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Removing Moral Hazard and Agency Costs in Banks: Beyond CoCo Bonds

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Removing Moral Hazard and Agency Costs in Banks: Beyond CoCo Bonds

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Abstract

The convex payoffs for equityholders in a corporate structure results in agency costs and moral hazard problems. The implicit government guarantee for banks accentuates these. We believe that the Basel III related bail-in contingent convertible (CoCo) structures do only not solve these problems, but may even aggravate them. In this paper we suggest solutions. The first is to replace the currently issued writedown/off and equity-conversion CoCo structures with a market-price equity-conversion CoCo bonds. This mirrors the full dilution effect of an ordinary equity raise in a distressed situation to reduce incentives for high risk-taking by equityholders. The second is to establish a Contingent Equity Base that replaces the incumbent shareholders once the CoCo is triggered. This will finally remove the perverse risk-taking incentives. The valuation of the CEB is then suggested.

JEL Classification: D82; G21; G28; G32

Keywords: CoCo bond; agency costs; moral hazard; bail-in; cost of equity

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1. Introduction

When a bank's solvency is deteriorating the bank usually has three options: issue equity, hoard capital by suspending dividends and share repurchase, or delever (decrease assets). The last of these usually comes with pernicious and counterproductive consequences for the economy as the bank freezes lending and curtails investments that dents the ordinary financing of companies and households. Equity issuance has its problems due to the potential lack of support of both equity insiders and outsiders; given the distressed financial situation of the bank, unless it finds the internal support from its equityholders base to raise the necessary equity at the current share price the bank would have to raise equity, and only if the market still has the appetite for it, at discount levels to secure enough interest. For these reasons, banks are now required to hold some types of contingent capital that automatically and seamlessly converts into equity to restore the solvency once the bank enters into a financial distress phase.

However the new Basel III related bail-in structures, namely contingent convertible (CoCo) bonds, come with implicit problems of agency costs. There are broadly two types of agency costs, the wealth transfer and the value destruction problems. The former arises from the convex nature of equityholders' payoffs, where whilst they gain from the potential upside from any uncertain projects or investments, their loss is limited to a level guaranteed by the bail-in-able bondholders. This is equivalent to a put option written by the guarantor. The problem arises as here the holders of the option (the equityholders) have the decision-making right to select the riskiness of the business (akin to the option holders being able to choose the volatility of the underlying asset), meaning that they would rationally choose higher risk investments. This results in a wealth transfer from the guarantor to the equityholders via higher option value. The value destruction problem refers to the negative externality associated with equityholders' decision; they would choose to undertake projects that have positive net present value (NPV) for them, even if it has a negative NPV for the bank as a whole. An extreme case of this is "gamble-for-resurrection". These agency costs are present even in a traditional Absolute Priority Rule (APR)[1], as pointed out in Jensen and Meckling (1976) amongst others, while Eberhart and Senbet (1993) investigated the incentive issues associated with the Deviation from the Absolute Priority Rule (DAPR)[2], which they considered to be an implicit feature of bond contracts. CoCo bonds were first proposed by Flannery (2005) - originally termed "Reverse Convertible Debentures (RCD)" - to formally incorporate DAPR in banking structures. Hori and Martin Cerón (2014) investigated the pay-off profiles of CoCo structures in detail, and established that the bail-in structures are equivalent to a "CoCo condor" structure written by the bondholders and held by the equityholders, i.e. an additional sale of options by the former to the latter. They concluded that the Basel III proposal aggravates the agency costs as a result.

Similarly, in the traditional (pre-Basel III) set-up there are moral hazard issues associated with both bondholders and equityholders. In the presence of inherent government bail-out, bondholders shirk in their monitoring effort of equityholders' behaviour. In turn, equityholders also take sub-optimally high level of risk due to the guarantee. It was pointed out in Hori and Martin Cerón (2015) that the CoCo bail-in structures simply shift the bondholders' moral hazard problem to the equityholders' and not eliminate it, where the source of moral hazard is replaced from the implicit government bail-out by more explicit bondholders bail-in. The paper showed that enforcing higher cost of capital, by means of ratchet covenants (while the solvency is still high) or asset / debt sweep covenants (when

[1] Where equityholders bear all the loss before the bondholders.

[2] Where bondholders start bearing some of the losses before the equityholders are wiped out.

close to the CoCo trigger level or the point of non-viability (PONV)), would reduce the equityholders' incentive for moral hazard. It is, however, very possible that this moral hazard is aggravated due to the new Basel III bail-in structures. This is because, as opposed to taxpayer bail-out, with bondholder bail-in there would be a lack of media scrutiny and the resulting reputational impact, and less vigorous (or even no) restrictions on dividend payouts or bankers' compensations, meaning that banks would find it easier to be bailed-in by bondholders than be bailed-out by taxpayers.

In this paper we suggest two ways to mitigate both the agency cost and moral hazard problems. The first is to improve the currently established CoCo structures. We argue here that the now commonly issued writedown/off CoCo bail-in bonds, when triggered, lead to a large wealth transfer from bondholders to the equityholders and should not be implemented at all. On the other hand the equity-conversion CoCos are equivalent to non-admissible debt-to-equity swap (NADES) (see Hori and Martin Cerón (2014)), which, compared to ordinary debt-to-equity swaps, favours equityholders by pre-setting the terms of conversion (in particular, the conversion price). We show here that a conversion price which is above the level expected for a bank in distress has an effect of partially offsetting the dilution effect of equity-conversion. Instead we suggest a *market-price equity conversion CoCo bonds*, which mirrors the dilution of an ordinary equity raise in a distressed situation. Contrary to the share price-linked CoCo trigger suggested by Sundaresan and Wang (2015) where the trigger is not based on solvency but on the level of share price, hence giving the market the discretion to force the CoCo trigger, our proposal encourages equityholders to take preemptive actions as the solvency deteriorates and the share price becomes depressed. More specifically, should the market turn very negative on the share price for fundamental or speculative reason, with our proposal the equityholders will have the incentive to raise equity before the conversion price of the CoCo significantly dilutes them. The second more radical solution is to establish a contingent equityholder base called the *Contingent Equity Base* (*CEB*) that initially sits off-balance sheet, but replaces the incumbent equityholders once the CoCo is triggered or the solvency falls below the PONV. While sitting off-balance sheet the CEB also acts as the contingent capital for a fee to "top up" the bank's solvency ratios such as to fulfill the regulator's requirement for CT1 and T1 ratios. As the bank builds its capital base towards these ratios, the contingent capital is wound down. As will be shown, this proposal would finally remove the "gamble-for-resurrection" and other risk-taking incentives, and encourage the equityholders to undertake monitoring. Several options for the valuation of the CEB are discussed, with the cost of equity suggested as the most appropriate one.

Since Flannery's (2005) proposed RCD, much of the literature has focused on the design and the valuation of the CoCo structures. Sundaresan and Wang (2010), Pennacchi (2010) and Albul, Jaffee and Tchistyi (2013) all consider market-price triggers. Sundaresan and Wang demonstrate that under this design, it does not generally lead to a unique equilibrium for the bank's share price. Albul *et al.* show the conditions under which the equilibrium is unique, while Pennacchi avoid the problem by basing the trigger on the capital ratio that included both the values of equity and CoCo bonds. Prescott (2011) proposes a dual trigger mechanism which also depends on the aggregate systemic risk in the banking sector. Both Berg and Kaserer (2011) and Himmelberg and Tsyplakov (2011) model triggers based on the asset value and investigate different designs (mainly of conversion ratios) of CoCo bonds. Hilscher and Raviv (2011) derive a closed-form solution for the CoCo bond price as a set of barrier options, while Koziol and Lawrenz (2012) and Albul *et al.* (2013) derive at their closed-form solutions using Duffie's (2001) asset pricing set-up. Many of these also investigate the incentive issues, including Pennacchi (2010), Berg and Kaserer (2011), Himmelberg and Tsyplakov (2011) and Koziol and Lawrenz (2012), however in much stylised models. For example Berg and Kaserer (2011) consider the extreme cases of complete writedown ("*Convert-to-Steal*" in the paper) or total expropriation of equityholders' position ("*Convert-to-Surrender*"). In Koziol and Lawrenz (2012), a CoCo trigger results in a coupon default of the CoCo bonds, but no additional capital or dilution of equityholders' holdings result. Additionally in most, conversion or coupon default occur all at once upon trigger. Glasserman and Nouri (2012) consider partial and ongoing conversion. Hori and Martin Cerón (2014) investigate in detail the more realistic trigger profile of partially converting CoCo bonds that attains minimum capital ratio required by the regulator, with the equityholders' position protected at the trigger level as long as the bank is solvent. This paper extends on this analysis by investigating formally the dilution effect of CoCo conversions, and proposes a novel solution to finally resolve the agency costs problem in the banking system.

The paper is organised as follows. In Section 2, we analyse the agency costs associated with both the writedown and equity-conversion CoCo bail-in structures, and argue for the equity market-conversion CoCo bonds as an alternative. In Section 3, we suggest a new Contingent Equity Base that would finally remove the agency costs and moral hazard problems associated with bank structure. In Section 4, we suggest a valuation for the CEB. In Section 5 we discuss the merits and the demerits of our proposals. Finally in Section 6, we give concluding remarks.

2. Market-price Equity-conversion CoCo Bail-in

Currently there exist the following two types of CoCo bail-in bonds:

1. Writedown/off bonds, where the bond principal is written-down or off on a temporary or permanent basis. Here we focus on a structure where the entire bond is written-down at the trigger, where any remaining principal net of the loss is converted into an item within the equity base as Contingent Capital Reserve (CCR) to account for any potential future losses. The ownership of this CCR is here assumed to be transferred to the equityholders.

