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Abstract

This paper investigates three consequences of the new financial regulation: the agency costs, the monitoring costs and the effect on banks' cost of capital. For the first, the shareholders' behaviour is analysed as a trade-off between the value of the bank and its volatility by using an indifference curve model of the bank's choice of optimal risk. While the first-best optimal risk maximises the value of the bank, the shareholders select sub-optimally high risks under bail-in structures. This leads to both the wealth transfer and the value destruction agency costs. For the second, as a result of these consequences of the DAPR (Deviation from the Absolute Priority Rule) the bondholders are forced to closely monitor the bank behaviour. Requiring higher rate of return for higher risk, reflecting the costs of monitoring, is shown to alleviate the agency problems. Different types of covenants are proposed as an efficient way of implementing this solution. For the third, the impact of

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the new bail-in structure and the monitoring costs on the WACC of 16 largest European banks is estimated, and is shown to increase the cost of capital by between 75% and 110%.

JEL Classification: D82; G21; G28; G32

Keywords: Indifference curves, CoCo, Bail-in, Covenants, WACC

1 Introduction

The new financial regulation aims to impose losses on bondholders on a going concern basis. This new regime, bail-in using contingent convertible (CoCo) bonds, where bondholders assume losses before the equity is fully depleted, is an implementation of the Deviation from the Absolute Priority Rule (DAPR).[1] This paper investigates two consequences of this implementation: the agency costs and the impact on the banks' cost of capital.

The introduction of DAPR implies that the shareholders' incentive to extract wealth via "looting" or to undertake "gamble-for-resurrection" (the traditional "risk-shifting" or over-investment problem) is aggravated as the bank's balance sheet deteriorates, since they know their maximum loss is limited at the CoCo trigger (if the bond is a write-down/off type) or with further dilution (if the CoCo is an equity-conversion type).[2] This gives rise to agency costs of wealth transfer and value destruction as the bank's solvency deteriorates and heads towards the PONV (Point of Non Viability). We extend our previous analyses of these agency costs in Hori and Martin Ceron (2014) by developing an optimal volatility model of firms using shareholders' indifference curves. This enables us to propose a solution to alleviate the agency problem.

More specifically, as demonstrated in Hori and Martin Ceron (2014), the agency problem can be construed as a sale of an option structure from the bondholders to the shareholders, where the buyer of the option, the shareholders, have the right to choose its volatility. The question that can be asked is then what the chosen level of volatility is, and how it is affected

[1] The Absolute Priority Rule (APR) is where the shareholders lose all their holdings before the bondholders are affected, as in the theoretical write-down of losses. DAPR deviates from this by imposing losses on the bondholders before the shareholders are completely wiped out.

[2] As underscored by Hori and Martin Ceron (2014), the equity-conversion CoCo bond is a NADES (Non-Admissible Debt to Equity Swap), and thus the dilution of shareholders is lower than it would be if they had to issue private equity at distressed share price levels at such low solvency levels.

by the new bail-in structures. The vast theory of firm literature does not tell us how a firm selects its optimal level of risk. Under the Absolute Priority Rule (APR) the shareholders have a payoff structure that is a call option (their loss is limited to their current position, while the potential income upside is unbounded). The positive vega position[3] of an option means that the value of the shareholders' position increases as the volatility increases. There is, however, no solution to the shareholders' optimal risk selection problem. In this paper, we develop a model of firm where a firm's activities are a portfolio of correlated projects, with uncertain future values and independent project-specific risks. Analogous to Markowitz's portfolio theory, there is a concave risk-future value "portfolio frontier" (here termed "project plans"). The crucial point is that the future values are discounted at the required rate of return for the associated risk, leading to better diversified project plans to be discounted at a lower rate. This results in a trade-off between the present value of the firm, V_0, and its associated risk, σ. The first-best optimal choice of risk maximises the value of the firm. The shareholders' choice of risk is determined by their indifference curves that is a loci of the pairs (V_0, σ) that yields the same present value of their position. They choose the highest indifference curve that is feasible with the firm's possible project plan, given by the one that is tangent to the project plans curve. Different bail-out / bail-in structures have different set of indifference curves, with steeper indifference curves yielding higher optimal risk choices. Our analysis shows that higher leverage means higher risk choice, and for reasonable levels of leverage, the shareholders choose risks in the ascending order for the cases of expropriation (where the shareholders are completely wiped out as the government takes over the firm), government bail-out, and bondholder bail-ins with equity-conversion CoCo bond and write-off CoCo bond, respectively. The choice of higher volatility means a transfer of wealth from bondholders to shareholders (from the seller of the option to the buyer), while the sub-optimal solution (i.e. non-value maximising) means value destruction.

Given this result, the next question asked is whether there is a way of alleviating the shareholders' incentive for high risk-taking. Using the above model, we are able to show that by imposing higher required rate of return for higher risk-taking, the shareholders will rationally

[3]The sensitivity of the value of an option, C, with respect to the volatility of the underlying asset price, σ, i.e. $Vega = \frac{\partial C}{\partial \sigma}$.

reduce the risk-level chosen. In policy terms this is analogous to Pigovian tax. The agency costs are the negative externality of shareholders' actions on the remaining stakeholders of the bank. By implementing higher costs on their action, the regulators can force the shareholders to select less risky choice. Alternatively, leaving it to the bondholders, this is akin to them demanding higher cost of debt, compensating them for their cost of closely monitoring the credit quality of the firm. The monitoring efforts that the bondholders are forced to bear due to their exposure to going concern losses translate into a cost that will be borne by the shareholders in the end via a higher cost of capital. This fact has been overlooked by the regulator and the market so far.

So how do we implement this idea in practice? We believe that the most efficient way for bondholders to monitor the credit quality and risk-taking profile of the bank is through the utilisation of covenants, mirroring the practice in the corporate bond market. Here we propose different types of covenants within the CoCo indentures as ways of tackling agency costs. When the firm's solvency is reasonably high, we propose a "ratchet" coupon financial accounting covenant. With a rise in the leverage ratio the ratchet is triggered, automatically increasing the cost of debt and the return on equity of the firm. Both the concave nature of the shareholders' return on equity (at each ratchet trigger point there is a step down in the ROE), and the higher cost of capital once triggered (as suggested above) discourage shareholders from taking higher risk. We show that this type of covenants are effective when the firm's solvency is high, but loses its effectiveness as the firm's balance sheet approaches the critical points (CoCo trigger or the PONV). Theoretically this is due to the quasi-concave nature of the indifference curves (the curve turns less concave, and eventually convex, at the low V_0 / high σ end); intuitively, near the critical point the allure of "gamble-for-ressurection" negates the positive effect of the ratchet coupon covenant. Therefore we suggest the use of this type of covenant at the CoCo bond inception while the solvency is high. In the falling solvency scenario we propose a different type of covenants, specifically asset sweep and debt sweep covenants. In the former the asset is partially sold off to pay down some of the debt, while in the latter newly issued debt is used to repay existing debts. Both discourage (or prevent, in the debt sweep case) shareholders from piling on more debt to attempt "gamble-for-ressurection". The mechanisms of both of these types of covenants are outlined in detail in the text.

