Does contingent capital induce excessive risk-taking and prevent an efficient recapitalization of banks?

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Abstract

Contingent capital instruments (CoCo-Bonds) currently receive much attention by regulators and academics as a mechanism to make the banking sector more resilient. In this paper we argue that CoCo-Bonds can have the opposite effect. The type of CoCo-Bonds that has been issued so far by Lloyds, Rabobank and Credit Suisse can potentially exacerbate future financial crises because these CoCo-Bonds magnify both the asset substitution as well as the debt overhang problem. This is driven by the fact that equity holders bear all of the losses up to a prespecified amount, while they can impose part of these losses on CoCo-Bond holders once losses exceed this amount. Losses which slightly exceed this amount are therefore more desirable for equity holders than losses which are slightly less than this amount.
This payoff profile induces two destabilizing effects: First, bank owners have an increased incentive for excessive risk-taking if the level of risk is non-contractible. Second, CoCo-Bonds might prevent private recapitalization for viable banks in the onset of future financial crises. Banks are therefore recapitalized too late thereby inducing or exacerbating a credit crunch. Finally, we show how a simple change in the conversion mechanism of these instruments will eliminate the debt overhang as well as the asset substitution problem.

Keywords: Contingent capital, banking regulation, risk-taking incentives, asset substitution, debt overhang, credit crunch

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1 Introduction

Contingent convertible capital (CoCo-Bonds) has been proposed as an instrument to strengthen the resilience of the financial system and to prevent a taxpayer funded bailout of financial institutions. CoCo-Bonds are debt instruments which automatically convert into equity in case of financial distress of a single bank and/or the whole financial system. The trigger event is usually defined as a certain regulatory capital ratio (such as the core Tier-1 ratio) falling below a prespecified threshold. Upon conversion, CoCo-Bond holders receive either a predetermined number of shares or a number of shares based on the share price before conversion. The key appeal of CoCo-Bonds is therefore to provide an additional source of equity supply under conditions of distress when other options of raising capital may be impossible.[1] CoCo-Bonds have already been proposed by Flannery (2002) and have recently received considerable attention as a potential instrument to ease the impact of future financial crises. Ben Bernanke and Timothy Geithner argued in a congressional testimony in April 2010 that contingent capital can act as a shock absorber that "can be used in a crisis to create more capital" (Geithner (2010)). Contingent capital has also been proposed by the Squam Lake Working Group on Financial Regulation, a group of 15 distinguished academics, as a way to stabilize large, systemically important financial institutions. Regulatory proposals have been put forward by the Bank for International Settlements (BCBS (2010)) and the regulatory body in Switzerland. Lloyds, Rabobank and Credit Suisse have already issued CoCo-Bonds totaling almost USD 25bn that – if converted – would increase the capital ratios of these banks by an average of approximately 2 percentage points.

The appeal of providing additional equity capital in times of distress is straightforward. CoCo-Bonds do, however, also have an impact on banks' ex ante incentives. We argue that CoCo-Bonds might have perverse incentives for bank owners if the conversion price is set too high, i.e. the number of shares that the CoCo-Bond holders receive is very low. The reason is that with a high conversion price a wealth transfer from CoCo-Bond holders to equity holders takes place at the time of conversion. This wealth transfer design can be observed for all CoCo-Bonds that have been issued so far. Roughly speaking equity holders have to bear the first losses up to an amount of X while they can impose part of these losses on CoCo-Bond holders once losses are above X. Equity holders are therefore better off when being directly below the trigger point than being directly above the trigger point. They fully participate in any increase in asset value while they can impose part of the losses in case of a decrease in asset value. This magnifies the asset substitution problem ("Gambling-for-Ressurection"). It also magnifies the debt overhang problem because investing new equity capital decreases the likelihood of conversion and therefore decreases the likelihood that a wealth transfer takes place. CoCo-Bonds therefore provide a huge disincentive to raise new equity

[1] In particular, equity issuances may themselves be viewed as revealing bad news about the bank, cf. Duffie (2010) and Myers and Majluf (1984).

capital in times of distress before conversion has taken place. According to IMF-estimates (IMF (2009)), banks worldwide raised USD 450bn in private equity capital (excluding government injections) in 2007/2008 which represents approximately 15% of total before-crisis regulatory capital.[2] Creating disincentives for such private recapitalizations will likely act as a destabilizing mechanism in the build-up of a future financial crisis.[3]

This paper is related to three different research areas. First, we draw upon the theoretical literature which establishes a link between capital structure and equity holders' incentives. This link has first been established by Jensen and Meckling (1976) and Myers (1977). According to Jensen and Meckling (1976) equity holders have an incentive to increase risk as they effectively hold a call option on the company's assets (asset substitution problem). The debt overhang problem goes back to Myers (1977). Companies in financial distress may reject positive NPV projects because benefits mostly accrue to bond holders. The asset substitution problem therefore predicts excessive risk-taking in the financial sector and a gambling for resurrection in times of a financial crisis (Dewatripont and Tirol (1994)). The debt overhang problem predicts that equity holders will be reluctant to provide new funds in times of financial distress because a signficant part of the benefits will accrue to bondholders. The debt overhang problem can also explain a credit crunch as banks will be even reluctant to grant loans with a positive NPV (Holmström and Tirole (1997)).

Second, there exists a large body of empirical literature on the role of bank incentives and financial crises. According to Stromberg et al. (2010), Fahlenbrach and Stulz (2011) and Beltratti and Stulz (2009) there is some evidence that banks with shareholder oriented incentives for CEOs performed worse during the crisis. They argue that in these banks asset substitution might have been a serious issue. Evidence from other periods are provided by Kose et al. (2000) and Esty (1998). A gambling for resurrection behavior of overindebted banks has also been documented empirically (Pontell (2005), Fukuda et al. (2006)). Several studies provide evidence that banks which are faced with a shock on capital (e.g. because of losses) respond by decreasing loan supply. These studies provide indirect evidence for the debt overhang problem (Bernanke et al. (1991), Peek and Rosengren (1995), Hancock et al. (1995) for the U.S. and Watanabe (2007) for Japan). These empirical results suggest incentives do have a first-order consequence for decision making and wrong incentives did play a major role in previous financial crises.

Third, our paper builds upon the growing literature on contingent capital. First proposed by Flannery (2002). the idea of contingent capital has been embraced by several authors (Duffie (2010), Squam Lake Working Group on Financial Regulation (2009)). Several papers derive val-

[2] In addition, governments injected another USD 380bn.

[3] Moreover, it leads to a non-selective recapitalization as viable banks are discouraged from recapitalizing and all banks will finally be recapitalized via contingent capital by a similar amount.

uation formulae for contingent capital instruments and discuss key design issues (Pennacchi et al. (2010), Glasserman and Nouri (2010), Albul et al. (2010), Sundaresan and Wang (2010), Posner (2010)). Sundaresan and Wang (2010) show that if conversion is triggered by market values falling below a certain threshold, CoCo-Bonds generally do not lead to a unique equilibrium for equity and CoCo-Bond prices. Multiple equilibria can cause problems because market participants might try to manipulate prices to achieve the optimal equilibrium for their holdings (Hillion and Vermaelen (2004)). These concerns of potential market manipulation are particularly important for smaller companies where market prices are more prone to manipulation. Pennacchi et al. (2010) have proposed a new form of contingent capital, labelled Call Option Enhanced Reverse Convertibles (COERCs), which eliminate concerns about a loss spiral and analyze the effect of COERCs on risk-taking incentives. Flannery (2009) also notes that "... we must take care that the conversion process does not influence managers to behave in a counter-productive way." This acknowledges the two-sided effects on banks: First, CoCo-Bonds can help recapitalizing a bank in times of distress. Second, the existence of CoCo-Bonds themselves can possibly change the way managers behave even before conversion. Surprisingly, the question of bank managers' incentives has only gained limited attention in the CoCo-Bond discussion which has so far predominantly focused on the macroeconomic impacts of ensuring capital supply in times of financial distress. Flannery (2002, 2009), Maes and Schoutens (2010) and Coffee (2010) all acknowledge that the resulting bank managers' incentives should be taken carefully into account in addition to the macroeconomic effects. Coffee (2010) thereby proposes that CoCo-Bonds should not convert into equity, but into preferred stock with cumulative dividends and voting rights. Thereby a class of shareholders is created which is rationally risk averse. Koziol and Lawrenz (2009) were the first to point out to the asset substitution problem associated with contingent capital with a high conversion price when managers endogenously chose the optimal level of contingent capital.

Our paper makes two key contributions to this literature. First, we provide a theoretical analysis of the incentive effects for equity holders if contingent capital is mandatorily introduced as part of a bank's capital structure. In our model, the amount of equity and contingent capital is exogenously set by the regulator and equity holders try to maximize the value of their claim. We show that if a wealth transfer takes place towards equity holders at conversion, CoCo-Bonds significantly exacerbate both the asset substitution as well as the debt overhang problem. We estimate the magnitude of these effects over a wide range of reasonable parameters for a bank with 100 assets which holds 10 equity and additional 5 CoCo-Bonds. Conversion is assumed to take place when losses exceed 5 and – based on the specification of CoCo-Bonds that have been issued so far – the wealth transfer is assumed to be approximately 50% of the CoCo-Bonds' notional value. The effects are highly econonomically significant. Close to the conversion point, bank owners' incentives for risk-taking are increased by a factor of 5-10. In addition, banks' equity holders would only be willing to provide new funds in times of distress if these new funds generated an NPV of more than 1.20 per 1

investment. Without CoCo-Bonds these numbers are less than 1.01 per 1 investment. The intuition is that a recapitalization reduces the likelihood of a wealth transfer from CoCo-Bond holders to equity holders.[4] Second, we analyze the main CoCo-Bond issuances that have occurred over the last two years (Lloyds, Rabobank, Credit Suisse). The size of these CoCo-Bond issuances varies from 0.5% of risk-weighted assets in the case of Rabobank to almost 4% in the case of Credit Suisse – well below the levels currently discussed by regulators. We show that these CoCo-Bonds are all designed in an incentive-distorting way because they results in a wealth transfer from CoCo-Bond holders to equity holders at conversion equal to on average 50% of the CoCo-Bond notional. We are in particular worried about the disincentives for a recapitalization before the triggers are hit. Given that the triggers are based on slowly reacting regulatory ratios, a long period of underinvestment by these banks in case of a crisis seems to be a real threat.

