Secretariat of the Basel Committee on Banking Supervision
Bank for International Settlements
CH-4002 Basel, Switzerland

Chicago, August 22, 2011

Dear Sir/Madam

We would like to comment on your proposals and discussion of contingent capital in your publication "Globally systematically important banks: assessment methodology and additional loss absorbency requirement."

We enclose a paper "Contingent Capital: the Case of Coercs" that proposes a design that we believe rectifies the negative issues of going concern contingent capital relative to equity, specified on page 18-19 of the document.

A coerc (call option enhanced reverse convertible) is a bond that mandatory converts into equity but gives an option to equity holders to undo the conversion by buying the shares back from the bondholders at the same conversion price. Practically speaking, at the time of the triggering event, a rights issue will be announced with the same exercise price as the conversion price of the bond. If the conversion price is set significantly below the trigger price, equity holders will have a large incentive to subscribe to the rights issue and repay the bonds in order to avoid massive dilution. This lowers the risks of the bonds and would make them appealing to a large number of risk-averse investors. Obviously, if the rights issue fails, bondholders will largely take over the firm, but under no circumstances will tax payers be asked to bail out bondholders.

We believe the design deals with the comments on page 18 (item 87). Specifically

(a) Trigger failure: the trigger is based on market leverage ratios (coercs plus equity/deposits) rather than book value ratios. We show in the paper that an equivalent trigger could be based on the CDS spread on the bank's senior debt. We believe market leverage ratios are the only way to design going concern contingent capital as the recent crisis of 2008 has shown. Book values are sticky and backward looking, which means that no conversions would have taken

place during the 2008 crisis. Note that the trigger is not based solely on the bank's stock price, as this may lead to multiple equilibria as pointed out by Sundaresan and Wang (2010).

(b) Cost effectiveness

The benefits from contingent capital relative to equity cannot be simply reduced to tax advantages. The interest payments on the (non-converted) debt reduce agency costs of equity in good times, when agency costs of equity are important. Moreover, increased equity finance is likely to increase agency costs in another way by increasing the separation between management and ownership, especially when ownership is dispersed. There is also no possibility for banks to financial engineer the instruments in such a way that tax payers will have to bail out the debt holders. Either the equity holders repay the coercs or the bondholders take over the firm.

(c) Complexity

Complexity is largely a result of risks. By designing the instrument in such a way that the equity holders have a large incentive to repay the debt holders, coercs have very low credit risk and are therefore easy to value. This is illustrated in the paper, e.g. Figures 4 to 6. This will make them appealing to investors who want to buy low risk instruments, so that contingent capital can become a successful instrument.

(d) Death spiral

By giving equity holders an option to undo the conversion by repurchasing the shares at the conversion price, incentives for bondholder to short the stock and force conversion below a "fair" stock price are avoided. The possibility for shareholders to undo the conversions also protects the pre-emptive rights of shareholders. Such pre-emptive rights are important to avoid that contingent capital becomes an instrument to take control of the bank.

(e) Adverse signaling

As the triggering is based on observed variables such as the market value of the sum of shareholders equity plus coercs or, alternatively, the CDS credit spread on

senior debt, the conversion is not giving a negative signal. Rather, a negative signal might occur if the trigger is set by regulators or others which are assumed to have superior information. When the trigger is reached, the bank will recapitalize itself which should increase the confidence in the bank's survival as a going concern.

(f) Negative shareholder incentives

If triggers are based on book value capital ratios then, indeed, bankers have an incentive to reduce lending, sell assets below fair value and engage in other activities that may increase these ratios at the expense of the real economy. But the coerc trigger is based on variables determined in the market, and as such cannot be easily manipulated. Specifically, if the banker's activities have negative effects on financial markets, the trigger will go off. Gambling behavior (excessive risk taking) is also avoided because the coercs are designed in such a way that their risk is low. Risk-shifting (investing in negative NPV projects to transfer wealth from bondholders to shareholders) is only a problem if debt is risky.

If the Committee would need more information and clarifications, please don't hesitate to contact us.

Sincerely

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Contingent Capital: The Case of COERCs

by

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Abstract

This paper introduces, analyzes and values a new form of contingent convertible (CoCo), a Call Option Enhanced Reverse Convertible (COERC). Issued as a bond, it converts to new shareholders' equity if a bank's market value of capital falls below a pre-specified trigger. Unlike other CoCos, a substantial number of new shares are issued to COERC investors at conversion, but the bank's original shareholders have the option to repurchase these shares at the bond's par value to avoid heavy dilution. As a result, COERC investors would almost always receive their bond's par value in cash at conversion. Compared to other proposed forms of CoCos, the COERC has lower credit risk when bank assets can experience sudden, large declines in value. Moreover, the COERC 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. Introduction

This paper introduces, analyzes and values a new security named Call Option Enhanced Reverse Convertible or COERC. It is a variation of contingent capital that addresses many of the criticisms made against standard forms of contingent capital. Contingent capital, also referred to as contingent convertibles (CoCos), is debt that converts to equity after some triggering event, such as a decline in a bank's capital below a threshold. The potential benefit of CoCos is that when a bank's initial equity capital is depleted, the bank automatically recapitalizes, thereby avoiding financial distress and the need for a government bailout. Originally proposed by Flannery (2005), interest in CoCos has grown since the 2007-2009 financial crisis because other debt-like forms of bank capital such as "subordinated debt and hybrid capital largely failed in its original objective of bearing losses" (HM (UK) Treasury (2009)). CoCos are included in the new Basel III capital standards, and some estimate that up to $1 trillion of CoCos may be issued to replace securities that will no longer qualify as regulatory capital.[1] Switzerland has taken the lead by requiring that its two major banks, UBS and Credit Suisse, increase their capital ratios to 19% with up to 9% of this requirement being met with CoCos.

The public policy debate regarding CoCos has spurred significant academic interest as well.[2] In general, these papers propose different designs for CoCos. Design issues are mainly focused on determining the trigger that leads to conversion as well as the conversion price. The purpose of this paper is to contribute to this literature by proposing a new design, the COERC. Note that this paper makes no policy recommendations about the desirability of CoCos relative to other methods to improve banks' capital requirements. Perhaps banks simply should be required to issue more equity as advocated by Admati et al (2010). The limited objective of this paper is to design a CoCo bond that has the following desirable characteristics. First, the trigger is based on market values of capital ratios rather than regulatory capital ratios that are based on book values. Second,

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[1] See "Potential $1 Trillion Bank Contingent Capital-Style Issuance Faces Uncertain Investor Interest," Standard and Poor's, www.standardandpoors.com/ratingsdirect, December 8, 2010.

[2] Recent academic studies on CoCos include Albul et al. (2010), Barucci and Del Viva (2011), Berg and Kaserer (2011), Bolton and Samama (2010), Calomiris and Herring (2011), Flannery (2009a, b), Glasserman and Nouri (2010), Hilscher and Raviv (2011), McDonald (2010), Squam Lake Working Group (2009), and Sundaresan and Wang (2010).

although based on market values of capital, the design avoids one of the main criticisms of market-based triggers: unjustifiable conversions as a result of manipulation or panic as well as multiple equilibria (Sundaresan and Wang (2010)). Third, in a realistic environment where bank asset values can suffer sudden losses (as occurs during a financial crisis), we show that a COERC is relatively easy to value. It has low default risk and regulatory risk, which should improve liquidity, minimize costs of financial distress and make it appealing to a large number of risk-averse investors. Fourth, the design preserves the pre-emptive rights of stockholders who may be concerned about losing control to CoCo investors after conversion. Finally, although the main purpose is to design an instrument that allows banks (or any other firm in general) to avoid financial distress, thereby reducing the likelihood of a public sector (taxpayer) bailout, we also intend this capital to be attractive to the issuing bank or firm. Imposing a security or capital structure that banks find overly burdensome may lead to 'regulatory arbitrage' including a shifting of risk to a 'shadow banking' sector of the financial system to which taxpayers may still be exposed.[3]

For a shareholder value-maximizing bank or firm, appropriately-designed CoCos can be an attractive financing instrument. Standard capital structure theory views a firm's choice of debt versus equity as a trade-off between the relative benefit of debt's corporate tax shield versus its higher costs of financial distress. Prior to conversion a CoCo bond possesses debt's tax shield, but it avoids direct costs of financial distress (bankruptcy costs) if it automatically converts to equity before the firm's net worth reaches a distressed level.[4] Even without tax benefits, CoCos may be beneficial in reducing agency costs. [5] Relative to equity, pre-conversion CoCos obligate a firm to pay coupons that can

[3] For example, if equity is tax-disadvantaged relative to debt, a higher equity capital requirement raises banks' costs of funding and reduces loan supply. Regulatory arbitrage may take the form of excessive off-balance sheet financing (securitization) as shown by Han, Park, and Pennacchi (2010).
[4] Automatic conversion avoids a hold-out problem associated with debt renegotiation where creditors are asked to voluntary exchange risky debt for equity: each individual creditor has an incentive to hold out, although creditors would be better off as a group to accept the restructuring proposal.
[5] Under current US tax law, it is questionable whether interest on CoCos would be tax deductible. However, if CoCos are considered as useful capital instruments that reduce the risk of future bail-outs, it is not unlikely that this tax law would be amended. Moreover, in Europe, interest on CoCos is tax deductible.

mitigate managerial agency costs of free cash flow.[6] CoCos may avoid the need for greater equity issuance that reduces managerial ownership and the alignment of interests between managers and shareholders.

However, compared to equity finance, CoCos, as any debt instrument, has higher costs of financial distress than equity. While the automatic conversion of debt into equity reduces direct bankruptcy costs, it may not eliminate the indirect costs of financial distress, i.e. costs arising from conflicts between bondholders and shareholders. This conflict is a result of the fact that debt is default-risky and that shareholders possess limited liability. Myers (1977) identifies two types of costs. First, shareholders have a moral hazard incentive to increase the firm's risk via investments in excessively (negative NPV) risky assets or higher leverage, as long as the decline in firm value is less than the decline in the value of the debt as a result of the increased default risk. Second, when a firm is in financial distress, total firm value might be increased with a new equity issue that reduces financial distress.[7] However, the "debt overhang" problem is a disincentive for shareholders to issue new equity if the increase in firm value is smaller than the wealth transfer to the debt holders as a result of the debt's reduced default risk. Hence a properly-designed CoCo should try to minimize these indirect costs of financial distress as well. The obvious solution is to make the CoCo bond close to default-free. A COERC has this quality because its investors almost always receive their promised par (principal) value. Thus, when a CoCo, such as a COERC, is essentially default-free, shareholders' incentives become similar to those that would exist under a regime of unlimited liability.

CoCos can be an effective restructuring vehicle if they are designed to convert to equity prior to the onset of severe financial distress. The CoCo issues made thus far by Lloyds Bank, Rabobank, and Credit Suisse are suspect in this regard because their conversion trigger is a regulatory (accounting-based) capital ratio that tends to lag behind a market value capital ratio and can be manipulated by bank management. Rather than being a capital instrument for preventing financial distress, these previous CoCo issues

[6] Jensen (1986) developed this argument for the advantage of debt. In a banking context, see Kashyap, Rajan, and Stein (2008).
[7] Alternatively, the firm could increase its equity-to-debt ratio by paying off debt with a new equity issue.

correspond to the Basel III "bail-in" capital standards approved in January 2011. These standards require that for hybrid instruments to qualify for Tier 1 or Tier 2 capital, they must be written-down or converted to equity at the point when a bank becomes "non-viable," defined as the time when a public sector injection of capital is imminent or regulators deem a write off is necessary. The goal of such bail-in CoCos is loss absorbency when the bank is a "gone concern," rather than avoiding financial distress in the first place. However, the Basel Committee and the Financial Stability Board are continuing to review how differently designed CoCos might satisfy additional capital requirements for global systemically important banks (G-SIBs).[8] The goal of such CoCos would be conversion into equity while the G-SIB was a "going concern;" that is, at an earlier stage prior to severe financial distress. Conversion to equity at an early stage would likely require a market capital trigger.[9]

The COERC that we introduce is meant to provide automatic capital restructuring of a bank *prior* to severe financial distress. Therefore, it is intended to convert at a relatively high market value of capital-to-debt ratio, defined as the sum of the market values of equity and CoCos divided by the book value of the bank's deposits and senior debt. The market value of capital at which conversion is triggered might be where a bank is considered adequately capitalized, but not well-capitalized, so conversion would tend to occur when the bank is a going concern rather than a gone concern.