In Hori and Martin Ceron (2014) we argued that the high vega and the low delta[4] of the shareholders' value for the CoCo bond bail-in structures implied that the agency costs are higher under these than under expropriation (i.e. no bail-out / bail-in). Here, we also argue that the steeper indifference curves for the CoCo bail-in (which again is due to higher vega and lower delta, as the slope of indifference curves is the negative of the ratio of vega to delta) means that there is higher wealth transfer and value destruction. However these analyses are undertaken assuming equal cost of capital under all structures. How the new bail-in structure affects banks' WACC is the second consequence of the Basel III regulation that we investigate in this paper. Admati, DeMarzo, Hellwig and Pfleiderer (2011) argue that higher equity requirements under the new regulation would lower both the cost of equity and the cost of debt, and therefore despite the change in the funding mix (more equity which has the higher cost), the weighted-average cost of capital (WACC) should remain unchanged. In contrast, we believe that the WACC would meaningfully rise on the back of bail-in (especially at the senior debt level) and the monitoring costs (throughout the entire unsecured debt). To demonstrate this, we estimate the pre- and post-Basel III WACC for the 16 largest European banks using the September 2014 quarterly reports and the market data as of beginning of October 2014, under sensible assumptions. A sensitivity analysis is then undertaken to test the robustness of the results on our assumptions. This yields a range of possible WACC estimates which are 75% to 110% higher than the current WACC level.[5] This will have effects on the behaviours of the bank, some of which are discussed in the concluding remarks.

So far the literature on agency costs associated with CoCo bond bail-in has focused mainly on highlighting the over-investment problem (for example Berg and Kaserer (2011), Hori and Martin Ceron (2014), Koziol and Lawrenz (2012), Pennacchi, Vermaelen and Wolf (2014) and Hilscher and Raviv (2014)). None of these consider bondholders' monitoring cost, which is ultimately borne by shareholders via higher cost of capital, as a mean to alleviate the agency problem. Jensen and Meckling (1976) investigates the role of monitoring cost in the context

[4] The sensitivity of the value of an option, C, with respect to the price of the underlying asset price, S, i.e. $\Delta = \frac{\partial C}{\partial S}$.

[5] The argument goes as follows. Despite banks having the incentive to issue secured debt (out of the scope of Bail I), they still have to issue unsecured debt which falls within the Total Loss Absorbing Capacity (TLAC) ratio and issue long term debt to meet the Net Stable Funding Ratio (NSFR). This comes at a cost that filters through to the overall cost of debt, which we believe will outweigh the supposedly lower cost of equity.

of a trade-off between firm value and non-pecuniary benefit for the managers of a firm. Their indifference curve analysis is akin to the one developed here. In a wider sense, our model contributes to the broader literature of theory of firm, in successfully answering the question: "How does a firm decide its optimal risk?" Whereas previous works point out the positive vega of the shareholders' position as the root of a firm's over-investment problem (e.g. Eberhart and Senbet (1993), Berg and Kaserer (2011), Hori and Martin Ceron (2014)), which leaves the question of "Then why do firms not keep increasing its risk-taking?", our optimal volatility model is able to answer this question specifically which leads to concrete policy suggestions.

The paper is structured as follows. Section 2 develops the optimal volatility model using indifference curves, to show that bail-out / bail-in structures result in higher risk-taking by the shareholders and higher value destruction for the firm. This is shown to be alleviated if higher required rate of return can be applied to higher risk-taking behaviour. In doing so, we emphasise the role that bondholders' monitoring costs will play as a result of the introduction of the bail-in structures. In Section 3 we suggest a practical way of implementing this by proposing financial and non-financial covenants in the CoCo bond indenture. In Section 4 we estimate the post-Basel III WACC for a sample of banks given the new solvency and liquidity rules within the bail-in framework, to show that the cost of capital of the banks is poised to rise sharply. Finally, Section 5 gives concluding remarks.

2 Indifference Curve Analysis

Consider a bank that raises fund by equity and debt. The fund is invested in a portfolio of projects, whose outcomes are uncertain. Then for risk-averse investors, the present value of the bank's asset value is estimated using an appropriate risk-adjusted discount rate. The optimal portfolio decision is then dependent on the risk-return profiles of the feasible project mixes. In particular there may be a trade-off between higher risk-taking, leading to a possible higher expected outcome at maturity, and higher discounted rate. There is, so far, nothing in the literature that suggests how the bank selects its optimal portfolio under such scenario.

Here we build a model of a simple bank with two possible investment projects with uncertain outcomes. Assuming sufficiently low correlation between the two outcomes, there is a risk-diversification effect in choosing a portfolio of the two projects. This results in a higher present value of the portfolio due to a lower risk-adjusted rate required for discounting. Under a simple condition then there exists an interior solution to the bank's maximum value, which is the bank's first-best choice of portfolio. However the decision of portfolio selection is taken by the shareholders, whose convex payoff structure (they gain fully from the bank's success, but their loss is limited) means that their optimisation behaviour of the value of their holdings would lead to a sub-optimal choice of portfolio selection. This can be analysed using an indifference curve model, similar to that adopted by Jensen and Meckling (1976) in their analysis of monitoring of the behaviour of the managers with non-pecuniary benefits. The indifference curves describe the trade-off between risk (volatility) and value, as described above, and are therefore downward-sloping. The curves are also quasi-concave in shape: it is concave when the value of the bank is high, while it becomes convex as the solvency drops towards the Point of Non Viability (PONV), particularly when a bail-out or a bail-in would put a floor to the value of the shareholders' position. The shareholders' choice of portfolio is given by the tangent point between the bank's possible project portfolio frontier and their highest attainable indifference curve. The choice of the second-best portfolio results in a lower present value of the bank's asset value, as well as a transfer of value from the bondholders to the shareholders due to higher risk taken. These represent the two types of agency costs, namely the value destruction and the wealth transfer. We analyse these under different restructuring scenarios of expropriation (i.e. no bail-out or bail-in), government bail-out with preference / ordinary shares, bail-in with equity-conversion CoCo bonds and bail-in with write-off CoCo bonds.

The set-up differs from the traditional models in two ways. Firstly, it assumes the distribution of possible future outcomes of projects to be given, which is then discounted to today to estimate the present values. Thus the choice of projects affect the present value, not only through the chosen expected future value, but also via its effect on the required discount rate. This differs from the Merton (1974) set-up, where the future values of a security is given as a distribution of outcomes given today's value of the security.[6] Secondly the model contrasts with

[6] Jensen and Meckling (1976) make the same point when they state, "While we used the option pricing model above to motivate the discussion and provide some intuitive understanding of the incentives facing the equity holders, the option pricing solutions of Black and Scholes (1973) do not apply when incentive effects cause V to be a function of the debt/equity ratio as it is in general and in this example. Long (1974) points out this

the CAPM set-up where the securities are priced assuming that all of idiosyncratic risk have been diversified away, which cannot be assumed for the limited number of possible projects available to a bank.