It is not clear how market forces would eliminate these wrong incentives. From a shareholders' perspective, asset substitution may be an optimal strategy. Debtholders, to some extent, may either force banks to internalize this problem via higher interest rates or confine it through monitoring. Risk-based capital rules might also help to curtail excessive risk-taking. For the taxpayer (who bears the implicit cost of the "too-big-to-fail" guarantee) it is much more difficult to put a price tag on that. Mitigating the debt overhang problem is even more cumbersome as equity holders cannot be contractually forced to recapitalize their banks in times of distress as long as their regulatory capital ratios are above the minimum requirements.[5] Both excessive risk-taking by banks as well as undercapitalization pose a real threat to the economy. First, the tax payer might have to intervene – as was the case in the recent financial crisis. Second, banks act as intermediaries so that an undercapitalization of banks has an effect on the real sector by decreasing the loan supply ("credit crunch"). Hence, the regulator has to consider rules that make shareholder/CEO incentives better aligned with all stakeholders.

What is a possible solution to avoid these problems? We propose a new form of CoCo-Bonds which we label Convert-to-Surrender Bonds (CoSu-Bonds). CoSu-Bonds are special types of CoCo-Bonds with two distinct features. First, just like CoCo-Bonds, they convert into equity in case of financial distress. Second, in contrast to classical CoCo-Bonds, a wealth transfer from equity holders to CoSu-Bond holders takes place at conversion. As a simple (though rather extreme) case, we discuss the situation where equity holders are totally wiped out in case of conversion. Thereby,

[4] For example, if a recapitalization of 1% (relative to risk weighted assets) decreases the likelihood of conversion by 10 percentage points and the wealth transfer is equal to 50% of the CoCo-Bond notional of 5% of risk-weighted assets – a reasonable amount for the CoCo-Bonds issued so far – then this easily transforms into a negative wealth effect for equity holders of $10\% \cdot 50\% \cdot 5\% = 0.25\%$. Therefore equity holders will only recapitalize the bank if this 1% injection generates an NPV of 1.25% – which is an additional hurdle rate of 25%.

[5] Limiting share repurchases and dividend payouts in times of a crisis might help to avoid making problems worse but do not help to improve the situation either. Other options discussed in the corporate finance literature such as contractual arrangements, private debt or renegotiation of debt do not seem to work in the banking sector.

equity holders lose disproportionately when things go bad. This creates a situation where bank owners are short in volatility and therefore naturally risk averse. In addition, equity holders of viable banks have an incentive to provide more capital in times of financial distress even if the NPV of new investments is slightly negative. This can potentially help to foster recapitalizations in the early run-up to a financial crisis while still providing new funds in times of a severe financial crisis for non-viable banks where equity holders might be unwilling or unable to inject capital on their own. The unique feature of CoSu-Bonds is therefore that they make bank equity holders naturally risk averse and give an incentive to recapitalize viable banks in times of a crisis. They can therefore potentially align regulators' and banks' incentives.

This paper is structured as follows. In section 2 we explain the driving factors behind the conversion price of CoCo-Bonds and bank owners' incentives based on a simple case in a single-period setup. In section 3 we develop general results in a continuous time model. In section 4 we explicitly analyze the CoCo-Bonds that have been issued so far by Lloyds, Rabobank and Credit Suisse. Section 5 discusses the policy implications of our proposal. Section 6 concludes.

2 A simple example

To illustrate our main arguments we provide a simple example. Bank A has 100 in assets, financed by demand deposits (85), CoCo-Bonds (5) and common equity (10), as shown in table 1. For reasons of simplicity we assume that no interest is paid on deposits or CoCo-Bonds and that all investors are risk-neutral. The bank has two options for its investment strategy which are depicted in table 1. Strategy I ("Safe gain") yields a profit of 10 if the economy ends up in the good state and a profit of 0 if the economy ends up in the bad state. Both states are assumed to occur with the same probability. Strategy II adds an additional "gamble" which yields an extra +5 gain in the good state and an extra -5 loss in the bad state.

Assets	Liabilities	Description
100	85	Demand deposits
	5	CoCo-Bonds
	10	Equity

	Good state	Bad state
Strategy I ("Safe gain")	10	0
Strategy II ("Safe gain + gambling")	15	-5

Table 1: Left-hand table: Balance sheet structure, right-hand table: Strategy options and payoffs.

We illustrate the resulting incentive effects for two extreme cases. In both cases we assume that conversion takes place once the asset value hits 95. At the time of the trigger event there is a net asset value of 10 left which has to be somehow divided between the CoCo-Bond holders and equity holders. This is done as follows in the two cases (cf. figure 1 for an illustration):

- In case A ("Convert-to-Steal"), CoCo-Bond holders are totally wiped out, i.e., equity holders receive 10 and CoCo-Bond holders receive 0. This is equivalent to saying that the conversion price is infinitely high or that the conversion rate equals 0 shares per 1 CoCo-Bond notional.
- In case B ("Convert-to-Surrender"), CoCo-Bond holders take over the whole company and equity holders are totally wiped out. This is equivalent to saying that the conversion price is 0 or that the conversion rate is infinite, i.e. there is an infinite number of shares granted per 1 CoCo-Bond-notional. We label CoCo-Bonds with this special feature as Convert-to-Surrender bonds (CoSu-Bonds).

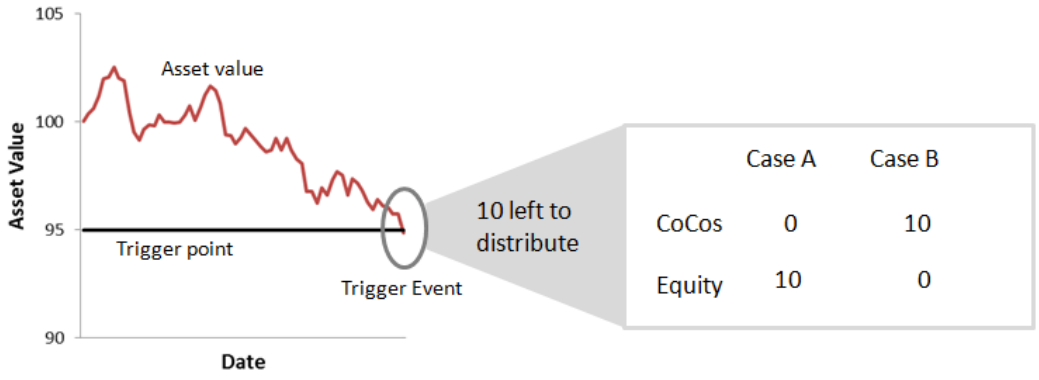

Figure 1: Illustration of trigger event and distribution of remaining 10 equity (10 equity less 5 losses plus 5 converted CoCos) to CoCo-Bond holders and equity holders.

How does the payoff to equity holders look like? These payoffs are depicted in figure 2. In case of either strategy I or the good state of strategy II, the trigger will not be hit and equity holders therefore always bear the total gain/loss from the respective strategy. If the economy ends up in the bad state and the bank has chosen strategy II, the conversion of the Coco-Bonds is triggered and the payoff depends on the conversion price. In case A (Convert-to-Steal), the losses to equity holders will be 0 (the total loss of 5 is borne by the CoCo-Bond holders). In case B (Convert-to-Surrender), equity holders lose 10 as now the CoSu-Bond holders own the total company. Please note that the loss to equity holders in case B is larger than the total loss on strategy II (-5). CoSu-Bond holders therefore even gain from conversion. This is a large incentive for bank owners not to undertake risk-shifting projects.

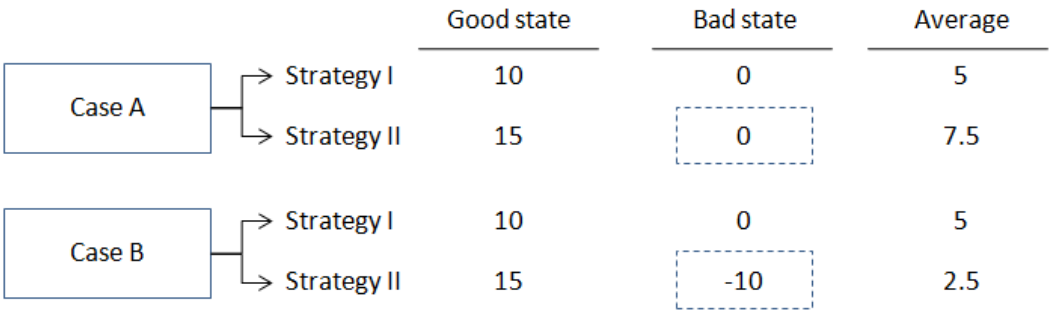

Figure 2: Gains/Losses for equity holders for different conversion prices (case A vs. case B) for the two different strategies. Case A assumes that CoCo-Bond holders are wiped out in case of conversion, case B assumes that equity holders are wiped out in case of conversion. The dashed rectangle shows the states in which conversion takes place.

Assuming equal probabilities therefore results in an NPV of 5 for strategy I for both case A and case B. In case of strategy II, the NPV is 2.5 in case of Convert-to-Steal and 7.5 in case of Convert-to-Surrender (cf. 2). Under Convert-to-Steal, equity holders therefore have a strong incentive to increase risk.[6] Such an asset substitution incentive cannot be in the interest of regulators and tax payers. In contrast, with a CoSu-Bond, banks will have an explicit incentive not to invest in risky projects just because risks can be shifted towards debtholders or taxpayers. This is an especially important feature for systemically relevant financial institutions, because their debt is effectively guaranteed by the government ("too-big-to-fail"). The effect on incentives for recapitalization in times of distress is similarly distorted. In the Convert-to-Steal case, equity holders will not recapitalize their banks when the asset value falls close to the trigger because this would decrease the chance of reaping a profit from conversion. With Convert-to-Surrender bonds there is a large incentive to recapitalize as this reduces the likelihood of being wiped out.[7]

Both arguments together suggest that Convert-to-Steal bonds can potentially exacerbate a future financial crisis while Convert-to-Surrender bonds may help to avoid excessive risk-taking and encourage early recapitalizations for viable banks. We will quantify these effects in a general setup in section 3 before we demonstrate in section 4 that all CoCo-Bonds that have been issued so far are very close to the Convert-to-Steal case.

[6] Of course, prudential banking regulation would require a bank to hold more equity if it follows strategy II. However, the financial crisis has certainly demonstrated that banks are able exploit loopholes of such regulations. Current regulatory reform aims at closing these loopholes. However, regulation will never be 100% waterproof. Cf. Berger et al. (1995) for unintended consequences of capital regulation, Rösch and Scheule (2011) for regulatory arbitrage via securitization before the financial crisis, Kretzschmar et al. (2010) for an argumentation why Basel II might have led to an undercapitalization of banks and Daníellson (2002) for general limits on model based regulation.