COERCs have two main features that distinguish them from other CoCo designs, and these two characteristics address criticisms of standard CoCos with market value triggers. First, if conversion is triggered by a decline in the market value of the bank's capital, a relatively large number of new shares would be issued to COERC investors such that the bank's existing shareholders would likely be heavily diluted. In other words, the market value of new shares issued to the holders of COERC bonds would likely exceed their bonds' par value, giving them a capital gain and the bank's existing shareholders a capital loss. However, the second main feature of COERCs allows existing shareholders to avoid

[8] See Basel Committee on Banking Supervision (2011).
[9] Andrew Haldane (2011), Executive Director for Financial Stability at the Bank of England advocates simple market value triggers for CoCos.

this dilution because they are given the right (option) to purchase the newly issued shares at an exercise price equal to the COERC bonds' par value.

What incentives are created by these two features? Because the effective share price at which conversion is triggered is intentionally set higher than exercise price needed to repay the par value of the COERC bonds, the existing shareholders will almost always have an incentive to exercise their option to purchase the shares issued to COERC investors. They will be *coerced* into repaying the COERC investors to avoid being heavily diluted. Moreover, rather than becoming shareholders when conversion is triggered, COERC investors end up receiving their bonds' par value in cash.

If an existing shareholder of the bank does not have the liquidity to exercise her in-the-money option to purchase the new shares, her purchase right can be sold to a more liquid investor who does. As a result, the bank is de-levered and the initial shareholders (or investors who purchased their rights) now own all of the bank's capital. The only instance where existing shareholders would decline exercising their right to repurchase the COERC investors' shares would be if a sudden, massive loss in the bank's capital triggered conversion but also left the large proportion of shares issued to COERC investors to be worth less than their bonds' par value. Only for such an extraordinary event would the COERC investors become shareholders and suffer a loss. As we will show using reasonable parameter values, COERC bonds might require a 20 basis point credit spread to cover the value of such potential losses.

The COERC design addresses several criticisms lodged against standard CoCos with market value triggers. While market value triggers are more timely and forward looking than regulatory capital (accounting) triggers, market values may be manipulated and could lead to instability. Speculators may have an incentive to purchase CoCos and short-sell the bank's stock in order to temporarily depress the value of shareholders' equity 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.[10] Once CoCos are converted, speculators obtain shares to cover their short positions and would experience a capital gain on their remaining shares at the expense of the now-diluted initial shareholders.[11]

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

CoCos also are criticized for being hard to value, which makes them unattractive to traditional fixed-income investors and makes credit rating agencies reluctant to rate them.[12] This criticism applies most to CoCos with triggers based on regulatory capital ratios and/or regulator discretion: banks can manipulate regulatory accounting and regulators' decisions are subject to political pressure.[13] But while CoCos with market

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[10] Oswald Grübel, CEO of UBS, states "As soon as you get near these trigger levels – you don't have to hit them – what do you think shareholders will do? They will get the hell out of that stock." See "Bankers Fear CoCos Are Another Crisis in the Making" *Financial Times* March 5, 2011.
[11] We give a numerical example of this later in the paper.
[12] See e.g. "Credit Suisse CoCo Investors Uncertain How to Value Notes," *The Financial Times* April 15, 2011. The Credit Suisse CoCo issue was rated BBB by Fitch, but Moody's and Standard & Poor's have yet to rate a CoCo, citing uncertainty over these bonds' potential losses.
[13] For example, Credit Suisse's CoCo, issued in February 2011, converts to equity if the bank's core Tier1 capital ratio falls below 7%. However, the Swiss regulator, FINMA, can also force conversion if it sees that Credit Suisse needs public funds to avoid insolvency. The conversion price is the minimum of $20 and the volume weighted average stock price five days before the conversion notice. Arguably, there are three reasons why this CoCo is risky. First the trigger is based on regulatory accounting capital ratios so that the stock price at the time of conversion is unpredictable. Second, if the stock price at the time of conversion is

value triggers are less exposed to regulatory risk, investors have complained that the likelihood of losses at conversion is still hard to predict. However, because COERCs are designed to be nearly default-free, it is relatively easy to value them. Even if the timing of conversion is hard to predict, the fact that CoCo investors almost always receive their bonds' par value should qualify them for a very high quality credit rating.

A related criticism of CoCos is that traditional fixed-income institutional investors may shy away from them because they do not wish to become bank shareholders. If capital markets are segmented between fixed-income and equity investors, there may be little demand for CoCos, raising their cost to banks that issue them. With COERCs, however, investors almost always receive cash equal to their bonds' par value at conversion. Thus, the probability that COERC investors become shareholders is much lower than with standard CoCos. Since COERC investors become shareholders only if a sudden, large loss leaves capital significantly below the conversion threshold, the probability of such an event might be similar to that of bankruptcy for standard bond investors, and even investors in standard bonds can become new shareholders in bankruptcy.

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.

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

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less than $20, CoCo investors can incur a significant loss. Third, the ability of FINMA to force conversion before the trigger is reached creates additional risk that is difficult to price.

received by financial markets, it was an exchange offer. In return for giving up more senior securities, investors in the ECN received an extra 1.5% or 2% additional coupon income. Another CoCo-like security was issued successfully by Rabobank in May of 2010. If the bank's regulatory capital ratio falls below 7%, the security's principal is written down by 75% and the remaining 25% is redeemed for cash. This security is not converted to new common equity, so it is not clear that it fits the standard definition of CoCo. The lack of equity conversion is likely due to Rabobank being a cooperative bank without traded common stock. Finally, in February 2011, Credit Suisse, encouraged by the Swiss National Bank, issued SF6 billion of CoCo notes with a 9% coupon rate to two Middle Eastern investors in exchange for existing Tier 1 notes. It also made a separate public CoCo issue for $2 billion at a 7.875 % coupon rate, with a common equity Tier 1 capital trigger ratio of 7%, a conversion cap of $20, and a maturity of 30 years. This issue was heavily oversubscribed, perhaps due to the issue's large credit spread.[14]

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

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[14] At the issue date, the 30-year Treasury yield was 4.16%, the AAA corporate bond yield was 5.26%, and the BBB (which was Fitch's rating of the CoCo) corporate bond yield was 6.14%.

Second, because regulators are aware that capital ratios are stale, they may be tempted to intervene and trigger conversion themselves. This regulatory risk may be difficult to assess, even for major credit rating agencies. Moreover, if regulatory capital ratios lag market ones but regulators forbear in triggering conversion, conversion may be delayed to a point when a bank's market value of capital is quite low and CoCo investors become more likely to sustain losses. This payoff structure may be unappealing to risk-averse fixed-income investors unless compensated by a large credit spread. Management may be reluctant to pay such credit risk premiums if it believes the firm's risk of financial distress is lower than that believed by CoCo investors.

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

Assume that a highly levered firm (bank) has assets with a value of A = \$1,100. The firm's liabilities consist of senior debt (deposits) worth D = \$1,000, a CoCo bond with par value of B = \$30, and common shareholders' equity worth $S \times n_0$ = \$70, where S is the stock price per share and n_0 is the number of shares outstanding. Let the number of shares outstanding be $n_0 = 7$, so that the stock price is currently \$10. To simplify the example, suppose that prior to conversion, the market value of the CoCo bond, V, equals its par

value, B, so that changes in the firm's assets affect only the stock price. We relax this assumption later when the CoCo bond's value, V, is permitted to differ from its par value due to possible default losses. For now, with the assumption that $V = B$ prior to conversion, the market value of total capital, $S \times n_0 + V = S \times n_0 + B$, varies only due to 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, $S \times n_0 + V$.[15] Assume also that the CoCo converts when the stock price, S, falls to $5, and the conversion price is also $5.

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

This example illustrates that CoCo investors have an incentive to manipulate stock prices downward through false rumours or through shorting the stock. As McDonald (2010)

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

points out, academics are generally sceptical about legally profitable manipulation, since a speculator who shorts a stock and drives its price down will subsequently drive the stock price up when covering the short. However, in the case of CoCos, the short-seller can cover the short position by shares provided by the issuer after conversion, thereby avoiding buying pressure.

Hillion and Vermaelen (2004) provide empirical evidence consistent with such market inefficiency by analyzing a similar convertible bond known as a "floating-priced convertible" or "death spiral." These bonds can be converted to equity at a pre-specified total value. Thus, at conversion, a variable number of new shares are issued to bondholders depending on the market price of the stock such that bondholders receive a specific equity value at conversion. Although the investor has the option of deciding when to convert, the non-converted principal plus accrued interest must be converted at maturity. As with CoCos, the motivation for floating-price convertibles is to avoid costs of financial distress by making the bonds default-free, which explains why these securities are typically issued by high growth risky firms. However, Hillion and Vermaelen report that, on average, the stock returns of firms that issue these bonds underperform the market by 85 % in the year after issuance. To explain this result, they develop a model of market manipulation where bondholders have an incentive to short stocks and convert afterwards using the shares obtained through conversion to cover their short position.

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

justifies its objection to CoCos with market based triggers on the basis of these manipulation/death spiral fears.[16]

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

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

[16] For example, see "Contingent capital: possibilities, problems and opportunities," Goldman Sachs mimeo, February 16, 2011, and "CoCos," Lex column, *Financial Times* July 21, 2011.

model where bank asset values follow a mixed jump-diffusion process. Such an environment is modelled by Pennacchi (2010), and the possibility that bank assets may suddenly decline in value (jump) can have qualitatively distinct effects on the value of CoCos and bank equity. In general, when discontinuous declines in bank asset values are possible, it may be impossible to design CoCos (or any other bank liability) that is completely default-free. In turn, if CoCos are not always valued at par, there can be wealth transfers at conversion and the multiple equilibrium problem re-emerges.

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

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

In this paper, we introduce an alternative CoCo structure that achieves the following objectives. First, the instrument does not encourage manipulation by short-sellers nor does it transfer wealth from shareholders to bondholders during a market panic. Second, it has less credit risk than other proposed CoCos, making it more attractive to risk-averse fixed-income investors. Third, as no regulators are involved, uncertainty due to regulatory discretion is avoided. Fourth, with the appropriate trigger mechanism, multiple equilibria are avoided. Finally, existing bank shareholders preserve their pre-emptive rights over bondholders, something which may be important for control reasons.

As mentioned earlier, COERCs have two distinctive features. The first is that a relatively large proportion of shares would be issued COERC investors at conversion which, absent

the second feature, would heavily dilute initial shareholders.[17] However, the second feature gives the bank's existing shareholders an option (warrant) to buy the shares back from the CoCo investors after conversion at a price equal to the CoCo bonds' par value. This call option ensures that shareholders can "undo" any wealth transfer to CoCo investors created by manipulation or panic. The large proportion of shares issued to CoCo investors gives a strong incentive for shareholders to exercise the call option and repay CoCos at their par value. This will, in turn, reduce the credit risk of CoCos, thereby enhancing their marketability with fixed income investors.

3.1 Numerical example

This section illustrates the basic features of a COERC with a numerical example. In the next section, we show how COERCs would be valued using the framework of Pennacchi (2010). Similar to the previous numerical example, let the COERC's par value equal $30 and the trigger stock price be $5. However, when conversion is triggered 30 new shares, rather than 6, are issued to COERC investors. Thus, the implied conversion price will be $1 rather than $5. Now suppose that the stock price is manipulated down to $5 and COERCs are converted into 30 new shares. Together with the 7 shares owned by the initial shareholders, the total number of shares outstanding is now 37, which translates into a fundamental (non-manipulated) share value of $100/37 = $2.70. Obviously, considering that shareholders have the right to buy back these shares at $1 so that their total payment to COERC investors is $30, they will do so. If they did not, their wealth would fall from $7×10 = $70 to $7×2.70 = $18.92, 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 the fundamental value of $2.70 per share, represents a gain of $51). As a result, the COERC investors end up being paid their bonds' par value.

Suppose instead there was *justified*, fundamental decline in the bank's stock price to $5 per share (implying a fall in market value of equity from $70 to $35). COERC bondholders will convert into 30 shares. The fully diluted value per share is now

[17] This feature can also be described as having the conversion stock price being set significantly lower than the trigger stock price.

$(30+35)/37 = $1.76 per share. Each shareholder will, again, exercise the option to buy the shares back at $1, so that COERC investors continue to receive their bonds' par value.