2.1 Bank's Project Plans

The bank has two possible projects, $i = 1, 2$, both of which mature at T. Their expected value and variance are given by $E\left[V_T^i\right]$ and σ_i^2, with correlation ρ. A "project plan" is given by the weights $(w, 1-w)$ of the two projects, and has the expected value and the variance,

$$\begin{aligned} E\left[V_T(w)\right] &= wE\left[V_T^1\right] + (1-w)\,E\left[V_T^2\right] \\ \sigma^2(w) &= w^2\sigma_1^2 + (1-w)^2\,\sigma_2^2 + 2w\,(1-w)\,\rho\sigma_1\sigma_2. \end{aligned} \tag{1}$$

Assume project 1 is riskier than project 2, i.e. $E\left[V_T^1\right] > E\left[V_T^2\right]$ and $\sigma_1 > \sigma_2$. Then in minimising $\sigma^2(w)$ with respect to $w \in (0,1)$, for low enough ρ, namely $\rho \in \left[-1, \frac{\sigma_2}{\sigma_1}\right)$, there exists a minimum-variance plan $w_{\min}$ with $\sigma_{\min} < \sigma_2$ given by,

$$\begin{aligned} w_{\min} &= \tfrac{\sigma_2^2 - \rho\sigma_1\sigma_2}{\sigma_1^2+\sigma_2^2-2\rho\sigma_1\sigma_2} \\ \sigma_{\min} = \sigma\left(w_{\min}\right) &= \tfrac{\left(1-\rho^2\right)\sigma_1^2\sigma_2^2}{\sigma_1^2+\sigma_2^2-2\rho\sigma_1\sigma_2}. \end{aligned} \tag{2}$$

Project plans $w \in [w_{\min}, 1]$ then represent the set of efficient plans, with $\sigma \in [\sigma_{\min}, \sigma_1]$. In this region then,

$$\frac{d\sigma}{dw} > 0 \text{ for } \sigma \in (\sigma_{\min}, \sigma_1] \tag{3}$$

where

$$\frac{d\sigma}{dw} = \frac{1}{\sigma}\left[w\sigma_1^2 - (1-w)\,\sigma_2^2 + (1-2w)\,\rho\sigma_1\sigma_2\right]. \tag{4}$$

Fig 1 depicts the graph of $E\left[V_T\right]$ for different values of $w \in [0,1]$, with its minimum-variance plan and the efficient plans on the upper branch.

The bank discounts the chosen project plan at the risk-adjusted rate $r\left(w, \sigma(w)\right)$, where

difficulty with respect to the usefullness of the model in the context of tax subsidies on interest and bankruptcy cost. The results of Merton (1974) and Galai and Masulis (1976) must be interpreted with care since the solutions are strictly incorrect in the contect of tax subsidies and/or agency costs."

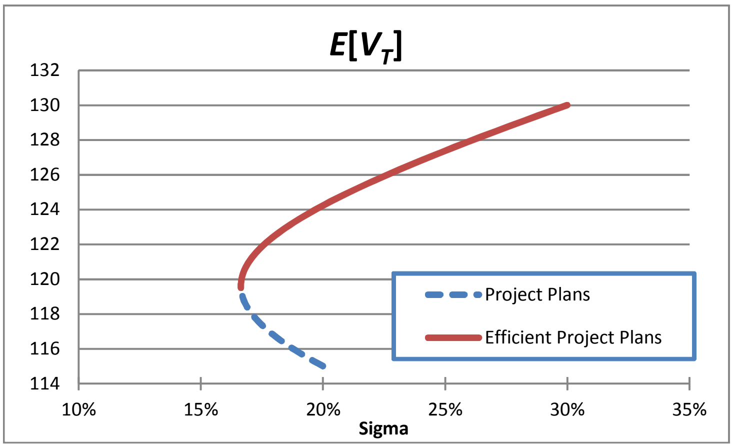

Figure 1: Expected bank value $E[V_T]$ for different values of w

$\frac{dr}{d\sigma} > 0$. The current market value of the bank is then given by,

$$V_0(w) = e^{-r(w,\sigma(w))T} E[V_T(w)]. \tag{5}$$

2.2 The First-best Optimal Plan

The first-best optimal plan for the bank is w^* such that

$$w^* = \arg \max_{w \in [w_{\min},1]} V_0(w). \tag{6}$$

To find the optimal plan we compute and equate to zero the derivative,

$$\frac{dV_0}{dw}(w) = -T\frac{dr}{dw} e^{-r(w,\sigma(w))T} E[V_T(w)] + e^{-r(w,\sigma(w))T} \left(E\left[V_T^1\right] - E\left[V_T^2\right]\right). \tag{7}$$

To rule out corner solutions, we require $\frac{dV_0}{dw}(w_{\min}) > 0$ and $\frac{dV_0}{dw}(1) < 0$. In particular, for the case $r(w,\sigma(w)) \equiv r(\sigma(w)) \Rightarrow \frac{dr}{dw} = \frac{dr}{d\sigma}\frac{d\sigma}{dw}$, as $\frac{d\sigma}{dw} = 0$ at $w = w_{\min}$,

$$\frac{dV_0}{dw}(w_{\min}) = e^{-r(\sigma_{\min})T} \left(E\left[V_T^1\right] - E\left[V_T^2\right]\right) > 0. \tag{8}$$

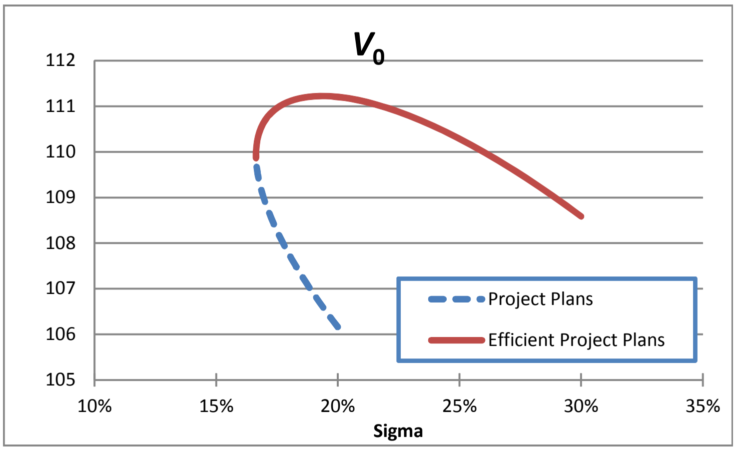

Figure 2: Bank's present value V_0 for different values of w

As this is strictly positive the solution cannot be at this point, i.e. $w^* > w_{\min}$. At $w = 1$, as then $E\left[V_T(1)\right] = E\left[V_T^1\right]$, $\sigma(1) = \sigma_1$ and $\frac{d\sigma}{dw}(1) = \sigma_1 - \rho\sigma_2$,

$$\frac{dV_0}{dw}(1) = e^{-r(1,\sigma_1)T}\left[-T\frac{dr}{d\sigma}\left(\sigma_1 - \rho\sigma_2\right)E\left[V_T^1\right] + \left(E\left[V_T^1\right] - E\left[V_T^2\right]\right)\right]. \tag{9}$$

Then for an interior solution w^* that satisfies

$$\frac{dV_0}{dw}(w^*) = 0, \tag{10}$$

we require $\frac{dV_0}{dw}(1) < 0$, i.e.

$$\frac{E\left[V_T^1\right] - E\left[V_T^2\right]}{T\left(\sigma_1 - \rho\sigma_2\right)E\left[V_T^1\right]} < \frac{dr}{d\sigma}(1). \tag{11}$$

What condition (11) implies is that, for an internal solution, the project plan risk needs to be sufficiently costly (the right-hand side is large), or else the bank would simply choose $w^* = 1$, i.e. only invest in the project with the highest expected value. Fig 2 depicts the graph of the present value V_0. The optimal plan w^* is given by the curve's maximum point.[7]

[7]Fig 2 is simluated using the linear average market price of risk case given in Example 2.

Example 1 (Constant Market Price of Risk)

$$r(w, \sigma(w)) = r_f + \lambda\sigma. \tag{12}$$

where λ *is the constant market price of risk and* r_f *is the market risk-free rate. Then* $\frac{dr}{dw} = 0$ *and* $\frac{dr}{d\sigma} = \lambda$ *and so an internal solution exists for* $\lambda > \frac{E[V_T^1] - E[V_T^2]}{T(\sigma_1 - \rho\sigma_2)E[V_T^1]}$.

