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ABSTRACT

Contingent Capital: The Case for COERCs*

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 into equity when the market value of equity relative to debt 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 jumps. Moreover, the structure eliminates concerns about putting the company in a “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.

JEL Classification: G01 and G20
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1. Introduction

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 has been proposed as a method to avoid a new financial crisis and avoid government bailouts of banks "too big to fail."[1] 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."[2] The fact is that, in order to save banks that are "too big to fail," governments have bailed out subordinated debt holders.

Contingent capital is an alternative to common shareholders' equity or regular, non-convertible subordinated debt. 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 costs of equity related to conflicts between bank managers and their shareholders. These agency costs may increase if regulators require increases in capital requirements in good times as well as bad times: firms with too much equity in good times will tend to waste it in negative net present value projects (Kashyap, Rajan, and Stein (2008)). In contrast, contingent capital will lower the leverage of the firm when it appears that the firm indeed should have less debt in its capital structure, i.e. in bad times, but not in good times. Compared to non-convertible debt, contingent capital will generate lower bankruptcy

[1] For example, on October 4 2010 the Swiss National Bank announced that UBS and Credit Suisse may need to boost their capital ratios to 19 % of their assets but could meet part of the requirement by issuing contingent convertibles.

[2] "Risk, Reward and Responsibility : The Financial Sector and Society" (2009), Her Majesty's Treasury.

[3] "Contingent Capital Discussion", mimeo, Anthony Ragozino and David Seaman, 2010.

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.

Before the trigger is activated, contingent capital securities will generate higher costs of financial distress than would be generated by equity.[4] So if bank regulators only want to minimize the financial distress costs, they should simply focus on increasing bank equity capital requirements. However, any attempt to impose regulation against the interest of the bank's shareholders will encourage regulatory arbitrage and may also reduce economic growth.[5] 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. Abdul, Jaffee, and Tchistyi (2010) show that as long as the benefits from reduced costs of financial distress compensate for the potential loss in tax shield,[6] firms will prefer to issue contingent capital rather than non-convertible debt.

In this paper we propose that banks and other firms that are concerned about the costs of financial distress issue a new form of contingent capital which we baptize COERC: a Call Option Enhanced Reverse Convertible. A major benefit of COERCs is a lowering of the debt overhang problem first pointed out by Myers (1977, 1984). When debt is risky, equity holders may refuse to reduce financial risk by contributing new equity capital when the benefit to debt holders is larger than the total increase in firm value. Moreover,

[4] Of course if the debt converts when the probability of financial distress becomes positive, then of course the costs of financial distress generated by contingent capital will be zero as well. Note that financial distress costs are broader than bankruptcy costs. As pointed out by Myers (1977), they include agency costs from risk-shifting as well as underinvestment.

[5] 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).

[6] The finding by Abdul, Jaffee, and Tchistyi (2010) that contingent capital has lower tax shield benefits than non-convertible debt is a result of their assumption that non-convertible debt is a perpetuity and that contingent capital may be converted into equity. It is not obvious that this conclusion still holds if after conversion, the firm issues new contingent capital.

equity issues are generally perceived by financial markets as negative signals, and investors may be reluctant to buy shares if they believe the firm is trying to issue overvalued stock. Duffie (2010) points out that this adverse selection problem can be avoided by issuing deep-discount rights issues, as in this case there is no distinction between new and old equity holders (provided every investor exercises his/her right). However, because of the debt overhang problem, managers who act in the interest of the shareholders may not be interested in such a deep discount rights offering. Hence Duffie (2010) proposes that because of social costs or systemic risk, regulators should force companies to make a deep discount rights issue when a certain level of financial distress is reached. A similar forced equity issue is proposed by Hart and Zingales (2009) who propose that whenever credit default swap (CDS) prices reach a certain level, regulators should force the company to issue equity. If it refuses, the regulator would take over.

The COERC provides an alternative form of *coercion* that is not enforced by a regulator, but by the fear of dilution. Specifically the security will force the company to issue equity at a discount to bond holders whenever the company is in financial distress. The trigger that indicates financial distress should be based on market values. However, this dilution can be undone by equity holders if they repay the debt. This will have two benefits relative to more classic reverse convertibles (contingent capital). First, by giving shareholders an incentive to repay the debt to avoid massive dilution, a COERC reduces the risk to the debt holders and makes the instrument more marketable than traditional reverse convertibles. Second, the fact that shareholders can always “undo” the conversion by repaying the debt means that conversions driven by irrational stock price behaviour or manipulation will not hurt shareholders.

Note that our construction also keeps regulators away from the decision process. This will make the instrument more acceptable to managers, as, unlike arrangements imposed by regulators, it is not designed to maximize debt holder value, but to maximize shareholder value. Regulators (rightly or wrongly) ignore the firm benefits of debt financing (such as tax savings and reduced agency costs of equity), and the costs of forcing equity holders to issue shares when their shares are undervalued.[7] 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.

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.

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.[8] 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)). Second, there is an issue about the marketability of such debt. Unlike a normal convertible bond, reverse-convertible bondholders are forced to become equity holders when the firm runs into trouble. It is true that, because of limited liability of equity holders, every default-risky bond can be considered as a risk-free bond plus a short put option written on the firm's assets.[9] However, here the put option will be exercised not in

[7] Unless the shares are issued in a rights issue and all current shareholders exercise their rights.

[8] 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.

[9] Indeed at maturity the value, V, of a zero-coupon bond with a face value of B will be the minimum of B and the value of the firm's total assets, A. In other words if $A < B$, the company defaults and the debt

the event of bankruptcy, but in the event of financial distress. This payoff structure may not appeal to the typical fixed income investor. The demand for securities may be so limited that issuing these securities on a large scale may become very expensive. 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.

So far two banks have issued securities that might be broadly classified as contingent capital. In November 2009 Lloyds Bank issued Enhanced Capital Notes (ECN). The securities (which are classified as Lower Tier 2 Capital) are convertible into equity whenever the Core Tier 1 ratio falls below 5%. 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 receive an extra 1.5% or 2% additional coupon income. It is not obvious that other investors would have had an appetite for such investment, considering the risk. Note that the conversion trigger is based on an accounting ratio rather then market value, so there is no guarantee that at the time of the conversion, the value of the converted shares will be equal to the nominal value of the bond.