[7] On the other hand, there is a chance that the benefits from this recapitalization accrue to CoCo-Bond holders if the trigger is hit later on anyway. However, this effect is usually a lot smaller than the effect from the lower likelihood of being wiped out as we will demonstrate in the next section.

3 A general solution

3.1 Model set up and objective function

In this section, we forumulate our model setup and the equity holders' objective function which determines equity holders actions and therefore the degree of both the asset substitution and the debt overhang problem.

Model setup:
We use a Merton-type structural model (Merton (1974)) and thereby focus on the conflict of interest between equity holders on one side and bond and CoCo-Bond holders on the other side. We abstract from any further agency conflicts such as the manager-owner conflict. In particular, the following assumptions and notations are used:

Assumption 3.1 *(Model setup)*

- *Asset values are assumed to follow a geometric Brownian motion with a risk-neutral drift r, a volatility of σ and a t=0 asset value V_0. Markets are arbitrage-free and complete and asset values are publicly observed and cannot be manipulated.*[8]
- *Equity holders can choose between different projects with volatilities $\sigma \in [\sigma_d, \sigma_u]$. The volatility is non-contractible, in particular interest rates on the CoCo-Bond cannot depend on the level of volatility.*
- *Both standard debt and CoCo-Bonds are assumed to be zero coupon bonds with the same maturity T and notionals N_{Debt} and N_{CoCo} and are issued at $t = 0$.*
- *Conversion of the CoCo-Bonds takes place if the asset value V_T falls below a certain threshold TP ("trigger point") at maturity T.*[9]
- *We consider three cases for the conversion price which we label "Convert-to-Steal" and "Convert-to-Surrender" and "No CoCo-Bond":*
  - *Convert-to-Steal-Type: If conversion takes place at T, equity holders receive the remaining net asset value $V_T - N_{Debt}$ (and CoCo-Bond holders receive nothing)*
  - *Convert-to-Surrender-Type: If conversion takes place at T, equity holders receive nothing (and CoCo-Bond holders receive the remaining net asset value $V_T - N_{Debt}$)*

[8] This assumption ensures that equity holders cannot temporarily report a lower asset value simply to trigger conversion without adversely affecting the intrinsic value of the firm.

[9] We focus on this market based trigger because introducing regulatory capital ratios would require further assumptions and add to the complexity of the model without having significant benefits for the type of analysis we want to conduct.

– *No CoCo-Bonds: Standard debt is issued instead of CoCo-Bonds so that the total notional of straight debt is* $N_{Debt} + N_{CoCo}$.[10] *If the asset value is below the debt notional at maturity, equity holders receive nothing.*

This simple Merton-type framework allows for a straightforward derivation of the main effects of CoCo-Bonds on banks' incentives. Extensions such as first-passage style triggers, jumps in the asset value process, stochastic interest rates, coupon payments, incomplete information about the asset value or different maturities of the straight debt and CoCo-Bond can be added to the model. While such extensions are mathematically relatively straightforward, one can get needlessly mired in algebraic complications. To ensure a proper focus and tractable solutions we focus on this intuitive set-up.[11]

Equity holders' objective function:
The equity holders' objective function is specified by the following assumption:

Assumption 3.2 *(Equity holders' objective function) Equity holders maximize the no-arbitrage value of their claim by chosing an optimal level of volatility and by deciding to recapitalize their bank or not at any point in time before conversion. In particular:*

- *Equity holders will increase the volatility whenever this increases the value of equity.*
- *Equity holders will recapitalize their bank with new equity capital whenenver the equity value after recapitalization is larger than the sum of the equity value before recapitalization plus the amount of the recapitalization.*

We thereby abstract from other distortions such as manager-owner conflicts or other parameters entering the equity holders utility function. We also explicitly refrain from modeling the amount of straight bonds, the amount of CoCo-Bonds and the design of CoCo-Bonds (trigger and conversion price) as an endogenous choice based on taxes, bankruptcy costs and implicit state guarantees. Banks did not choose to voluntarily issue contingent capital over the past decades, so CoCo-Bonds do not seem to be part of an optimal capital structure purely from a banks' point of view (probably because straight debt was very cheap due to an implicit state guarantee). Our aim is to analyze what

[10] This refers to a situation where the regulator sets minimum requirements on the amount of equity and CoCo-Bonds. If no requirement on CoCo-Bonds is set, banks will simply issue more straight debt.

[11] Glasserman and Nouri (2010) provide an in-depth discussion of the valuation of contingent capital with coupon payments in a first-passage time framework. Pennacchi (2010) develops a general structural model for contingent capital valuation including jumps in the asset value and stochastic interest rates. With jumps in the asset value, equity holders always have an incentive to increase the likelihood of large jumps as a compensation for a small increase in the asset value drift. These incentives cannot by mitigated using contingent capital because contingent capial only makes a difference when the resulting asset values are larger than the notional value of debt but smaller than the notional value of debt and contingent capital. Duffie and Lando (2001) provide a formula for the valuation of straight bonds with incomplete information and De Vries (2005) have pointed out to the importance of the fat tail property for the likelihood of financial crisis.

happens if regulators *force* banks to hold contingent capital. Therefore, from a banks' point of view both the amount of contingent capital as well as the amount of equity are exogenous parameters.

3.2 Payoff profile and valuation

Given the objective function of equity holders (value maximization) and the model assumptions we are now able to derive formulae for the payoff profile and formulate the value of equity in the presence of CoCo-Bonds as a sum of certain plain-vanilla European options.

The payoff profile:
The payoff to equity holders is depicted in figure 3 for all three cases ("Convert-to-Steal", "Convert-to-Surrender", "No CoCo-Bonds").[12] The crucial feature is the payoff function at the trigger point. In the Convert-to-Steal case equity holders bear all of the losses up to the trigger point. Once the trigger is breached, these losses are partly transferred from equity holders to CoCo-Bond holders. Therefore, equity holders are better off for a time-T asset-value of $TP - \epsilon$ than for a time-T asset-value of $TP+\epsilon$. In the Convert-to-Surrender case equity holders are totally wiped out at conversion. Equity holders are better off for a time-T asset value of $TP+\epsilon$ than for a time-T asset-value of $TP-\epsilon$.

These payoffs can be described in terms of a classical European call option combined with binary call options. A binary call option with strike price K and maturity T on an underlying process V pays out one unit if $V_T > K$ and nothing otherwise. In the Convert-to-Steal case the payoff to equity holders is equal to one call option with strike price N_{Debt}, minus N_{CoCo} times a binary call option with strike TP. In the Convert-to-Surrender case the payoff to equity holders is equal to one call with strike TP plus $(TP - N_{Debt} - N_{CoCo})$ binary calls with strike TP:

$$S_{C-t-Steal} = C(Strike = N_{Debt}) - N_{CoCo} \cdot DigC(Strike = TP) \quad (1)$$

$$S_{C-t-Surr} = C(Strike = TP) + (TP - N_{Debt} - N_{CoCo}) \cdot DigC(Strike = TP) \quad (2)$$

Here, $S_{C-t-Steal}$ and $S_{C-t-Surr}$ denote the equity value in the Convert-to-Steal and Convert-to-Surrender cases, C denotes the value of a European call option and $DigC$ denotes the value of a Digital call option. If no CoCo-Bonds are issued ($N_{CoCo} = 0$, $TP = N_{Debt}$) the payoff is equal to the value of a call option with a strike price equal to the notional value of the debt.

Valuation:
The equity value can now be derived based on the valuation formulae for call options and binary

[12] Investors of Convert-to-Steal Bonds would require a higher nominal interest rate than holders of straight debt or Convert-to-Surrender Bonds. Thereofore, the t=0-leverage based on market values of debt and equity would be slightly different in all three cases. Alternatively, the same t=0-leverage could be generated by giving holders of Convert-to-Steal bonds a higher payoff if the asset value at the end of maturity is above the trigger. Our results are not materially affected by the choice of either of these two options.

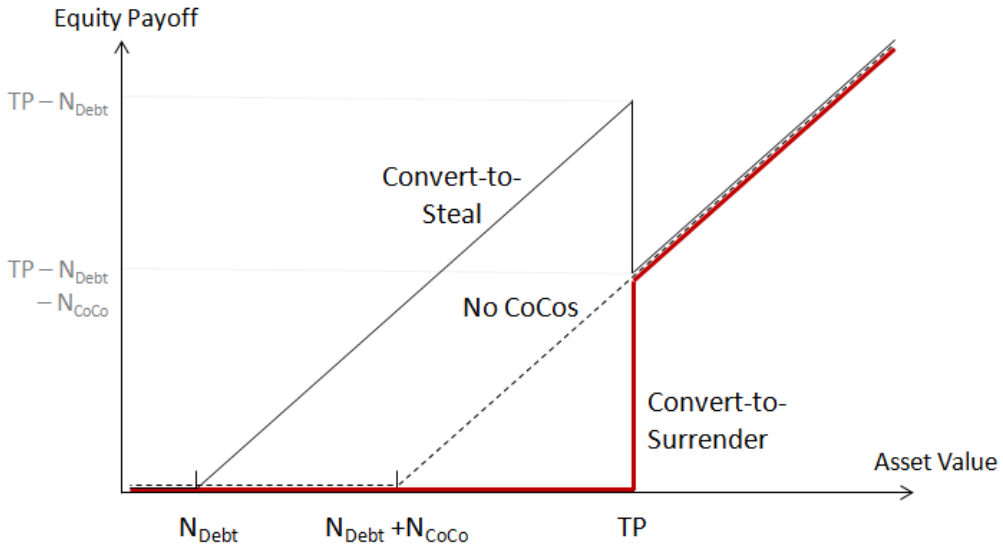

Figure 3: Payoff to equity holders at maturity T for the cases Convert-to-Steal, Convert-to-Surrender and the case without CoCo-Bonds. N_{Debt} denotes the notional of the straight debt, N_{CoCo} denotes the notional of the CoCo-Bonds and TP denotes the trigger point. We assume that straight debt is issued instead of CoCo-Bonds in the case without CoCo-Bonds.

call options:

$$S_{C-t-Steal} = V_0 e^{-rT} N\left[d_1(N_{Debt})\right] - N_{Debt} e^{-rt} N\left[d_2(N_{Debt})\right] - N_{CoCo} \cdot e^{-rT} N\left[d_2(TP)\right] \quad (3)$$

$$S_{C-t-Surr} = V_0 e^{-rT} N\left[d_1(TP)\right] - TP e^{-rt} N\left[d_2(TP)\right] - (TP - N_{Debt} - N_{CoCo}) \cdot e^{-rT} N\left[d_2(TP)\right] \quad (4)$$

A detailled derivation is given in appendix A. Again, the limit in both cases for a CoCo-Bond notional of $N_{CoCo} = 0$ (and $TP = N_{Debt}$) gives us the value of a call option with the strike equal to the debt notional.