Example 2 (Linear Average Market Price of Risk)

$$r(w, \sigma(w)) = r_f + \lambda(w)\,\sigma(w). \tag{13}$$

where $\lambda(w)$ *is given by the weighted average of the respective market prices of risk of the two projects,* λ_1 *and* λ_2*,*

$$\lambda(w) = w\lambda_1 + (1 - w)\,\lambda_2. \tag{14}$$

For our numerical analyses in this section we use the linear average market price of risk given in Example 2.

2.2.1 Discussion: CAPM

As opposed to the above example, in the Capital Asset Pricing Model (CAPM) the risk-adjusted rate of return is linear in w,

$$r(w) = wE[r_1] + (1 - w)\,E[r_2] = r_f + [w\beta_1 + (1 - w)\,\beta_2]\,MRP \tag{15}$$

where MRP is the market risk premium $MRP = E[r_M] - r_f$ and $E[r_M]$ is the expected market return rate. In this case then, $\frac{dr}{dw} = (\beta_1 - \beta_2)\,MRP$, and so,

$$\frac{dV_0}{dw}(w) = -T(\beta_1 - \beta_2)\,MRP\; e^{-r(w)T}E[V_T(w)] + e^{-r(w)T}\left(E\left[V_T^1\right] - E\left[V_T^2\right]\right), \tag{16}$$

for which,

$$\begin{aligned}
\frac{dV_0}{dw}(1) &= -T(\beta_1-\beta_2)\,MRP\; e^{-E[r_1]T}E\left[V_T^1\right]+e^{-E[r_1]T}\left(E\left[V_T^1\right]-E\left[V_T^2\right]\right)\\
&= \left[1-T(\beta_1-\beta_2)\,MRP\right]e^{-E[r_1]T}E\left[V_T^1\right]-e^{-E[r_1]T}E\left[V_T^2\right]\\
&\approx e^{-T(\beta_1-\beta_2)MRP}\left(e^{-E[r_1]T}E\left[V_T^1\right]-e^{T(\beta_1-\beta_2)MRP}e^{-E[r_1]T}E\left[V_T^2\right]\right)\\
&= e^{-T(\beta_1-\beta_2)MRP}\left(V_0^1-V_0^2\right).
\end{aligned} \tag{17}$$

This is positive assuming $V_0^1 > V_0^2$. Hence there is no internal solution for the optimal plan for the bank. Specifically, the bank would always simply choose the riskier project 1.

The reason for this is that, with CAPM, the project-specific idiosyncratic risks are assumed to have been diversified away. In contrast in the constant and linear average λ examples, for ρ low enough there is enough risk-diversification effect, such that a combination of the two projects would have higher present value than the present values of the single projects due to the lower risk-adjusted discount rate.

2.3 Shareholders' Choice of Risk

In the above section we established the bank's first-best choice of risk. However it is the shareholders who choose the bank's project plan. In this section we investigate their choice under different restructuring scenarios of expropriation, government bail-out, equity-conversion CoCo bond bail-in and write-off CoCo bond bail-in. For this we build a model of indifference curve analysis. The payoffs and the valuations under Merton (1974) framework for each of the restructuring scenarios are given in Appendix C, the derivations of which are given in detail in Hori and Martin Ceron (2015).

The simple firm considered is financed by equity capital and discount bonds with maturity T. The total face value of the bonds is F, which may include equity-conversion CoCo bond (face value F_C) or write-off CoCo bond (face value F_W). The face value of the plain vanilla bond is F_B. Therefore the firm can either have $F = F_B$ (expropriation or government bail-out), $F = F_B + F_C$ (equity-conversion CoCo bond bail-in) or $F = F_B + F_W$ (write-off CoCo bond bail-in). The total asset value at time T is V, which is split between the stakeholders. The bail-in bonds trigger at the capital ratio of τ. There is a minimum capital ratio of $\underline{E}$, applied to both preference and ordinary shares, which the regulators insist on after a rescue. Similarly, where the rescue is in the form of preference shares, there is a minimum common equity floor of $\underline{E_C}$ for ordinary shares.

2.3.1 Expropriation

Expropriation occurs when there is no bail-out or bail-in by either the government or the bondholders. All of the loss incurred is therefore borne firstly by the shareholders, then by the bondholders, according to the Absolute Priority Rule (APR). As stated, we assume there to be a minimum capital ratio, $\underline{E}$, under which the government injects capital in order to restore the balance sheet to $\frac{F}{1-\underline{E}}$. The payoffs to the shareholders and bondholders at time T in this no bail-out / bail-in scenario is well established in the literature. Specifically, the shareholders' payoff equals the call option payoff with strike price F, the value of which is given by the familiar Black-Scholes option pricing formula,

$$V_E^N = C(F) \tag{18}$$

where $C(K)$ is the value of a call option with strike price K given by,

$$\begin{aligned} C(K) &= V_0 N(d_1(K)) - Fe^{-rT} N(d_2(K)) \\ \text{with} \quad d_1(K) &= \frac{\ln\left(\frac{V_0}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} \text{ and } d_2(K) = d_1(K) - \sigma\sqrt{T}. \end{aligned} \tag{19}$$

σ is the volatility of the plan chosen and r is the risk-free rate. The superscript N indicates the case of no bail-out / in.

The shareholders' *indifference curves* (ICs) are defined as the loci of pairs (V_0, σ) that yields the same value of V_E^N, i.e. all values of V_0 and σ such that,

$$V_E^N(V_0, \sigma) = V \tag{20}$$

for a given value of V. We list some properties of the ICs:

Properties 1 (Shareholders' Indifference Curves) *The ICs have the following properties:*

1. *The ICs are downward-sloping.*

2. *The ICs are quasi-concave.*

3. *Given V_E^N, the IC steepens as F increases, pivoted at $\sigma = \infty$.*

Proof. From the definition of the ICs,

$$\begin{aligned} dV_E^N &= \tfrac{\partial V_E^N}{\partial V_0} dV_0 + \tfrac{\partial V_E^N}{\partial \sigma} d\sigma = 0 \\ \Leftrightarrow \tfrac{dV_0}{d\sigma} &= -\tfrac{\partial V_E^N / \partial \sigma}{\partial V_E^N / \partial V_0} = -\tfrac{vega^N}{\Delta^N} = MRS^N. \end{aligned} \tag{21}$$

MRS is the marginal rate of substitution between V_0 and σ along the IC, and,

$$\begin{aligned} \Delta^N &= N(d_1) \\ vega^N &= V_0 \sqrt{T} N'(d_1). \end{aligned} \tag{22}$$

Immediately, ICs are downward-sloping as both Δ^N and $vega^N$ are strictly positive,

$$MRS^N = -\frac{V_0 \sqrt{T} N'(d_1)}{N(d_1)} < 0. \tag{23}$$

To check the curvature of the ICs, consider the limits of σ. First when it becomes large, using the limiting properties of call option values outlined in Properties B1 of Appendix B,

$$\lim_{\sigma \to \infty} V_E^N = V_0 \tag{24}$$

i.e. the shareholders' position approximates the asset value. Therefore at this point $\Delta = 1$ and $vega = 0$, and hence $MRS^N \to 0$ as σ becomes large. At the other limit when σ approaches zero,

$$\lim_{\sigma \to 0} V_E^N = \max\left[V_0 - Fe^{-rT}, 0\right]. \tag{25}$$

On an IC where $V_E^N > 0$ then, V_0 must unambiguously be greater than Fe^{-rT} as $\sigma \to 0$. Therefore, at this point the shareholders' position approximates the value of the forward $V_0 - Fe^{-rT}$, and thus again $\Delta = 1$ and $vega = 0$, making $MRS^N \to 0$ as $\sigma \to 0$. Given that $MRS^N < 0$ for $\sigma \in (0, \infty)$, the curves must therefore be quasi-concave.[8] Finally, as F increases V_0 has to adjust in order to keep V_E^N constant for given σ,

$$\begin{aligned} dV_E^N &= \frac{\partial V_E^N}{\partial F} dF + \frac{\partial V_E^N}{\partial V_0} dV_0 = 0 \\ \Leftrightarrow \frac{dV_0}{dF} &= -\frac{\partial V_E^N / \partial F}{\partial V_E^N / \partial V_0} = \frac{e^{-rT} N(d_2)}{N(d_1)} > 0 \text{ for } \sigma < \infty. \end{aligned} \tag{27}$$