Other contingent securities tied to an accounting ratio were issued 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. Again, Rabobank is not really representative for the average bank: it is a very conservative bank with one of the highest credit ratings in the world, which makes the write down extremely unlikely. 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.

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

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holders take over the company, so $V = A$. When $A > B$, $V = B$. This is exactly the same payoff as an investor who owns a risk-less bond with face value B and has written a put option on A with an exercise price equal to B. So $V = B - \text{Put}(A,B)$. Shareholders can hurt bondholders by increasing the value of the put option in two ways: by underinvestment (which lowers A) or by excessive risk taking (which increases the volatility of 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. 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, $S \times n_0 + V$.[10] 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

[10] 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, $S \times n_0 + V$.

$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.

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 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.

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." Hillion and Vermaelen (2004) find that companies who issue mandatory convertibles with such floating conversion prices tend to experience massive stock price declines in the year after the issue, which is consistent with short-and-convert manipulation. 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. However, even without manipulation by short-sellers, unjustified panic selling (which is not confined to small firms) would lead to the same dilution in shareholder 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 is clear that during the financial crisis (Fall 2008) panic selling was more the rule than the exception. It also shows that any realistic model for pricing contingent capital should allow for jumps in value.

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 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) also 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. 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:

1. The instrument does not encourage manipulation by short-sellers nor does it transfer wealth from shareholders to bondholders during a market panic.
2. It is less risky than other "classic" contingent capital securities that have been proposed in the literature, so that the security has better marketability.
3. As no regulators are involved, uncertainty due to regulatory discretion is avoided.
4. With the appropriate trigger mechanism, multiple equilibria are avoided.

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 should make it more appealing (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 $\text{Max}\left[A-1030,0\right]$. 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 $\text{Max}\left[A-1000,0\right]$ which is less than $30. Shareholders obtain the residual, equal to 7/37 of $\text{Max}\left[A-1000,0\right]$. 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

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[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.

> αA^*; 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 Some caveats

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.

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 weeks later. Once the rights issue is completed, the funds will be used to repay the debt. In other words, once the trigger generates conversion, 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.

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.

Throughout our analysis we have assumed that the managers of the firm, for example, bank managers, want to maximize shareholder value. Kashyap, Rajan and Stein (2008) point out that bank regulatory pressure to increase equity capital may create agency problems: equity gives managers significant discretion and provides opportunities for them to destroy value in negative net present value projects. COERCSs are in that respect superior to equity financing: as long as the bank's stock price stays above the trigger level, the security imposes the same discipline as a debt instrument. Capital is only provided in bad states of the world, and it is used to repay bonds, not to engage in negative net present value projects. After recapitalisation, the bank can reissue new COERCs to make sure that this pressure is restored. 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. The difference with our proposal is that 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.

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. We argue 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. We believe that this is important to mitigate regulatory risk as well as the negative price impact that may result from a regulatory announcement. If the trigger is based on a prespecified market value/book value of debt ratio, then of course the trigger stock price will depend on the available information about book values of debt. Hence the quality of the trigger will depend on the quality of the accounting information. Hart and Zingales (2009) propose a trigger based on CDS prices. As this is a more pure market based variable than market equity/book value of debt, such a trigger may well be better than a leverage ratio that is still partially based on book values. 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.

While we do not suggest that regulators should force banks to issue COERCs, regulators should facilitate the issuance by considering COERCs as very close to Tier 1 capital. Note that the Enhanced Capital Notes (ECN) issued by Lloyds Banking Group in 2009 are classified as Lower Tier 2 Capital. 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.

3.4 COERCS and multiple equilibria

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. 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 can 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, as Sundaresan and Wang (2010) show, when conversion can take place before maturity, this is no longer guaranteed.

They propose a solution: 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 suggestns, one needs an alternative design to avoid multiple equilibria. Our solution, which is implemented in the next section, is to have conversion 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 $S \times n_0 + V = A - D$.[12] 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.

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

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

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.

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:[13]

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

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

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

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.

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

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.[14] 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.

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 $D_t - A_t$.[15] 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

[14] 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.

[15] Under these assumptions, the fair credit spread on deposits equals $h_t = \lambda\left[N\left(-d_1\right) - x_t \exp\left(\mu_y + \frac{1}{2}\sigma_y^2\right)N\left(-d_2\right)\right]$ 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.

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

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

In the example of the previous Sections 2 and 3, $D_0 = 1000$, $B = 30$, and conversion is triggered when $\overline{e} = 3.5\%$.[16] 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 $\overline{e}D_t / n_0 = \left(\overline{a}_t - B - D_t\right) / n_0$, where $\overline{a}_t$ is the value of A_t that satisfies equation (4).

[16] 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.

Note that equation (4) can be rewritten as

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

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 $n_1 \gg B/\left(\overline{e}D_t / n_0\right)$; that is, the price per share at which COERC investors can purchase stock is $B/n_1 \ll \overline{e}D_t / n_0$, so that it is much less than the trigger price.[17] If conversion is triggered, say at date t_c, because $A_{t_c} \leq B + D_{t_c}\left(1+\overline{e}\right)$, 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 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

[17] 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.

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).[18] 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%.

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

[18] 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 $\hat{x} = 1.10$.

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.[19] 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 $\overline{e} = 3.5\%$. 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 $\overline{e} = 2.0\%$. 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 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

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

of shares equals that which converts the contingent capital to equal its par value if the post-conversion stock price equals the trigger price:[20]

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

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 $\overline{e} D_{t_c}$, 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.

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

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, $\alpha = B/\left(B+\bar{e}D_t\right)=6/13$, 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.[21] 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

[21] 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 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.

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, $-\partial V$, following an increase in one of the bank's risk parameters.[22] 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 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.[23]

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[22] 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.

[23] 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

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.[24] 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 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

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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.

[24] 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.

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.[25] 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 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.

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

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. Finally, 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). As the source of his problem is the result of potential wealth transfers from shareholders to bondholders, the warrant attached to the instrument greatly reduces this possibility.