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

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

3.2 Graphical illustration

Figure 2 illustrates our analysis, assuming that conversion and the repurchase option can only occur at the COERC bond's maturity. It shows the payoffs of the bond (with par value of $30) and the payoffs to shareholders as a function of total asset value of the firm at the bonds' maturity date. Note that because the firm has $1,000 of senior debt, all other claims become worthless if firm value falls below $1,000. The solid line shows the

payoffs when bonds are not convertible, while the interrupted line shows the case of COERCs.

If the bonds were not convertible, their value, *V*, would be worth \$30 as long as the total firm asset value, *A*, is higher than \$1,030. If *A* falls below \$1,030 but above \$1,000, the shareholders are wiped out and the bondholders receive *A*- \$1,000. Note that in this case we get the classic hockey stick graph for the value of equity, equal to $\text{Max}\left[A-1030,0\right]$. 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: shareholders are now interested in preserving firm value between \$1,000 and \$1,037. This interest is a direct result of the fact that the COERC investors have to share the value of the firm with the equity holders whenever the value of the firm is in the \$1,000-\$1,037 range.

Note that by putting the conversion price very low (at \$1) COERC bondholders' risk is only marginally higher than that of non-convertible bonds. If we had put the conversion and trigger price at \$5, the shareholders would have refused to repay the debt when firm value falls below \$1,065, not \$1,037. In that case, the risk of the bondholders would have been higher. Graphically, the blue line in Figure 2 would start going down when the asset value reaches \$1,065.[18]

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[18] Note that the figure is somewhat oversimplified: if the COERC is more risky than a non-convertible bond, the par value should be higher than 30. As the default risk of a bond increases, its promised par value should increase. However, as shown in the next section, when conversion can occur prior to maturity, COERCs can be less risky than non-convertible bonds.

Some basic valuation insights can be obtained from Figure 2. At the maturity of the COERC, its value will be the minimum of its par value of B and $\alpha(A\text{-}1000)$, where α is equal to the number of shares obtained by COERC investors after conversion (n_1) divided by the total number of shares outstanding after the conversion ($n_0 + n_1$). In our numerical example, $n_0 = 7$ and $n_1 = 30$, so that $\alpha = 81.1\%$. Let us redefine $\text{Max}\left[A-1000,0\right]$ as A^*; that is, the combined value owned by the COERC investors and initial shareholders. 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 default-free bond and a short put that allows shareholders to sell back a fraction of the firm, αA^*, to the COERC investors at an exercise price of B. The shareholders will exercise the option when $B > \alpha A^*$; that is, when the value of the firm owned by the COERC investors following conversion is less than the par value of the COERCs.

3.3 COERCS and multiple equilibria

As mentioned earlier, Sundaresan and Wang (2010) argue that a conversion price based solely on the firm's stock price leads to multiple equilibria in that there are not individually unique market values for the stock, S, and the CoCo bond, V. The intuition is that the stock price depends on the conversion decision and vice versa. Consider the following numerical example provided by Sundaresan and Wang.[19]

Let there be one period before maturity and assume the firm's asset payoffs satisfy the trinomial tree shown in Figure 3. If we also assume risk neutrality and a zero discount rate, the current value of the firm's assets will be worth \$1030, reflecting a 30% probability that, at maturity, assets are worth \$1200, a 40% probability that assets are worth \$1000, and a 30% probability that assets are worth \$900. Senior debt, with a promised payment of \$1000 at maturity is then currently worth \$970 = 0.7×1000 + 0.3×900.

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

Now, one equilibrium is that the current stock price is low enough to trigger conversion and COERC investors are issued 30 shares. Figure 3 shows that if this occurs, and the shareholders purchase these newly issued shares at the $1 conversion price, the COERC will be worth $30 and the value of shareholders' equity after repayment equals 0.3×(1200 – 1000) – 30 = $30.[20] Therefore, with 7 original shares owned by the initial shareholders, the pre-conversion value of equity must be $30/7 = $ 4.29 which is below the trigger price of $5. Hence, conversion is a possible equilibrium.

However, another equilibrium outcome is that the current stock price is higher than the $5 trigger and conversion does not occur. If so, then the COERC value equals 0.3×$30 = $9. The value of shareholders equity is then 0.3×(1200 – 1030) = $51, so that the equilibrium stock price is $51/7 = $7.29, which is above the trigger price. Hence, non-conversion is also an equilibrium outcome.

The simple solution to this multiple equilibrium problem is to make the trigger a function of the sum of the value of shareholders' equity and the value of COERCs, rather than only the value of shareholders' equity or just the stock price. Note that in both equilibria the sum of the current values of shareholders' equity and COERCs is $60.[21] If we specify in the COERC contract that conversion is mandatory whenever the market value of total 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, there is a unique equilibrium when the conversion trigger is based on the *sum* of the market values of shareholders' equity and COERCS; that is, the market value of total capital equal to $S\times n_0 + V = A - D$.[22] Such a trigger is a natural market-value counterpart to the regulatory capital triggers seen in CoCos that have been issued thus far.

3.4 Some caveats

[20] Indeed, the initial shareholders have an incentive to purchase the 30 newly issued shares because the fully diluted share price becomes $0.3×(1200 – 1000)/37 = $1.62.
[21] Equity equals $30 and COERCs equal $30 in the first equilibrium and equity equals $51 and COERCs equal $9 in the second equilibrium.
[22] We are grateful to Stewart Myers for first suggesting this approach.

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

For the conversion to take place at very low stock prices, shareholders will need to approve a significant increase in the number of authorised shares. Note that after the conversion, the number of shares (and stock price) can be restored through a reverse stock split. In general, shareholders are reluctant to authorise such a large dilution as it can lead to a loss of control. However, since the COERC structure allows shareholders to preserve their pre-emptive rights (again a unique feature relative to other CoCos), control by the initial shareholders' can be maintained.

One potential concern about CoCos in general is the effect on fully diluted earnings per share (EPS).[23] Although diluted EPS may not be economically meaningful, in practice many investors focus on this financial ratio. According to US GAAP "Potentially issuable shares are included in diluted EPS using the 'if-converted' method if one or more contingencies relate to the entity's share price." As the COERC trigger is based on a market capital ratio, not a stock price, it is unclear whether a firm issuing a COERC would have to report a heavily reduced EPS, particularly since shareholders have

[23] See Bolton and Samama (2010, p.39).

purchase rights. Under IFRS "potentially issuable shares are considered 'contingently issuable' and are included in diluted EPS using the if-converted method only if the contingencies are satisfied at the end of the reporting period." This rule would appear to lead to dilution only if conversion is triggered, which of course makes sense.

Although 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 contribute more funding to the firm can sell their rights to other investors who rationally will exercise the option. If no one exercises the call option, CoCo investors would realize a large windfall gain: in the example where the combined value of equity and COERCs falls to $65, COERC investors would end up with 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, which essentially is analogous to the firm buying put options on its own stock. Their solution requires the existence of default-free entities that sell such insurance. As Duffie (2010) points out, if the source of distress is a general financial crisis, the put seller may itself be distressed and unable to honour its commitments. Bolton and Samama (2010) propose that banks buy puts from long-term investors such as Sovereign Wealth Funds and other large institutional investors.

The COERC trigger is issuer specific. Kashyap, Rajan and Stein (2008) propose a trigger mechanism based on aggregate bank losses. McDonald (2010) proposes a dual price trigger: conversion would be mandatory if the stock price falls below a trigger value *and* the value of a financial institutions stock index falls below another trigger. These proposals allow all financial institutions to recapitalize during a widespread financial crisis, but permit an individual institution to fail during normal times. A similar dual trigger mechanism is proposed by the Squam Lake Working Group (2009) proposal: banks would issue debt and the debt would convert into equity when a regulator declares that there is a systematic crisis *and* the issuer would violate covenants. These approaches

assume that the main purpose of CoCos is to mitigate the consequences of a major financial crisis. But the goal of the current paper is more general: to design a security that has the benefits of debt financing over equity financing but with lower financial distress costs than other debt securities. As a consequence, 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, thereby avoiding regulatory risk which is difficult to estimate. A trigger based on a market value of total capital ratio, equal to the sum of the market values of equity plus COERCs, divided by the par value of senior debt (deposits), will depend on the availability of information on senior debt and the liquidity of COERCs. Since COERCs are nearly default-free, they should be relatively liquid. Moreover, the next section shows how a conversion trigger leading to a unique equilibrium may be based on other market variables that reflect the firm's market value of total capital ratio. Specifically, Hart and Zingales (2009) propose a trigger based on a bank's credit default swap (CDS) spread, and we show that if the CDS is written on the bank's senior debt, their trigger is equivalent to a market value of capital trigger. Hence, if CDS written on the bank's senior debt are liquid, a trigger based on them can be used for COERCs.

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

conversion occurs at an early stage of financial distress, the resulting higher level of equity decreases any disincentive to issue additional equity or new COERCs.

4. Valuation

This section analyzes how the contractual features of COERCs and the risk of the bank that issues them affect the fair credit spread that COERC investors would require. Credit spreads, or new issue yields, for COERCs are also compared to those for standard CoCos and non-convertible bonds. We also analyze a bank's risk-shifting incentives and its debt overhang problem when it issues COERCs versus other forms of convertible and non-convertible bonds. The setting for valuing these bonds is the structural model of Pennacchi (2010). Here we summarize the model's assumptions and refer the reader to the original paper for details.[24]

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

To account for the conditions that arise during a financial crisis, we model bank assets with a stochastic process that allows their value to experience sudden jumps. As a consequence, the bank's stock price (as well as its bond's value) can also experience the sudden large changes in value that are evident in Figure 1. Denote the date *t* value of the bank's assets as A_t. These assets' risk-neutral rate of return, dA_t^* / A_t^*, satisfies the jump – diffusion process:[25]

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

[24] We assume that the issuance of COERCs or other securities does not change the total value of the issuing firm; that is, the analysis does not consider tax and financial distress costs. Rather, our focus is on analyzing how contractual features and bank risk characteristics affects bond yields. Albul et al. (2010) and Barucci and Del Viva (2011) consider a firm's optimal issuance of CoCos, senior debt, and equity using Leland (1994) style models that include taxes and bankruptcy costs.

[25] 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 $E^Q\left[\bullet\right]$.

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 jump size's standard deviation.

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

Our model assumes bank deposits have a very short maturity 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.[26] 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:

[26] 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.

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

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

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

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

where $d_1 = \left[\ln\left(x_t\right) + \mu_y\right]/\sigma_y$ and $d_2 = d_1 + \sigma_y$.[27] Note that h_t is a strictly decreasing, convex function of the bank's asset to deposit ratio, $x_t \equiv A_t/D_t$.

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 is exposed to both interest rate risk and credit risk whereas the value of floating-coupon bonds is sensitive only to credit risk. At date 0, the fixed coupon rate, c, or fixed spread, s, is set such that the bond sells (is issued) at its par value, B. The method of determining this new issue coupon rate (yield) or coupon spread will be discussed shortly.

[27] Note that this credit spread depends only on the bank's current asset-to-deposit ratio and the parameters of the asset jump process. Only jumps that wipe out the bank's capital can impose losses on depositors.

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

$$\bar{e} = \frac{A_t - D_t - B}{D_t} \tag{5}$$

In the example of the previous Sections 2 and 3, $D_0 = 1000$, $B = 30$, and conversion is triggered when $\bar{e} = 3.5\%$.[28] If there are n_0 shares of equity outstanding and the current level of deposits is D_t, then the post-conversion trigger stock price can be expressed as $\bar{e}D_t / n_0 = \left(\bar{a}_t - D_t - B\right) / n_0$, where $\bar{a}_t$ is the value of A_t that satisfies equation (5).