3.3 Proxies for asset substitution and debt overhang

The valuation formulae (3) and (4) allow us to derive proxies for the asset substitution problem and for the debt overhang problem based on the Greeks of the equity value.

Asset substitution:
Jensen and Meckling (1976) point out that equity holders have an incentive to increase the riskiness of the assets because they effectively hold a call option on the companies' assets. The natural candidate to measure the degree of the asset substitution problem is therefore the derivative of the equity value with respect to the volatility ("Vega"):

Proposition 3.3 *(Asset substitution) The Vega of the equity value is a proxy for the asset substitution problem. In the presence of contingent capital of the Convert-to-Steal and Convert-to-Surrender type, Vega can be determined as:*

$$\frac{\partial S_{C-t-Steal}}{\partial \sigma} = V_0\sqrt{T}N'\left[d_1(N_{Debt})\right] + N_{CoCo}\frac{e^{-rT}d_1(TP)N'\left[d_2(TP)\right]}{\sigma} \quad (5)$$

$$\frac{\partial S_{C-t-Surr}}{\partial \sigma} = V_0\sqrt{T}N'\left[d_1(TP)\right] - (TP - N_{Debt} - N_{CoCo})\frac{e^{-rt}d_1(TP)N'\left[d_2(TP)\right]}{\sigma} \quad (6)$$

A derivation is given in appendix A. Using $N_{Debt} = 0$ and $TP = N_{Debt}$ we get the usual call option Vega ($V_0\sqrt{T}N'\left[d_1(N_{Debt})\right]$).

Using Vega as a proxy for the magnitude of the asset substitution problems assumes that equity holders can only symmetrically increase the riskiness of the assets. This is a natural limitation of the Merton framework. Again, we make this assumption to allow for a certain tractability. The Vega therefore provides a lower bound for the true magnitude of the asset substitution problem. Based on inspection of (5) and (6) we see that – as long as the current asset value is above the trigger value and therefore $d_1(TP) > 0$ – Convert-to-Steal Bonds increase Vega while Convert-to-Surrender bonds decrease the Vega as long as the trigger point is above the total notional of straight debt and the CoCo-Bond. Intutively, as long as the bank's assets are above the threshold, equity holders have an increased incentive to gamble in the Convert-to-Steal case while the opposite affect can be observed in the Convert-to-Surrender case if the second term in (6), which stems from the concavity effect induced by the straight bond, is large enough to offset the first term which stems from the convexity induced by the straight bond. In equilibrium, equity holders would therefore chose the maximum asset value possible and CoCo-Bond holder would demand a correspondingly high interest rate in the Convert-to-Steal case. In the Convert-to-Surrender case, banks can potentially be naturally risk averse and would invest – given the same NPVs – in projects with the lowest riskiness possible.

Debt overhang:
The debt overhang problem states that equity holders might be reluctant to provide new funds and conduct positive NPV projects in times of financial distress because the benefits partly accrue to bond holders. Applied to the banking sector this means that equity holders will be reluctant to recapitalize their banks in times of financial distress and will therefore decrease the loan supply. The key metric for assessing the magnitude of the debt overhang problem is therefore the increase in the asset value which is necessary to motivate equity holders to invest USD 1 equity. In the absence of a debt overhang problem the required increase is simply USD 1. In the presence of a debt overhang problem this amount exceeds USD 1. More formally, we are interested in the amount

x which solves the following equation:

$$Equity(V_t + x) = Equity(V_t) + 1.$$

Using the derivative of the equity value with respect to the asset value ("Delta") this can be reformulated as:

$$x \approx 1/\Delta,$$

where Δ denotes the Delta of the equity value. The formula is exact if we look at arbitrarily small investments. The following proposition recapitules this discussion and provided specific formulae for these proxies.

Proposition 3.4 *(Debt overhang) The inverse of the Delta of the equity value is a proxy for the magnitude of the debt overhang problem. In the presence of contingent capital of the Convert-to-Steal and Convert-to-Surrender type, the inverse of the Delta can be determined as:*

$$1/\Delta_{C-t-Steal} = \left(\frac{\partial S_{C-t-Steal}}{\partial V_0}\right)^{-1} = \left[N\left[d_1(N_{Debt})\right] - N_{CoCo}\frac{e^{-rT}N'\left[d_2(TP)\right]}{\sigma V_0\sqrt{T}}\right]^{-1} \quad (7)$$

$$1/\Delta_{C-t-Surr} = \left(\frac{\partial S_{C-t-Surr}}{\partial V_0}\right)^{-1} = \left[N\left[d_1(TP)\right] + (TP - N_{Debt} - N_{CoCo})\,\frac{e^{-rT}N'\left[d_2(TP)\right]}{\sigma V_0\sqrt{T}}\right]^{-1} \quad (8)$$

The proof can be found in appendix A. By inspection, Convert-to-Steal type bonds increase the debt overhang problem.[13] Equity holders are reluctant to commit own funds because this decreases the likelihood that they can "steal" money from the contingent capital holders. The opposite effect can be observed for Convert-to-Surrender bonds which mitigate the debt overhang problem as long as the trigger is higher than the combined notional of debt and contingent capital.

3.4 Results

To illustrate the resulting effects we choose the following parameters:

- The asset value is set to $V_0 = 100$.
- The risk-free rate is assumed to be $r = 5\%$.
- The notionals are set to $N_{Debt} = 85$ (straight debt) and $N_{CoCo} = 5$ (CoCo-Bond) and the trigger point is set to $TP = 95$. This can be interpreted as a capital ratio of 10%, an additional buffer of CoCo-Bonds equal to 5% of the (risk-weighted) assets and a conversion

[13] Please observe that the fraction after N_{CoCo} is always positive so that a higher amount of contingent capital decreases the term in paranthesis and therefore increases the reciprocal.

of the CoCo-Bonds to equity once the capital ratio falls below 5% (i.e. the assets fall below 95).[14]

- The maturity of both debt and the CoCo-Bonds is set to $T = 0.25$. Of course, CoCo-Bonds would definitely have a longer maturity. However, banks usually have short term liabilities. Hence, if the trigger is observed on a say quarterly basis, conversion of CoCo-Bonds will be considered each quarter.

- We use a range of 0-10% for the asset volatility based on values from Gropp and Heider (2010). Gropp and Heider (2010) report a mean asset volatility for a sample of banks from the U.S. and EU from 1991-2004 of 3.6% with a standard deviation of 3.4%. In times of crises – where asset substitution and debt overhang problems are more prevalent – asset volatility is likely to be higher than this unconditional mean.

This parameter choice results in a risk-neutral probability that the trigger is hit of 0.56% per quarter or 2.27% per annum (using the midpoint of 5% for the asset volatility).[15] A credit default swap paying one in case of conversion would therefore have a spread of (roughly) 227 bp. Given that bank CDS are currently trading at appr. 50-150 bp and the trigger event should be more likely than an outright default this seems to be a reasonable calibration.

Asset substitution:
Figure 4 depicts the results for the asset substitution problem for the parameter combinations given above. The left-hand graph shows the equity value as a function of the asset volatility. The right-hand graph shows the Vega of the equity value as a function of the asset value and therefore allows to compare the magnitude of the asset substitution problem for different asset values. We make two key observations: First, in absolute terms, the sensitivity in the case without CoCo-Bonds is dwarfed by both other cases. So if asset substitution is a relevant problem without CoCo-Bonds, it is an even more important topic if CoCo-Bonds are part of the capital structure. Second, the Convert-to-Steal-type Bonds significantly increases bank managers' incentives to increase risk whereas the Convert-to-Surrender-type Bonds significantly decrease risk-taking incentives. Both observations together have an alarming implication: Banks' incentives to increase risk will be an order higher if

[14] The new Basel III rules require banks to hold capital of 7-10.5% depending on which definition of capital is used. Banks are likely to add an additional buffer to ensure that small changes do not directly push them below the reegulatory requirements. The Swiss regulator has proposed contingent capital of up to 9% of risk weighted assets which is likely to be an upper limit for discussions outside Switzerland. The CoCo-Bonds issued so far specify either a trigger point of a 5% capital ratio or a 7% capital ratio, usually based on core Tier-1 capital.

[15] The probability that the trigger is hit is equal to the probability that a European put option is in-the-money at maturity. This can be determined as $Q := \Phi\left((ln(K/V_0) - (r - 0.5\sigma^2))/(\sigma\sqrt{T})\right)$ where Φ is the cumulative standard normal distribution function, K the strike price, V_0 the current asset value, σ the volatility and T the maturity, cf. e.g. Duffie and Singleton (2003). Applying this formula with $V_0 = 100$, $K = 95$, $r = 5\%$ and $\sigma = 5\%$ results in $Q = 0.56\%$ for $T = 0.25$ and $Q = 2.27\%$ for $T = 1$.

Convert-to-Steal-type CoCo-Bonds are mandatorily introduced. This can be illustrated by a simple example: By doubling asset volatility from 5% to 10%, bank managers can increase the value of equity by only 0.13% without CoCo-Bonds but by 4.43% with Convert-to-Steal-type CoCo-Bonds (cf. left-hand graph in figure 4). The situation is even worse once we are in a crisis and asset values are lower. E.g. for an asset value of 96, Vega is roughly 3%, implying that the equity value can be increased by more than 3% for each 1PP increase in asset volatility (cf. right-hand graph of figure 4). Without CoCo-Bonds Vega is less than 0.10%, i.e. significantly less than a tenth compared to the Convert-to-Steal case. Larger maturities increase the asset substitution problem but decrease the difference between the asset substitution problem with and without CoCo-Bonds. Still, even for maturities of up to three years we find that Convert-to-Steal Bonds magnify the asset substitution problem by a factor of 5. If asset substitution and gambling for resurrection was a problem without CoCo-Bonds, it might become an enormous problem with Convert-to-Steal-type CoCo-Bonds. The opposite effect can be observed for Convert-to-Surrender-type CoCo-Bonds which even make equity holders naturally risk averse.

