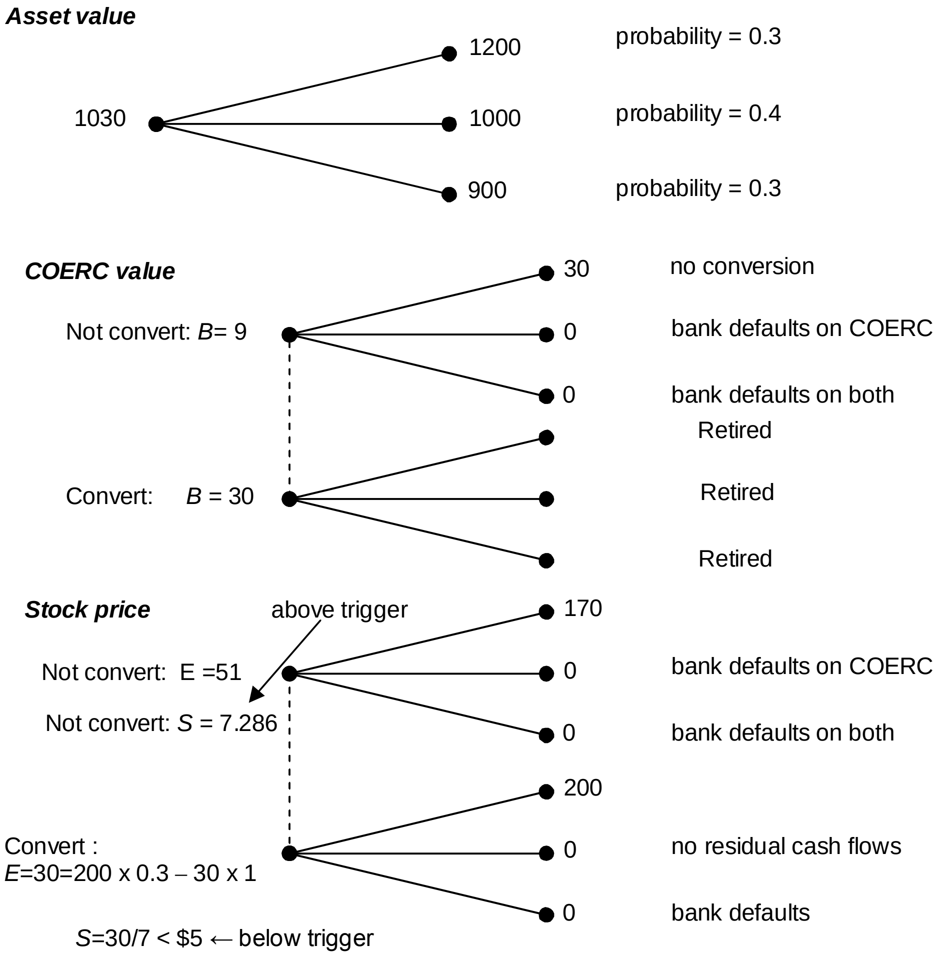


Figure 3

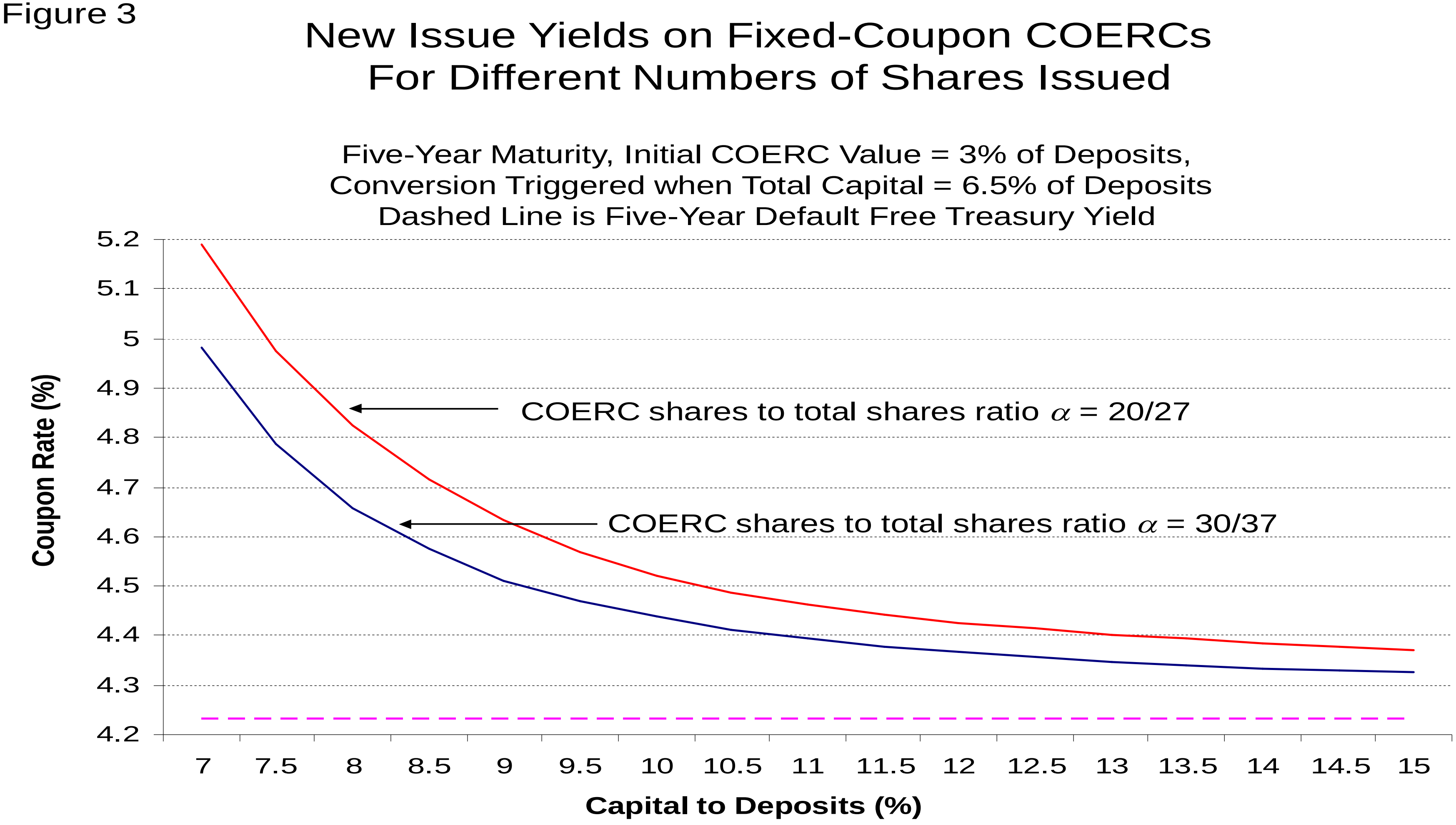

New Issue Yields on Fixed-Coupon COERCs
For Different Numbers of Shares Issued
Five-Year Maturity, Initial COERC Value = 3% of Deposits,
Conversion Triggered when Total Capital = 6.5% of Deposits
Dashed Line is Five-Year Default Free Treasury Yield
Coupon Rate (%)
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
COERC shares to total shares ratio α = 20/27
COERC shares to total shares ratio α = 30/37
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
12.5
13
13.5
14
14.5
15
Capital to Deposits (%)