Thus the IC shifts up. To show that this shift is a steepening of the curve pivoted at $\sigma = \infty$, note first that $\lim_{\sigma \to \infty} \frac{dV_0}{dF} = 0$. At any other values of σ,

$$\begin{aligned} \frac{dMRS^N}{dF} &= \frac{\partial MRS^N}{\partial F} + \frac{\partial MRS^N}{\partial V_0} \frac{dV_0}{dF} \\ &= \left[-\frac{V_0}{F\sigma} \frac{N'(d_1)}{N(d_1)} \left(d_1 + \frac{N'(d_1)}{N(d_1)} \right) \right] + \left[\frac{N'(d_1)}{\sigma N(d_1)} \left(d_2 + \frac{N'(d_1)}{N(d_1)} \right) \right] \frac{e^{-rT} N(d_2)}{N(d_1)} \\ &= -\frac{N'(d_1)}{\sigma N(d_1)} \left[\frac{V_E^N}{F N(d_1)} \left(d_1 + \frac{N'(d_1)}{N(d_1)} \right) + \sigma \sqrt{T} \frac{e^{-rT} N(d_2)}{N(d_1)} \right] < 0. \end{aligned} \tag{28}$$

The final line is negative $\forall \sigma < \infty$ as each term within it are positive except for d_1, and $xN(x) + N'(x) > 0 \; \forall x$ which is shown in Property A2 of Appendix A. Thus the ICs steepens as F increases. ■

These properties are demonstrated in Fig 3. The shareholders' optimisation problem is the selection of the highest attainable indifference curve given project plans (5). Diagrammatically, the solution is given by the tangent point shown in Fig 4. The graph suggests that the shareholders would choose a higher risk project plan w^N than the bank's first-best choice w^*. More formally,

Proposition 1 *$w^N > w^*$.*

Proof. The shareholders' choice of the optimal project plan is determined by,

$$\max_{w \in [w_{\min}, 1]} V_E^N = C(F) \text{ subject to } V_0(w) = e^{-r(w, \sigma(w))T} E[V_T(w)]. \tag{29}$$

[8] The curvature of the ICs is given by,

$$\frac{d^2 V_0}{d\sigma^2} = \frac{\partial}{\partial \sigma}\left(\frac{dV_0}{d\sigma}\right) + \frac{\partial}{\partial V_0}\left(\frac{dV_0}{d\sigma}\right)\frac{dV_0}{d\sigma} = -\frac{V_0\sqrt{T}}{\sigma}\frac{N'(d_1)}{N(d_1)}\left[\left(\frac{N'(d_1)}{N(d_1)} + d_2\right)^2 + d_2\sigma\sqrt{T}\right]. \tag{26}$$

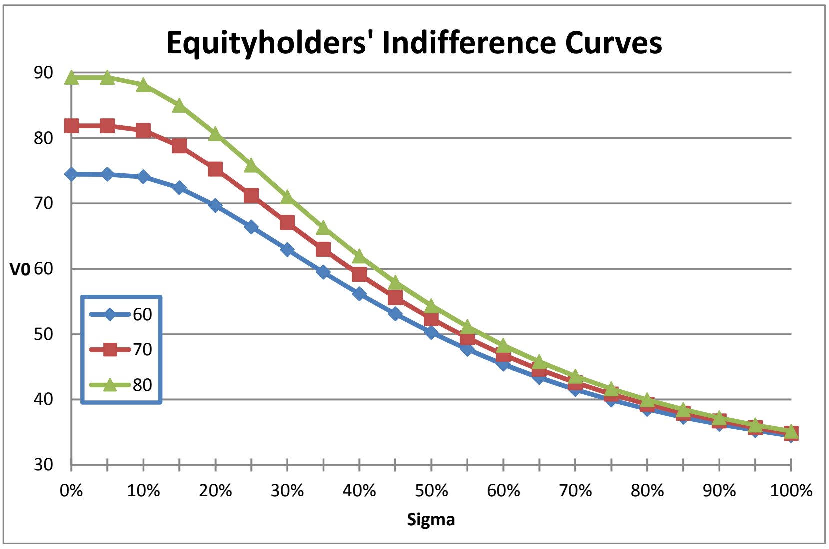

Figure 3: Equityholders' indifference curves for different debt levels F

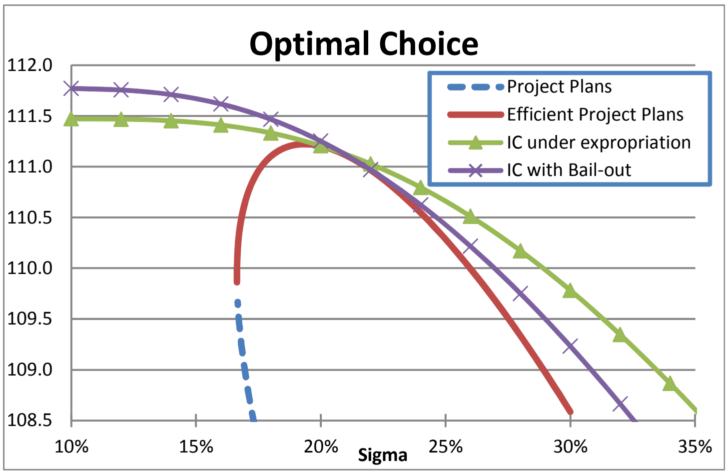

Figure 4: Shareholders' optimal choice with (i) no bail-out, and (ii) bail-out.

The solution w^N is the w that satisfies,

$$\frac{dV_E^N}{dw}(w) = \frac{\partial V_E^N}{\partial V_0}\frac{dV_0}{dw} + \frac{\partial V_E^N}{\partial \sigma}\frac{d\sigma}{dw} = N(d_1(F))\frac{dV_0}{dw}(w) + V_0\sqrt{T}N'(d_1(F))\frac{d\sigma}{dw}(w) = 0. \quad (30)$$

But at w^*, we know from (10) that $\frac{dV_0}{dw}(w^*) = 0$. On the other hand $\frac{d\sigma}{dw} > 0$ for $w \in [w_{\min}, 1]$, and hence $\frac{dV_E^N}{dw} > 0$ at w^*. Thus $w^N > w^*$. ■

The indifference curve analysis is particularly useful as it demonstrates clearly the agency costs associated with having the shareholders as the decision maker of firm's risk-taking. As proved the shareholders select a higher risk project plan w^N compared with the firm value maximising w^*. Immediately then, by shareholders optimising the value of their holdings and not that of the firm, it results in *value destruction* of the firm. This is one type of agency costs. The other type is the *wealth transfer*. The shareholders' position is a long call option as given above, the value of which increases with the increase in the risk chosen. In contrast the bondholders hold a short put option,

$$V_D^N = Fe^{-rT} - P(F) \quad (31)$$

where $P(K)$ is the value of a put option with strike price K given by,

$$P(K) = -V_0 N(-d_1(K)) + Fe^{-rT}N(-d_2(K)), \quad (32)$$

and $d_1(K)$ and $d_2(K)$ are given in (19). Put-call parity[9] implies that V_D^N decreases by the same amount as the increase in V_E^N with the increase in the risk. The shareholders' choice of w^N away from the first-best w^* therefore results in the wealth being transferred from the bondholders to the shareholders.