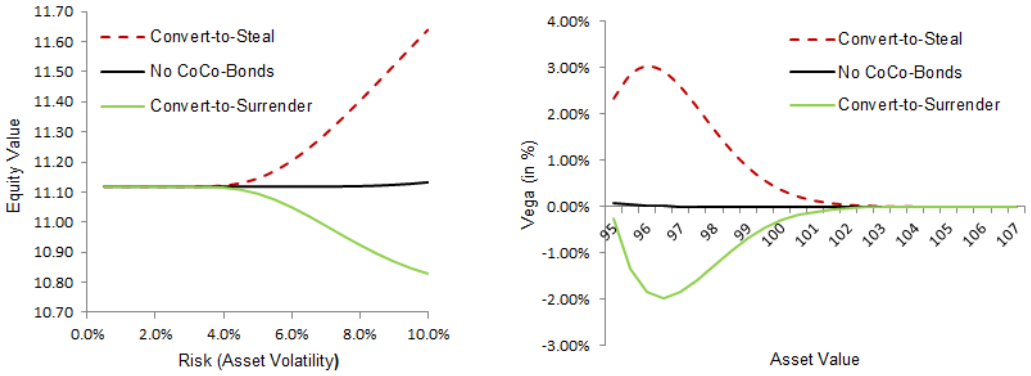

Figure 4: Asset substitution problem. Left-hand picture: Equity value as a function of the asset volatility for all three cases (Convert-to-Steal, Convert-to-Surrender and the case without CoCo-Bonds). Right-hand picture: Vega of the equity value as a function of the asset value. Other parameter values are: $V_0 = 100$ (varies in the right-hand picture), $r = 5\%$, $\sigma = 5\%$ (varies in the left-hand picture), $N_{Debt} = 85$, $N_{CoCo} = 5$, $TP = 95$ and $T = 0.25$.

Debt overhang:

Figure 5 presents the inverse of the delta as a proxy for the debt overhang problem for all three cases (No CoCo-Bonds, Convert-to-Steal, Convert-to-Surrender). It shows the banks' incentives for different economic situations (normal asset value, high asset value after gains, low asset value after a crisis). With a Convert-to-Steal type Bond, the debt overhang problem is significantly exacerbated in times of a crisis. A higher asset value means a lower probability of conversion and therefore a

lower probability of a subsequent wealth transfer from CoCo-Bond holders to equity holders.[16] For example, with an asset value of 96 (i.e. 1 above the conversion threshold of 95), an increase in asset value of USD 2.19 per USD 1 of equity injection is needed to make this a worthwile investment for equity holders. As a comparison, the value for the case without CoCo-Bonds is less than USD 1.01 per USD 1 investment. The message behind these numbers is simple: Equity holders will not recapitalize the bank on their own in times of distress because they would thereby significantly reduce the likelihood that they can impose some of the losses on creditors. Convert-to-Steal-type CoCo-Bonds induce the opposite effect. Injecting more equity funds in times of financial distress decreases the likelihood that the trigger is breached and therefore decreases the likelihood that equity holders lose all of their investment. Therefore, Convert-to-Surrender Bonds will encourage recapitalizations in times of financial distress.

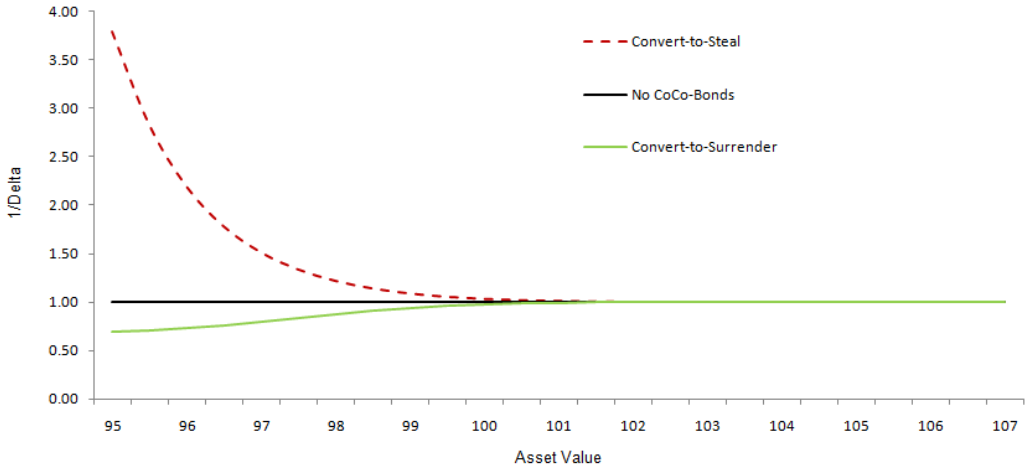

Figure 5: Debt overhang problem I. Inverse of the Delta of the equity value as a function of the asset value for all three cases (Convert-to-Steal, Convert-to-Surrender and the case without CoCo-Bonds). Other parameter values are: $r = 5\%$, $\sigma = 5\%$, $N_{Debt} = 85$, $N_{CoCo} = 5$, $TP = 95$ and $T = 0.25$.

Further comments:

So far, we have looked at one (realistic) calibration and the extreme cases of Convert-to-Steal and Convert-to-Surrender. What happens for other parameter combinations and CoCo-Bonds which are in between these two extreme cases? First, while other parameter combinations change the specific numbers the main message does not change. Convert-to-Steal type Bonds encourage risk-taking and discourage recapitalizations in times of distress while the opposite is true for Convert-to-Surrender

[16] There are actually two effects at work: First, with Convert-to-Steal, there is a larger likelihood for equity holders that they can reap the full benefits of the additional investment of USD 1. Second, there is a lower likelihood of wealth transfer from CoCo-Bond to equity holders for each dollar increase in asset value. The second effect dominates the first when the wealth transfer is sufficiently large.

bonds. The effects of the asset substitution problem are more pronounced for larger CoCo-Bond notionals (because they determine the one-off gain equity holders can make at conversion) and longer maturities (because they increase the convexity effect). The effects for the debt overhang problem are more subtle. Larger CoCo-Bond notionals amplify the debt overhang problem in the case of Convert-to-Steal bonds. They do not, however, further increase the incentives to recapitalize in the case of Convert-to-Surrender bonds.[17]

CoCo-Bonds with a pre-specified conversion price, for instance depending on the equity price, lie somewhere in between our two extreme examples. The magnitude of the resulting effects both for the asset substitution problem as well as the debt overhang problem are therefore somewhere in between the effects discussed above. To generate the desired incentive effect of equity holders being short volatility and having a delta of more than one, as a necessary condition a wealth transfer from equity holders to CoCo-Bond holders has to occur at conversion. This condition is not satisfied for the CoCo-Bonds that have been issued so far by Lloyds, Rabobank and Credit Suisse. On the contrary, theses CoCo-Bonds are remarkably close to the Convert-to-Steal case as we will demonstrate in the next section.

For the real-life cases we observe that CoCo-Bond holders usually suffer a loss of approximately 50% upon conversion. For a setup with 5% CoCo-Bonds and a trigger at an asset value of 95 this translates into a case where equity holders own 75% of the after-conversion shares while CoCo-Bond holders receive 25%. This "75/25" case is depicted in figure 6 along with the Convert-to-Surrender and the Convert-to-Steal cases for an asset value of 96 (1 unit above the trigger point) and different levels of the asset volatility from 2.5% to 10%.[18] The inverse of the delta for the "75/25" case is always above USD 1.20. Even using very conservative assumptions we therefore conclude that a required level of 5% contingent capital will make equity holders very reluctant to inject new equity in times of distress. If a bank is 1PP above the trigger equity holders will require at least USD 1.20 NPV per USD 1.00 investment for the parameter combinations we have analyzed here.

[17] Further details on these results and further analysis for other parameter combinations are available on request.

[18] An asset volatility of 2.5% is even lower than the unconditional mean reported in Gropp and Heider (2010) and therefore seems to be a lower boundary during a financial crisis. An asset volatility of 10% translates into an equity volatility of more than 100% – a value that seems to be an upper bound even during severe periods of stress. Please note that delta converges to one if the asset volatility converges to infinity, therefore the function is not increasing in the volatility.

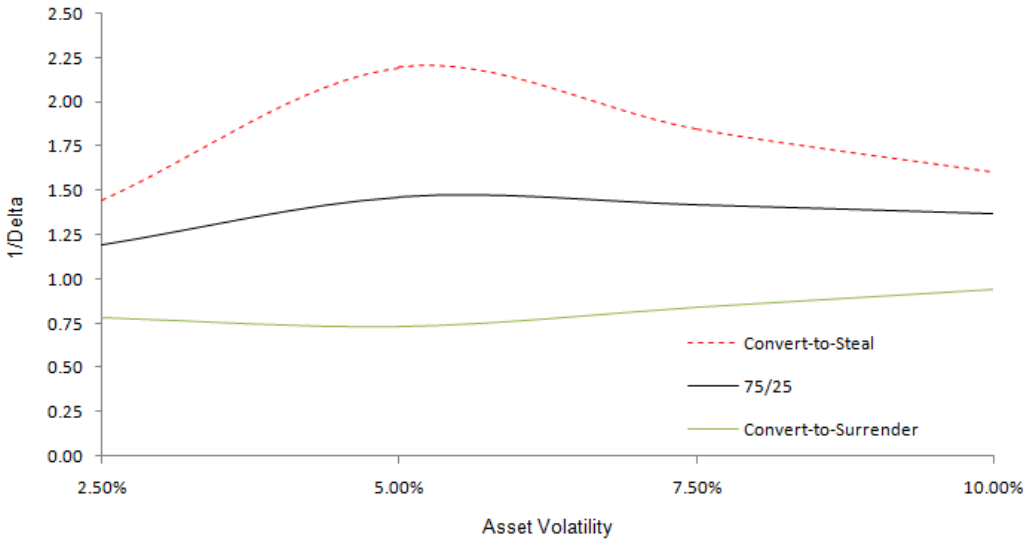

Figure 6: Debt overhang problem I. Inverse of the Delta of the equity value as a function of the asset volatility close to the trigger point for all three cases (Convert-to-Steal, Convert-to-Surrender and the case without CoCo-Bonds) and a "75/25" case. The case "75/25" represents a case where equity holders own 75% of the net wealth after conversion. Other parameter values are: $V_0 = 96$ (=1PP above the trigger of $TP = 95$), $r = 5\%$, $N_{Debt} = 85$, $N_{CoCo} = 5$, $TP = 95$ and $T = 0.25$.