Note that equation (5) can be rewritten as

$$\frac{A_t - D_t}{D_t} = \frac{S_t \times n_0 + V_t}{D_t} = \bar{e} + \frac{B}{D_t} \tag{6}$$

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

Furthermore, since the market value capital ratio in equation (6) is $(A_t - D_t)/D_t = x_t - 1$, the bank's asset to deposit ratio, x_t, can be viewed as the "state" variable triggering the conversion event. But since from equation (4) the credit spread on the bank's senior debt, h_t, bears a one-to-one relationship to this asset to deposit ratio, x_t, any trigger based on a critical value of x_t can be translated into a critical value for h_t. The implication is that a

[28] Note that the trigger ratio in equation (5) allows for the (realistic) possibility that the quantity of deposits can change over time. Alternatively, one could specify the trigger stock price to be fixed. But if the bank changes its asset value by issuing or reducing deposits, then the ratio of equity to deposits (senior debt) will not always be the same at the trigger stock price. From a regulatory viewpoint, it might be preferable to make the trigger be a fixed market value equity to deposit ratio. But this requires the trigger stock price (assuming the number of shares are constant) to be proportional to deposits. More generally, one might wish to allow the bank to issue or repurchase shares, in which case the stock price again will need to be adjusted so that the trigger continues to reflect a fixed equity to deposit ratio.

market value trigger that is immune to the multiple equilibrium problem can be either based on the market value of total capital ratio, $(S_t \times n_0 + V_t)/D_t$, or the credit spread or CDS spread on the bank's senior debt, h_t (c.f., Hart and Zingales (2009)). For example, if there are concerns that a CoCo may be illiquid and its market value, V_t, is hard to observe, but a liquid market for CDS written on the bank's senior debt exists, then a trigger when this CDS spread rises to a critical level may be preferable.[29]

Let us now consider the specific case in which the convertible bond is a COERC. Let n_1 be the total number of new shares offered to COERC investors for converting to common equity, where $n_1 \gg B / \left(\overline{e} D_t / n_0\right)$; 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.[30] 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

$$V_{t_r} = \begin{cases} B & \text{if } B \leq \alpha\left(A_{t_r} - D_{t_r}\right) \\ \alpha\left(A_{t_r} - D_{t_r}\right) & \text{if } 0 < \alpha\left(A_{t_r} - D_{t_r}\right) < B \\ 0 & \text{if } A_{t_r} - D_{t_r} \leq 0 \end{cases} \tag{7}$$

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

[29] As long as the value of the bank's senior debt does not depend on the split between the values of the more junior CoCo and shareholders' equity, a senior debt CDS trigger has a unique conversion equilibrium.
[30] While the trigger price depends on D_t, the variation in D_t relative to D_0 is likely to be sufficiently small so that the inequality will hold.

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

New issue yields for fixed-coupon COERC bonds are graphed in Figures 4 to 6. The parameter assumptions regarding the term structure of interest rates, the bank's jump-diffusion risk parameters, capital targeting behavior, and deposit growth are the same as the benchmark parameters listed in Pennacchi (2010).[31] 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 4, conversion is assumed to be triggered when the post-conversion equity value equals 3.5% of deposits; that is, $\overline{e} = 3.5\%$. 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 (7) above.

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

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.[32] Consequently, there is a greater possibility that COERC investors will suffer a loss in value at conversion.

The blue schedule in Figure 5 repeats the blue schedule in Figure 4; 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 5 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%. For each initial level of capital, new issue yields are higher compared to the blue schedule because with a smaller amount of original shareholders' equity, a smaller downward jump in the bank's asset value is sufficient to dissuade the original shareholders from buying back the newly issued COERC shares at par.

For comparison, we next consider the value of a standard CoCo bond that is assumed to have the same general structure as the COERC. The CoCo is assumed to convert at the same trigger value, equation (4), but receive a different number of shares, n_1, upon conversion to common equity. It is assumed that this number of shares equals that which converts the CoCo to equal its par value if the post-conversion stock price equals the trigger price:[33]

$$n_1 = B / \left(\overline{e} D_t / n_0 \right) \tag{8}$$

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

[32] In other words, the first line of the COERC payoff in equation (7) becomes less likely.
[33] Note that the trigger price depends on D_t.

to contingent capital investors as a proportion of total shares if conversion occurs, then for this case

$$\alpha = \frac{B / \left(\bar{e}D_t / n_0\right)}{B / \left(\bar{e}D_t / n_0\right) + n_0} = \frac{B}{B + \bar{e}D_t} \tag{9}$$

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 $A_{t_c} \le B + D_{t_c}\left(1 + \bar{e}\right)$, then the value of the CoCo at conversion, say V_{t_c}, will be

$$V_{t_c} = \begin{cases} \alpha\left(A_{t_c} - D_{t_r}\right) & \text{if } 0 < \alpha\left(A_{t_c} - D_{t_c}\right) \le B \\ 0 & \text{if } A_{t_c} - D_{t_c} \le 0 \end{cases} \tag{10}$$

Note from equation (5) that if $A_{t_c} = \bar{e}D_{t_c} + B + D_{t_c}$, so that conversion occurs smoothly at an asset value that leaves the ex-post conversion value of equity exactly equal to $\bar{e}D_{t_c}$, 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 $A_{t_c} < \bar{e}D_{t_c} + B + D_{t_c}$, then the CoCo's conversion value is strictly less than its par value.

This is the conversion method for standard CoCos that is assumed in Figures 6 and 7. Figure 6 shows that the new issue yields for fixed-coupon CoCos (without the call option enhancement) is always larger than those for comparable COERCs. For a given level of capital, yields increase as α, the ratio of shares issued to COERC investors to total shares, declines. For standard CoCos, 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 7 makes the same comparison but where both COERCs and standard CoCos pay floating, rather than fixed, coupons. It also considers floating-coupon, non-convertible subordinated debt that has the same par value (B = 3%×D_0) and maturity (T = 5 years) as

the COERCs and standard CoCos. What is graphed are these three bonds' new-issue credit spreads (in basis points) over the short-term default-free interest rate r_t. This is done for various initial capital to deposit ratios. Note that new-issue credit spreads for non-convertible subordinated debt are calculated for capital as low as 3.5% of deposits while credit spreads for COERCs and standard contingent capital are calculated at capital only as low as 7% of deposits because they convert at a 6.5% capital threshold.

Similar to Figure 6, Figure 7 shows that the greater number of shares issued to COERC investors, together with shareholders' call option to buy them back, leads to more states of the world where bondholders are paid back at par, thereby reducing the COERC's new issue credit spread relative to that of standard CoCos. Moreover, Figure 7 shows that COERCs can be less risky than even non-convertible subordinated bonds.[34] 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 $3\%\div\alpha = 3\%\div(30/37) = 3.7\%$ 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 CoCos (and in some cases, non-convertible debt) have implications for a bank's risk-shifting incentives. As pointed out by Merton (1974), shareholders' equity of a levered, limited-liability firm is comparable to a call option written on the firm's assets with a strike price equal to the promised payment on the firm's debt. By raising the risk of the firm's assets, the shareholders can increase the volatility and, in turn, the value of their

[34] 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 7 where CoCos without a call option have higher credit spreads than non-convertible subordinated debt. Recall that standard CoCos can be interpreted as a COERC where α is at a minimum (trigger and conversion prices are equal), which in this example is $\alpha = 6/13$.

call option at the expense of the firm's debt value. This moral hazard incentive to transfer value from debt holders to equity holders tends to rise as the firm becomes more levered.

The risk-shifting incentives of banks that issue COERCs, standard CoCos, and non-convertible bonds can be analyzed in the context of our model. We calculate the change in the value of the bank's shareholders' equity, ∂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.[35] 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.[36]

Figures 8 to 11 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, CoCos, or non-convertible subordinated debt). As in our previous examples, the conversion threshold for COERCs and standard CoCos is assumed to be at a total capital value of 6.5% of deposits.

Figure 8 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,

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[35] 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.

[36] 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.

except for convertible bonds at capital levels near the conversion threshold.[37] However, the most important finding is that the increase in equity is greater then the bank issues a standard CoCo 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 CoCos. Furthermore, because COERCs have a high probability of being converted at par, they benefit from the ability to exit the bank earlier than non-convertible bond investors.

The same qualitative finding occurs in Figure 9 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 CoCos or non-convertible bonds. A similar result emerges in Figure 10 which computes the rise in the value of equity following a decline in the mean jump size, μ_y.[38] A bank that issues COERCs, rather than standard CoCos or subordinated debt, has a smaller incentive to choose investments or activities that are subject to large losses.

As noted earlier, in our model non-convertible bonds, standard CoCos (with a par-conversion trigger), and COERCs are default-free if jump risk is absent and only diffusion risk affects bank asset values. Thus, increasing diffusion risk could not change the value of equity or these three bonds. However, when both jump and diffusion risks are present, risk-shifting incentives are influenced by diffusion risk. We now assume our model's jump risk parameters are at their benchmark levels and consider a rise in the diffusion risk parameter, σ. Figure 11 shows that for high capital levels, greater diffusion

[37] 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.
[38] The figure shows the change in the value of equity when μ_y declines from -1% to -1.25%.

risk is qualitatively similar to greater jump risk in that it makes capital depletion more likely. However, the reverse occurs for convertible bonds at low levels of capital where increases in diffusion risk can hurt shareholders. The intuition for this result is that greater diffusion risk increases the likelihood that assets decline to the trigger threshold continuously, making conversion occur exactly at par. Thus, greater diffusion risk could counteract jump risks which create the possibility of conversion at less than par.

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

We quantify debt overhang by calculating the change in the value of the bank's shareholders' equity, ∂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 12 shows calculations of $\partial E/\partial A - 1$ for a bank that issued either a non-convertible subordinated bond, standard CoCos, or a COERC. In each case the bonds were assumed to be issued at a fair floating-coupon credit spread when the bank had total capital equal to 10% of deposits, with 3% of it in the form of the bonds. As before, the conversion threshold for COERCs and standard CoCos is assumed to be when total capital equals 6.5% of deposits. The calculations assume the amount of new equity, ∂A, equals 0.125% (one-eighth of a percent) of deposits.

Relative to non-convertible subordinated debt, Figure 12 shows that COERCs reduce the debt overhang problem for any level of bank capital. In addition, for most capital levels

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

5. Summary

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

Because COERCs have low credit risk, they can lower not only the direct, but also the indirect, costs of financial distress. Relative to standard CoCos, or even non-convertible bonds, COERCs' lower default risk mitigates the excessive risk-taking incentives that are typically present in a levered firm. The COERC design that reduces the possibility of wealth transfers between their investors and shareholders also helps solve the 'debt overhang' problem of high leverage: because of the limited liability of equity, firms will tend to refuse to replenish their capital, even when it would increase total firm value.

Although this paper focused on the problems of banks, we argue that COERCs could be used by non-bank corporations to lower their costs of financial distress. Unlike some other CoCos, with COERCs involvement by government regulatory authorities is not required other than allowing the tax deductibility of COERC interest expense. Obviously it would be ironic if government policy handicapped debt that reduces the likelihood of a financial crisis while favouring standard debt that does not.

References

Admati, Anat , Peter de Marzo, Martin Hellwig and Paul Pfleiderer, 2010, "Fallacies, irrelevant facts and myths in capital regulation: why bank equity is not expensive," working paper, Stanford University.

Adrian, Tobias and Hyun Song Shin, 2010, "Liquidity and leverage," *Journal of Financial Intermediation* 20, 418-437.

Albul, Boris, Dwight Jaffee and Alexei Tchistyi, 2010, "Contingent convertible bonds and capital structure decisions," working paper, University of California, Berkeley.

Barucci, Emilio and Luca Del Viva, 2011, "Dynamic capital structure and the contingent capital option," working paper, Politecnico di Milano and ESADE Business School.

Basel Committee on Banking Supervision, 2011, "Global systematically important banks: Assessment methodology and the additional loss absorbency requirement," Bank for International Settlements.

Berg, Tobias and Christoph Kaserer, 2011, "Does contingent capital induce excessive risk-taking and prevent an efficient recapitalization of banks?" working paper, Humboldt University and Technical University Munich.

Bolton, Patrick and Frederic Samama, 2010, "Contingent capital and long term investors: a natural match?," conference paper, Columbia University Committee on Global Thought.

Calomiris, Chares and Richard Herring, 2011, "Why and how to design a contingent convertible debt requirement," working paper, Columbia University and University of Pennsylvania.

Collin-Dufresne, Pierre and Robert Goldstein, 2001, "Do credit spreads reflect stationary leverage ratios?" *Journal of Finance* 56, 1929-1957.

Cox, John, Jonathan Ingersoll, and Stephen Ross, 1985, "A theory of the term structure of interest rates," *Econometrica* 53, 385-408.

Duffie, Darrell, 2010, "A contractual approach to restructuring financial institutions", Chapter 6 of George Schulz, Kenneth Scott, and John Taylor (eds.) *Ending Government Bailouts as We Know Them*, Hoover Press.

Flannery, Mark, 2005, "No pain, no gain: Effecting market discipline via 'reverse convertible debentures," in Hal S. Scott (ed.) *Capital Adequacy beyond Basel*: *Banking, Securities and Insurance*, Oxford: Oxford University Press.

Flannery, Mark, 2009a, “Market value triggers will work for contingent capital investments,” working paper, University of Florida.

Flannery, Mark, 2009b, “Stabilizing large financial institutions with contingent capital certificates, working paper, University of Florida.