COERCs not only alleviate the costs of financial distress but may make future financial distress less likely. 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%

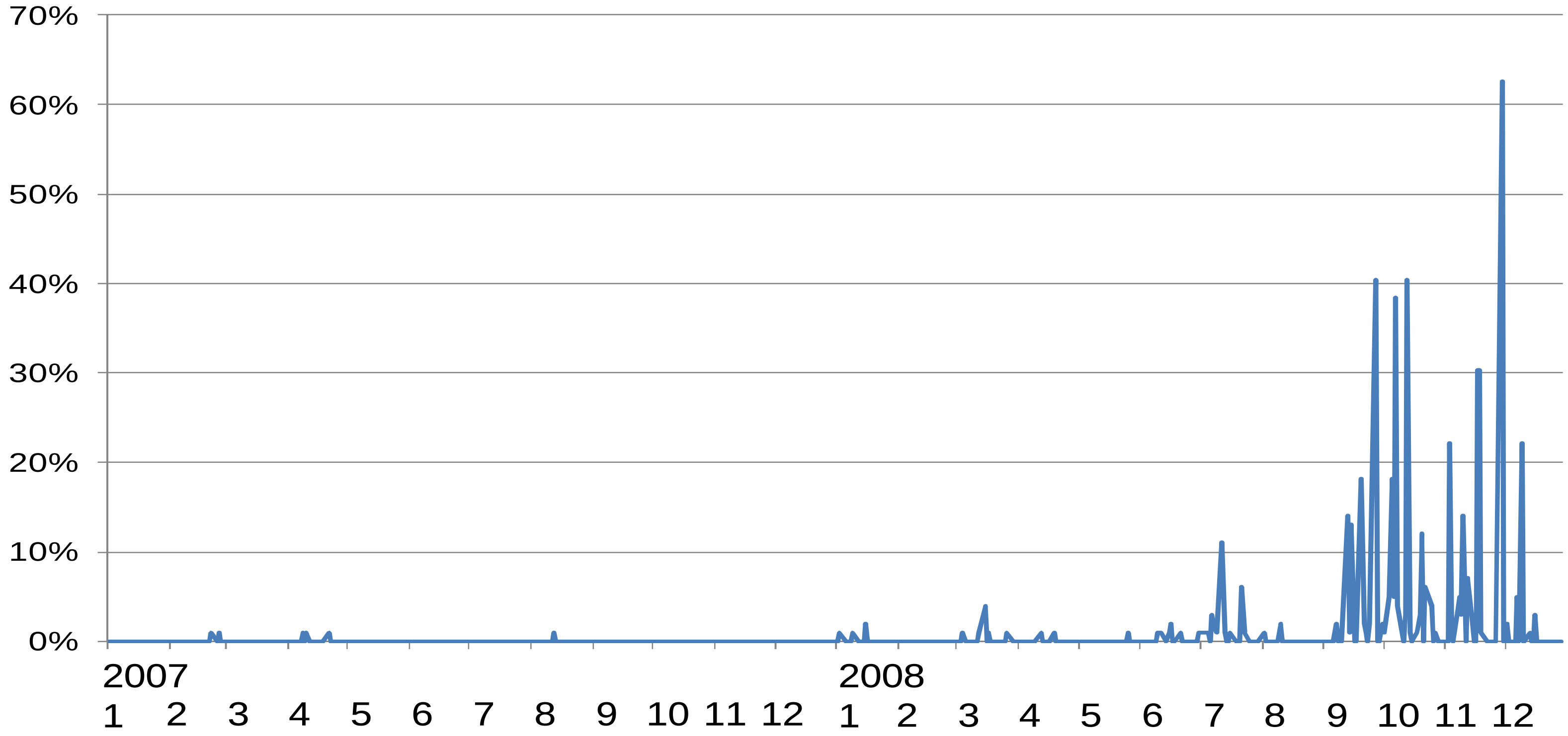
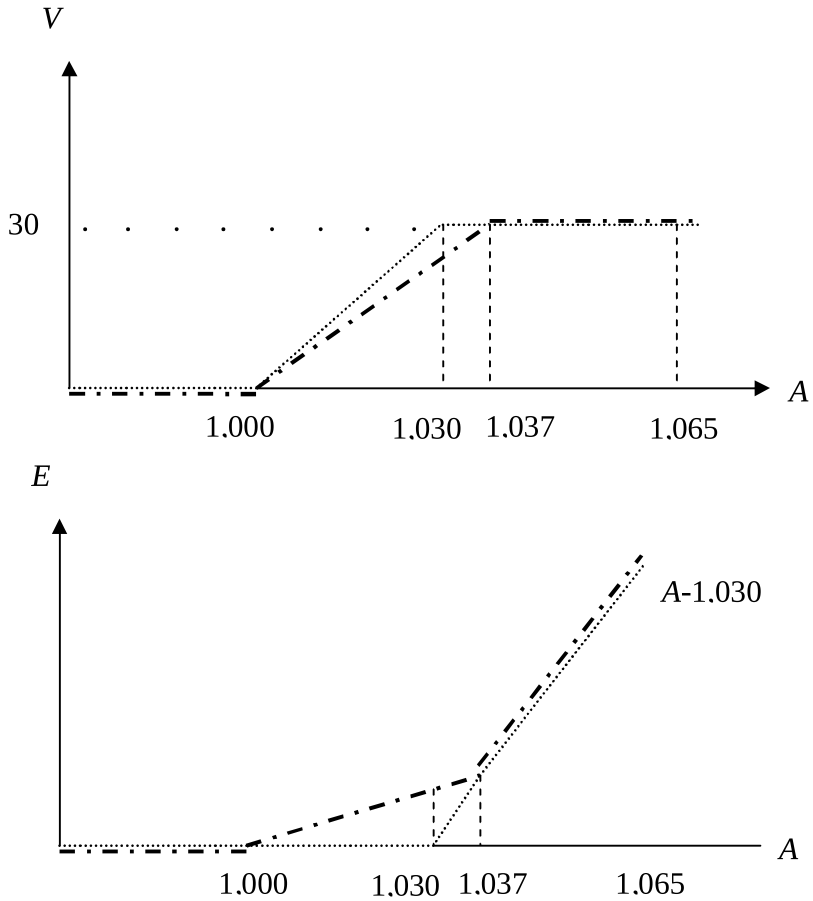