We can also state the following:

Proposition 2 *The risk-taking is higher, the higher the leverage.*

[9] The *put-call parity* states that, for a non-dividend paying underlying asset, the value of a call option plus a bond equals the value of a put option plus the underlying asset, i.e. $C(K) + Ke^{-rT} = P(K) + S$. As values of the bond or the underlying asset do not depend on the volatility of the underlying asset price, an increase in the volatility therefore must induce the same increase in the values of the call and the put options.

Proof. This follows immediately from the third property of Properties 1 - the steeper the IC, the further along to the right the tangent point is in Fig 4. ■

This implies higher agency costs for higher leveraged banks.

2.3.2 Government Bail-out

In the above expropriation case, in the worst case scenario both shareholders and bondholders would lose all of their holdings. Here the government bails out both stakeholders so that their positions are guaranteed at the minimum common equity floor $\underline{E_C}$ and F, respectively. Additionally, in order to attain the minimum capital ratio $\underline{E}$ the government makes a further capital injection of E_G and the balance sheet is restored to $\frac{F}{1-\underline{E}}$. This capital injection could be in the form of preference shares or ordinary shares.

As given in Appendix C the value of shareholders' position when there is government bail-out is,

$$\begin{aligned} V_E^{BO} &= \frac{F\underline{E_C}}{1-\underline{E}} e^{-rT} + C\left(F + \frac{F\underline{E_C}}{1-\underline{E}}\right) \\ &= C(F) + \left[P\left(F + \frac{F\underline{E_C}}{1-\underline{E}}\right) - P(F)\right]. \end{aligned} \tag{33}$$

where $C(K)$ and $P(K)$ are given by (19) and (32), respectively. The second line is derived using the put-call parity of Black-Scholes option pricing model, and it reflects better the government bail-out guarantee which is expressed as a long put bear spread, $P\left(F + \frac{F\underline{E_C}}{1-\underline{E}}\right) - P(F)$. As with the expropriation case the shareholders' choice can be investigated using their indifference curves:

Proposition 3 *The ICs are steeper for the bail-out case than for the expropriation case.*

Proof. Consider the ICs, IC^N and IC^{BO}, with the same values for shareholders $V_E^N = V_E^{BO} > 0$. First investigate what happens when $\sigma \to 0$. Applying Properties B1 in Appendix B,

$$\lim_{\sigma \to 0} V_E^N = \lim_{\sigma \to 0} V_E^{BO} = V_0 - Fe^{-rT} \tag{34}$$

Hence $V_0^N(0) = V_0^{BO}(0)$ at $\sigma = 0$, where $V_0^N(\sigma)$ and $V_0^{BO}(\sigma)$ are the values of V_0 required to attain a given shareholders' value V_E when the volatility is σ. For $\sigma > 0$, given that

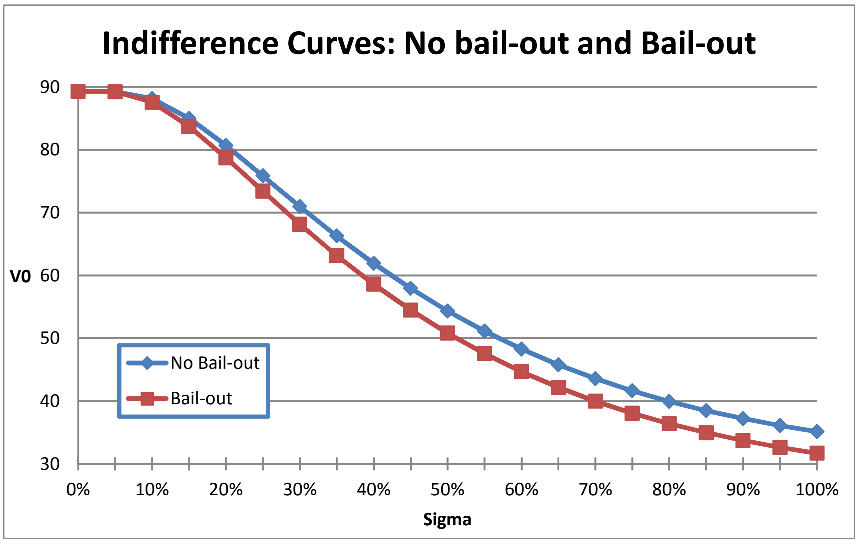

Figure 5: Shareholders' indifference curves for (i) no bail-out and (ii) government bail-out cases

$P\left(F+\frac{FE_C}{1-\underline{E}}\right) > P(F)$, if $V_0^N(\sigma) = V_0^{BO}(\sigma)$ then $V_E^N < V_E^{BO}$, strictly. Thus to have $V_E^N = V_E^{BO}$, it must be that $V_0^N(\sigma) > V_0^{BO}(\sigma)$. Hence IC^{BO} is below IC^N for $\sigma > 0$. ■

Fig 5 demonstrates this result. Now Fig 4 suggests that the shareholders would choose a higher risk project plan w^{BO} than w^N under the expropriation case,

Proposition 4 $w^{BO} > w^N$.

Proof. This time the shareholders' project plan choice w^{BO} is determined by,

$$\max_{w\in[w_{\min},1]} V_E^{BO} = \frac{FE_C}{1-\underline{E}}e^{-rT} + C\left(F+\frac{FE_C}{1-\underline{E}}\right) \text{ subject to } V_0(w) = e^{-r(w,\sigma(w))T}E\left[V_T(w)\right]. \tag{35}$$

The solution w^{BO} is the w that satisfies,

$$\begin{aligned} \frac{dV_E^{BO}}{dw}(w) &= \frac{\partial V_E^{BO}}{\partial V_0}\frac{dV_0}{dw} + \frac{\partial V_E^{BO}}{\partial \sigma}\frac{d\sigma}{dw} \\ &= N\left(d_1\left(F+\frac{FE_C}{1-\underline{E}}\right)\right)\frac{dV_0}{dw}(w) + V_0\sqrt{T}N'\left(d_1\left(F+\frac{FE_C}{1-\underline{E}}\right)\right)\frac{d\sigma}{dw}(w) = 0. \end{aligned} \tag{36}$$

But at w^N,

$$\frac{dV_E^{BO}}{dw}\left(w^N\right) = \left[-N\left(d_1\left(F+\frac{F\underline{\underline{E_C}}}{1-\underline{E}}\right)\right)\frac{N'\left(d_1\left(F\right)\right)}{N\left(d_1\left(F\right)\right)} + N'\left(d_1\left(F+\frac{F\underline{\underline{E_C}}}{1-\underline{E}}\right)\right)\right] V_0\sqrt{T}\frac{d\sigma}{dw}\left(w^N\right) \tag{37}$$

Here $\frac{dV_0}{dw}\left(w^N\right)$ was replaced using (30). As again $\frac{d\sigma}{dw} > 0$ for $w \in [w_{\min}, 1]$, this is positive if and only if,

$$\frac{N'\left(d_1\left(F+\frac{F\underline{\underline{E_C}}}{1-\underline{E}}\right)\right)}{N\left(d_1\left(F+\frac{F\underline{\underline{E_C}}}{1-\underline{E}}\right)\right)} > \frac{N'\left(d_1\left(F\right)\right)}{N\left(d_1\left(F\right)\right)}. \tag{38}$$

Given that $d_1\left(F+\frac{F\underline{\underline{E_C}}}{1-\underline{E}}\right) < d_1\left(F\right)$, this is true from Property A2. ■

Fig 6 demonstrates the effect of the government bail-out. On the graph three ICs are drawn together with the efficient project plans frontier: the IC under expropriation, and two ICs with government bail-out. Of the latter two, one intersects the project plans frontier at the tangent point of the expropriation IC, while the other is the tangent IC to the project plans frontier. Again, the graph demonstrates the steepening of the IC under the government bail-out scenario compared with the expropriation case. This is caused by the increase in the vega of the shareholders' position due to the possibility of the bail-out (recall in (21) that the slope of indifference curve is given by the ratio of the shareholders' vega to delta positions). The graph further shows, as a result of the steepening, that the shareholders would choose a higher risk but lower value project plan by shifting out onto a higher IC to the right. This demonstrates the aggravation of both value destruction and the wealth transfer agency costs compared with the expropriation scenario.