Flannery, Mark, 2010, “A fix to the death spiral Problem,” mimeo.

Flannery, Mark and Kasturi Rangan, 2008, “What caused the bank capital build-up of the 1990s?, *Review of Finance* 12, 391-429.

Glasserman, Paul and Behzad Nouri, 2010, “Contingent capital with a capital ratio trigger”, working paper, Columbia University

Haldane, Andrew, 2011, “Capital discipline,” paper presented at American Economic Association Meetings, Denver CO, January 9.

Han, Joongho, Kwangwoo Park, and George Pennacchi, 2010, “Corporate taxes and securitization,” working paper, University of Illinois.

Hart, Oliver and Luigi Zingales, 2009, “How to avoid a new financial crisis”, working paper.

HM (UK) Treasury, 2009, “Risk, reward and responsibility: the financial sector and society,” available at hm-treasury.gov.uk.

Hillion, Pierre and Theo Vermaelen, 2004, “Death spiral convertibles,” *Journal of Financial Economics* 71, 381-415

Hilscher, Jens and Alon Raviv, 2011, “Bank stability and market discipline: The effect of contingent capital on risk taking and default probability,” working paper, Brandeis University.

Jensen, Michael, 1986 “Agency costs of free cash flow, corporate finance and takeovers”, *American Economic Review* 76, 323-329.

Kasyhap, Anil, Raghu Rajan and Jeremy Stein, 2008, “Rethinking capital regulation,” Federal Reserve Bank of Kansas City Economic Symposium on *Managing Stability in a Changing Financial System*.

Leland, Hayne, 1994, “Corporate debt value, bond covenants, and optimal capital structure,” *Journal of Finance* 49, 1213-1252.

Memmel, Christoph and Peter Raupach, 2010, How do banks adjust their capital ratios?, *Journal of Financial Intermediation* 19, 509-528.

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

McDonald, Robert, 2010, "Contingent capital with a dual price trigger," working paper, Northwestern Universiy

Myers, Stewart, 1977, "Determinants of corporate borrowing," *Journal of Financial Economics* 5, 147-175

Pennacchi, George, 2010, "A structural model of contingent bank capital," Federal Reserve Bank of Cleveland Working Paper 10-04.

Squam Lake Working Group, 2009, "An expedited resolution mechanism for distressed financial firms: regulatory hybrid securities," Council on Foreign Relations.

Sundaresan, Suresh and Zhenya Wang, 2010, "Design of contingent capital with a stock price trigger for mandatory conversion," working paper, Columbia University.

Table 1

Mean and Median 2008 Tier 1 Common Ratios of 50 Major U.S. Banks
In Percent

	March 31	June 30	Sept 30	Dec 31
Mean	8.07	8.14	8.16	9.12
Median	7.88	7.92	7.89	9.14

2008 Tier 1 Common Ratios of Selected Large Banks
In Percent

	March 31	June 30	Sept 30	Dec 31
Bank of America Corp	6.08	6.80	6.10	7.47
Bank of NY Mellon Corp	7.44	7.94	8.00	11.90
Capital One FC	9.48	9.90	10.58	12.46
Citigroup	5.83	6.79	6.14	9.48
JP Morgan Chase & Co	7.01	6.86	6.91	8.94
Wells Fargo & Co	6.69	6.53	6.45	5.98

Note: The Tier 1 common ratio is defined as Tier 1 capital minus qualifying minority interest in consolidated subsidiaries minus qualified preferred stock minus other deductions divided by risk weighted assets. Data source: Y-9C Bank Holding Company Reports obtained from the Federal Reserve Bank of Chicago.

Figure 1

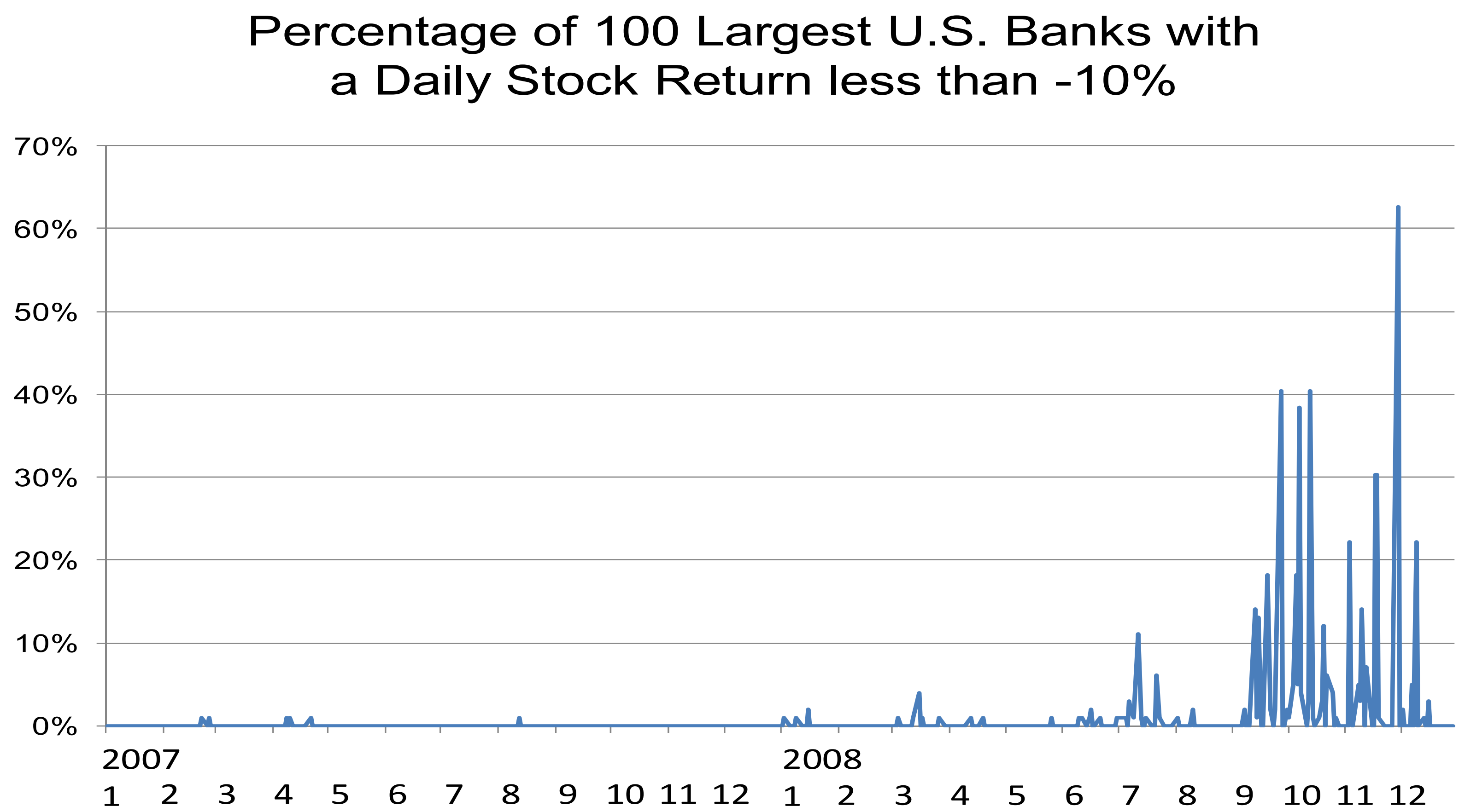
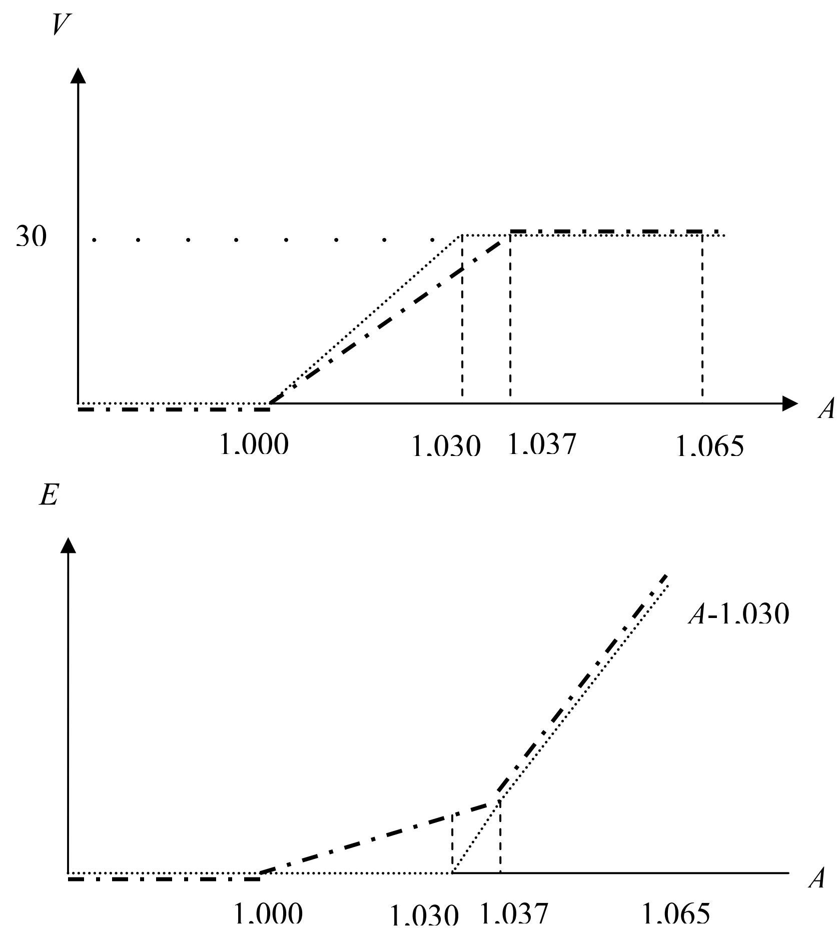

Percentage of 100 Largest U.S. Banks with a Daily Stock Return less than -10%
70%
60%
50%
40%
30%
20%
10%
0%
2007
1 2 3 4 5 6 7 8 9 10 11 12
2008
1 2 3 4 5 6 7 8 9 10 11 12