Figure 4

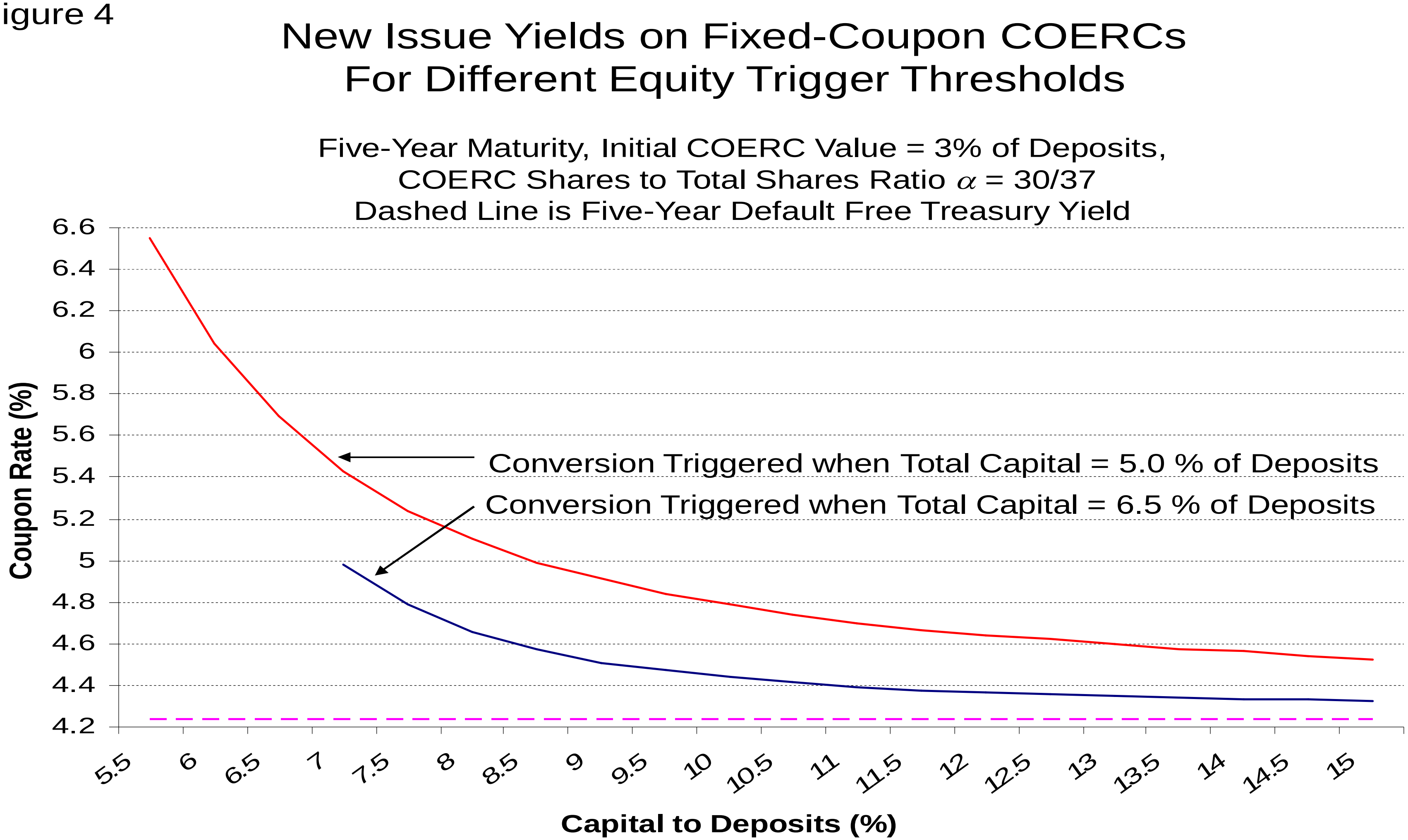

New Issue Yields on Fixed-Coupon COERCs
For Different Equity Trigger Thresholds
Five-Year Maturity, Initial COERC Value = 3% of Deposits,
COERC Shares to Total Shares Ratio α = 30/37
Dashed Line is Five-Year Default Free Treasury Yield
Conversion Triggered when Total Capital = 5.0 % of Deposits
Conversion Triggered when Total Capital = 6.5 % of Deposits
Coupon Rate (%)
6.6
6.4
6.2
6
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
12.5
13
13.5
14
14.5
15
Capital to Deposits (%)