Figure 2 COERC versus Straight Debt



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

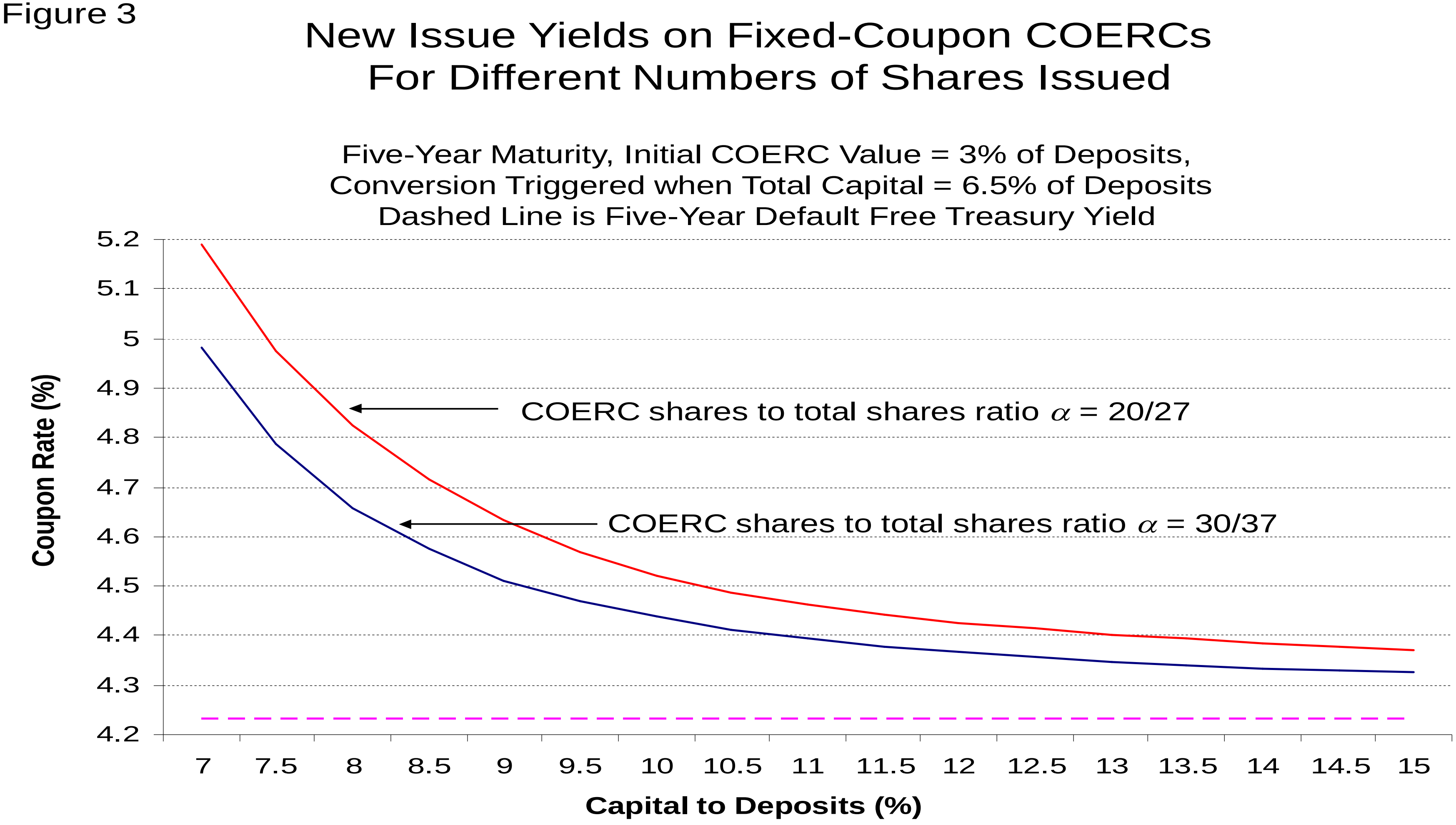

New Issue Yields on Fixed-Coupon COERCs
For Different Numbers of Shares Issued
Five-Year Maturity, Initial COERC Value = 3% of Deposits,
Conversion Triggered when Total Capital = 6.5% of Deposits
Dashed Line is Five-Year Default Free Treasury Yield
Coupon Rate (%)
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
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