2.3.3 Equity-conversion CoCo Bond Bail-in

Next we consider contingent convertible bond structures. We begin with the equity-conversion CoCo bond. This is triggered to restore the capital ratio to the minimum level $\underline{E}$ when the pre-conversion capital ratio falls below τ. As opposed to the government bail-out case, there is no external capital injection and therefore the balance sheet remains depleted. It is assumed that when the CoCo bond is not enough to cover the loss incurred, then the regulator will exercise its bail-in power to convert the necessary plain vanilla debt into ordinary shares to restore

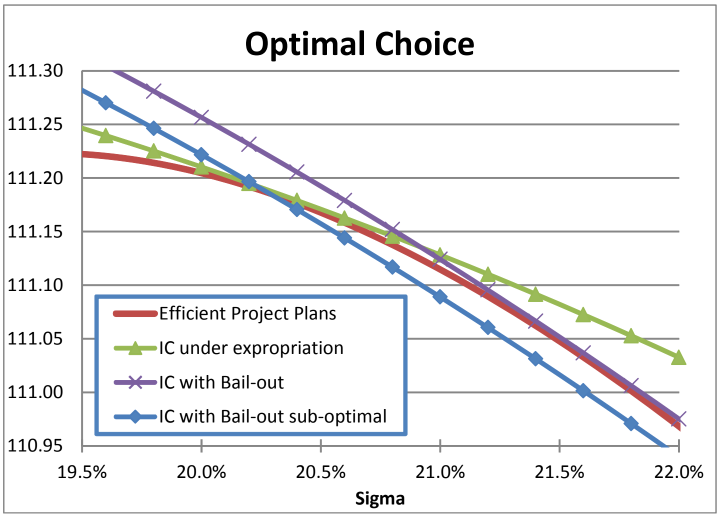

Figure 6: Wealth transfer and value destruction effects

solvency. The details of the shareholders' and bondholders' payoff schedules are discussed in Hori and Martin Ceron (2015).

As noted in Appendix C, the value of shareholders' position under equity-conversion CoCo bond bail-in is given by,

$$\begin{aligned} V_E^C &= \tau V_0 + (1-\tau) C\left(\tfrac{F}{1-\tau}\right) \\ &= C(F) + \left[(1-\tau) P\left(\tfrac{F}{1-\tau}\right) - P(F)\right]. \end{aligned} \tag{39}$$

The shareholders' project plan choice w^C is then determined by,

$$\max_{w \in [w_{\min},1]} V_E^C = C(F) + \left[(1-\tau) P\left(\frac{F}{1-\tau}\right) - P(F)\right] \text{ subject to } V_0(w) = e^{-r(w,\sigma(w))T} E[V_T(w)]. \tag{40}$$

Then,

Proposition 5 $w^C > w^N$.

Proof. Here we give an intuitive proof. (39) shows that the shareholders' position under equity-conversion CoCo bond bail-in is the expropriation position $V_E^N = C(F)$ plus a long put bear spread-like structure, $(1-\tau) P\left(\frac{F}{1-\tau}\right) - P(F)$. This latter structure represents the

CoCo bail-in guarantee. For the range of values of V_0 and F that we are interested the delta of this long put bear spread is negative. The vega of a put bear spread is always positive. This implies that $\Delta_E^C < \Delta_E^N$ and $Vega_E^C > Vega_E^N$. In (21) we derived that the slope of the IC is the MRS which is the negative of the ratio of vega to delta. Therefore MRS^C is more negative than MRS^N, implying a steeper IC under the equity-conversion CoCo bail-in than under expropriation. Thus $w^C > w^N$. ■

2.3.4 Write-off CoCo Bond Bail-in

Finally, we consider the write-off CoCo bond bail-in. As opposed to the equity-conversion CoCo bonds, for which partial conversion is possible, when the trigger occurs at the capital ratio of τ the whole of the write-off CoCo bond is immediately written off to cover the loss. It is unclear what happens in reality to the remainder of the written-off bond when the write-off more than covers the firm's loss. Here, it is assumed that this net amount is added to the shareholders' position as contingent capital reserve. As with the equity-conversion case, with no external capital injection, the balance sheet remains depleted after a loss. Again the payoff schedules are discussed in detail in Hori and Martin Ceron (2015).

With write-off CoCo bond bail-in the value of shareholders' position is given by (see again Appendix C),

$$\begin{aligned} V_E^W &= \tau V_0 + (1-\tau)\, C\left(\tfrac{F_B}{1-\tau}\right) - F_W B_C\left(\tfrac{F_B}{1-\tau}\right) \\ &= C(F) + F_W B_P\left(\tfrac{F}{1-\tau}\right) - \left[P(F) - (1-\tau)\, P\left(\tfrac{F_B}{1-\tau}\right)\right] \end{aligned} \tag{41}$$

where F_B and F_W are the face values of the plain vanilla bond and the write-off CoCo bond respectively, and $B_C(K)$ and $B_P(K)$ are the price of the binary call and put options with unit payout at strike K,

$$\begin{aligned} B_C(K) &= e^{-rT} N(d_2(K)) \\ B_P(K) &= e^{-rT} N(-d_2(K)). \end{aligned} \tag{42}$$

The shareholders' project plan choice w^W is then determined by,

$$\max_{w\in[w_{\min},1]} V_E^W = C(F) + F_W B_P \left(\frac{F}{1-\tau}\right) - \left[P(F) - (1-\tau) P\left(\frac{F_B}{1-\tau}\right)\right] \tag{43}$$
$$\text{subject to } V_0(w) = e^{-r(w,\sigma(w))T} E[V_T(w)].$$

Then,

Proposition 6 $w^W > w^N$.

Proof. Very similar to the proof of Proposition 5. ■

2.4 Simulated Results

To compare the outcomes between the different restructuring structures, we simulate the optimal risk chosen by the shareholders under the different structures for varying values of F. This is done by numerically solving the shareholders' maximisation problems for each scenario, namely (29), (35), (40) and (43), using Newton-Raphson numerical estimation to solve for the values w such that $\frac{dV_E^X}{dw} = 0$ for $X \in \{N, BO, C, W\}$. This is then applied to (1) to compute the optimal $\sigma^X(w)$. The values used for the simulation are: $E\left[V_T^1\right] = 130$, $E\left[V_T^2\right] = 115$, $\sigma_1 = 30\%$, $\sigma_2 =, \%$, $\rho = 0$, $\lambda_1 = 0.5$, $\lambda_2 = 0.25$, $T = 1$ and $r_f = 3\%$. Where required, the level of CoCo bond is assumed to be 10% of the total debt level, with the CoCo trigger level $\tau = 7\%$. For the solvency requirements the minimum capital ratio and the common equity floor are $\underline{E} = 10\%$ and $\underline{E_C} = 5\%$. Given these volatilities and the market risk premium, the present values of the two projects are $V_0^1 = 108.6$ and $V_0^2 = 106.2$. The simulated results for the optimal $\sigma(w)$ are shown in Fig 7. The graph of the results are plotted in Fig 8.