Figure 5

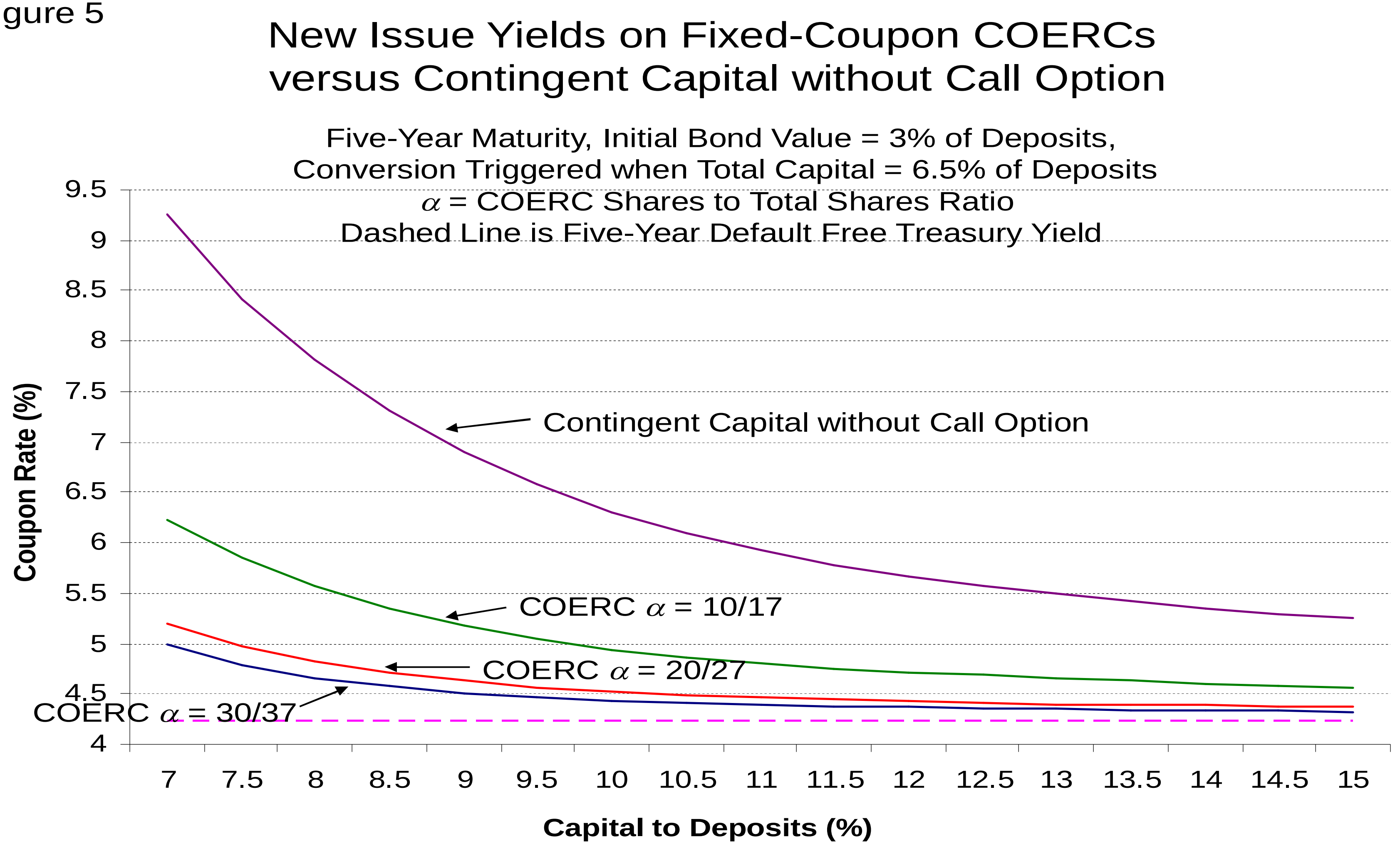

New Issue Yields on Fixed-Coupon COERCs
versus Contingent Capital without Call Option
Five-Year Maturity, Initial Bond Value = 3% of Deposits,
Conversion Triggered when Total Capital = 6.5% of Deposits
α = COERC Shares to Total Shares Ratio
Dashed Line is Five-Year Default Free Treasury Yield
Contingent Capital without Call Option
COERC α = 10/17
COERC α = 20/27
COERC α = 30/37
Coupon Rate (%)
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
12.5
13
13.5
14
14.5
15
Capital to Deposits (%)