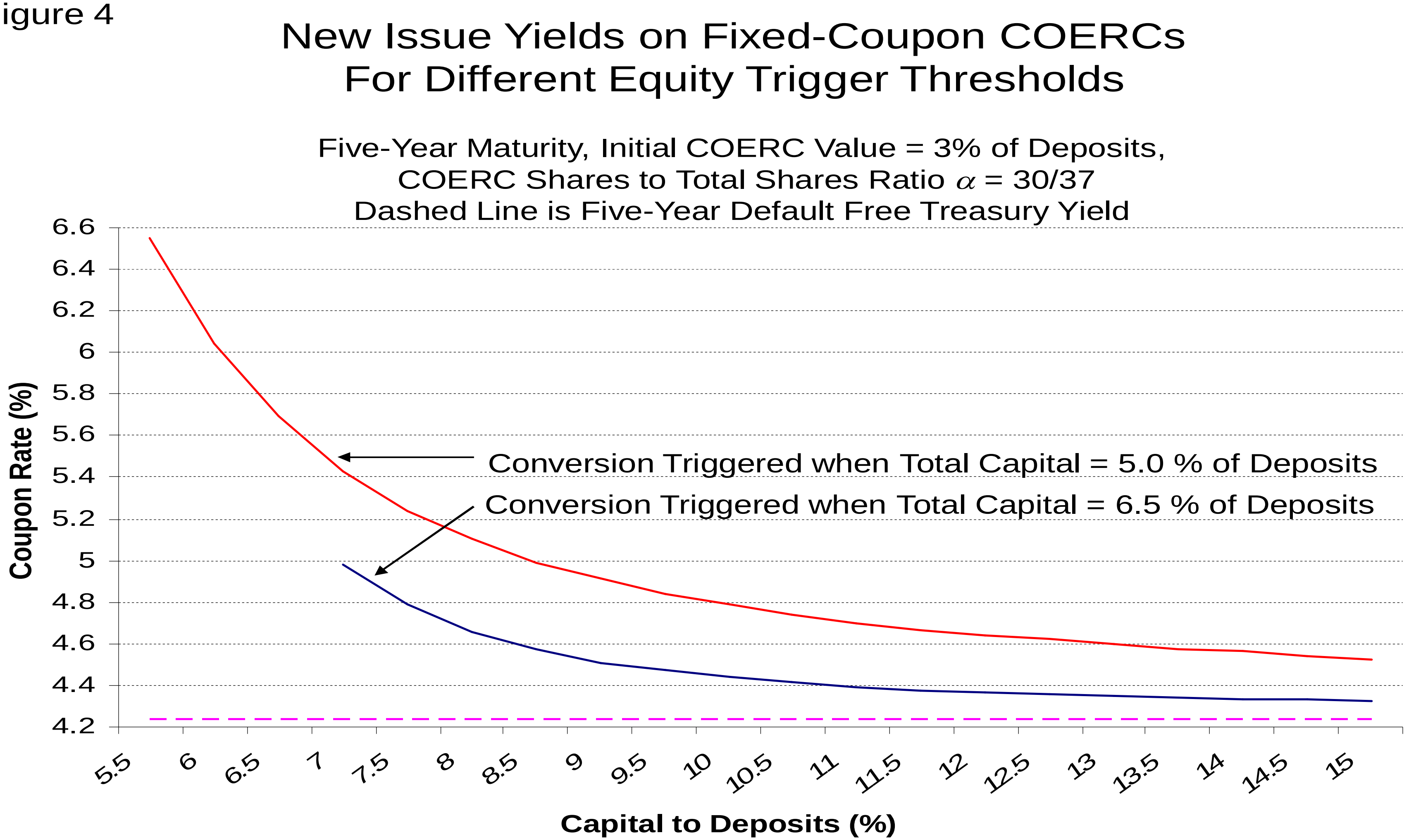
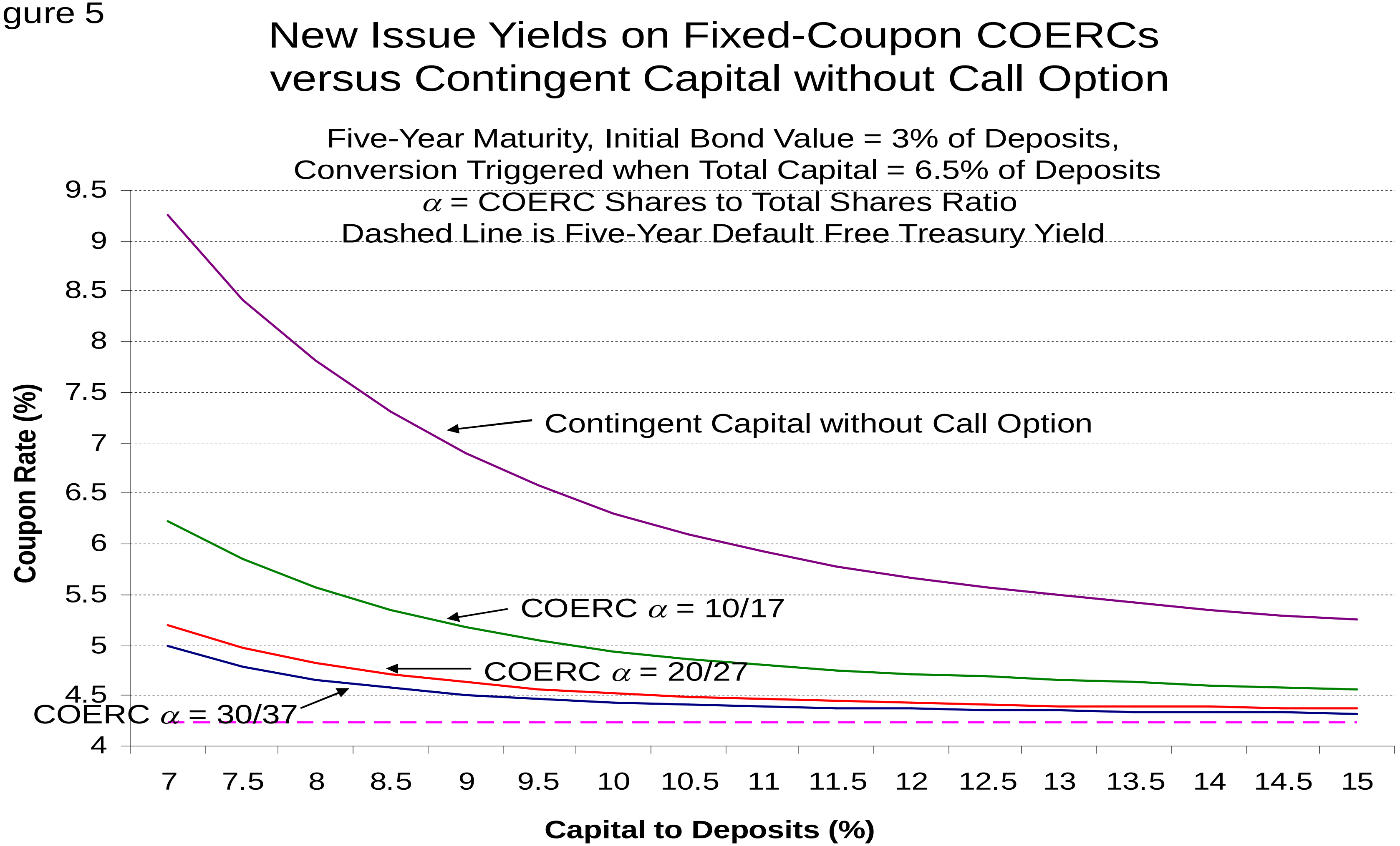

New Issue Yields on Fixed-Coupon COERCs
For Different Equity Trigger Thresholds
Five-Year Maturity, Initial COERC Value = 3% of Deposits,
COERC Shares to Total Shares Ratio α = 30/37
Dashed Line is Five-Year Default Free Treasury Yield
Coupon Rate (%)
6.6
6.4
6.2
6
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
Conversion Triggered when Total Capital = 5.0 % of Deposits
Conversion Triggered when Total Capital = 6.5 % of Deposits
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 (%)
Capital to Deposits (%)
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