Debt overhang problem. Inverse of the Delta of the equity value as a function of the asset value for all three cases (Convert-to-Steal CoCos, Convert-to-Surrender CoCos (CoSu-Bonds) and the case without CoCo-Bonds). Other parameter values are: $r = 5\%$, $N_{Debt} = 85$, $N_{CoCo} = 5$, $TP = 95$ and $T = 0.25$.

4 Real-life examples: Lloyds, Rabobank, Credit Suisse

Background on CoCo-Bond issuances:
So far three major banks have issued CoCo-Bonds. A summary of these issuances can be found in table 2. Lloyds issued Enhanced Capital Notes (ECNs) with a total notional of GBP 8.3bn in November 2009 via a (forced) conversion of subordinated debt.[19] The issue was split into several series with maturities ranging from 10-23 years and coupons ranging from 6.385%-16.125%. The ECNs convert to equity if Lloyds Core-Tier-1-ratio (CT1-ratio) drops below 5% and thereby immediately raise the CT1-ratio by 2.0 percentage points. ECN holders will receive a total of 13.6bn shares on conversion which is equal to 17% of the after-conversion total shares outstanding.

[19] These numbers are taken from the exchange offer publication (LLoyds Banking Group (2009)) and Lloyds annual report 2010. In some of Lloyds presentations two other Tier-2-issuances are sometimes subsumed under the label "ECN" bringing the total notional to GBP 9.0bn. As these Tier-2-issuances are not convertible to equity we do not treat them as CoCo-Bonds here.

Rabobank issued Senior Contingent Notes (SCNs) in March 2010 to institutional investors. These SCNs have a notional of EUR 1.25bn, a coupon of 6.875% and a maturity of 10 years. If the bank's equity ratio[20] falls below 7% these SCNs will be written off by 75% and the reamining 25% (EUR 0.31bn) are immediately due. In a strict sense, they are therefore not pure CoCo-Bonds but forms of bail-in capital because they do not convert to equity.[21] However, since they also impose losses on SCN holders in a going-concern scenario these notes are usually subsumed under the label CoCo-Bond.

Credit Suisse followed in February 2011 with an announcement of issuing CHF 6.0bn[22] of Buffer Capital Notes (BCN) in an exchange for Tier-1 capital notes to Qatar Holding LLC and The Olayan Group (a Saudi Arabian conglomerate with a large investment unit) and an additional USD 2.0bn to institutional investors. The CHF 6.0bn issue carries a coupon of 9.0-9.5%. It is a forward issue which will not be not be settled before October 2013. The latter USD 2.0bn issue carries a coupon of 7.875% and has a maturity of 30 years. These notes were issued to fulfill the requirements by the Swiss regulator FINMA and count as high trigger contingent capital. These two BCNs will convert into equity at CHF 20 per share and BCN noteholders would own an aggregate of 30% of the outstanding shares after conversion.

Wealth transfer at conversion:
We have established in the last section that the key determinant for the influence of CoCo-Bonds on incentives is the existence and magnitude of a wealth transfer at conversion. How large is the wealth transfer in case of the four CoCo-Bonds issued by Lloyds, Rabobank and Credit Suisse? In general this wealth transfer can be determined as the difference between i) the notional value of the CoCo-Bond and ii) the value of the shares that CoCo-Bond holders receive at conversion:

$$WT = N_{CoCo} - \%SharesCoCo \cdot MCap@Conversion, \tag{9}$$

where WT denotes the wealth transfer, N_{CoCo} the notional of the CoCo-Bonds, $\%SharesCoCo$ the percentage of outstanding shares owned by the CoCo-Bond holders after conversion and $MCap@Conversion$ denotes the market capitalization after conversion has taken place. It is important to note that wealth transfer refers to the differences in payoff directly above and directly below the trigger point. Since market participants will anticipate this wealth transfer, prices will already reflect the likelihood of such a wealth transfer before conversion.

[20] The equity ratio is roughly defined as the bank's balance sheet equity capital divided by the risk weighted assets. It is usually slightly higher than the core Tier-1 ratio because core Tier-1 capital includes certain deductions from the balance sheet equity capital.

[21] Rabobank is not publicly listed which is probably one reason why Rabobank chose not to make these CoCos convertible into equity.

[22] The issue actually consists of CHF 2.5bn and USD 3.5bn. To avoid further complexity and because USD and CHF had an exchange rate of close to one at issuance date we subsume these under one issue of CHF 6.0bn.

	Lloyds	Rabobank	Credit Suisse 1	Credit Suisse 2
Name	ECN (Enhanced Capital Notes)	SCN (Senior Contingent Notes)	BCN (Buffer Capital Notes)	BCN (Buffer Capital Notes)
Issue Date	Nov-09	Mar-10	Feb-11 / Oct-13	Feb-11
Currency	GBP	EUR	CHF/USD	USD
CoCo notional	8.3bn	1.25bn	6.0bn	2.0bn
Core-Tier 1 capital (CT1) as of Dec 2010	41.4bn	31.2bn	26.6bn	26.6bn
CoCo notional in % of CT1 capital	20%	4%	23%	7%
CoCo notional in % of RWA	2.0%	0.6%	2.7%	0.9%
Coupon	6.385% - 16.125%	6.875%	9.0-9.5%	7.875%
Maturity	10-23 years	10 years	na	30 years
Trigger	CT1 / RWA < 5%	Equity / RWA < 7%	CT1 / RWA < 7% + FINMA discretion	CT1 / RWA < 7% + FINMA discretion
%SharesCoCo	17%	na	20%	8%
Shares outstanding as of Dec 2010	68.1bn	na	1.2bn	1.2bn
Shares CoCo after conversion	14.0bn	na	0.3bn	0.1bn
Conversion price	0.59	na	20.00	20.00
Notional	8.3bn	na	6.0bn	2.0bn

Table 2: Overview of recent CoCo-Bond issues. $CT1$ denotes Core Tier-1 Capital, RWA denotes risk weighted assets, $FINMA$ stands for the Swiss Financial Market Supervisory Authority and "%SharesCoCo" denotes the number of shares that CoCo-Bond holder receive at conversion divided by the total number of outstanding shares after conversion.

N_{CoCo} and $\%SharesCoCo$ can be determined directly from the respective prospectus and are reported in table 2. $MCap@Conversion$ has to be estimated. We make the simplifying assumption that the equity value moves one-to-one with the regulatory capital and that risk weighted assets do not change, i.e. changes in capital ratios are only due to changes in capital. For example, if today's capital ratio is 10% and the trigger is 5% we assume that the equity value directly before conversion will also be half of today's equity value, excluding gains from the likelihood of conversion. This back-of-the-envelope calculation is likely to be conservative. First, market values usually decline faster and sooner than Tier-1-ratios due to the stickiness of accounting ratios. Second, accounting ratios are not observed in continuous time so that the Core-Tier-1 ratio at conversion is likely to be lower than 5%. Therefore, these assumptions provide a lower limit for the wealth transfer at conversion. Using these assumptions the market capitalization after conversion can be determined as

$$MCap@Conversion = MCap_{today}\frac{TriggerRatio}{Ratio_{today}} + N_{CoCo},$$

where $MCap@Conversion$ denotes the market capitalizsation directly after converions, $MCap_{today}$ denotes the market capitalization today, $TriggerRatio$ denotes the capital ratio which triggers conversion[23], $Ratio_{today}$ denotes the value of the respective ratio tody and N_{CoCo} denotes the notional of the CoCo-Bond. Finally, we set the wealth transfer in relation to both the notional of the CoCo-Bonds (to get an indication of the loss that CoCo-Bond holders will experience at conversion) and in relation to the equity value directly above the trigger.

For example, we get the following results for the Lloyds CoCo-Bonds (cf. table 3): The current market capitalization (as of Dec, 31st, 2010) of Lloyds is GBP 44.7bn and the Core-Tier-1-ratio is 10.2%. Our rough estimate of the combined market value of current equity capital and ECNs at the trigger point is 5%/10.2%· 44.7bn + 8.3bn = 30.2bn. Hence, the 17% share of the ECN holders will be worth approximately GBP 5.1bn – which is a 38% discount on the nominal value and 14% of the equity value directly above the trigger. The wealth transfer in percent of the CoCo notional is larger for the Rabobank CoCo-Bond (75%). Because the Rabobank issue is smaller in size, the wealth transfer is smaller in percent of the equity capital and therefore the incentive effects are larger for the Lloyds CoCo-Bond. The interpretation of the wealth transfer in the Credit Suisse case is more subtle. The core Tier-1 ratio needs to decline by 42.6% (=1-7.0/12.2) in order to hit the trigger. Assuming a 42.6% deline in equity value results in a post-conversion equity value of CHF 31.6bn and leads in a pro-forma value of CHF 6.4bn (CHF 2.1bn) for the first (second) issue which is even slightly above the notionals of CHF 6.0bn (CHF 2.0bn). Since such a wealth transfer to CoCo-Bond holders is explicitly ruled out in the prospectus, no wealth transfer at all would take

[23]This ratio is the core Tier-1 ratio in case of Lloyds and Credit Suisse and the equity ratio – a simpler measure which is roughly equal to balance sheet equity capital divided by risk-weighted assets – in case of Rabobank.

place. Since our assumptions are conservative, we would in reality still expect a wealth transfer to equity holders at conversion because the sensitivities are rather large. As a point of reference, if we assume that the decline in the regulatory ratio by 42.6% leads to a decline in the equity value by 60% the combined wealth transfer is already larger than 20% of the CoCo-Bond notional and approximtely 10% of the equity value dirctly above the trigger. In all three cases we would likely see a wealth transfer from CoCo-Bond holders to equity holders which exceeds 10% of the equity value directly above the trigger. This value of 10% is therefore taken as a reference point for the following discussion.

What does that mean for incentives? First of all, if one of these banks is close to the trigger an increase in equity value of 10% is a worse outcome than a decrease of 1% and a subsequent conversion of CoCo-Bonds into equity. This numbers suggest that generating stable positive profits is not in the interest of shareholders anymore in times of a crisis and risk-shifting is very likely to happen. Even worse, there is a huge disincentive for shareholders to recapitalize the bank on their own. Directly above the trigger point an injection of new funds equal to 10% of the market capitalization will have the same effect in terms of the old shareholders wealth as losing another pound and subsequently hitting the trigger. Roughly speaking, the first 10% of a recapitalization in times of distress (in percent of the prevailing market capitalization) are sunk costs for old shareholders. This injection of funds therefore has to be hugely profitable, otherwise equity holders will refrain from recapitalizing their bank. Given that regulatory capital ratios are slowly moving this is likely to result in long period of underinvestment also with likely effects on the credit supply.