Figure 6

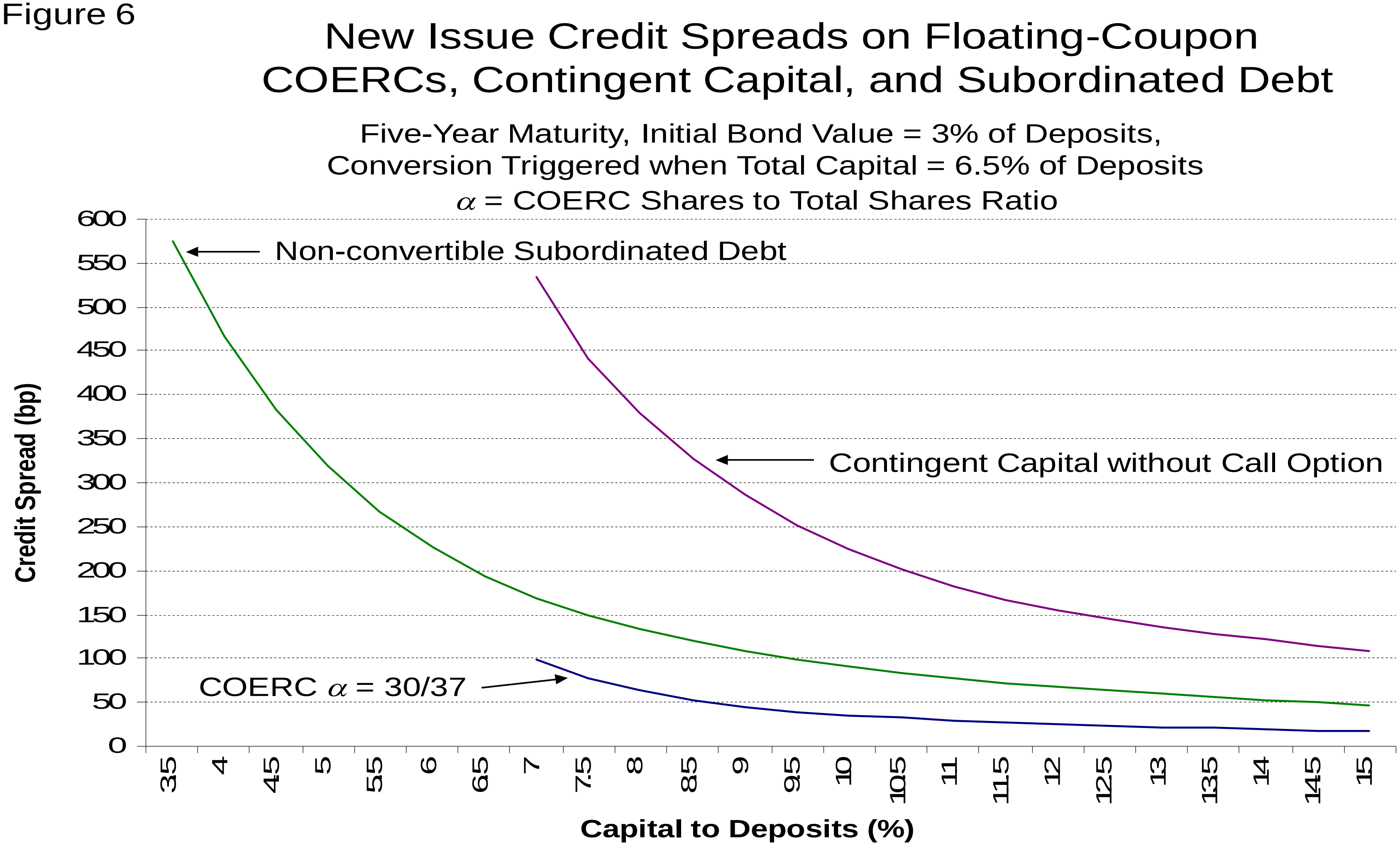

New Issue Credit Spreads on Floating-Coupon
COERCs, Contingent Capital, and Subordinated Debt
Five-Year Maturity, Initial Bond Value = 3% of Deposits,
Conversion Triggered when Total Capital = 6.5% of Deposits
α = COERC Shares to Total Shares Ratio
Non-convertible Subordinated Debt
Contingent Capital without Call Option
COERC α = 30/37
Credit Spread (bp)
Capital to Deposits (%)
600
550
500
450
400
350
300
250
200
150
100
50
0
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
12.5
13
13.5
14
14.5
15

Figure 7

Change in the Value of Shareholders' Equity per Deposit For a 25% Increase in Frequency of Jumps (λ)