2. Equity-conversion bonds where the bonds are converted to equity at a preset price.

We argue here that both formats accentuate the wealth transfer problem associated with bail-in structures. Consider first writedown/off bonds. With these, the CoCo bondholders are precluded from any potential future equity upside whilst providing the guarantee on the downside. For example, with a one-off loss (e.g. a rogue trader causing a multi-billion loss) that triggers the CoCos, the bondholders are erased from the balance sheet altogether, while the share price would gradually recover once investors are reassured that the loss is a one-off and would not affect the bank's normalised[3] ROE. Moreover under a falling solvency scenario, the structure encourages free-riding behaviours of the equityholders, and in extreme cases to "gamble-to-resurrect". To see this more formally, consider a bank with an initial asset value of V_0. The bank is funded by equity and bond borrowing. The bonds consist of vanilla bonds with a total face value of F_B and a CoCo bail-in bond with face value F_W. Hence $F = F_B + F_W$. The equityholders' position is then $E_E = V_0 - F$. The

[3]Adjusted for cyclical variations or one-off effects.

conversion is triggered when the CT1 ratio $\frac{V-F}{V}$ falls below τ, which occurs for bank values of $V \leq \frac{F}{1-\tau}$. After the trigger the regulator also insists on a minimum required CT1 ratio of $\underline{E}$, which, for very low V, is assumed to be achieved by a forced one-to-one conversion of the vanilla bond.[4] The details of the payoffs to and the losses of the bondholders and the equityholders for different outcomes of V are given in Appendix A.1. By construction, the writedown bondholders lose everything once the bail-in is triggered, and therefore their payoff is given by,

$$D_W = F_W \chi_{V \geq \frac{F}{1-\tau}} \tag{1}$$

where $\chi_{V \geq \frac{F}{1-\tau}} = \begin{cases} 1 \quad , \quad \text{if } V_T \geq \frac{F}{1-\tau} \\ 0 \quad , \quad \text{if } V_T < \frac{F}{1-\tau} \end{cases}$, is an indicator function. The equityholders' position has a floor at the trigger level, and therefore the value of their original holdings is,

$$E_E = \max \left[V - F, \tau V \right]. \tag{2}$$

Additionally, the equityholders' position is boosted by the newly converted CCR, the value of which is given by (see Appendix A.1 for derivation),

$$E_R = \max \left[(1-\tau) V - F_B, 0 \right] \chi_{V \leq \frac{F}{1-\tau}}. \tag{3}$$

[4] "Under BRRD [Banking Recovery and Resolution Directive], senior unsecured bank debt will become 'bail-in-able' during times of distress from 2016, although some countries have fast-tracked the legislation." *The Financial Times,* "Scene changes on risks and rewards of bank debt", 10th September 2015. Also, "Regulators, seeking to correct what was seen as the perverse immunity bank bondholders enjoyed in the crisis, required senior bank bonds to become 'bail-inable' - meaning they would take losses when banks failed... In the words of one investor, nearly all bank debt had now become coco-like - something engineered by regulators to take losses, albeit after a failure." *The Financial Times*, "New rules, old problems", 31st March 2016.

The total equityholders' position is then,

$$E_E + E_R = (V - F) + \max\left[F - (1-\tau)V, F_W\right]\chi_{V \le \frac{F}{1-\tau}}. \tag{4}$$

We term the second term of (4) the *gains from trigger*. This is clearly positive and take a value of at least F_W, giving the equityholders a perverse incentive to trigger. A numerical example of the payoffs and the losses are also given in Appendix A.1.

Next consider equity-conversion bonds where the CoCo investors end up with a share of the equity capital. This results in a dilution effect for the original equityholders. However, as analysed in detail in Hori and Martin Cerón (2014), the structure is equivalent to a Non-Admissible Debt-to-Equity Swap (NADES), where, as opposed to traditional corporate restructuring proceedings, bondholders are unable to participate in the negotiations of the debt-to-equity exchange.[5] We argue below that when the conversion price is set at a level higher than the book value at the time of conversion, one of the consequences of NADES is that it offsets some of the dilution effect of conversion. Consider again our example bank, but with an equity-conversion CoCo bond with face value F_C, i.e. $F = F_B + F_C$. The conversion is again triggered for bank values $V \le \frac{F}{1-\tau}$, but this time the CoCo bond is partially converted to equity in such a way that the bank's CT1 ratio is restored to a regulator specified minimum required level of $\underline{E}$. Consider for example a bank valued initially at $V_0 = 110$, with $F_B = 80$ and $F_C = 10$. Then the equityholders' initial position is $V_0 - (F_B + F_C) = 20$. Let also $\tau = 7\%$ and $\underline{E} = 10\%$. Then the CoCo conversion is triggered for V below $\frac{F}{1-\tau} = 96.77$. Take the example of $V = 95$, where the bank has incurred a loss of 15. The equityholders take the initial loss up to the trigger level,

[5] In contrast, in an admissible debt-to-equity swap, the bondholders with their bargaining power are able to set favourable bail-out terms, including the conversion price.

i.e. $E_E = \tau V = 95 \times 0.07 = 6.65$, which is a loss of $L_E = 20 - 6.65 = 13.35$ for the equityholders. The CoCo bond is partially converted so that they end up with an equity position that makes up the shortfall between $E_E = \tau V$ and the minimum required level $\underline{E}V$, i.e. $E_C = (\underline{E} - \tau) V = (0.10 - 0.07) \times 95 = 2.85$. The vanilla and CoCo bondholders together hold $(1 - \underline{E}) V = 0.9 \times 95 = 85.5$, so the CoCo bondholders' remaining bond position is $D_C = 85.5 - F_B = 85.5 - 80 = 5.5$. This means that the CoCo bondholders' total position is $D_C + E_C = 5.5 + 2.85 = 8.35$, i.e. they bear the loss of $L_C = 10 - 8.35 = 1.65$. This is the remaining loss after the equityholders' share of 13.35. Further cases of numerical examples are given in Appendix A.2.

Consider now the dilution effect of this. For demonstration, first assume that the market price-to-book ratio is 1, and that the conversion takes place at the book value at the time of trigger. This means that that the theoretical ex-rights price (TERP) is the same as the pre-conversion book value. The original equityholders' position is now reduced to $\frac{E_E}{E_E + E_C} = \frac{6.65}{6.65 + 2.85} = 70\%$, i.e. they are diluted by 30%. More generally, with $E_E = \tau V$ and $E_E + E_C = \underline{E}V$, the equityholders' dilution is restricted to $\frac{\underline{E} - \tau}{\underline{E}}$. However in reality, the equity-conversion CoCo bonds are converted into equity at a pre-specified fixed conversion price. Let this conversion price be ρ. If the number of shares for the original equityholders is N_E, then,

Proposition 1 *The dilution is less than $\frac{\underline{E} - \tau}{\underline{E}}$ for all triggers if*

$$\rho > \frac{F}{N_E} \frac{\tau}{1 - \tau}. \tag{5}$$

Proof. As the CoCo bondholders receive equity of $E_C = (\underline{E} - \tau) V$ upon conversion at the preset price of ρ, they receive N_C shares, where

$$N_C = \frac{(\underline{E} - \tau) V}{\rho}. \tag{6}$$

The proportion of the equity held by the original equityholders post-conversion is $\frac{N_E}{N_E+N_C}$, or equivalently, their holding is diluted by $1 - \frac{N_E}{N_E+N_C} = \frac{N_C}{N_E+N_C}$, which when substituting for N_C is,

$$\text{Dilution } = \frac{(\underline{E} - \tau) V}{\rho N_E + (\underline{E} - \tau) V}. \tag{7}$$

This is less than $\frac{\underline{E}-\tau}{\underline{E}}$ when $\rho > \frac{\tau V}{N_E}$, i.e. when the CoCo bonds are converted into equity at a price higher than the equity book value just prior to the trigger, $\frac{E_E}{N_E} = \frac{\tau V}{N_E}$. Given ρ, this happens for asset values $V < \frac{\rho N_E}{\tau}$. As trigger occurs for $V \leq \frac{F}{1-\tau}$, a sufficient condition for this to be true at all conversion is that $\frac{F}{1-\tau} < \frac{\rho N_E}{\tau}$, which is equivalent to (5). ■

This means that when condition (5) is satisfied, in all cases of preset fixed price conversion the conversion price has the effect of partially offsetting the dilution effect of bail-in. Additionally, this is still the case even if (5) is not satisfied for sufficiently low values of V, or more specifically, when $V < \frac{\rho N_E}{\tau}$. In Hori and Martin Cerón (2014) the fixed-price equity-conversion structure was analysed to be equivalent to a Non-Admissible Debt-to-Equity Swap (NADES), as opposed to a traditional admissible debt-to-equity swap where the bondholders utilise fully their bargaining power to set the optimal (from the bondholders' point of view) bail-out terms including the conversion price. Proposition 1 is one of the consequences of the structure being a NADES.

In view of the results so far, we make two suggestions for dampening the agency costs and the moral hazard incentives. The first is to rule out writedown/off structures altogether due to their pay-off profile that creates a perverse incentive to trigger for the equityholders. Berg and Kaserer (2011) makes a similar observation by using vega[6] of the equityholders' position as a measure of the degree of the asset substitution problem, which is shown to be higher for the writedown (or "*Convert-to-Steal*" in their paper) bonds than if subordinate bonds were issued instead. Separately, Himmelberg and Tsyplakov (2011) estimates that a principal writedown in the order of 75% may cause a bank to "burn" as much as 3% of assets, in a numerical simulation on a dynamic structural model. Here we argue this by the unambiguously positive gains from trigger term in eqn (4).

Secondly for an equity-conversion CoCo bond, Proposition 1 outlined the cases where preset fixed price conversion contributes to partially offsetting the dilution effect of bail-in. Our suggestion is then to replace fixed-price equity-conversion CoCo bonds with market-price equity-conversion CoCo bonds. More specifically, we propose a CoCo that converts at the existing market share price plus a discount (of 30%, for example). We show below that this effectively removes the NADES effect. With this proposal the CoCo bonds are exchanged at a price that mirrors the economics of an ordinary equity raise of a distressed bank, where new shares are issued at the prevailing price plus a significant discount, reducing the perverse incentive of gambling with the bondholders' wealth.

Let the conversion price now be $\rho(V)$, which depends on the firm's value V. This is proposed to be the market share price with a discount of $\delta \geq 0$,

$$\rho(V) = \frac{\lambda \tau V}{N_E}(1-\delta). \tag{8}$$

[6] Sensitivity of the value of the position (in this case, the equityholders') with respect to changes in the volatility of the value of the asset.

where λ is the market price-to-book ratio. As the firm's status deteriorates this conversion price falls via three channels: lower V, lower price-to-book ratio λ and higher discount δ on the share price. The number of shares received by the CoCo bondholders is now,

$$N_C = \frac{(\underline{E} - \tau) V}{\rho(V)} = \frac{N_E (\underline{E} - \tau)}{\lambda \tau (1 - \delta)}. \tag{9}$$

For constant λ and δ, this is equivalent to a fixed-number conversion. Otherwise N_C is increasing for a decreasing λ or an increasing δ. The dilution is now,

$$\text{Dilution} = \frac{N_C}{N_E + N_C} = \frac{\underline{E} - \tau}{\lambda \tau (1 - \delta) + (\underline{E} - \tau)}. \tag{10}$$

Then,

Proposition 2 *The dilution is more than* $\frac{\underline{E}-\tau}{\underline{E}}$ *if*

$$\lambda (1 - \delta) < 1. \tag{11}$$

Proof. Follows immediately from $\frac{\underline{E}-\tau}{\lambda\tau(1-\delta)+(\underline{E}-\tau)} > \frac{\underline{E}-\tau}{\underline{E}}$. ∎

In summary, there are two channels for equity dilution with the CoCo equity-conversion trigger: one, the capital injection due to the equity conversion, where the original equity-holders' holding is reduced to $\frac{\tau}{\underline{E}}$, and the other, where the equity conversion happens at a favourable price for the CoCo bondholders, increasing the proportion that they hold to above $\frac{\underline{E}-\tau}{\underline{E}}$. The condition for the second dilution to be positive is given by Proposition 2, which is satisfied if the price-to-book ratio λ falls to below 1, or if there is a sufficient discount δ in the conversion price such that (11) is satisfied. This is demonstrated in the numerical example below, where $N_E = 10$ million, $\lambda = 1$ and $\delta = 30\%$. As before,

$F_B = 80$, $F_C = 10$ and $\tau = 7\%$ and the trigger occurs at $\frac{F}{1-\tau} = 96.77$. Below 88.89, the forced-writedown of the vanilla bond kicks in to maintain the minimum equity capital ratio $\underline{E} = 10\%$. As shown, the dilution is lower than $\frac{\underline{E}-\tau}{\underline{E}} = 30\%$ for the fixed-price conversion CoCo, while it is higher at 38% for the market-price conversion.