A more detailled assessment of the Lloyds issuance:
In the following, we will analyze the incentive effect of the Lloyds issue in more detail. We thereby make the following assumptions:

- Assumptions as in section 3 (Merton framework and main parameters).
- The maturity is set equal to 0.25, i.e. a quarterly observation of the trigger event.
- Changes in the Tier-1-ratio can only be induced by gains/losses (no change in RWA via increased/decreased business volume, no changes in average risk weight, no new equity issuance, etc.).
- The market value of equity moves one-to-one with the core-Tier-1-capital. E.g. if the CT1-ratio drops from 9% to 8.1% (i.e. by 10%), then the market value of equity will also drop by 10%.
- All values are as of Dec, 31st, 2010.

	Lloyds	Rabobank	Credit Suisse 1	Credit Suisse 2
A1: Trigger ratio	5.0%	7.0%	7.0%	7.0%
A2: Ratio as of Dec 2010	10.2%	14.2%	12.2%	12.2%
A3: Fraction (=A1/A2)	49.0%	49.3%	57.4%	57.4%
B1: Market Cap as of Dec 2010	44.7bn	31.2bn	44.7bn	44.7bn
B2: Market Cap at Trigger + ε (=B1·A3)	21.9bn	15.4bn	25.6bn	25.6bn
B3: Notional CoCo-Bonds	8.3bn	1.25bn	6.0bn	2.0bn
B4: Market Cap at Trigger - ε (=B2+B3)	30.2bn	16.6bn	31.6bn	27.6bn
C1: %SharesCoCo	17%	na	20%	8%
C2: Value of CoCo after conversion (=C1·B4)	<5.1bn	0.3bn	<6.4bn	<2.1bn
C3: Wealth transfer to shareholders (=B3-C2)	>3.2bn	0.9bn	>0bn	>0bn
in % of CoCo-Bond notional (=C3/B3)	>38%	75%	>0%	>0%
in % of Market Cap at Trigger + ε (=C3/B2)	>14%	>6%	>0%	>0%

Table 3: Wealth transfer at conversion for recent CoCo-Bond issues. Values for Lloyds are in GBP, for Rabobank in EUR, for Credit Suisse 1 in CHF and for Credit Suisse 2 in USD. "%SharesCoCo" is taken from table 2 and denotes the number of shares that CoCo-Bond holder receive at conversion divided by the total number of outstanding shares after conversion.

- We use a "Risk-weighted balance sheet", meaning that we use the RWAs of GBP 406.4bn as a proxy for the assets and the amount of Core Tier-1 capital (GBP 41.4bn) as a proxy for equity. The trigger of a 5% Core Tier-1-ratio therefore translates into a loss of GBP 20.3bn ((41.4-20.3)/406.4=5%). From table 2, we use a notional of the CoCo-Bonds of GBP 8.3bn and a fraction of 17% of the after-conversion equity which is owned by the CoCo-Bond holders.

Figure 7 depicts both the magnitude of the asset substitution problem (left-hand picture) as well as the magnitude of the debt overhang problem (right-hand picture). We observe two main results: First, the ECNs are very close to the Convert-to-Steal case from an incentive point of view. Second, both the asset substitution problem and the debt overhang problem are significantly magnified. Due to the ECNs, equity holders have a significant interest in increasing the riskiness of the portfolio. An increase of the asset volatility by 1 percentage point translates into an increase in equity value of up to 1% if the company is close to the trigger point. Not less worrisome is the debt overhang problem: An increase in NPV of up to USD 1.20 per USD 1 investment is needed to make it beneficial for equity holders to inject more capital.

All these numbers are certainly lower bounds. First, we have made a very conservative assumption that in times of financial distress share prices only fall by the same amount as the regulatory capital ratios. If share prices decline earlier and sharper then the wealth transfer at conversion is even larger which further exacerbates both the asset substitution and the debt overhang problem. Second, Lloyds has only GBP 8.3bn of CoCo-Bonds outstanding compared to RWA of GBP 406.4bn (approximately 2%). If regulators force banks to hold larger amounts of CoCo-Bonds of the

Convert-to-Steal-type the incentive to "gamble for resurrection or conversion" and the disincentive to raise new equity in times of distress will be further aggravated. All these numbers are certainly lower bounds. First, we have made a very conservative assumption that in times of financial distress share prices only fall by the same amount as the regulatory capital ratios. If share prices decline earlier and sharper then the wealth transfer at conversion is even larger which further exacerbates both the asset substitution and the debt overhang problem. Second, Lloyds has only GBP 8.3bn of CoCo-Bonds outstanding compared to RWA of GBP 406.4bn (approximately 2%). If regulators force banks to hold larger amounts of CoCo-Bonds of the Convert-to-Steal-type the incentive to "gamble for resurrection or conversion" and the disincentive to raise new equity in times of distress will be further aggravated.

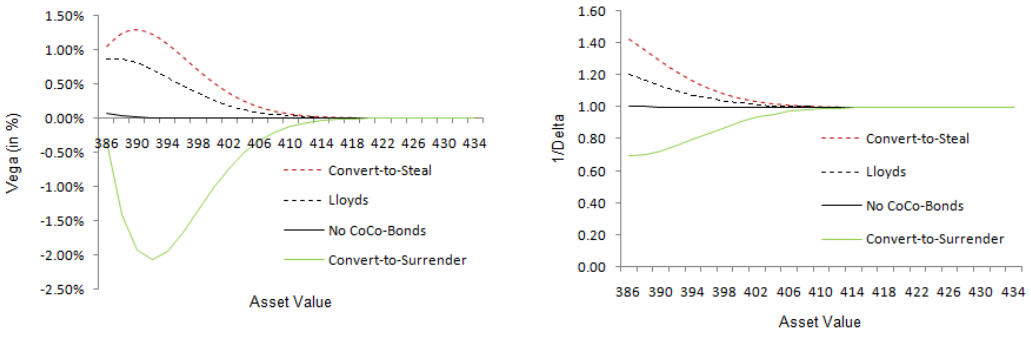

Figure 7: Asset substitution and debt overhang problem for Lloyds. Left-hand picture: Vega of LLoyds equity value as a function of the assets value. Right-hand picture: Inverse of the Delta of Lloyds equity value as a function of the asset value. The respective values for Lloyds equity holders are depicted with a black dotted line. The values for the Convert-to-Surrender case, the Convert-to-Steal case and the case without CoCo-Bonds are depicted for reference. Other parameter values are: $r = 5\%$. $\sigma = 5\%$ and $T = 0.25$.

5 Policy discussion

What is the impact of CoSu-Bonds on the capital raising capabilities?
Conditional convertible capital has the appealing advantage that the issuer can increase her capital whenever she is in financial distress. Obviously, such an instrument could be particularly interesting for stabilizing the financial system. This is a major reason why CoCo-Bonds are considered as a new regulatory capital component for banks. Even though it seems that CoCo-Bonds and CoSu-Bonds share this feature, the impact of these two instruments on capital raising capabilities is truly different. In fact, CoSu-Bonds improve the capital raising capabilities of a bank in a much sounder way as CoCo-Bonds do. For a better understanding of this argument the following should be noted: In this paper we have shown that CoCo-Bonds increase the debt overhang problem. As shareholders gain or, at least, do not lose from conversion, they do not have any incentive to avoid conversion.

Hence, in a crisis situation shareholders have a strong incentive to wait until conversion is triggered. Afterwards capital will be increased, first because of conversion, and second because there might also be an offering of new stocks. If the bank has issued CoSu-Bonds the opposite is true. As shareholders lose from conversion, they have any incentive to avoid it and, as a consequence, are more inclined to increase equity before conversion is triggered. It is obvious that in a crisis situation avoidance of mandatory conversion should have a stabilizing effect on market stability. Therefore, the difference as to whether a capital increase takes place before or after conversion is not negligible.

What is the impact of CoSu-Bonds on risk-taking incentives?
As far as risk-taking incentives are concerned, CoSu-Bonds have two appealing features compared to CoCo-Bonds: First, we have shown that under a wide range of parameters the existence of CoSu-Bonds eliminates the asset substitution incentives for bank owners. In fact, bank owners profit from reducing – and not from increasing – the bank's asset volatility, i.e. they are short in asset volatility. Second, they are still long in the bank's asset value, i.e. they profit from any increase in the present value of future cash flows. Hence, we argue that CoSu-Bonds are an appealing instrument not only for having an additional equity buffer under conditions of distress, but also for mitigating the risk shifting problem. As we have shown with the examples of Lloyds, Rabobank and Credit Suisse, current CoCo-Bonds are structured in a way that they even increase the risk-taking incentives for bank owners.

What is the impact of CoSu-Bonds on the managers' incentives?
In this paper we have analyzed the impact of CoSu-Bonds on the risk-taking incentives of bank owners. There was no formal analysis of the impact on the risk-taking incentives of bank managers. This is, of course, an important issue that must be left for further research. The crucial question is how risk-taking incentives generated by stock options, or similar instruments, are changed, if CoSu-Bonds are introduced. We do not yet know exactly how these incentives would be influenced. However, it is obvious in any case that risk-taking incentives generated by stock options will be mitigated. Whether and under what specific conditions they can even be eliminated has to be left open at this point. But shareholders can only be expected to set the right incentives for the management, if their own incentives are compatible with the goal of a stable banking system.

Will banks issue CoSu-Bonds voluntarily?
Most probably not. First of all, the existence of a CoSu-Bond makes default for equityholders more likely. Hence, introducing a CoSu-Bond leads to a redistribution of wealth from incumbent shareholders to CoSu-Bondholders and holders of straight debt. However, as far as the redistribution towards CoSu-Bondholders is concerned, this might not be a problem. As long as CoSu-Bonds are issued on the basis of preemptive rights attached to stocks, no redistributions occurs. Redistribution towards holders of straight debt, however, cannot be avoided. But this objection would also apply

to any regulatory intervention towards lifting capital ratios. Second, for systemically relevant institutions there is also a transfer of wealth from stockholders to the taxpayer, as CoSu-Bonds make government subsidizes for systemically relevant institutions less likely. Third, to the extent that the bank managers own stock options – or other similar instruments – there would be a transfer of wealth from managers to all other stakeholders. Fourth, as long as there is not a developed market for CoCo- or CoSu-Bonds, the issuance is encumbered with several imponderables. It is unlikely that the management of a bank would deliberately expose themselves to such a risky and most probably costly undertaking.