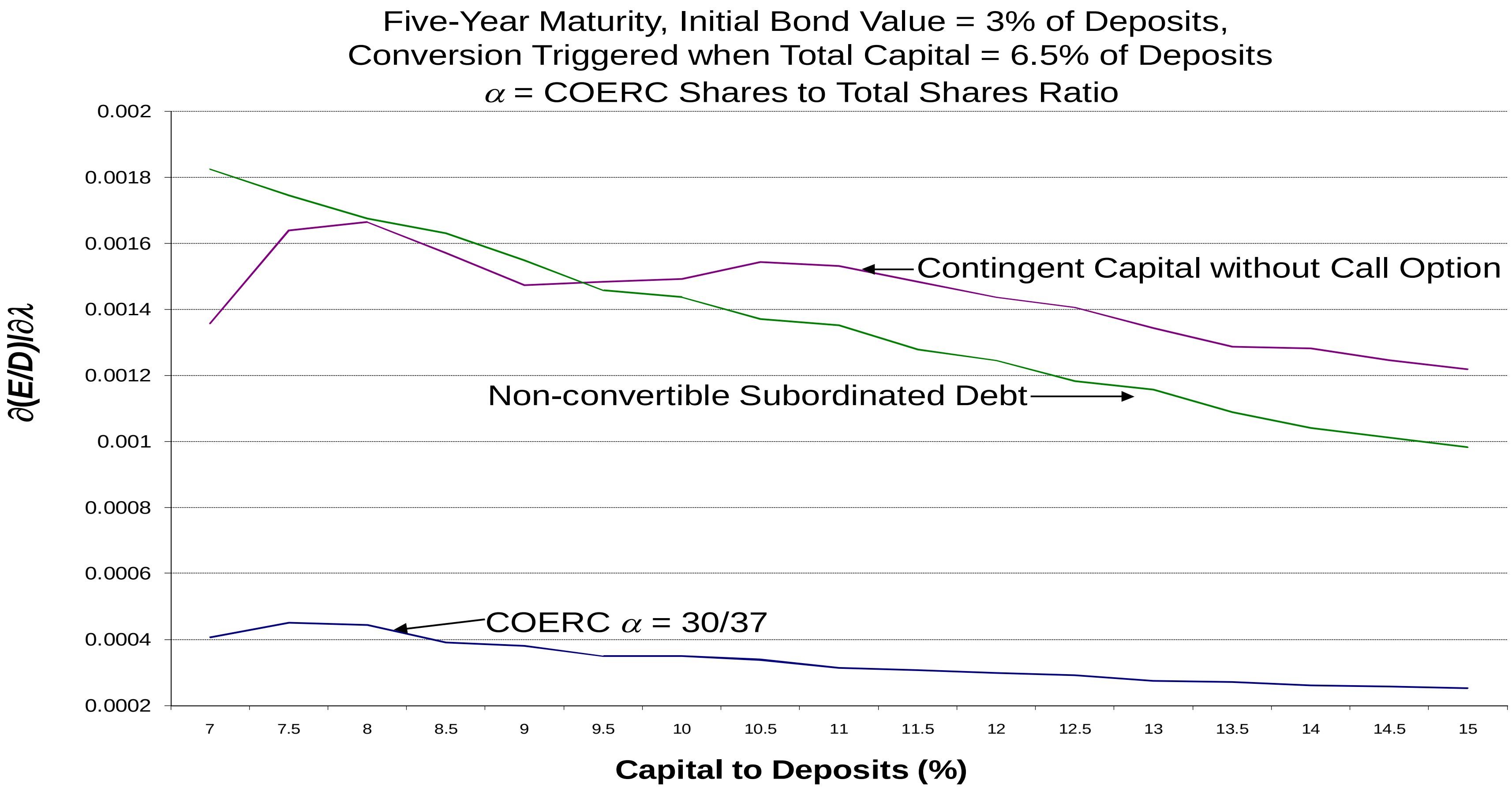


Figure 8

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

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

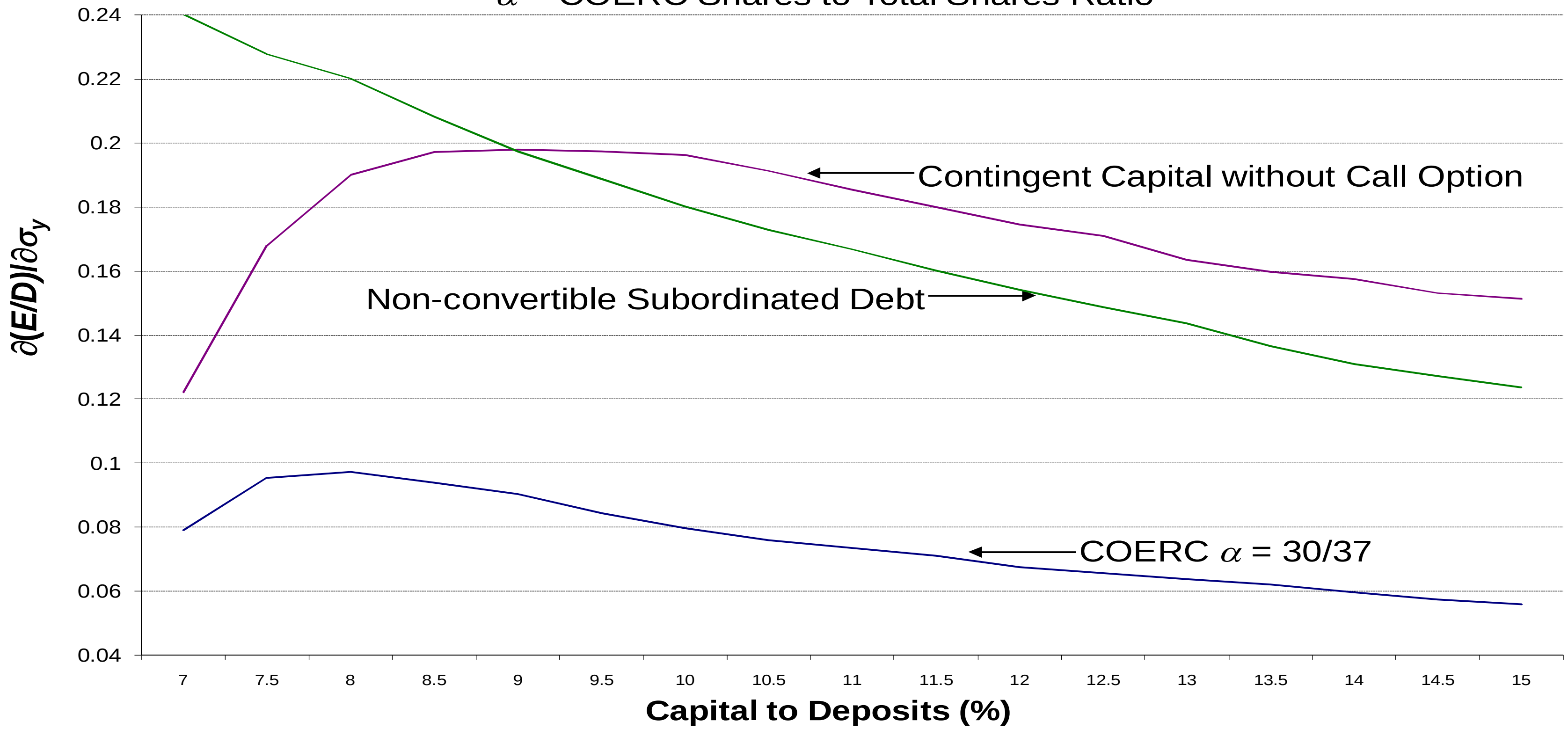


Figure 9 Change in the Value of Shareholders' Equity per