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

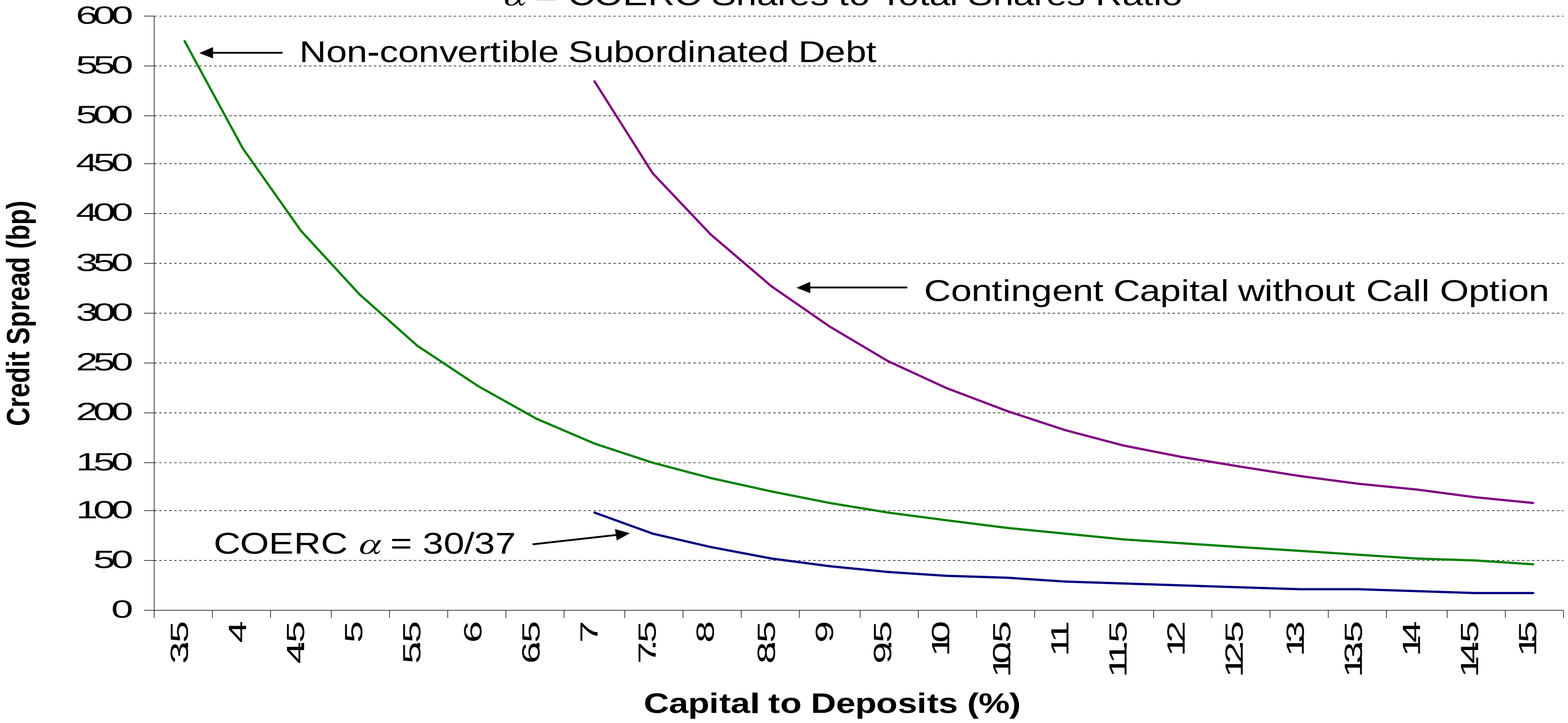


Figure 7

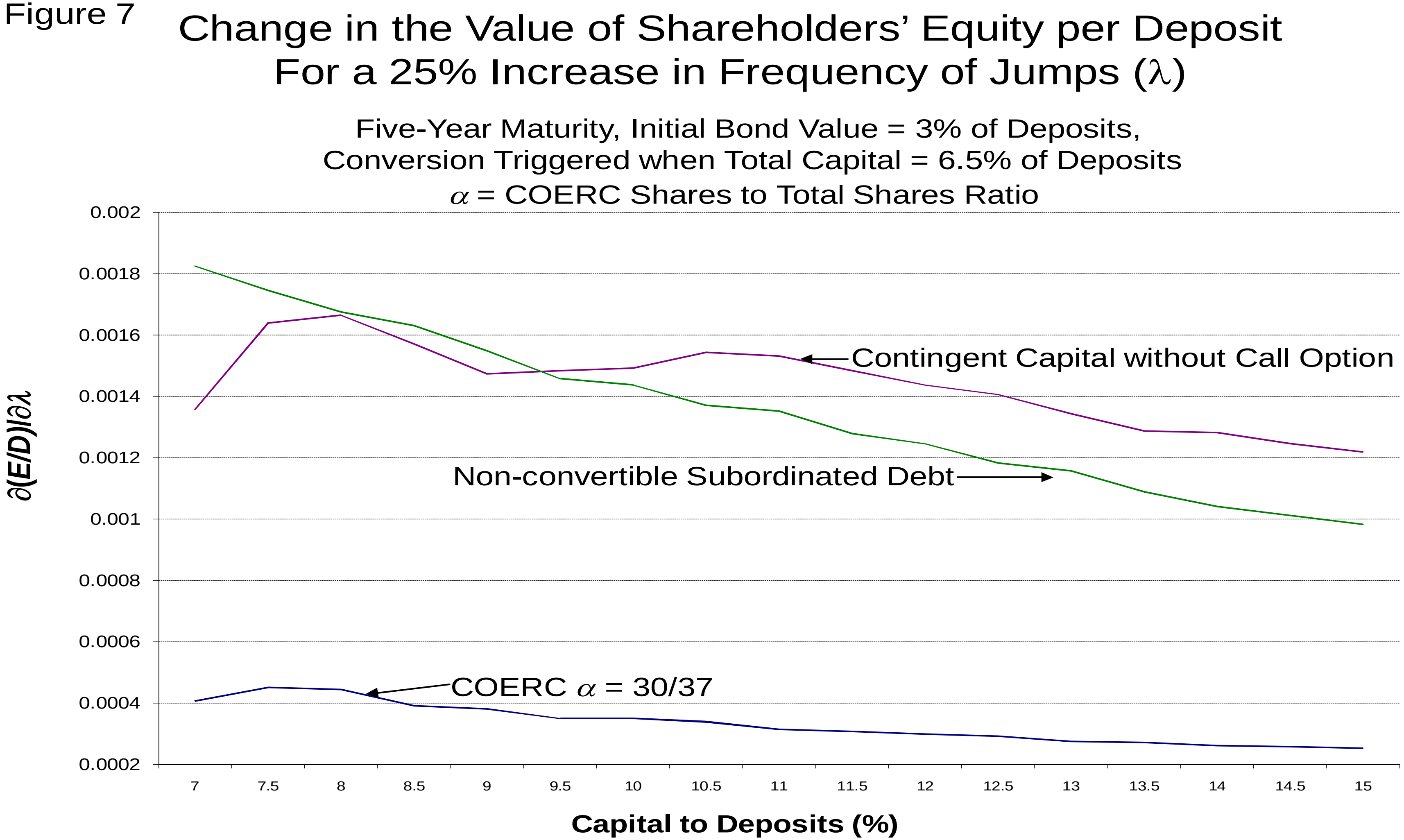
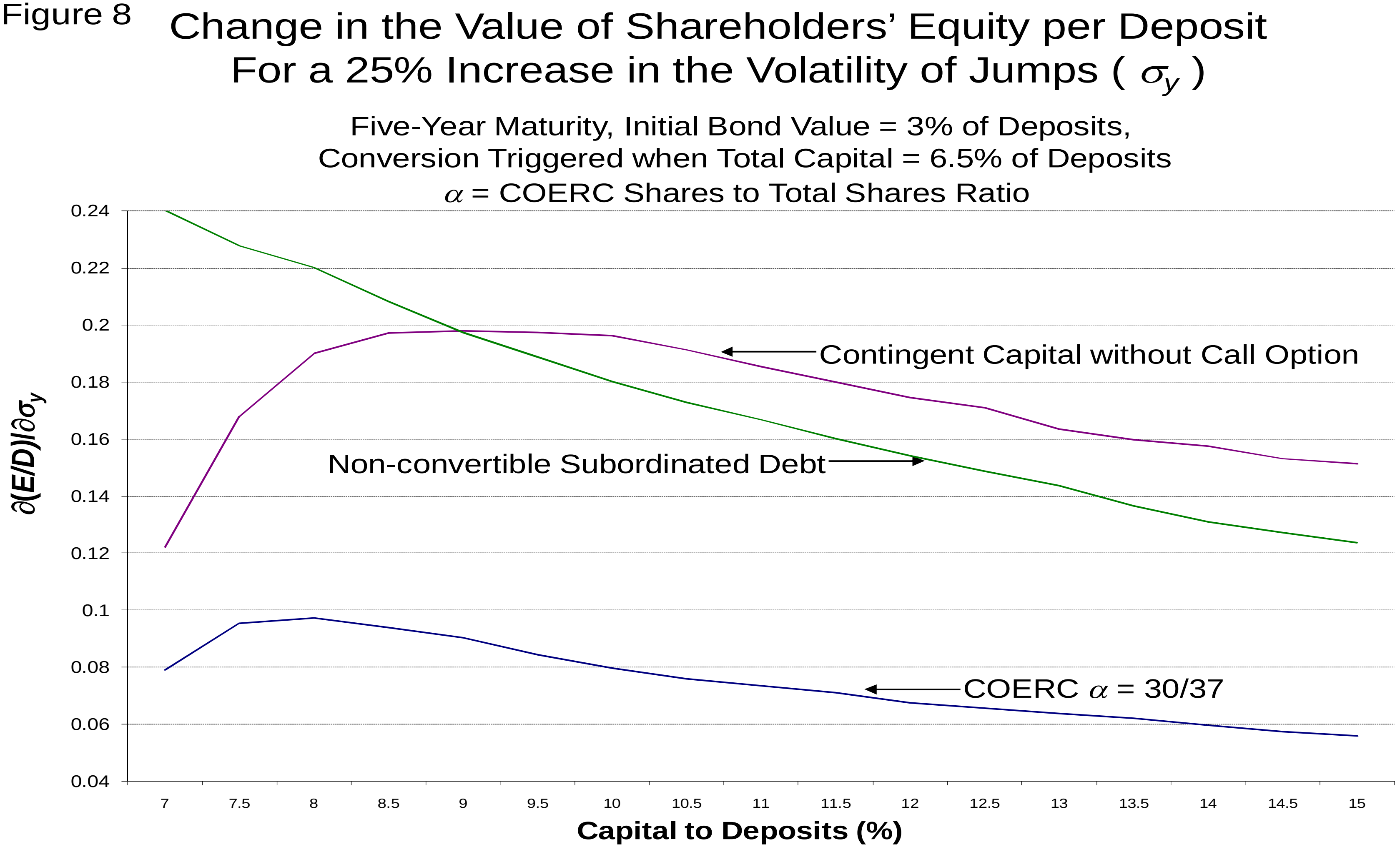

Change in the Value of Shareholders' Equity per Deposit
For a 25% Increase in Frequency of Jumps (λ)
Five-Year Maturity, Initial Bond Value = 3% of Deposits,
Conversion Triggered when Total Capital = 6.5% of Deposits
α = COERC Shares to Total Shares Ratio
∂(E/D)/∂λ
0.002
0.0018
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
Contingent Capital without Call Option
Non-convertible Subordinated Debt
COERC 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 8



Change in the Value of Shareholders' Equity per Deposit
For a 25% Increase in the Volatility of Jumps (σy)
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
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
∂(E/D)/∂σy
Contingent Capital without Call Option
Non-convertible Subordinated Debt
COERC 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 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