Figure 2 COERC versus Straight Debt



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

V = Subordinated Bonds; *E* = Shareholders' Equity; *A* = Total firm value

Figure 3 Multiple Equilibria

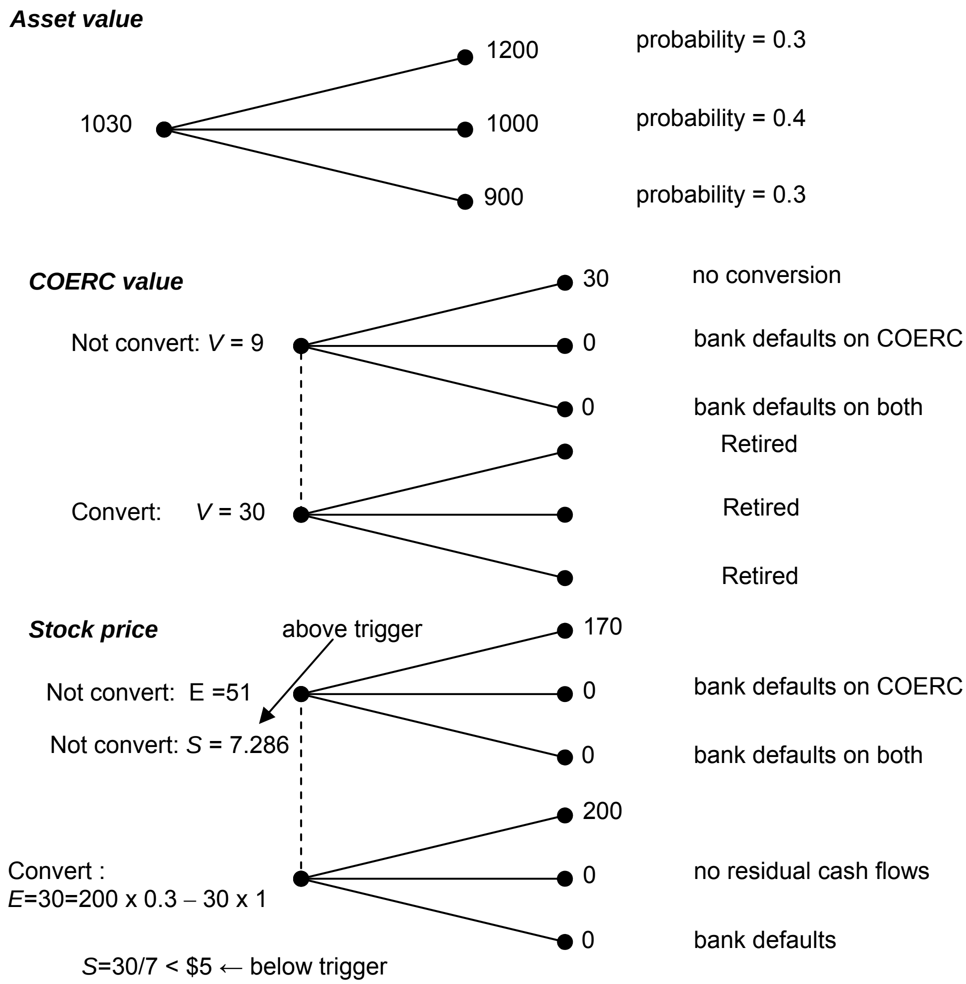


Figure 4

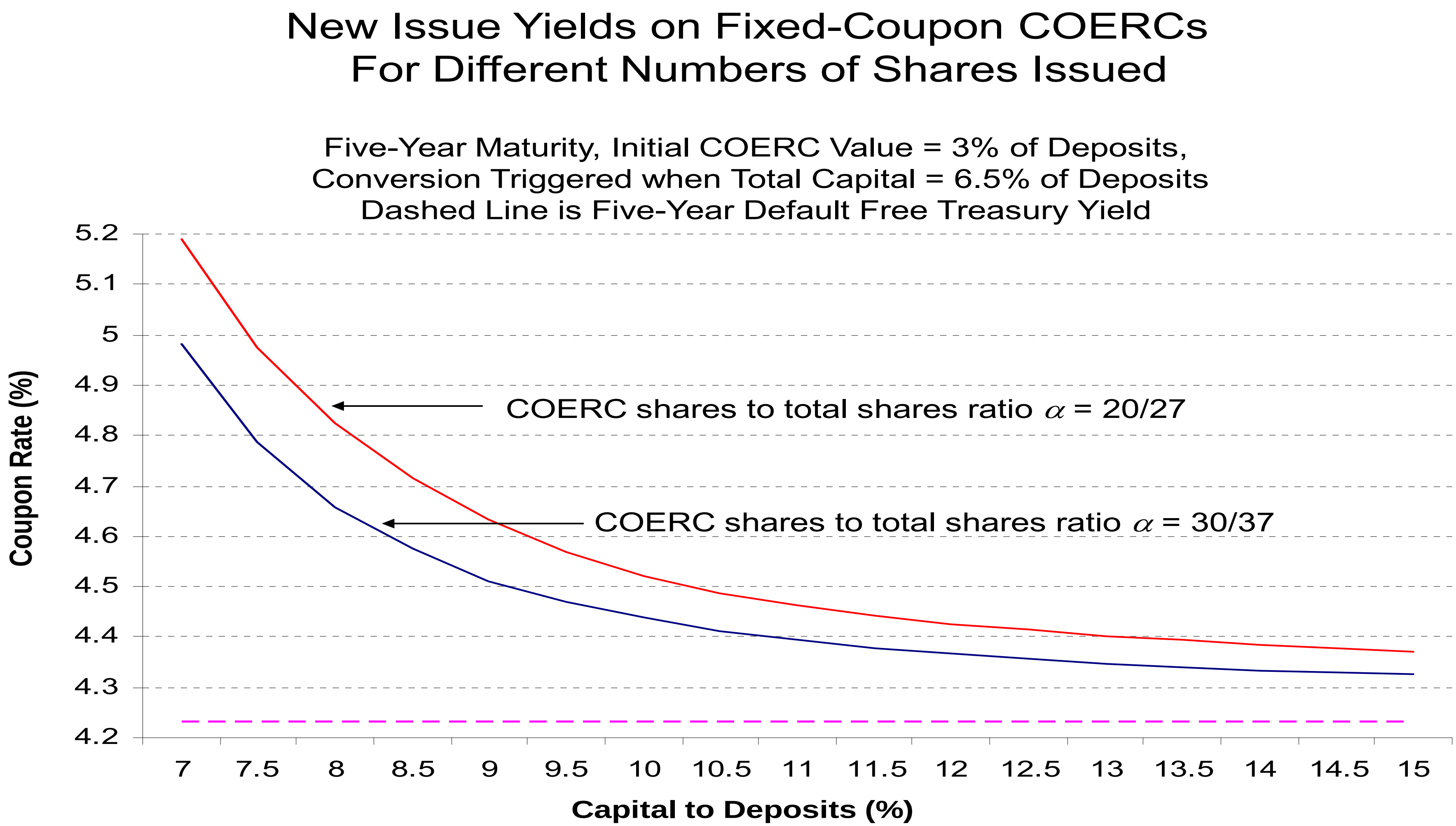
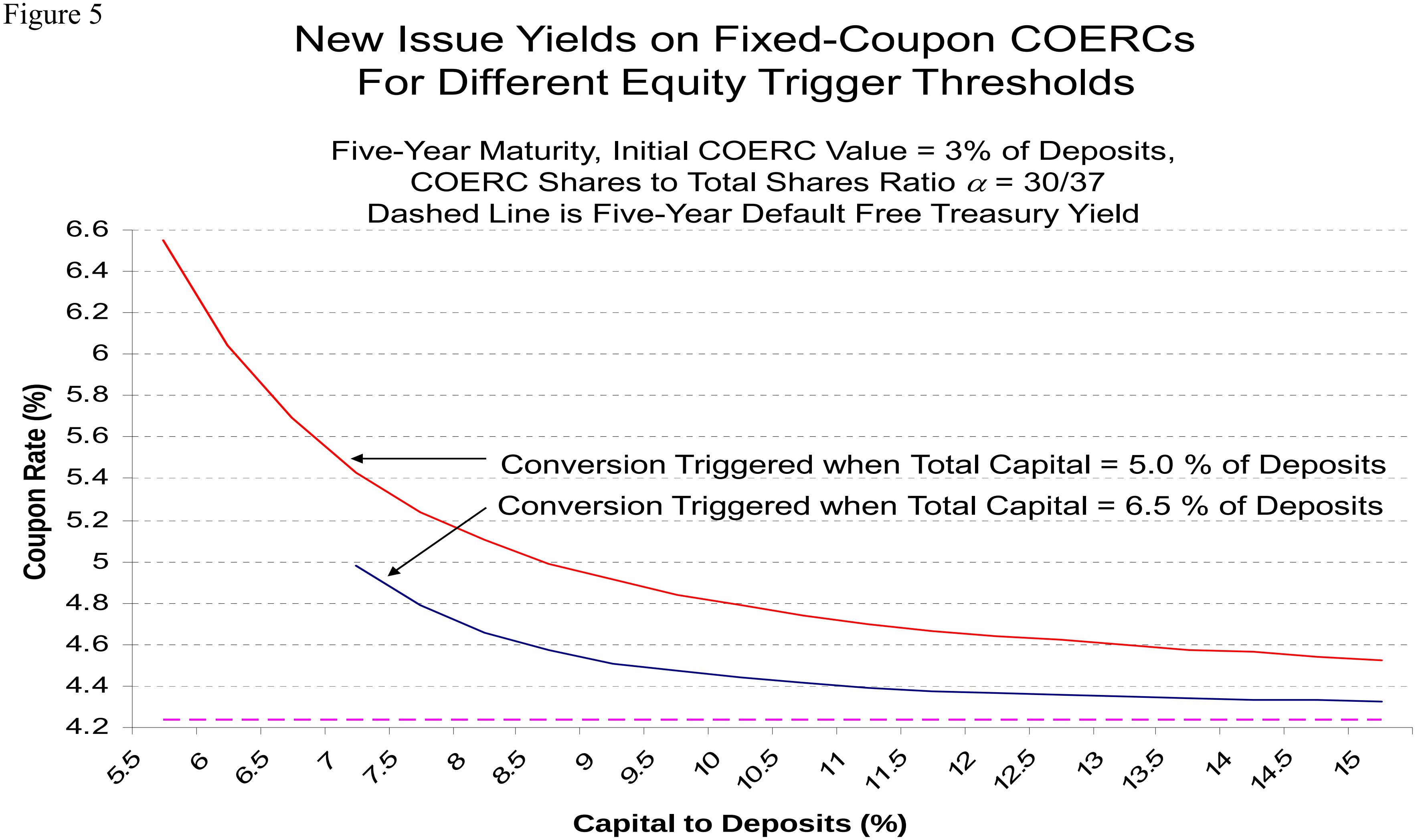

New Issue Yields on Fixed-Coupon COERCs
For Different Numbers of Shares Issued
Five-Year Maturity, Initial COERC Value = 3% of Deposits,
Conversion Triggered when Total Capital = 6.5% of Deposits
Dashed Line is Five-Year Default Free Treasury Yield
COERC shares to total shares ratio α = 20/27
COERC shares to total shares ratio α = 30/37
Coupon Rate (%)
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
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
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 6

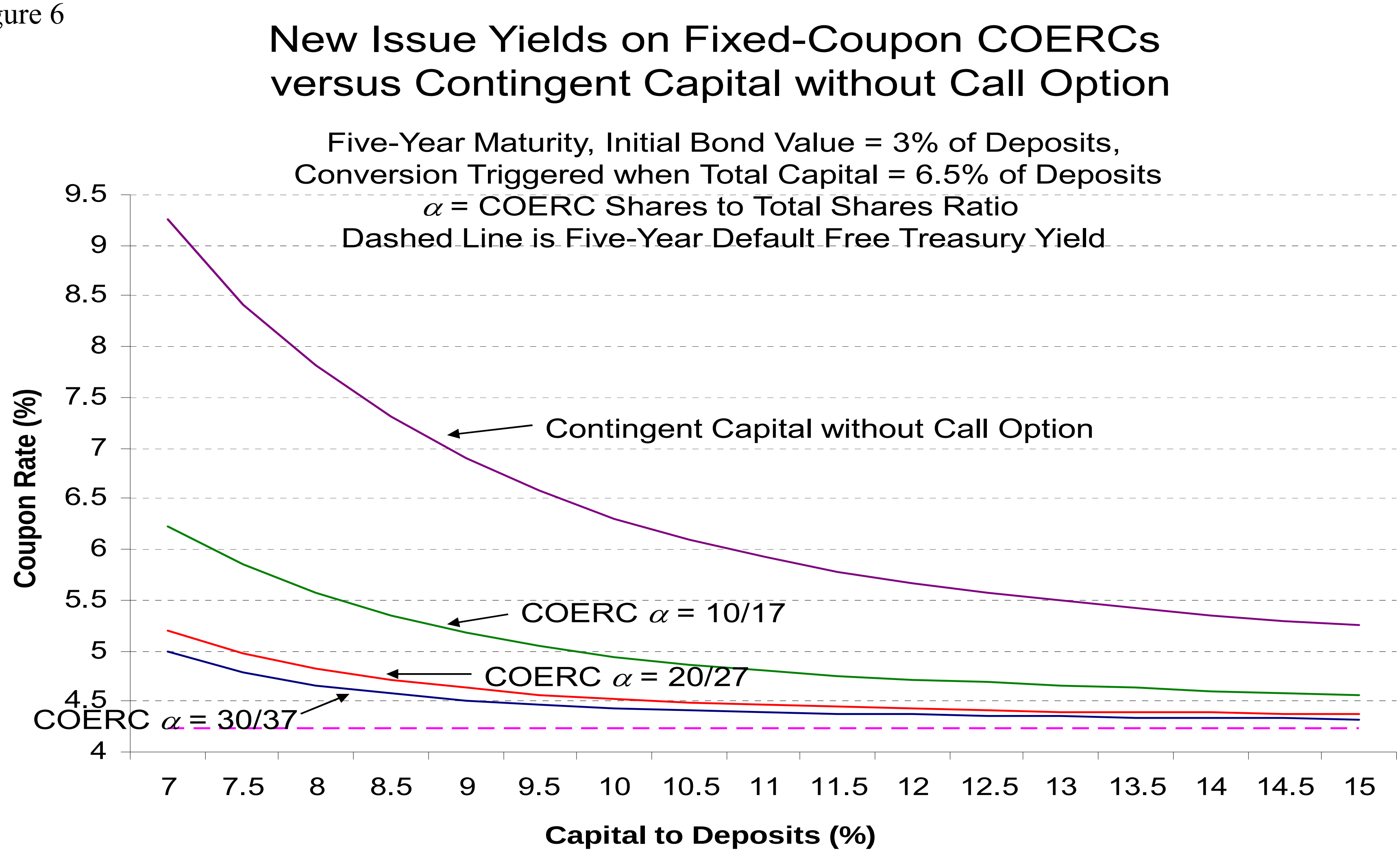

New Issue Yields on Fixed-Coupon COERCs
versus Contingent Capital without Call Option
Five-Year Maturity, Initial Bond Value = 3% of Deposits,
Conversion Triggered when Total Capital = 6.5% of Deposits
α = COERC Shares to Total Shares Ratio
Dashed Line is Five-Year Default Free Treasury Yield
Contingent 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 7