Deposit For a 25% Decline in the Mean Jump Size (μ_y)

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

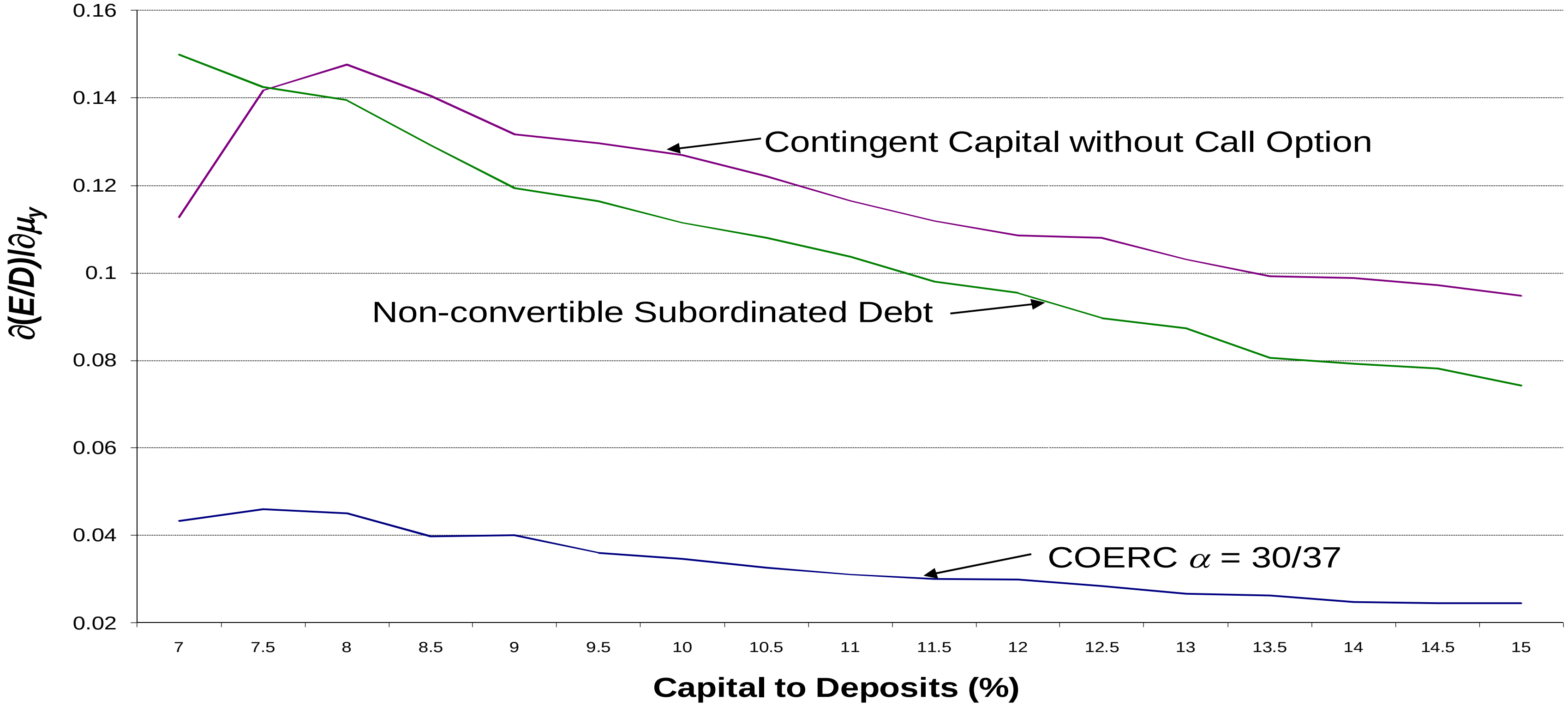


Figure 10 Change in the Value of Shareholders' Equity per Deposit For a 25% Increase in Diffusion Volatility (σ)