V	80.0	85.0	88.89	90.0	95.0	96.77	100.0
Market share price $\frac{E_E}{N_E}$	0.28	0.30	0.31	0.32	0.33	0.34	0.50
Fixed conversion price ρ	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Fixed-price conversion N_C (m)	4.00	4.25	4.44	4.50	4.75	4.84	0
Dilution	16.7%	17.5%	18.2%	18.4%	19.2%	19.5%	0%
Market-price conversion price $\rho(V)$	0.20	0.21	0.22	0.22	0.23	0.24	0.35
Market-price conversion N_C (m)	12.24	12.24	12.24	12.24	12.24	12.24	0
Dilution	38.0%	38.0%	38.0%	38.0%	38.0%	38.0%	0%

The payoffs and losses for the general case is shown in Appendix A.3. In particular the payoff to the original equityholders is given by,

$$E_E = (V - F) + \left[F - \frac{\lambda\tau(1-\delta)(1-\underline{E}) + (\underline{E}-\tau)}{\lambda\tau(1-\delta) + (\underline{E}-\tau)} V \right] \chi_{V \leq \frac{F}{1-\tau}}. \tag{12}$$

Again the second term is the gains from trigger. Then,

Proposition 3 *There is a range of V just below the trigger point for which the gain from trigger is negative if $\lambda(1-\delta) < 1$.*

Proof. The gain from trigger in (12) is negative for the following values of V,

$$\frac{\lambda\tau(1-\delta) + (\underline{E}-\tau)}{\lambda\tau(1-\delta)(1-\underline{E}) + (\underline{E}-\tau)} F < V \leq \frac{F}{1-\tau}. \tag{13}$$

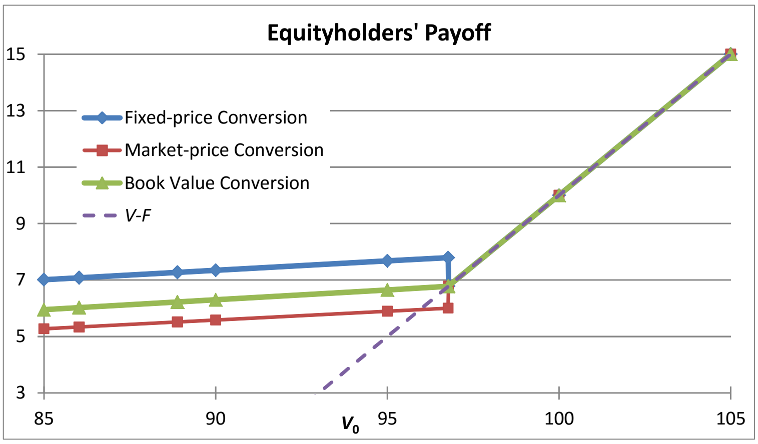

Figure 1: Equityholders' Payoffs

This is not an empty set if,

$$\frac{\lambda\tau(1-\delta)+(\underline{E}-\tau)}{\lambda\tau(1-\delta)(1-\underline{E})+(\underline{E}-\tau)} < \frac{1}{1-\tau} \Leftrightarrow \lambda(1-\delta) < 1. \tag{14}$$

■

This means that with our proposed market-price equity-conversion CoCo bond, the equityholders are worse off just below the trigger point than just above it as long as the condition in Proposition 3 is satisfied, removing to an extent the "gamble-for-ressurection" incentive. Fig 1 shows the positive and negative gains from trigger at the trigger point under fixed-price and market-price equity-conversion CoCo bail-ins. The negative gains from trigger is indicated by the payoff line below the dashed $\max[V-F,0]$ line.

Finally, we justify the adoption of discount $\delta > 0$ to the conversion price. There is already a vast literature that touches upon the reasons of the usual discount in equity offerings. These include:

1. *Signalling effect.* This arises from the asymmetric information where the managers

hold more information than the investors. The market participants assume that when a company issues shares, the management believes that the shares are overpriced, while when they use internal resources, then the management believes that the shares are underpriced. Therefore any equity raise warrants a discount to compensate investors from the asserted overpricing. The same could be said between the current equityholders and the potential new investors, where the higher the internal support from equityholders, the better the signalling effect to the market.

2. *Transaction costs.* When a company decides to issue shares rather than using internal funds, it incurs issuance costs that investors incorporate as a discount to the share price (see for example Williamson (2002)).

3. *Modigliani-Miller Proposition 1* (MMP1): The well-known theory refers to the value of the levered company being equal to the value of the unlevered bank plus the tax shield of the debt. Thus, if the company intends to use the proceeds of the equity raising to lower the debt, the company value should drop (by the value of the tax shield relinquishment) that could warrant a discount.

All of these reasons also apply to our CoCo trigger situations.

3. The Contingent Equity Base

The above proposal does not fully remove the risk-taking incentive from equityholders as solvency moves closer to the point of non-viability (PONV). Take a scenario where solvency is rapidly deteriorating and the equityholders do not want to (or cannot) issue equity. The CoCo bail-in will then be triggered. Since equityholders know that contingent capital will be issued (even at distressed levels owing to our proposal), which rescues the equityholders in a going-concern basis (as opposed to facing a gone-concern liquidation), there remains an incentive to "loot" or "gamble-for-resurrection". As such, the moral hazard does not disappear entirely as long as the equityholders do not face full dilution on a going-concern basis. Full dilution of equityholders would be the only way to restore the absolute priority rule (APR)[7]. What we propose in this section is not for the equity to be written-off, but for the incumbent equityholders to be fully diluted. This revolutionary proposal would finally remove the intrinsic moral hazard of the banking industry.

We propose that banks should have an ongoing Contingent Equity Base (CEB) formed by a new equityholders base. The CEB will have a dual role:

- The CEB will take over the bank once the bank solvency falls below the PONV (whose threshold could be either the CoCo trigger or the level set by the regulator).
- The CEB will sit off-balance sheet for a fee as a "top-up" contingent line for the bank to make up the short-fall in their CT1 and T1 ratios.

The first of these roles means that once the solvency falls below the PONV, the incumbent equityholders are replaced by the new equityholder base and lose all their remaining equity holdings. In a falling solvency scenario, it would then be in the equityholders' interest to raise equity (instead of gambling with bondholders' money) in order to preserve their equity investment. This mirrors the traditional equity expropriation by the state, *a la* Bankia in 2012 or SNS in 2013. The main difference is that this proposal relies on private money rather than public resources.

More specifically, the new recapitalisation mechanism works as follows:

1. Initially a CEB is set up by equity investors with in-depth knowledge and expertise in

[7] Where bondholders assume losses only once equity holders are wiped out.

the banking industry, who are able to assess the risk and rewards of such commitment. This CEB will sit "idle" off the bank's balance sheet until a rescue is triggered.

2. The bank should have, at all times, as much CoCo bonds as necessary to restore the bank's solvency from the PONV/CoCo trigger to the level set by the regulator (perhaps $10 - 10.5\%$ CT1). These CoCo bonds are marked to market so that the regulator (and the bank and investors) know realistically how much equity will be created upon CoCo trigger. Additionally, the bank is required to meet a minimum T1 ratio (e.g. 14%). Until these ratios are reached the CEB will commit equity of their own as a contingent line, which will make up the difference between the minimum required T1 ratio and the existing ratio. The CEB will charge a fee for this contingent equity.

3. As the CoCo bonds and/or equity are raised to meet the capital requirements, the CEB is withdrawn accordingly. Once the capital requirements are fulfilled, the CEB providers recover their entire equity investment, but they remain contingent future equityholders. Essentially the CEB line plays the role of an "equity revolving facility", where, if solvency drops, there is always contingent equity underpinning the bank's balance sheet.

4. Once the CoCo bail-in is triggered or the solvency falls below the PONV, the incumbent equityholders are replaced by the CEB providers and lose their entire investment. The CEB providers become the new equityholders. The existing CoCo bonds convert as proposed in Section 2, recapitalising the bank to reach the minimum CT1.

5. After a CEB takeover a new CEB is set-up. The CEB will set aside equity until the bank reaches its compulsory T1 ratio.

6. The CEB providers cannot be at anytime equityholders of the bank before the restructuring happens. Thus they are precluded from trading the shares of this bank. This has a two-fold objective: to minimise the risk of share price speculation, and to ensure that a new equity investor base replaces the old (failed) equityholders.

7. Should the CoCo bail-in be triggered while CEB equity line is still active (i.e. the bank is still building capital to cancel the CEB equity line), the CEB converts at the same price as the CoCo. This ensures the capitalisation of the bank at all times even if the bank has not fulfilled his compulsory solvency ratios.

We illustrate the process in an example depicted in Fig 2. The regulator imposes a minimum capital ratios of $\underline{E} = 10\%$ and $T = 14\%$ for CT1 and T1, respectively. The CoCo trigger is $\tau = 7\%$.

Case 1 The initial state. The firm's asset value $V_0 = 110$ is funded by $F_B = 80$ of vanilla bonds and $F_C = 10$ of equity-conversion CoCo bond, with the equityholders holding $E_E = 20$ of equity capital. The CT1 and T1 ratios are 18.2% and 27.3% respectively, above the required ratios.