Nevertheless, it should be noted that CoSu-Bonds would also have positive effects on shareholders. First, the probability of bankruptcy is reduced and, hence, the expected present value of bankruptcy cost will be lowered. Second, implementing a mechanism that reduces the risk-taking incentive lowers the agency cost of debt. To this extent, the bank's net interest income increases making the bank more valuable. Third, to the extent that CoSu-Bonds are a substitute to equity, a positive tax-shield effect should be realized.

Therefore, under the hypothetical situation of defining a de-novo capital structure, it could well be that CoSu-Bonds would be a part of it. Under an existing capital structure this is much more difficult. In fact, for the time being there are just a very few real life examples of banks issuing contingent convertible debt. In all of these cases a CoCo-Bond structure was chosen instead of a CoSu-Bond structure. Given our analysis, this is not surprising.

How to implement CoSu-Bonds from a regulatory perspective?
Starting from 2019 all banks subject to the Basle accord are expected to have a minimum total capital ratio of 8.0%, a minimum tier-1 capital ratio of 6% and a minimum common equity capital ratio of 4.5%.[24] Regulators now could implement two simple additional rules: First, banks are allowed to provide tier-2 capital in form of CoSu-Bonds. Second, under the condition that the equity capital ratio by the end of any quarter falls below a given ratio, conversion becomes mandatory. This trigger point, of course, should be at least 4.5%; it could make sense to set it even higher. If regulators decide to force systemically relevant banks to have even higher capital ratios, this could easily be handled within these two rules. As all new rules regarding the minimum capital standards are finally implemented after a transition period lasting until 2019, there should be sufficient preparation time for market participants.

Finally it should be noted that the Swiss Government proposed to increase the total capital ratio of UBS and Credit Suisse to 19%. Up to 9 percentage points can be raised via issuing CoCo-Bonds with a trigger set at a 7% resp. 5% common equity ratio. According to this proposal, banks are free

[24] In addition, a quasi-mandatory capital buffer of 2.5% is required for all three ratios.

to choose the details of how to determine the conversion price. A selective, non-global introduction of capital standards is, however, always prone to regulatory arbitrage (Moshirian (2011)). As argued by Moshirian (2008), in the light of financial globalisation, regulation can only be effective with efficient international rules and institutions. Given that contingent capital can potentially limit the too-big-to-fail guarantees, removing this subsidy in some but not all countries can potentially distort international competition.

Should banks have the choice between issuing CoCo-Bonds or CoSu-Bonds?
Basically, it could be argued that the regulator just recognizes CoCo-Bonds as a part of tier-2 capital. It is then up to the banks whether to issue such bonds and how to structure them. If they like, they could set the conversion price extremely low, making the Coco-Bond very similar to a CoSu-Bond. They could, however, also do the opposite, making the CoCo-Bond a Convert-to-Steal bond. According to what we have discussed in this paper, the regulator should not grant this freedom to the bank. In fact, if the conversion price of the CoCo-Bond is too high, risk-taking incentives at the side of bank-owners are even enforced as compared to the situation without any CoCo-Bonds. The same is true as far as the debt overhang problem is concerned. Hence, unrestricted CoCo-Bonds could increase the instability of the financial system instead of reducing it. This is particularly worrying as the perverse risk-taking incentives with classical CoCo-Bonds are highest in case of financial distress.

Should the issuance of CoSu-Bonds be mandatory?
This is, of course, a crucial question. Taking most of the pertinent discussions CoCo-Bonds most likely will soon be accepted as a substitute to (tier-2) capital by financial authorities. However, it is unlikely that their issuance will be considered as being mandatory. The basic idea behind this is that the capital structure is the outcome of a complex bargaining process, where the cost of equity (including agency cost) is traded-off against the cost of debt (including agency cost as well). Any restriction set by a regulatory authority would therefore distort this process and, hence, generate a deadweight loss.

This consideration, however, neglects path dependency and market failures in corporate governance systems. Even though CoSu-Bonds may be an attractive instrument for mitigating the asset substitution and debt overhang problem, their first implementation is, as we have already mentioned, encumbered by substantial imponderability. Moreover, bank managers have only weak incentives to implement these instruments. Therefore, it is a serious concern from a social perspective whether the regulator should leave the decision about issuing CoSu-Bonds to the discretion of the banks and their management.

Are CoSu-Bonds subject to price manipulations?
According to some proposals made in the literature (cf. e.g. Flannery (2002)) the trigger point

of CoCo-Bonds is determined on the basis of the market value of the bank's equity. In this case, however, it can be shown that multiple equilibria exist (cf. Sundaresan and Wang (2010)), unless the construction of CoCo-Bonds does not obey to some specific characteristics. Even though this is a technical argument, concerns have been raised that CoCo-Bonds could create strong incentives for price manipulation. To put it very simple, either equity holders (if a wealth transfer to equity holders takes place) or CoCo-Bondholders (if a wealth transfer to CoCo-Bond holders takes place) have an incentive to depress the bank's stock price, e.g. by short-selling the stock. Without going too much into detail, we would like to point out to two issues here: First, the triggers applied so far (e.g. in the Lloyds, Rabobank and Credit Suisse case) are usually determined on the basis of accounting figures, so with these trigger events conversion can never be forced via any type of price manipulation on the market. However, setting a trigger based on accounting ratios comes at a cost. The assessment of whether the trigger point is reached is left to the bank management, most probably in cooperation with the financial supervision authority. This makes the mandatory conversion subject to window dressing or even criminal behavior. It cannot be ruled out that this causes serious mistrust on the side of investors making the market for these bonds potentially collapse.

But even if the trigger would be set based on the market price, we think that price manipulations of this type will be rare due to two reasons: First, CoCo- or CoSu-Bonds would be required for systemically important financial institutions. Their pure size and market capitalization will make price manipulations hard to succeed. Second, the usual price manipulation arguments only work under the assumptions that the intrinsic value of the company is unaffected by the price manipulation. For banks, this is certainly not the case since financial distress by itself causes heavy costs for a bank. This reduces or even eliminates incentives to profit from manipulating the price of a bank's stock. In addition, there is a simple trick in the Convert-to-Surrender case of how to ensure unique equilibria: By giving equity holders the option to raise sufficient new equity when the trigger is hit – and thereby circumventing conversion – CoSu-Bond holders can no longer profit from manipulating the stock price while the benefits from reduced risk-taking incentives remain. A similar argument can also be found in Pennacchi et al. (2010).

6 Conclusion

In the aftermath of the financial crisis conditional convertible bonds (CoCo-bonds) gained a lot of attention by academics as well as regulators. Typically, these bonds are constructed as convertible debt with the specific characteristic that conversion into stocks does not take place at the discretion of bondholders but is mandatory once the bank's equity falls below a prespecified trigger point. This mechanism is appealing, as it makes sure that banks can increase their equity exactly in the situation when this is most important. Without such CoCo-Bonds, it is further argued, it would be extremely difficult for a bank to increase equity under circumstances of individual or even systemic

distress.

In this paper we looked at this conversion mechanism of CoCo-Bonds in more detail and showed that it is encumbered by three serious problems. First, if the conversion price is set defectively, CoCo-Bonds may enforce the already existing risk-taking incentives of bank owners. In the context of a Merton structural model with a set of reaonable parameters we showed that the equity value will increase by more than 2% for a 1 percentage point increase in asset risk close to conversion. This is a factor of 5-10 compared to a situation without CoCo-Bonds. Second, the debt overhang problem could also be exacerbated with the issuance of CoCo-Bonds. Again, for a set or reasonable parameters, we show that one needs at least USD 1.20 of NPV in order to attract a USD 1 equity investment close to conversion. Third, by generating this barrier for issuing new equity before conversion, the market mechanism of selecting viable banks for recapitalization is undermined. Of course, all of this is bad news for the stability of the banking system, as the existence of CoCo-Bonds could increase risk-taking incentives beforehand, making the occurrence of a crisis more likely, and hamper efficient recapitalization afterwards.

In this paper we have shown that the crucial driver for these effects is the conversion price. Loosely speaking, as long as the conversion price is set in a way that conversion generates a redistribution of wealth from debtholders to shareholders, these unintended incentive effects arise. We show that all CoCo-Bonds that have been issued so far (LLoyds, Rabobank, Credit Suisse) are designed in such an incentive-distorting way. We have proposed a new way to eliminate the debt overhang problem and simultaneously implementing a risk-reducing incentive for bank owners. More specifically, we propose an instrument we label Convert-to-Surrender-Bonds (CoSu-Bonds), a special type of a contingent convertible bond.

We suggest that the conversion price should be set in a way that it induces a redistribution of wealth from equity holders to debtholders. As an extreme case, one can think of a conversion price of zero. In that case CoSu-Bondholders would take over the bank once its equity ratio falls below a critical level triggering conversion. Former shareholders would lose all their stakes in the company. CoSu-Bonds therefore eliminate the asset substitution problem. Under a wide range of reasonable parameters, we show that a 1 percentage point increase in asset risk reduces equity value by more than 1% close to the conversion point. Moreover, the debt overhang problem is mitigated, too. A USD 1 equity investment immediately before conversion becomes profitable even when the NPV of this investment is only USD 0.8. Therefore, while CoCo-Bonds hinder recapitalization, CoSu-Bonds generate incentives to recapitalize viable banks in an early stage in the run-up to a financial crisis.

A Pricing and Greeks for contingent capital

The price of a European call option (C) and a European binary call option ($DigC$) can be determined as:

$$C = V_0 e^{-rT} N(d_1) - K e^{-rT} N(d_2) \quad (10)$$

$$DigC = e^{-rT} N(d_2) \quad (11)$$

with

$$d_1 = d_1(K) = \frac{ln(V_0/K) + (r + 1/2\sigma^2 T}{\sigma\sqrt{T})}$$

$$d_2 = d_2(K) = d_1(K) - \sigma\sqrt{T}$$

The corresponding derivations with respect to the asset value V_0 and the volatility σ are:

$$\frac{\partial C}{\partial V_0} = N(d_1) \quad (12)$$

$$\frac{\partial C}{\partial \sigma} = V_0\sqrt{T}N'(d_1) \quad (13)$$

$$\frac{\partial DigC}{\partial V_0} = \frac{e^{-rT}N'(d_2)}{\sigma V_0\sqrt{T}} \quad (14)$$

$$\frac{\partial DigC}{\partial \sigma} = -\frac{e^{-rT}d_1 N'(d_2)}{\sigma} \quad (15)$$

where

$$N'(x) = \frac{1}{\sqrt{2\pi}} e^{-1/2x^2}$$

Applying (10)-(15) to (1) and (2) yields (3)-(8).

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