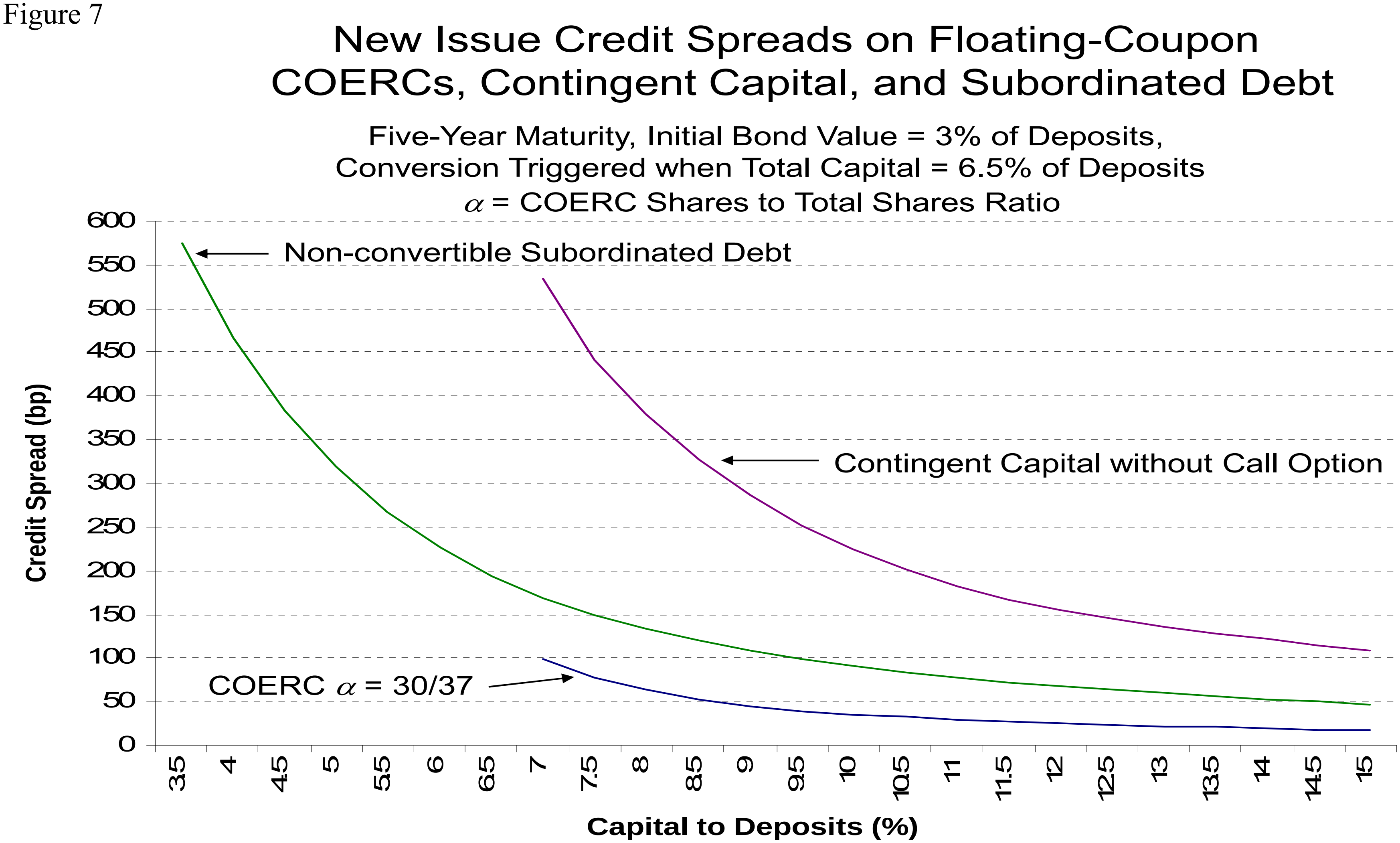
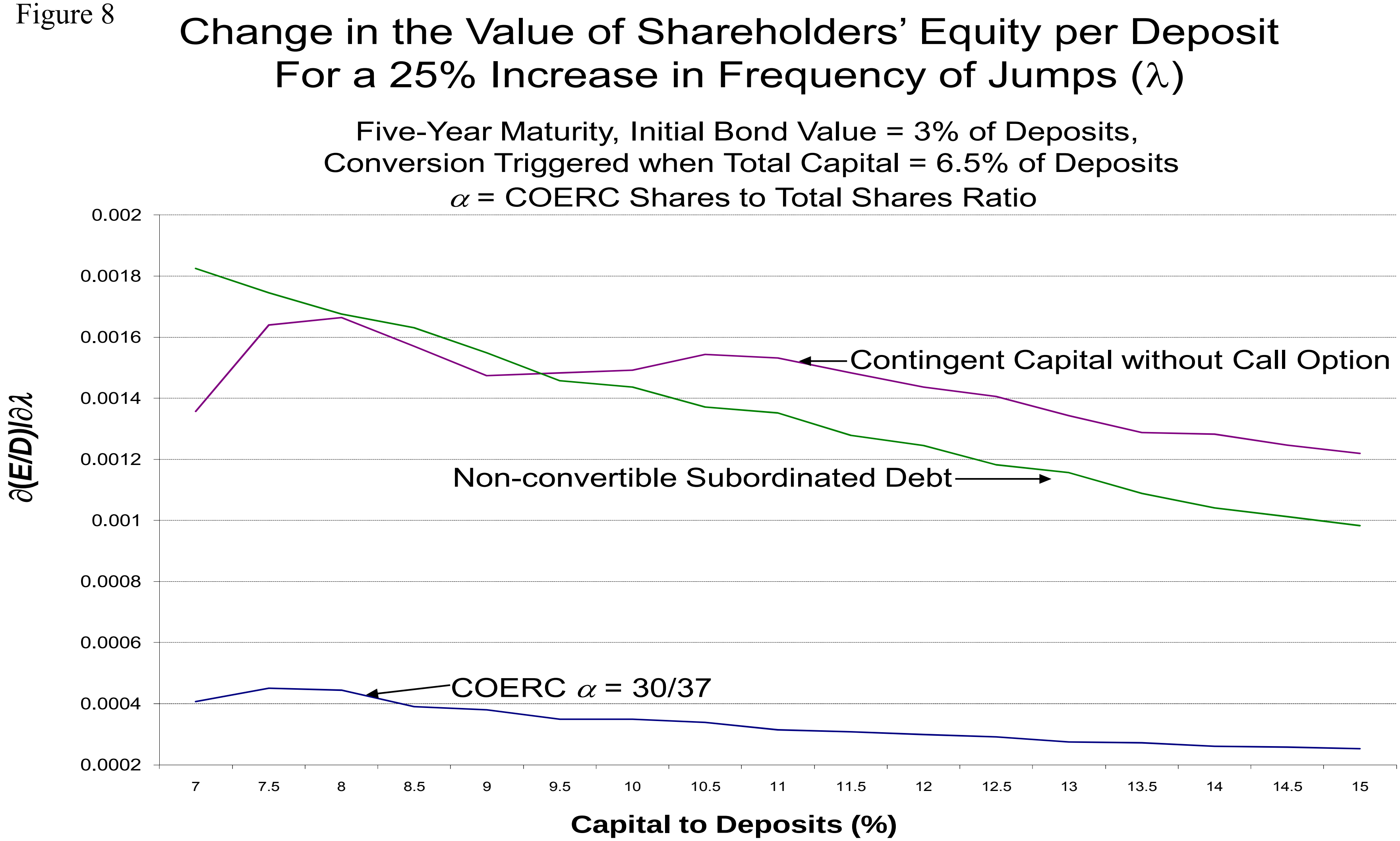
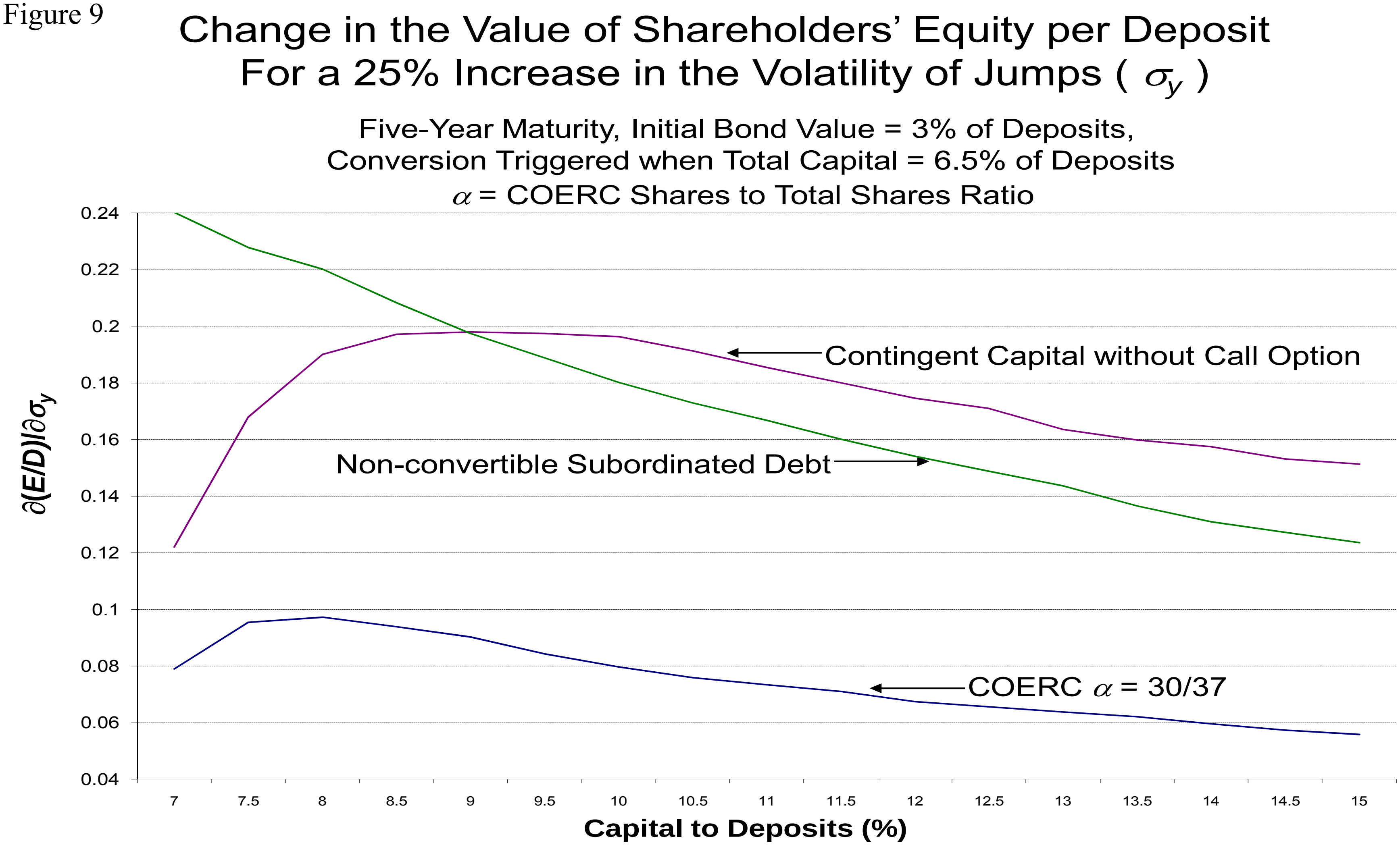

New Issue Credit Spreads on Floating-Coupon
COERCs, Contingent Capital, and Subordinated Debt
Five-Year Maturity, Initial Bond Value = 3% of Deposits,
Conversion Triggered when Total Capital = 6.5% of Deposits
α = COERC Shares to Total Shares Ratio
Non-convertible Subordinated Debt
Contingent Capital without Call Option
COERC α = 30/37
Credit Spread (bp)
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
Capital to Deposits (%)