Case 2 The asset value falls to $V = 95$, incurring a loss of 15 for the bank. With $\tau V = 0.07 \times 95 = 6.65$, the incumbent equityholders bear an initial loss of $20 - 6.65 = 13.35$. This leaves a further loss of $15 - 13.35 = 1.65$ and the CoCo bail-in is triggered. As with the traditional equity-conversion CoCo bail-in, the CoCo bond is partially converted such that the CT1 is restore to $\underline{E}V = 0.1 \times 95 = 9.5$, i.e. they receive equity of $E_C = 9.5 - 6.65 = 2.85$. This leaves the CoCo bond worth $D_C = (1 - \underline{E})\,V - F_B = 0.9 \times 95 - 80 = 5.5$. This means that $10 - 5.5 = 4.5$ of the CoCo bond has converted into $E_C = 2.85$ of equity, implying a loss for the CoCo bondholders of $L_C = 4.5 - 2.85 =$

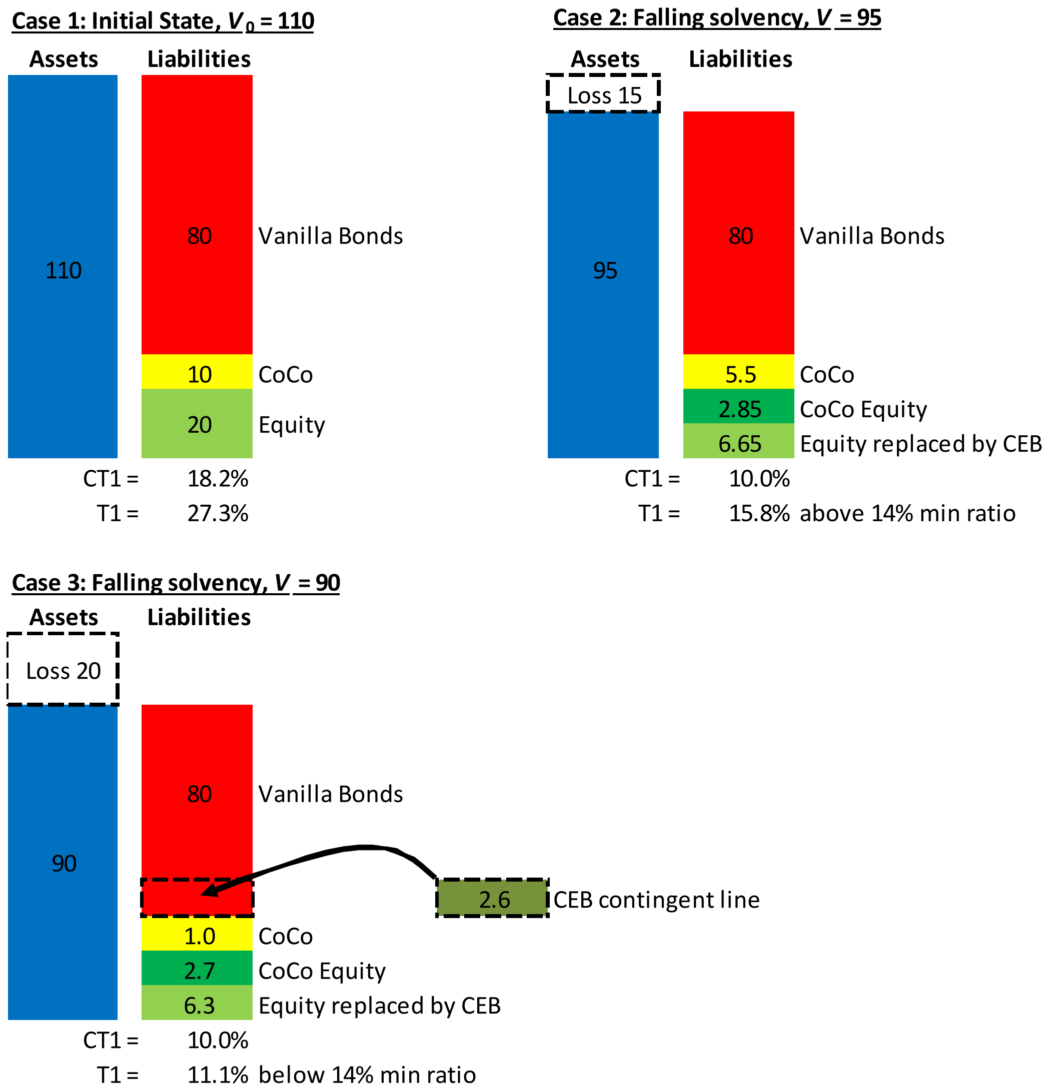

Figure 2: Falling Solvency Cases under CEB

1.65, which is exactly the remaining loss. The difference with the traditional bail-in is that here the CEB replaces the original equity, resulting in $E_E = 0$ and $E_{CEB} = 6.65$. In this case the T1 ratio is $(5.5 + 2.85 + 6.65)/95 = 15.8\%$, above the required ratio of 14%.

Case 3 The asset value falls to $V = 90$, incurring a loss of 20 for the bank. Analogously with Case 2, CEB providers expropriate the incumbent equityholders and receive $E_{CEB} = 0.07 \times 90 = 6.3$. A proportion of the loss $L_E = 20 - 6.3 = 13.7$ is borne by the incumbent equityholders' original position, with the remaining loss of 6.3 being borne by the CoCo bondholders. Their resulting position is $E_C = (0.1 - 0.07) \times 90 = 2.7$ of equity and $D_C = 0.9 \times 90 - 80 = 1$ of remaining CoCo bond. Additionally, in this case the T1 ratio of $(1 + 2.7 + 6.3)/90 = 11.1\%$ is now below $T = 14\%$, so a CEB contingent line of $E_{T_1} = (0.14 - 0.111) \times 90 = 2.6$ is set-up for a fee off-balance sheet to top-up the ratio. This remains until the bank builds up its T1 capital to T.

Further cases of numerical examples are given in Appendix A.4, as well as more general payoffs to, and losses of, the bondholders and the equityholders for different outcomes of V. In particular, the payoff for the original equityholders is summarised as,

$$E_E = (V - F)\,\chi_{V > \frac{F}{1-\tau}}. \tag{15}$$

The comparison of the equityholders' payoffs between the ordinary equity-conversion and the CEB conversion is shown in Fig 3. The gains from trigger is clearly negative, eliminating any incentive to gamble-to-ressurect close to the trigger point.

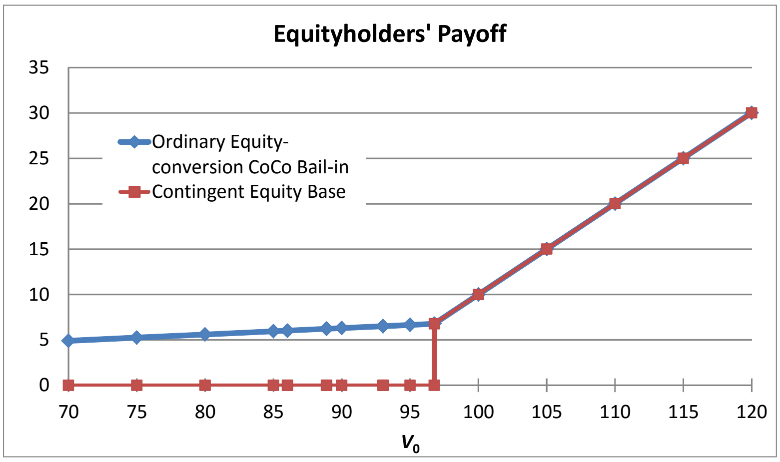

Figure 3: Equityholders' payoffs for ordinary equity conversion and CEB conversion

4. CEB valuation

Our proposal suggests that the CEB commits a contingent equity line until the T1 ratio (CT1 plus CoCos) is achieved. This will guarantee the necessary capitalisation at all times, as already discussed. Until the solvency ratios are met and the CEB line is cancelled, the bank pays the CEB a fee for the outstanding equity line. This will encourage the bank to build up capital on its own or issue more CoCo bonds. We discuss here what the level of this fee should be, or in other words, what the correct equity valuation is for the CEB line.

There is no straightforward measure as all equity valuation has its merits and shortcomings. Accountancy based measures such as return on equity (ROE) and dividends yield are objective. However the valuation becomes challenging if the bank is loss making or not paying dividends, in which case the normalised earnings or dividends would have to be estimated.

Instead, we suggest using the cost of equity (COE) of the bank to set the fee charged by the CEB. This is because setting a fee lower than the bank's COE would mean that the bank can earn a higher return on capital elsewhere, discouraging them to build up capital in order to cancel the CEB line. To calculate the COE is not a clear cut exercise either as it also entails its own difficulties. We suggest two ways to estimate the COE:

1. *Market data based*: Appendix B shows that the price-to-book ratio (P/B) is given by,[8]

$$P/B = \left(\frac{ROE - g}{COE - g}\right)(1 + g)\,, \tag{16}$$

   where g is the bank's growth rate. Then the implied COE can be estimated by using the normalised ROE, g (can use nominal growth of the country where the bank has its main operations) and the current P/B ratio. However there are two important weaknesses of using this method:

   - P/B does not take into consideration the balance sheet risk of the bank (though this may be reflected through COE[9]).
   - Using market values is sensitive to market manipulation and would make the CEB price market driven.

2. *CAPM*: Though the limitations are well known, CAPM is used by both practitioners and academics to calculate the weighted average cost of capital (WACC) of companies and banks by,

$$COE = RFA + \beta \times ERP, \tag{17}$$

[8] Damodaran on http://people.stern.nyu.edu/adamodar/pdfiles/pbv.pdf has $P/B = \frac{ROE-g}{COE-g}$ by assuming that "the return on equity is based upon expected earnings in the next time period". This removes the $(1+g)$ factor from (16).

[9] The COE can be estimated by CAPM, as described in (17), reflecting the financial leverage of the bank in its equity beta:

$$\beta_{equity} = \beta_{asset} + \frac{D}{E}\left(\beta_{asset} - \beta_{debt}\right),$$

where D is the level of debt and E is the level of equity.

	BARCLAYS	HSBC	LLOYDS	RBS	STANDARD CHARTERED	COMMERZ BANK	DB	BBVA	SANTANDER	INTESA	UNICREDIT	BNP	BPCE	CREDIT AGRICOLE	SOCIETE GENERALE	Average
RFA	1.4%	1.4%	1.4%	1.4%	1.4%	0.3%	0.3%	1.5%	1.5%	1.6%	1.6%	0.6%	0.6%	0.6%	0.6%	**1.1%**
Beta	1.2x	1.0x	1.0x	1.3x	1.0x	1.0x	1.1x	1.2x	1.1x	1.2x	1.3x	1.2x	1.1x	1.3x	1.4x	**1.1x**
ERP	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	**6.0%**
P/B	0.6x	0.6x	1.1x	0.7x	0.4x	0.4x	0.5x	1.0x	0.9x	0.9x	0.6x	0.6x	0.5x	0.5x	0.5x	**0.7x**
2015 ROE	6.9%	9.2%	12.1%	6.0%	8.8%	3.8%	5.1%	7.5%	8.2%	6.4%	5.4%	8.1%	7.0%	6.8%	6.8%	**7.2%**
CAPM COE	8.6%	7.4%	7.4%	9.2%	7.4%	6.3%	6.9%	8.7%	8.1%	8.8%	9.4%	7.8%	7.2%	8.4%	9.0%	**7.9%**
Implied COE at g=2%	10.3%	11.3%	10.9%	7.9%	12.0%	6.1%	7.9%	7.7%	8.8%	6.8%	8.1%	11.7%	10.8%	11.3%	11.7%	**9.5%**

Figure 4: COE estimations for 14 European banks

where RFA is the risk free asset return and ERP is the equity risk premium. RFA can be estimated, for example, using the nominal yield of the 10 year sovereign bond where the bank has its main operations. For β, one possibility is to use the two year adjusted beta of the bank relative to the equity market where the bank has its main operations. The ERP is the most sensitive and critical parameter within the CAPM COE and it has been thoroughly scrutinised by both the practitioner and academic world. There is no standard method to estimate it. In Appendix C, we show an example of the estimated UK ERP according to the UK utility regulator Ofcom (Fig 11), and the difference between the historical ERP of the UK and the world taken from Dimson and Hanke (2004) (Fig 12). Given these, we conclude that $4\% - 6\%$ would be a plausible range.