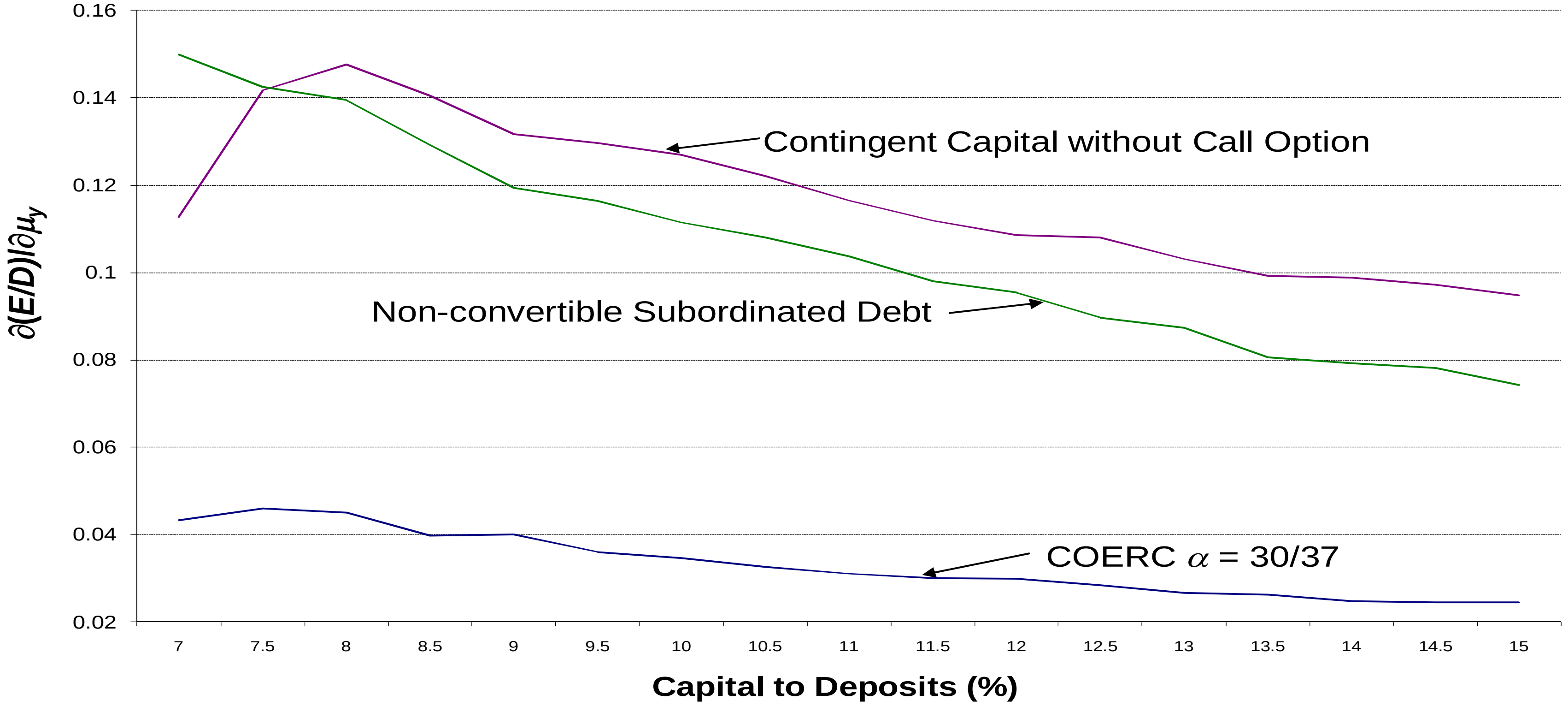


Figure 10 Change in the Value of Shareholders' Equity per Deposit For a 25% Increase in Diffusion Volatility (σ)

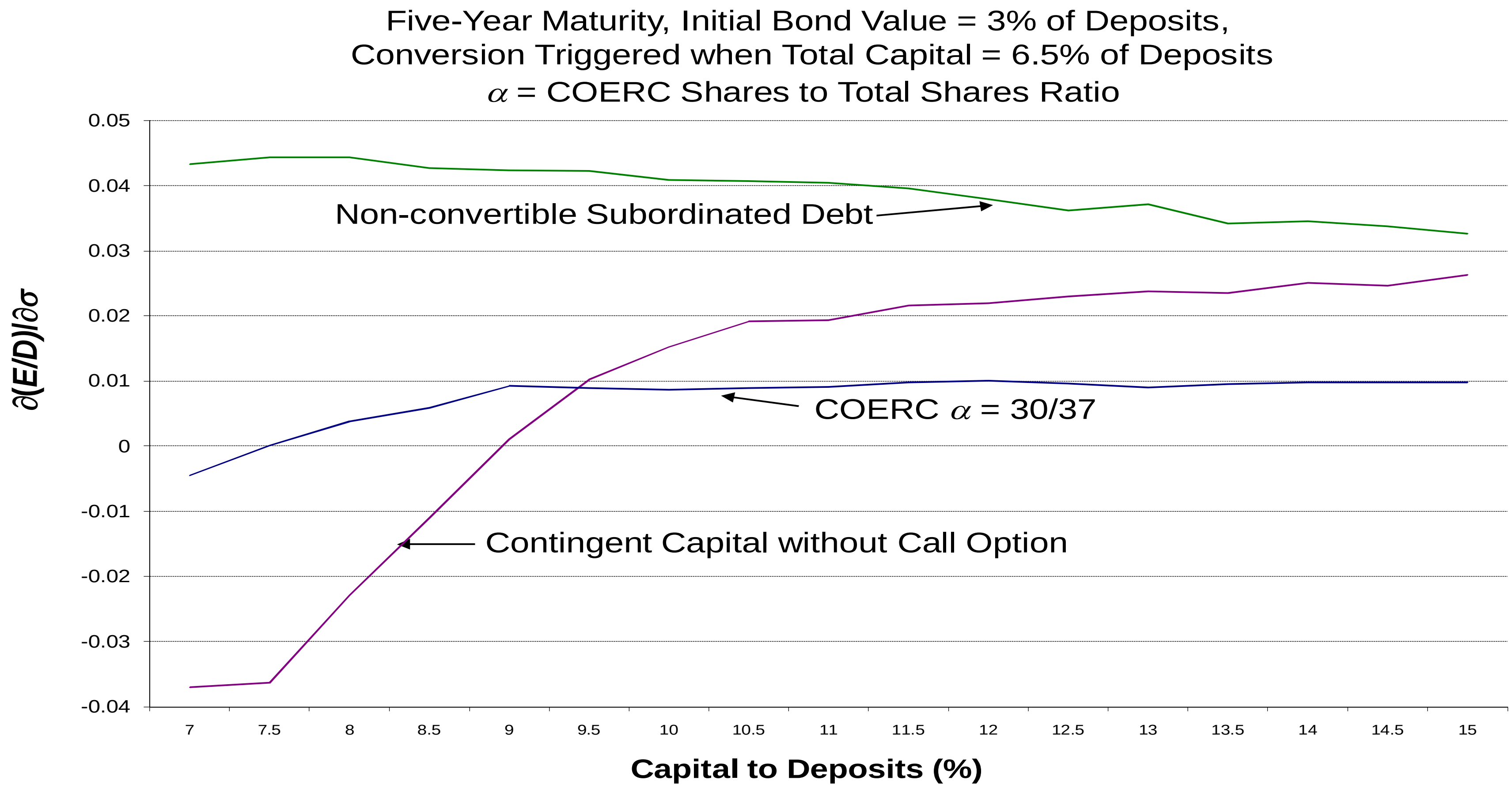


Figure 11

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

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