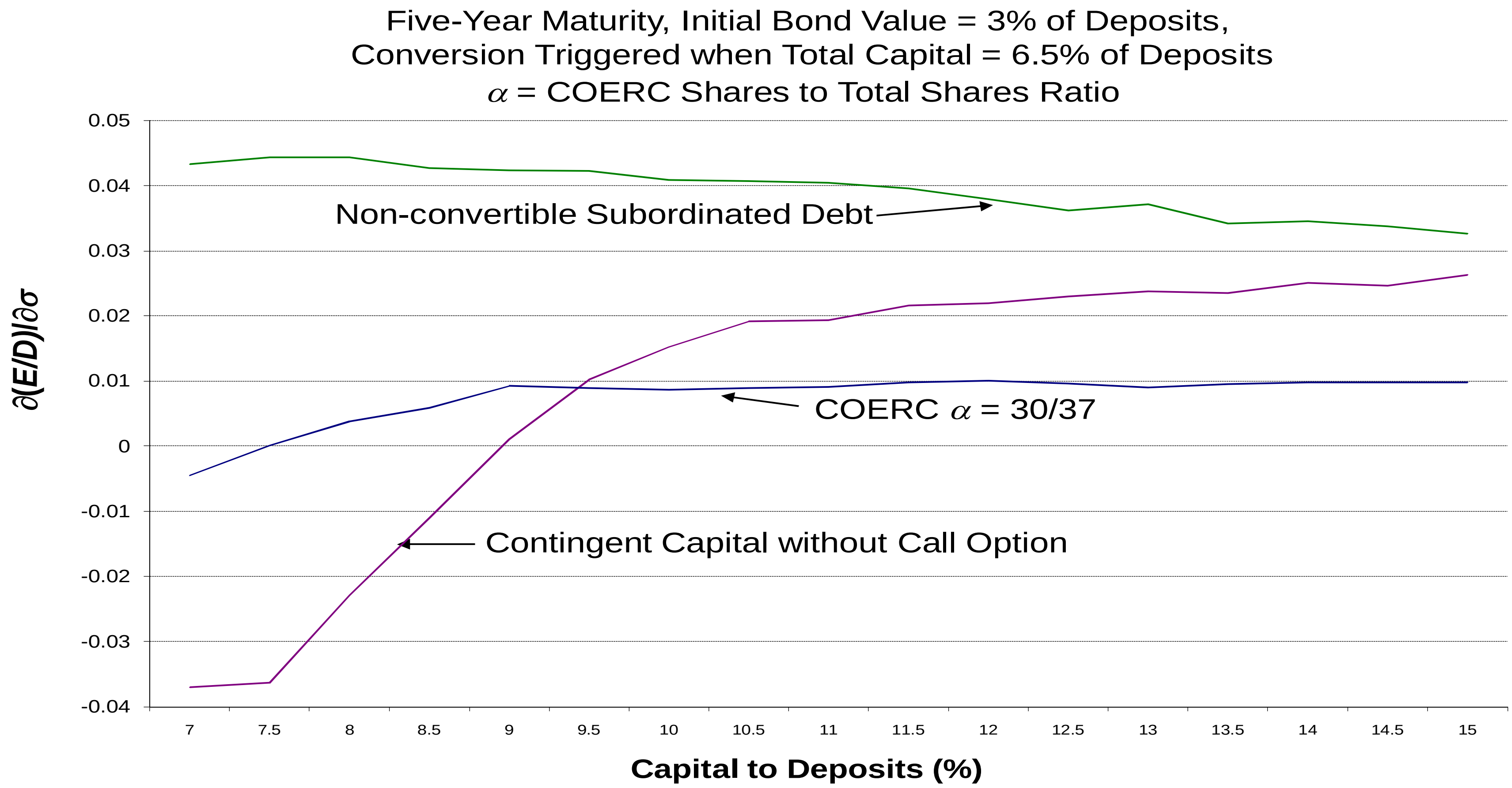


Figure 11

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