Fig 4 shows the estimated COEs of the 14 largest banks of the European Union as of 30 January 2015, with the average CAPM COE of 7.9% (using $ERP = 6\%$) and the market implied COE of 9.5% (using $g = 2\%$). Similarly, with the range $4 - 6\%$ for ERP, the CEB equityholders should earn a fee in the range $5.6\% - 8\%$ on average for our sample of banks, as calculated in Fig 5.

ERP	COE
3%	4.5%
4%	5.6%
5%	6.8%
6%	7.9%
7%	9.1%
8%	10.2%

Figure 5: CAPM COE estimations

5. The Merits and Demerits of Our Proposal

Through a combination of both schemes (market-price based CoCo bonds and the CEB), the regulator can finally remove the intrinsic moral hazard of the banking industry as well as dampening the negative effects of the agency costs stemming from the bail-in. The CEB proposal may seem radical, but as already stated, it mirrors the states' expropriation of failing banks, such as Bankia (2012), SNS (2013) and Banco Espirito Santo (2014). In both the equityholders lose their entire investment on a going-concern basis. The difference is that one is achieved using public fund, while the other relies on private money. The new equityholders replacing the existing equityholders would hopefully instill the necessary discipline to bolster capital and redirect the bank towards a viable business path. Further, upon breaching its PONV, the existing CoCo bonds would replenish the CT1 while a new CEB would be set up to achieve the minimum T1, conveying comfort to the market to raise new equity and operate as a solid going-concern entity.

Overall we believe the trade-off between risks and rewards are well balanced across different actors:

- Existing equityholders: This proposal is not ROE dilutive pre-trigger for existing equityholders even if the CEB line is still active as it is kept off-balance sheet. The bank will have to honour the contingent equity line fee as if they were preference shares, but they do not participate in any dividend payout or equityholder repurchase. The equityholders have the incentive to hoard capital and raise equity (through net income or equity contribution) to cancel the CEB line. They lose their entire investment once the PONV is breached, but it would also face full dilution if the bank were to be expropriated. On the other hand, the bank will be well capitalised at all times leading to lower cost of equity (via beta) and cost of debt, and in general the WACC, which would help to boost the overall profitability of the bank. The need to impose losses on further unsecured debt such as senior debt would also no longer be necessary.

- CEB: The CEB commits capital which is at risk of being converted to equity, and charges a fee for this commitment. Though it will receive the equity for free from the existing equityholders upon a distressed event, there are strings attached to it. The CEB will have to be fully involved in the recapitalisation process and perhaps even contribute more money of their own since there could be more potential losses and impairments in the balance sheet after the CoCo triggers, or the bank could struggle to rebuild solvency. By charging an onerous fee equivalent to the COE, the CEB structure will encourage equityholders to strive to replenish capital.

- Bondholders: The harmful bail-in related agency costs vanish and, despite the APR still not fully restored (the equity is not fully consumed before their investment is forced to be written-down), the bondholders face a relatively more benign restructuring.[10] They are no longer at the mercy of equityholders that can free-ride on their

[10] They even stand to recoup their losses if, in due course, share price recovers to make up for their initial debt to equity swap loss, unless they are forced to sell equity as many CoCo bondholders are fixed income investors who cannot hold equity.

investment. Furthermore, with our proposal the debt-to-equity exchange takes place at market prices rather than transferring wealth through the inherent NADES of the CoCo bonds currently issued.

- Regulator: It stands to benefit the most, due to the permanent recapitalisation of the bank even in a distressed event. Effectively it can delegate bank monitoring to the market and relieve itself from its traditional role of rescuer of last resort.

Though the scheme has its merits, the proposal also has its shortcomings. We envisage two main problems with mitigating factors:

- Existing equityholders and equity valuation: will they accept a scheme in which they can lose their entire investment on a going-concern basis? How will the CEB and the CEB line affect the valuation of the existing shares?

- CEB: Would there be enough support and appetite in the market to become contingent equityholders of systematically important banks and commit resources through the CEB line?

As far as the former is concerned, it is obvious that equityholders will not be pleased with the new framework. However, neither government bail-out nor the existing bail-in frameworks are viable alternatives as they aggravate moral hazard and agency cost problems. The current set-up must change and the equityholders need to come to terms that, once the bank reaches the PONV, the going-concern value of their equity investment is similar to the gone-concern recovery value of zero, in spite of the difficulty of liquidating a bank due to the systemic risks attached to it. Therefore equityholders should revise their investment stance on a highly levered vehicle like a bank and balance out the risk and rewards of their investment. The CEB line is not ROE dilutive but it is ROE consuming, as the bank has to pay a fee in the same way it serves the fee for its preference shares and subordinate bonds. The bank will then have to decide whether it should raise capital immediately to cancel this contingent equity line on the basis of its high costs, because the bank believes its COE is lower than the fee, or maintain it because of its belief that it can earn a higher return on capital elsewhere if the COE is higher than the fee. We proposed above that the CEB line should be priced to the COE, which should encourage the bank to raise equity.

Moreover, we believe the COE should drop via lower beta (lower financial leverage thanks to the permanent capitalisation) and higher equity. Higher equity means that the cost of debt (COD) should also fall due to less bail-in-able debt required and lower coupons for the issued CoCo bonds, improving the overall WACC of the bank. What is inevitable is the premium demanded for holding banks' shares by investors, making the ownership of banks' shares a target to sophisticated investors that better understand the risk-reward of the investment. Overall, we believe the new scheme should not meaningfully affect the traditional relation between P/B[11] and ROE.

As regards the latter, the amount of monetary equity commitment required to set up the CEB line at the moment is not very significant, bearing in mind that banks have come a long way in restoring and boosting capitalisation. As shown in Fig 6, by early 2015 most of the too-big-to-fail (TBTF) banks boasted a fully-loaded CT1 (FLCT1) of above 10%, close to the expected minimum levels of $11-11.5\%$.[12] Indeed the average FLCT1 of the 14 banks was already 10.3%, with, for example, Intesa Bank at nearly 12.5%. We view, therefore, that the contingent equity needed to accomplish this scheme is financially digestible to the

[11] P/B would reflect both the lower ROE (due to the CEB fee) and the lower COE (via lower beta). However in the long-run, the bank would be in a better condition to lend and increase assets to enhance its ROE, which would have a positive impact on its equity multiples.

[12] Recent trends from the UK and Euro zone regulator suggest higher CT1 than previously discussed and hence a $11-11.5\%$ minimum CT1 is not far-fetched.

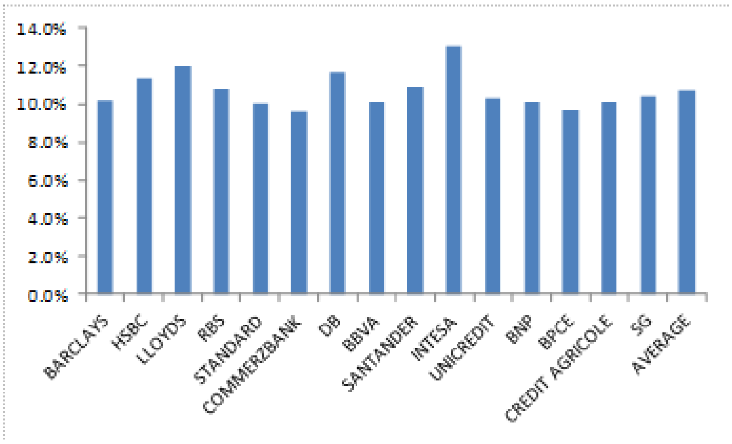

Figure 6: FLCT1 at 14 banks on 31 January 2015. Source: Bloomberg and author

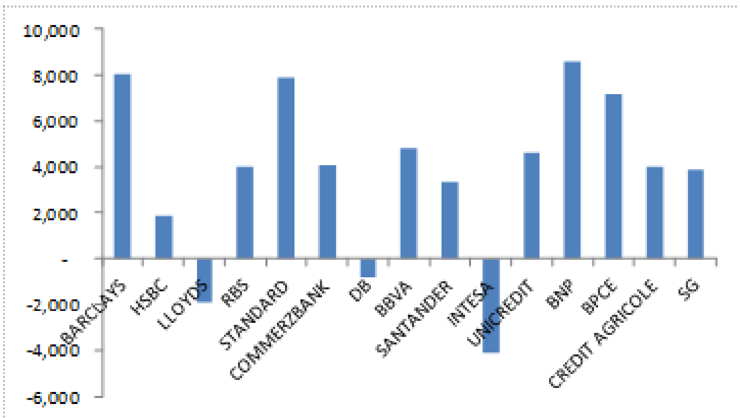

Figure 7: FLCT1 shortfall at 14 banks on 31 January 2015. Source: Bloomberg and author

market. As of 31 January 2015, the FLCT1 shortfall of the 14 biggest banks in the EU is estimated to be €62bn, assuming a 11.5% minimum level. The shortfall at each bank is shown in Fig 7.

If we exclude the existing non-compliant T1 debt (which we expect to be called or tendered) the fully-loaded T1 (FLT1) shortfall would be close to €110bn. The shortfall at each bank is shown in Fig 8. We believe a combination of equity and CoCo bonds should plug in this capital shortfall in a reasonable amount of time, especially given the low yielding environment and the improving fundamentals of the banks.

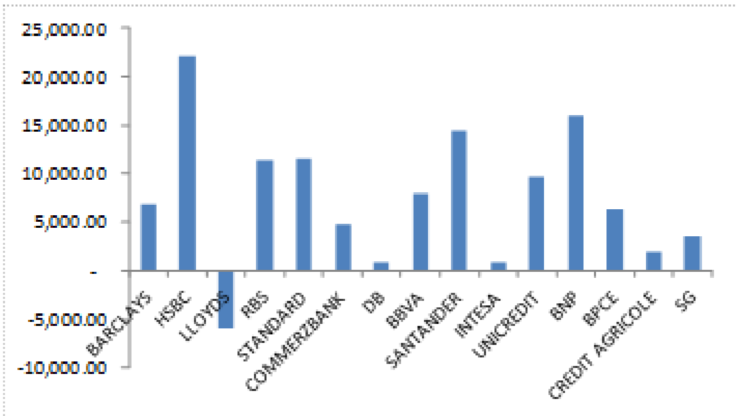

Figure 8: FLT1 shortfall at 14 banks on 31 January 2015. Source: Bloomberg and author

Should a bank fail and a new CEB line is required, we believe this investment will be palatable to investors unless the fallout of this bank triggers a chain of bank failures. However, this possibility should diminish overtime owing to how stringent regulation has become on cross-holding stakes that will force banks out of owning each other's shares. For example if Barclays Bank were to fail, the amount of equity and CoCo bonds necessary to boost the capital ratios from CT1 and T1 ratios of 10%[13] to 11.5% CT1 and 14% T1 would be €5bn and €10bn, respectively.