Figure 8



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 9



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
$\partial(E/D)/\partial\sigma_y$
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
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 10

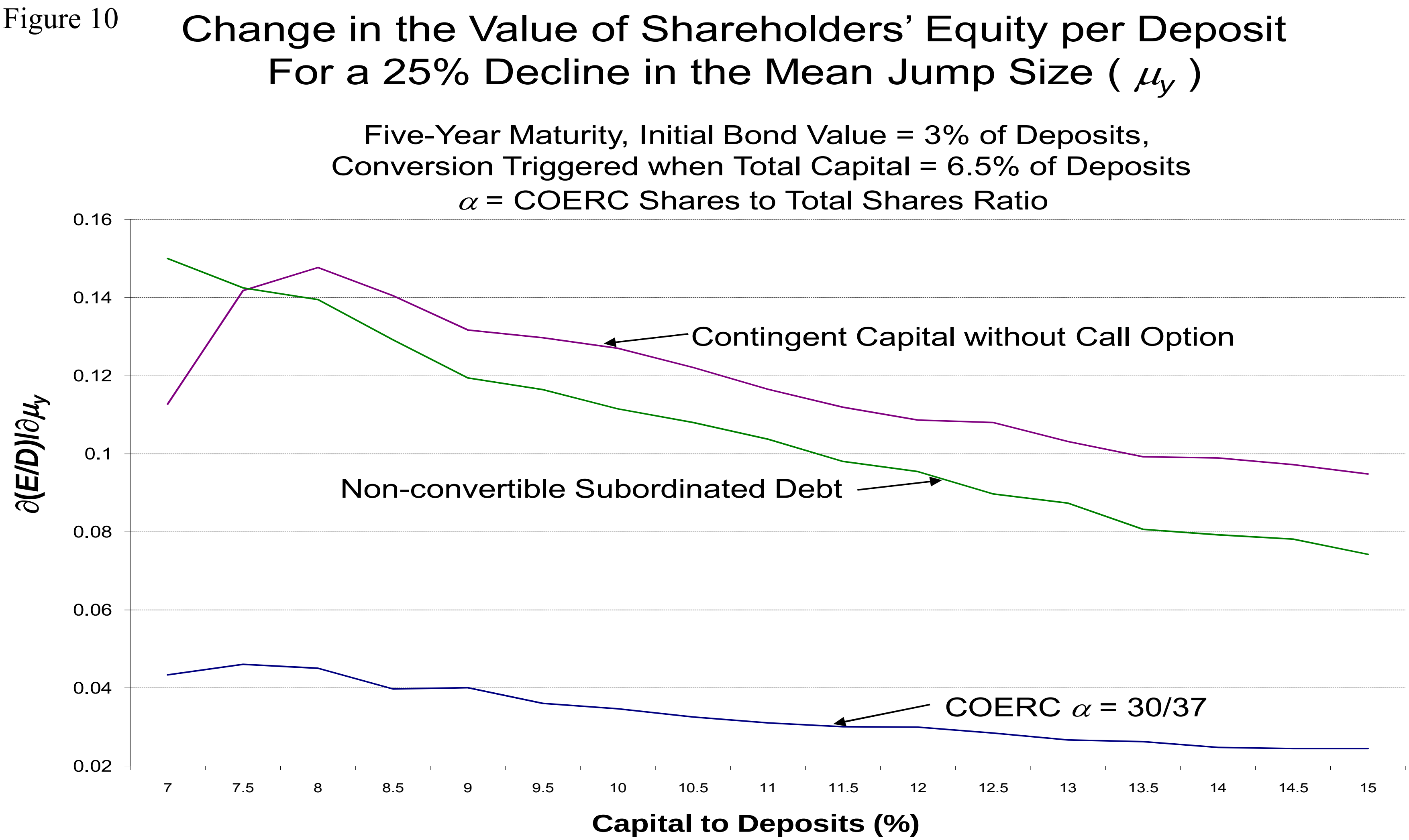

Change in the Value of Shareholders' Equity per Deposit
For a 25% Decline in the Mean Jump Size (μ_y)
Five-Year Maturity, Initial Bond Value = 3% of Deposits,
Conversion Triggered when Total Capital = 6.5% of Deposits
α = COERC Shares to Total Shares Ratio
$\partial(E/D)/\partial\mu_y$
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
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 11

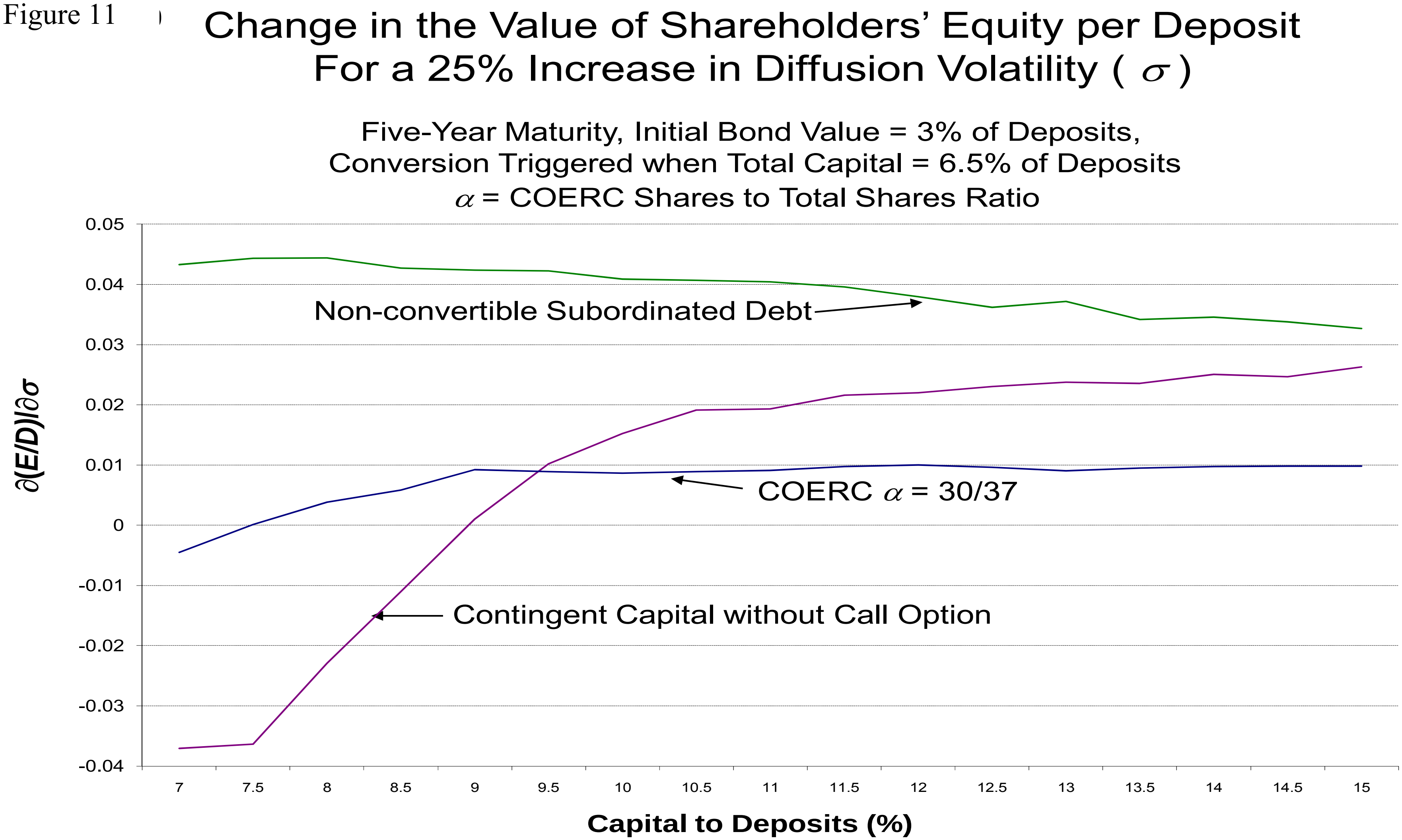
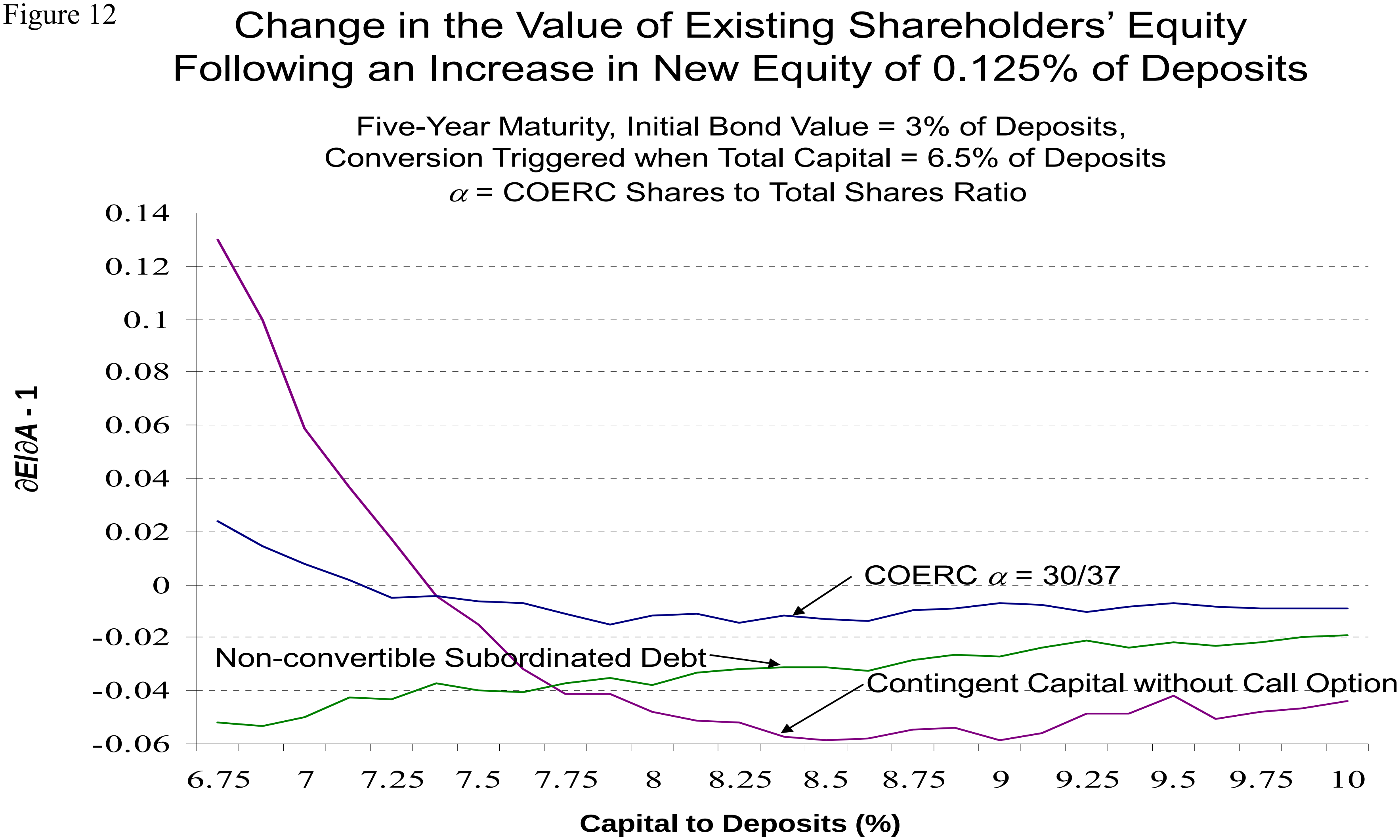

Change in the Value of Shareholders' Equity per Deposit
For a 25% Increase in Diffusion Volatility (σ)
Five-Year Maturity, Initial Bond Value = 3% of Deposits,
Conversion Triggered when Total Capital = 6.5% of Deposits
α = COERC Shares to Total Shares Ratio
Non-convertible Subordinated Debt
COERC α = 30/37
Contingent Capital without Call Option
∂(E/D)/∂σ
Capital to Deposits (%)
0.05
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
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 12



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
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
∂E/∂A - 1
COERC α = 30/37
Non-convertible Subordinated Debt
Contingent Capital without Call Option
6.75
7
7.25
7.5
7.75
8
8.25
8.5
8.75
9
9.25
9.5
9.75
10
Capital to Deposits (%)