In the current low yield climate, earning a COE-equivalent fee to hold contingent equity is fairly attractive deal for investors. Fig 9 is a scatter graph of the banks' ROE vs their P/E ratios. It demonstrates that the banks are trading at the P/B ratio of 0.7 for a 2015 expected ROE of 7%, implying that the banks are barely covering their COE given how depressed the banks' ROEs are. Consequently, for CEB investors to earn a 8% fee (assuming a 6% ERP) to become contingent equityholders of a bank looks like an attractive proposition in this

[13]This is the assumed level of CT1 after CoCo bail-in and CEB takeover (see the examples in Appendix A). Note if all CoCo bonds are converted into equity then the T1 ratio would equal this CT1 ratio.

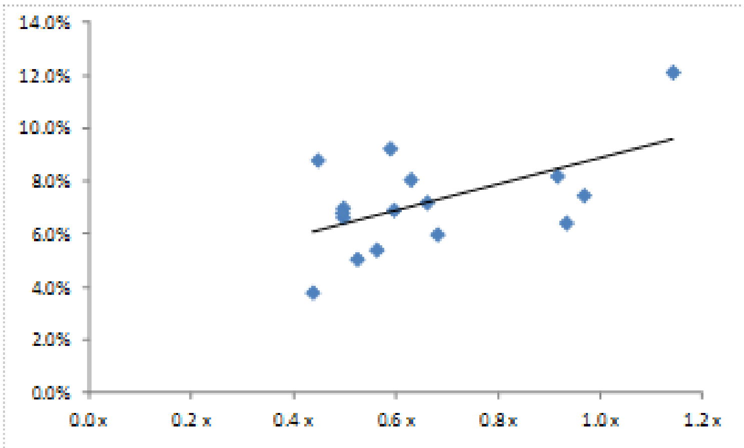

Figure 9: ROE vs P/B ratio, 31 January 2015. Source: Bloomberg and author

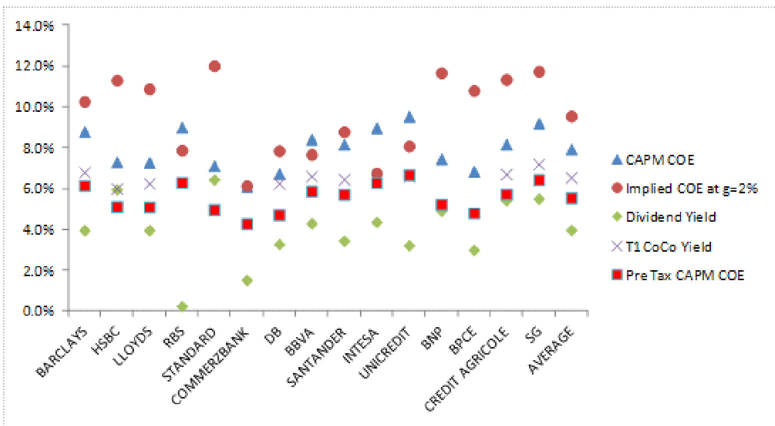

Figure 10: COE, Dividend yied and T1 CoCo bond yield at 14 banks. Source: Bloomberg and author

low yield environment. In Fig 10, we can observe that the CAPM COE fee looks compelling relative to other equity (or equity linked) valuation methods such as the dividend yield, and the existing yield on T1 CoCo bonds.

6. Concluding Remarks

Since the 2008 banking crisis, much effort has been spent by the regulators to ensure the stability of the banking sector. The implicit government bail-out led to banks' moral hazard behaviours, which placed a heavy burden on the tax payers to clear up the system. With the recognition of the systemic risk of the sector the new regulations resort to the deviation from absolute priority rule (DAPR) to impose losses on bondholders. As shown in Hori and Martin Cerón (2014), the DAPR leads to agency costs of wealth transfer and value destruction, giving rise to perverse incentives for equityholders that will seek to exploit them.

In this paper we investigated in detail the currently employed CoCo formats and made alternative suggestions. The writedown CoCo bond creates a large incentive for "gamble-for-resurrection" and therefore should be abolished. The equity-conversion CoCo bond is a form of non-admissable debt-to-equity swap (NADES) that presets the conversion price in advance, which results in offsetting the dilution effect of bail-in conversion. Instead we propose a CoCo bond that converts at the prevailing market share price with a discount, where the CoCo trigger mirrors the equity raise that would take place at these distressed levels. The CoCo bonds would then be converted at a "fair" price, diluting the equityholders' position as would happen in a distressed equity raise. Thus the equityholders would have an incentive to curtail risk-taking and raise equity before the painful dilution sets in.

Notwithstanding this, the new CoCo bond proposal does not eliminate entirely the agency costs problems. Shareholders could still decline any equity raise and attempt "gamble-for-resurrection", as they can rely on the contingent capital provided by CoCo bond holders to aid them recover some of their capital in the case that their gamble does not pay off. We therefore suggest a novel approach to permanently extinguish the moral hazard and the bail-in agency costs by creating a Contingent Equity Base (CEB) contributed by future equityholders. If existing equityholders face full dilution on a going concern basis, as would be the case if full expropriation occurs in a similar fashion to Bankia, SNS or Banco Espirito Santo rescues in 2012-14, equityholders would have a strong incentive to avoid the solvency falling close to the PONV/CoCo trigger. In this environment, where banks are bolstering capital, the necessary equity support for the too-big-to-fail banks would hopefully be economically palatable. Our proposal suggests a generous fee for the CEB at the level of cost of equity. From the recovery value standpoint, having this equity-line makes existing equityholders worse off compared to the existing structure. However in the present format, bail-in has inherent risks that are currently not fully considered. We strongly advocate replacing it with a scheme where equityholders can face full expropriation if their financial and business decisions turn out to be incorrect, removing the perverse incentive to misbehave. Our CEB proposal that mimics the full going-concern equityholders expropriation accomplishes this.

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Appendix

A. Payoffs

A.1. Writedown CoCo Bond

We describe the payoffs to the vanilla bondholders, the CoCo bondholders and the equityholders when the bank value at the maturity of the bonds is V. Initially, the value of the bank is V_0, and the face values of the vanilla and writedown bonds are F_B and F_W. Then the total bond face value is $F = F_B + F_W$ and the equityholders' initial position is $V_0 - F$. When the CT1 capital ratio hits the level τ the writedown bail-in is triggered, at which point the entire F_W is written down. Part of this is used to payoff the loss remaining after the initial loss taken by the equityholders, while any remaining principal is converted to a contingent capital reserve (CCR). We assume that the possession of this CCR is transferred to the equityholders. After a bail-in the bank is required to maintain a minimum capital ratio $\underline{E}$. In the cases of very low V this is achieved by a forced one-to-one conversion of the vanilla bond. The remaining (if any) values of vanilla and writedown bonds are given by D_B and D_W, while E_E and E_B are the resulting equity positions (excluding the CCR) of the equityholders and the vanilla bondholders. The CCR is given by E_R. L_E, L_B and L_W denote the losses of the equityholders, the vanilla bondholders and the writedown bondholders, respectively. Then for different values of V in the order of falling solvency:

- For $V > \frac{F}{1-\tau}$, the capital ratio is above τ. Then all profits / losses are claimed / borne by the equityholders according to the APR. Thus $D_B = F_B$, $D_W = F_W$, $E_B = E_R = 0$ and $E_C = V - F$. The losses are $L_E = V_0 - V$ (negative if profit) and $L_B = L_W = 0$.

- For $V \leq \frac{F}{1-\tau}$, the writedown is triggered. Assume first a small enough loss such that the vanilla bondholders are unaffected, i.e. $D_B = F_B$ and $E_B = L_B = 0$. The writedown bond is converted to equity in its entirety, so $D_W = 0$. Thus the total equity position is $E = E_E + E_R = V - F_B$. Of this, the original equityholders' position is $E_E = \tau V$, leaving the remaining equity $E_R = E - \tau V = (1-\tau)\,V - F_B$ as the CCR. The CoCo bondholders lose everything, $L_W = F_W$, while the equityholders bear the remaining loss $L_E = (V_0 - V) - F_W$. The capital ratio is boosted to $\frac{V-F_B}{V}$, which is above the minimum required level of $\underline{E}$ when $V > \frac{F_B}{1-\underline{E}}$.

- For $V \leq \frac{F_B}{1-\underline{E}}$, the writedown conversion of the CoCo bond is no longer enough to retain the capital ratio above $\underline{E}$. As stated we assume that then the vanilla bond is forced to be converted one-to-one to equity, such that the total equity position is $\underline{E}V$. The remaining bond position is then $D_B = (1-\underline{E})\,V$. Of the equity, the equityholders hold τV of their original equity holdings and the converted CCR of $E_R = (1-\tau)\,V - F_B$, while the vanilla bondholders hold the converted $E_B = F_B - (1-\underline{E})\,V$. The total position of the vanilla bondholders is still F_B and so $L_B = 0$. For the others $L_W = F_W$ and $L_E = (V_0 - V) - F_W$ as above.

- Finally for $V \leq \frac{F_B}{1-\tau}$, the CCR is totally wiped out, i.e. $E_R = 0$. The vanilla bonds are now used to writedown the loss beyond that borne by the original equityholders, as well as being forced to convert to equity to maintain $\underline{E}$. Then $D_B = (1-\underline{E})\,V$ and the total equity position is $\underline{E}V$, of which the original equityholders hold $E_C = \tau V$ and the vanilla bondholders hold $E_B = (\underline{E} - \tau)\,V$. The losses are now, $L_W = F_W$, $L_B = F_B - (1-\tau)\,V$ and $L_E = (V_0 - F) - \tau V$.

For technicality here we assume that $\frac{F_B}{1-\underline{E}} < \frac{F}{1-\tau} \Leftrightarrow F_W > \left(\frac{\underline{E}-\tau}{1-\tau}\right) F$, i.e. the proportion of the total bond that is the writedown bond is more than $\frac{\underline{E}-\tau}{1-\tau}$. In summary,

V	$\left[0, \frac{F_B}{1-\tau}\right]$	$\left(\frac{F_B}{1-\tau}, \frac{F_B}{1-\underline{E}}\right]$	$\left(\frac{F_B}{1-\underline{E}}, \frac{F}{1-\tau}\right]$	$\left(\frac{F}{1-\tau}, V_0\right)$	$[V_0, \infty]$
D_B	$(1-\underline{E})V$	$(1-\underline{E})V$	F_B	F_B	F_B
D_W	0	0	0	F_W	F_W
E_B	$(\underline{E}-\tau)V$	$F_B-(1-\underline{E})V$	0	0	0
E_R	0	$(1-\tau)V-F_B$	$(1-\tau)V-F_B$	0	0
E_E	τV	τV	τV	$V-F$	$V-F$
L_B	$F_B-(1-\tau)V$	0	0	0	0
L_W	F_W	F_W	F_W	0	0
L_E	$(V_0-F)-\tau V$	$(V_0-V)-F_W$	$(V_0-V)-F_W$	$V_0-V>0$	$V_0-V<0$
Notes	Forced equity-conversion of D_B to cover loss and attain $\underline{E}$.	$\underline{E}$ breached. Forced equity-conversion of D_B to attain $\underline{E}$.	CoCo bond triggered & added as CCR. $\underline{E}$ not breached.	τ not breached. E_E written down.	Balance sheet expanding.

The payoffs can be summarised as,

$$D_B = \min\left[(1-\underline{E})V, F_B\right]$$

$$D_W = F_W \chi_{V>\frac{F}{1-\tau}}$$

$$E_B = \max\left[F_B-(1-\underline{E})V, 0\right] - \max\left[F_B-(1-\tau)V, 0\right]$$

$$E_R = \max\left[(1-\tau)V - F_B, 0\right]\chi_{V\leq\frac{F}{1-\tau}}$$

$$E_E = \max\left[V-F, \tau V\right],$$

where $\chi_{V>\frac{F}{1-\tau}} = \begin{cases} 1 & , \text{ if } V_T > \frac{F}{1-\tau} \\ 0 & , \text{ if } V_T \leq \frac{F}{1-\tau} \end{cases}$, is an indicator function.

As a numerical example let $V_0 = 110$, $F_B = 80$, $F_W = 10$, $\tau = 7\%$ and $\underline{E} = 10\%$. Then $\frac{F}{1-\tau} = 96.77$, $\frac{F_B}{1-\underline{E}} = 88.89$ and $\frac{F_B}{1-\tau} = 86.02$ and:

V	80.0	85.0	86.02	88.89	90.0	95.0	96.77	100.0	105.0	110.0
D_B	72.00	76.50	77.42	80.00	80.00	80.00	80.00	80.00	80.00	80.00
D_W	0	0	0	0	0	0	0	10.00	10.00	10.00
E_B	2.40	2.55	2.58	0	0	0	0	0	0	0
E_R	0	0	0	2.67	3.70	8.35	10.00	0	0	0
E_E	5.60	5.95	6.02	6.22	6.30	6.65	6.77	10.00	15.00	20.00
L_B	5.60	0.95	0	0	0	0	0	0	0	0
L_W	10.00	10.00	10.00	10.00	10.00	10.00	10.00	0	0	0
L_E	14.40	14.05	13.98	11.12	10.00	5.00	3.23	10.00	5.00	0
CT1 ratio	10.0%	10.0%	10.0%	10.0%	11.1%	15.8%	17.3%	10.0%	14.3%	18.2%

A.2. Equity-conversion CoCo Bond

Similar to the writedown case, F_B and F_C are the face values of the vanilla and equity-conversion CoCo bonds such that $F = F_B + F_C$, with the CoCo trigger occurring at the CT1 ratio τ. However, in this case the CoCo bond is only partially converted in such a way as to maintain the minimum required capital ratio $\underline{E}$, with $F - (1 - \underline{E})\,V$ of the bond converting into $(\underline{E} - \tau)\,V$ of equity. In the extreme case that the whole CoCo bond conversion cannot cover the loss, the vanilla bonds are forced to be written down as before. Additionally, initially we assume that the conversion occurs at the equity book value, so that the equityholders' position is guaranteed at τV, or equivalently, their dilution is limited to $\frac{\tau}{\underline{E}}$. The case of market-price conversion is examined in A.3. Then,

- For $V > \frac{F}{1-\tau}$, the capital ratio is above τ. Thus as in the writedown bond case, $D_B = F_B$, $D_C = F_C$, $E_B = E_R = 0$, $E_C = V - F$, $L_E = V_0 - V$ and $L_B = L_C = 0$.

- For $V \leq \frac{F}{1-\tau}$, the CoCo conversion is triggered. The equityholders' position has a floor at $E_E = \tau V$. The CoCo bond is partially converted to equity such that the

CT1 ratio is restored to $\underline{E}V$, i.e. $E_C = (\underline{E} - \tau) V$. The original equityholders' loss is therefore limited to $L_E = (V_0 - F) - \tau V$, with the CoCo bondholders taking the remaining loss of $L_C = F - (1 - \tau) V$. $D_C = (1 - \underline{E}) V - F_B$ remains as CoCo bond. The vanilla bondholders are unaffected and so $D_B = F_B$ and $E_B = L_B = 0$.

- For $V \leq \frac{F_B}{1-\underline{E}}$, the whole of CoCo bond is converted. Thus $D_C = 0$, $E_C = (\underline{E} - \tau) V$ and $L_C = F - (\underline{E} - \tau) V$. The equityholders' position and loss are still limited to $E_E = \tau V$ and $L_E = (V_0 - F) - \tau V$. To cover the remaining loss, the vanilla bonds are forced to be written down so that $D_B = (1 - \underline{E}) V$ and $L_B = F_B - (1 - \underline{E})$.

Again assuming that $F_C > \left(\frac{\underline{E}-\tau}{1-\tau}\right) F$,

V	$\left[0, \frac{F_B}{1-\underline{E}}\right]$	$\left(\frac{F_B}{1-\underline{E}}, \frac{F}{1-\tau}\right]$	$\left(\frac{F}{1-\tau}, V_0\right)$	$[V_0, \infty]$
D_B	$(1-\underline{E})V$	F_B	F_B	F_B
D_C	0	$(1-\underline{E})V-F_B$	F_C	F_C
E_C	$(\underline{E}-\tau)V$	$(\underline{E}-\tau)V$	0	0
E_E	τV	τV	$V-F$	$V-F$
L_B	$F_B-(1-\underline{E})V$	0	0	0
L_C	$F_C-(\underline{E}-\tau)V$	$F-(1-\tau)V$	0	0
L_E	$(V_0-F)-\tau V$	$(V_0-F)-\tau V$	$V_0-V>0$	$V_0-V<0$
Notes	All CoCo converted. D_B written down.	τ breached. CoCo partially converted.	τ not breached. E_E written down.	Balance sheet expanding.

The summarised payoffs are then,

$$
\begin{aligned}
D_B &= \min\left[(1 - \underline{E}) V, F_B\right] \\
D_C &= \max\left[(1 - \underline{E}) V - F_B, 0\right] + \left[F - (1 - \underline{E}) V\right] \chi_{V > \frac{F}{1-\tau}} \\
E_C &= (\underline{E} - \tau) V \chi_{V \leq \frac{F}{1-\tau}} \\
E_E &= \max\left[V - F, \tau V\right].
\end{aligned}
$$

Again for $V_0 = 110$, $F_B = 80$, $F_C = 10$, $\tau = 7\%$ and $\underline{E} = 10\%$, $\frac{F}{1-\tau} = 96.77$ and $\frac{F_B}{1-\underline{E}} = 88.89$ and:

V	80.0	85.0	88.89	90.0	95.0	96.77	100.0	105.0	110.0
D_B	72.00	76.50	80.00	80.00	80.00	80.00	80.00	80.00	80.00
D_C	0	0	0	1.00	5.50	7.09	10.00	10.00	10.00
E_C	2.40	2.55	2.67	2.70	2.85	2.90	0	0	0
E_E	5.60	5.95	6.22	6.30	6.65	6.77	10.00	15.00	20.00
L_B	8.00	3.50	0	0	0	0	0	0	0
L_C	7.60	7.45	7.33	6.30	1.65	0	0	0	0
L_E	14.40	14.05	13.78	13.70	13.35	13.23	10.00	5.00	0
CT1 ratio	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	14.3%	18.2%

A.3. Market-price Equity-conversion CoCo Bond

The payoffs and the losses for the equityholders and the bondholders for the market-price equity-conversion CoCo bond described in the text are,

V	$\left[0, \frac{F_B}{1-\underline{E}}\right]$	$\left(\frac{F_B}{1-\underline{E}}, \frac{F}{1-\tau}\right]$	$\left(\frac{F}{1-\tau}, V_0\right)$	$[V_0, \infty]$
D_B	$(1-\underline{E})V$	F_B	F_B	F_B
D_C	0	$(1-\underline{E})V - F_B$	F_C	F_C
E_C	$\frac{(\underline{E}-\tau)}{\lambda\tau(1-\delta)+(\underline{E}-\tau)}\underline{E}V$	$\frac{(\underline{E}-\tau)}{\lambda\tau(1-\delta)+(\underline{E}-\tau)}\underline{E}V$	0	0
E_E	$\frac{\lambda\tau(1-\delta)}{\lambda\tau(1-\delta)+(\underline{E}-\tau)}\underline{E}V$	$\frac{\lambda\tau(1-\delta)}{\lambda\tau(1-\delta)+(\underline{E}-\tau)}\underline{E}V$	$V-F$	$V-F$
L_B	$F_B - (1-\underline{E})V$	0	0	0
L_C	$F_C - \frac{(\underline{E}-\tau)\underline{E}}{\lambda\tau(1-\delta)+(\underline{E}-\tau)}V$	$F - \frac{(1-\underline{E})\lambda\tau(1-\delta)+(\underline{E}-\tau)}{\lambda\tau(1-\delta)+(\underline{E}-\tau)}V$	0	0
L_E	$(V_0-F) - \frac{\lambda\tau(1-\delta)\underline{E}}{\lambda\tau(1-\delta)+(\underline{E}-\tau)}V$	$(V_0-F) - \frac{\lambda\tau(1-\delta)\underline{E}}{\lambda\tau(1-\delta)+(\underline{E}-\tau)}V$	$V_0 - V > 0$	$V_0 - V < 0$
Notes	All CoCo converted. D_B written down.	τ breached. CoCo partially converted.	τ not breached. E_E written down.	Balance sheet expanding.

These can be expressed as,

$$
\begin{aligned}
D_B &= \min\left[\left(1-\underline{E}\right)V, F_B\right] \\
D_C &= \max\left[\left(1-\underline{E}\right)V - F_B, 0\right] + \left[F - \left(1-\underline{E}\right)V\right]\chi_{V>\frac{F}{1-\tau}} \\
E_C &= \tfrac{(\underline{E}-\tau)}{\lambda\tau(1-\delta)+(\underline{E}-\tau)}\underline{E}V\chi_{V\le\frac{F}{1-\tau}} \\
E_E &= (V-F) + \left[F - \tfrac{\lambda\tau(1-\delta)(1-\underline{E})+(\underline{E}-\tau)}{\lambda\tau(1-\delta)+(\underline{E}-\tau)}V\right]\chi_{V\le\frac{F}{1-\tau}}.
\end{aligned}
$$

A.4. Contingent Equity Base

Again let the firm's initial asset value be V_0, with the face values of vanilla bonds and the equity-conversion CoCo bond given by F_B and F_C, respectively, such that $F = F_B + F_C$. Assume that initially the CT1 and T1 ratios, $\underline{E}$ and T, are fulfilled, i.e. $\frac{V_0-F}{V_0} \ge \underline{E}$ and $\frac{V_0-F_B}{V_0} \ge T$. In the case that the bank fails to maintain its required T1 ratio, a contingent line of E_{T_1} is kept off-balance sheet by the CEB providers. The CoCo trigger level is τ. Upon trigger, E_{CEB} denotes the capital expropriated by the CEB investors from the original equityholders. Then,

- For $V > \frac{F}{1-\tau}$, the CT1 capital ratio is above τ. Thus as in the ordinary equity-conversion case, $D_B = F_B$, $D_C = F_C$ and $E_E = V - F$, with the equityholders bearing all of the loss, $L_E = V_0 - V$ (negative if profit).

- For $V \le \frac{F}{1-\tau}$, the CoCo conversion is triggered. Here the equityholders' position is then wholly expropriated by the CEB investors. Thus $E_E = 0$, $L_E = V_0 - F$ and $E_{CEB} = \tau V$. As with the ordinary equity-conversion the CoCo bond is partially converted to equity such that $D_C = \left(1-\underline{E}\right)V - F_B$, $E_C = \left(\underline{E}-\tau\right)V$ and $L_C = F - (1-\tau)V$. The vanilla bondholders are unaffected and so $D_B = F_B$ and $E_B = L_B = 0$. Additionally, $E_{T_1} = 0$ as long as $\frac{D_C+E_C+E_{CEB}}{V} = \frac{V-F_B}{V} > T \Leftrightarrow V > \frac{F_B}{1-T}$.

- For $V \leq \frac{F_B}{1-T}$, the T1 capital ratio breaches the minimum required ratio T. Then the CEB investors provide $E_{T_1} = F_B - (1-T)\,V$ of contingent line. In the long-run the bank will be required to replace this amount with T1 securities (equity or CoCo bond) to bring the T1 ratio back up to T. As they do so this contingent line will be drawn down. As this contingent line is kept off-balance sheet, the total balance sheet remains at V and the positions and losses of all stakeholders remain the same as in the $\frac{F_B}{1-T} < V \leq \frac{F}{1-\tau}$ case above.

- For $V \leq \frac{F_B}{1-\underline{E}}$, the whole of CoCo bond is converted, i.e. $D_C = 0$, $E_C = (\underline{E} - \tau)\,V$ and $L_C = F - (\underline{E} - \tau)\,V$. As above the CEB investors take over the original equityholders' position, and therefore $E_E = 0$, $L_E = V_0 - F$ and $E_{CEB} = \tau V$. To cover the remaining loss, the vanilla bonds are forced to be written down, with $D_B = (1-\underline{E})\,V$ and $L_B = F_B - (1-\underline{E})\,V$. Additionally, the CEB investors provide the contingent line of $E_{T_1} = (T - \underline{E})\,V$ off-balance sheet.

Thus,

V	$\left[0, \frac{F_B}{1-\underline{E}}\right]$	$\left(\frac{F_B}{1-\underline{E}}, \frac{F_B}{1-T}\right]$	$\left(\frac{F_B}{1-T}, \frac{F}{1-\tau}\right]$	$\left(\frac{F}{1-\tau}, V_0\right)$	$[V_0, \infty]$
D_B	$(1-\underline{E})V$	F_B	F_B	F_B	F_B
D_C	0	$(1-\underline{E})V-F_B$	$(1-\underline{E})V-F_B$	F_C	F_C
E_C	$(\underline{E}-\tau)V$	$(\underline{E}-\tau)V$	$(\underline{E}-\tau)V$	0	0
E_E	0	0	0	$V-F$	$V-F$
E_{CEB}	τV	τV	τV	0	0
E_{T_1}	$(T-\underline{E})\,V$	$F_B-(1-T)\,V$	0	0	0
L_B	$F_B-(1-\underline{E})\,V$	0	0	0	0
L_C	$F_C-(\underline{E}-\tau)\,V$	$F-(1-\tau)\,V$	$F-(1-\tau)\,V$	0	0
L_E	V_0-F	V_0-F	V_0-F	$V_0-V>0$	$V_0-V<0$
Notes	All CoCo converted. D_B written down.	T breached. CoCo partially converted. Contingent line provided off-balance sheet.	τ breached. CoCo partially converted.	τ not breached. E_E written down.	Balance sheet expanding.

The summarised payoffs are,

$$
\begin{aligned}
D_B &= \min\left[(1-\underline{E})\,V, F_B\right] \\
D_C &= \max\left[(1-\underline{E})\,V - F_B, 0\right] + \left[F - (1-\underline{E})\,V\right]\chi_{V>\frac{F}{1-\tau}} \\
E_C &= (\underline{E}-\tau)\,V\chi_{V\leq\frac{F}{1-\tau}} \\
E_E &= (V-F)\,\chi_{V>\frac{F}{1-\tau}} \\
E_{CEB} &= \tau V\chi_{V\leq\frac{F}{1-\tau}} \\
E_{T_1} &= (1-T)\max\left[\frac{F_B}{1-T} - V, 0\right] - (1-\underline{E})\max\left[\frac{F_B}{1-\underline{E}} - V, 0\right].
\end{aligned}
$$

By letting $V_0 = 110$, $F_B = 80$, $F_C = 10$, $\tau = 7\%$, $\underline{E} = 10\%$ and $T = 14\%$, $\frac{F}{1-\tau} = 96.77$, $\frac{F_B}{1-T} = 93.02$ and $\frac{F_B}{1-\underline{E}} = 88.89$. Then,

V	80.0	85.0	88.89	90.0	93.2	95.0	96.77	100.0	105.0	110.0
D_B	72.00	76.50	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00
D_C	0	0	0	1.00	3.72	5.50	7.09	10.00	10.00	10.00
E_C	2.40	2.55	2.67	2.70	2.79	2.85	2.90	0	0	0
E_E	0	0	0	0	0	0	0	10.00	15.00	20.00
E_{CEB}	5.60	5.95	6.22	6.30	6.51	6.65	6.77	0	0	0
E_{T_1}	3.20	3.40	3.55	2.60	0	0	0	0	0	0
L_B	8.00	3.50	0	0	0	0	0	0	0	0
L_C	7.60	7.45	7.33	6.30	3.49	1.65	0	0	0	0
L_E	20.00	20.00	20.00	20.00	20.00	20.00	20.00	10.00	5.00	0
CT1 ratio	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	14.3%	18.2%
T1 ratio	10.0%	10.0%	10.0%	11.1%	14.0%	15.8%	17.3%	20.0%	23.8%	27.3%

B. P/B Ratio

Let the bank's return on equity (ROE) be R, and its net income and book value at time t be NI_t and BV_t, respectively. Assume that R is constant over time. Then,

$$R = \frac{NI_t}{BV_t} = \frac{NI_{t+1}}{BV_{t+1}}. \tag{18}$$

Now at t, NI_t is split into dividend d_t and retained earnings RE_t. Then $BV_{t+1} = BV_t + RE_t$. The growth rate g is that of the net income, i.e.

$$g = \frac{NI_{t+1}}{NI_t} - 1 = \frac{BV_{t+1}}{BV_t} - 1 = \frac{RE_t}{BV_t}. \tag{19}$$

The second equality uses (18), while the third equality results from substituting for BV_{t+1}. Therefore $RE_t = g.BV_t$ and similarly $RE_{t+1} = g.BV_{t+1}$. Now from Gordon Growth Model the market value at t is,

$$MV_t = \frac{d_{t+1}}{k-g}, \tag{20}$$

where k is the bank's cost of equity (COE). Then,

$$MV_t = \frac{NI_{t+1} - RE_{t+1}}{k-g} = \frac{NI_{t+1} - g.BV_{t+1}}{k-g} = \left(\frac{R-g}{k-g}\right) BV_{t+1} = \left(\frac{R-g}{k-g}\right)(1+g)\, BV_t. \tag{21}$$

Hence,

$$\frac{MV_t}{BV_t} = \left(\frac{R-g}{k-g}\right)(1+g).$$

C. Equity Risk Premium

Fig 11 is an example of the estimated UK ERP according to the UK utility regulator Ofcom, while Fig 12 shows the difference between the historical ERP of the UK and the world.

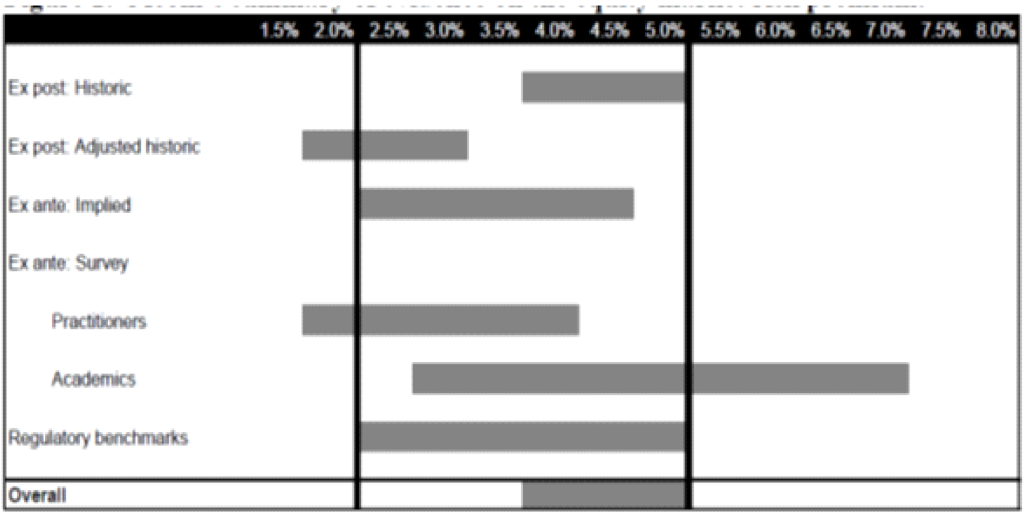

Figure 11: Source: Evidence on the equity market risk premium, Cooper (2005)

	UK	World
Method A:		
Historical geometric mean premium vs bills[1]	4.3	4.6
Adjustment (market re-rating)[2]	0.3	0.8
Adjusted geometric mean premium vs bills	4.0	3.8
Adjustment (geometric to arithmetic)[2]	2.0	1.3
Forecast relative to bills	6.0	5.1
Bond minus bill premium[1]	0.7	0.9
Forecast relative to bonds (A)	**5.3**	**4.2**
Method B:		
Arithmetic premium relative to bonds[1]	5.3	5.1
Adjustment (market re-rating)[2]	0.3	0.8
Forecast relative to bonds (B)	**5.0**	**4.3**

Figure 12: Source: Dimson and Hanke (2004)