The simulated results suggest the following,

- For low leverage, the risk chosen approaches the first-best.
- For higher leverage, the shareholders choose the risks in the ascending order of expropriation, government bail-out, equity-conversion CoCo bond bail-in and write-off CoCo bond bail-in.

F	First-best	Expropriation	Bail-out	Equity-conversion CoCo	Write-off CoCo
30	19.36%	19.36%	19.36%	19.36%	19.36%
35	19.36%	19.36%	19.36%	19.36%	19.36%
40	19.36%	19.36%	19.36%	19.36%	19.36%
45	19.36%	19.36%	19.36%	19.36%	19.36%
50	19.36%	19.36%	19.36%	19.36%	19.36%
55	19.36%	19.36%	19.36%	19.37%	19.37%
60	19.36%	19.37%	19.39%	19.40%	19.43%
65	19.36%	19.40%	19.47%	19.49%	19.57%
70	19.36%	19.50%	19.68%	19.74%	19.93%
75	19.36%	19.75%	20.20%	20.34%	20.73%
80	19.36%	20.34%	21.56%	21.86%	22.49%
85	19.36%	21.81%	26.02%	26.12%	26.30%
90	19.36%	26.45%	36.00%	33.63%	32.41%
95	19.36%	36.00%	44.03%	39.95%	38.34%

Figure 7: Simulated results for equityholders' risk choice for different leverage

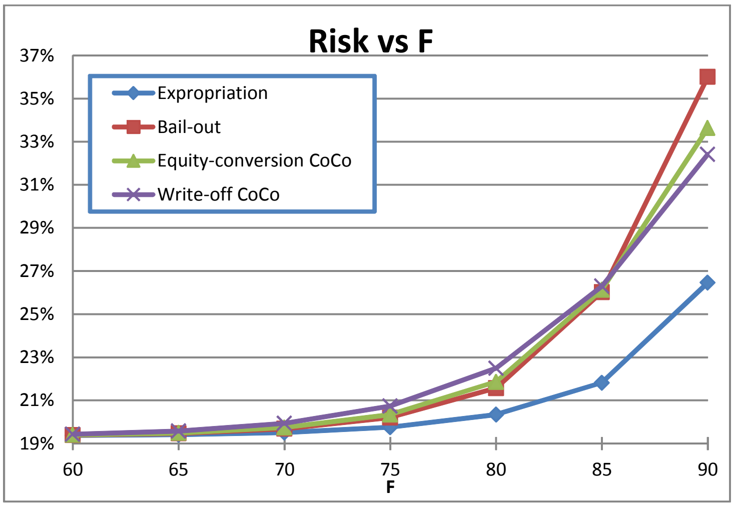

Figure 8: Shareholders' chosen risk for different leverage

- For very high leverage, the bail-out structure induces the highest risk-taking, with lower risk-taking for the write-off structure.

The explanations for the last point are as follows. For the bail-out, in our analysis the shareholders are guaranteed to the common equity floor $\underline{E_C}$ of the restored balance sheet level $\frac{F}{1-\underline{E}}$, while in the bail-in cases their guarantee is at the trigger level τ of the depleted balance sheet V_T. For example when $\underline{E_C} = 5\%$, $\frac{F}{1-\underline{E}} = 100$ and $\tau = 7\%$, under the government bail-out the shareholders are never worse off than $\frac{\underline{E_C}F}{1-\underline{E}} = 5$, while under the bail-in structures their position τV_T can be as low as 0 (see Fig 27 in Appendix C). This gives the shareholders incentive for higher risk-taking under government bail-out in high-leverage cases. For the write-off CoCo bail-in case, the jump up in the payoff for the shareholders at the strike price $\frac{F}{1-\tau}$ due to the binary put (as shown in Fig 27), implies that close to the strike price, the shareholders would not prefer high volatility which would reduce the probability of ending up with a high payoff (i.e. within the triangle area in Fig 27). This reduces the incentive for high risk-taking in high-leverage cases for the write-off bail-in structure.

Here it is also assumed that the government bail-out takes the form of ordinary shares capital injection (see again Hori and Martin Ceron (2015)). Another possibility would be for the capital injection to be in the form of preference shares. As modelled, these two bail-out structures would have the same payoffs for the shareholders at the maturity T. In reality though the two would result in different behaviours by the shareholders. Specifically, the lack of dilution and the higher expected ROE would mean that the shareholders are more likely to take higher risks with the preference shares bail-out.

2.5 Monitoring Cost

The inevitable agency costs of bail-in should encourage bondholders to monitor shareholders' behaviour. This results in monitoring costs to the bondholders. For example, a passive asset manager who has been investing in financial bonds for its index tracking portfolio now needs fundamental analysts to monitor the credit quality of the banks. This is costly. Jensen and Meckling (1976) argue that these monitoring costs are ultimately borne by shareholders via higher cost of capital (WACC) demanded. The threat of the fall in the bank's value should in turn curb the bank's risk-taking behaviour and discipline shareholders. In this section we

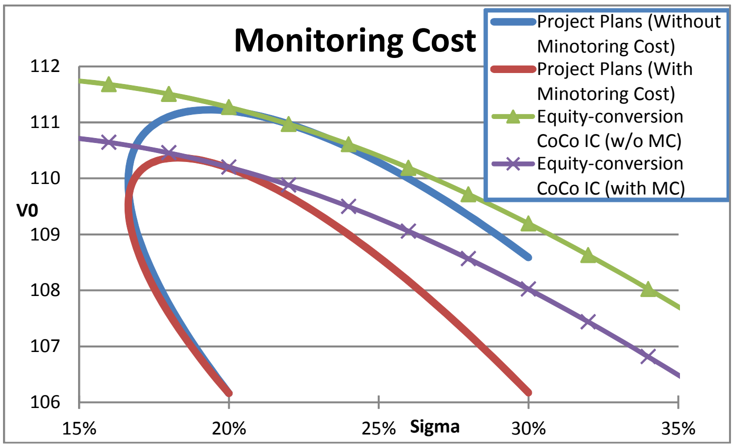

Figure 9: Effect of Monitoring Cost on Shareholders' Choice of Risk

demonstrate this mechanism using the model developed above.

The rise in the return demanded by the investors, due to the monitoring costs, is here represented by an increase in the price of risk for the higher risk project 1 from λ_1 to λ_1'. This is the higher WACC of choosing a higher proportion of the riskier project. As a result, the present value of the project plans are reduced for the riskier choices. This is depicted in Fig 9 by the "squeezing" of the project plans frontier. In again selecting the tangent point with their ICs (here with equity-conversion CoCo bond bail-in), the shareholders' optimal choice of project plan is now of a lower risk.

In policy terms this is analogous to Pigovian tax. The agency costs are the negative externality of shareholders' actions on the remaining stakeholders of the bank. By implementing higher costs on their action, the regulators can force the shareholders to select less risky choice. As a demonstration, Fig 10 simulates the resulting behaviour of the shareholders with varying degrees of increase in λ_1, when $F = 80$. It shows that with sufficient rise in the cost of choosing the riskier project, the shareholders can be made to choose the first-best risk level for all structures. There is, however, a social cost of the value of firm being lowered as a result, as shown in Fig 9.

More formally,

Proposition 7 *The higher the required rate of return of the riskier project* 1*, the lower the*

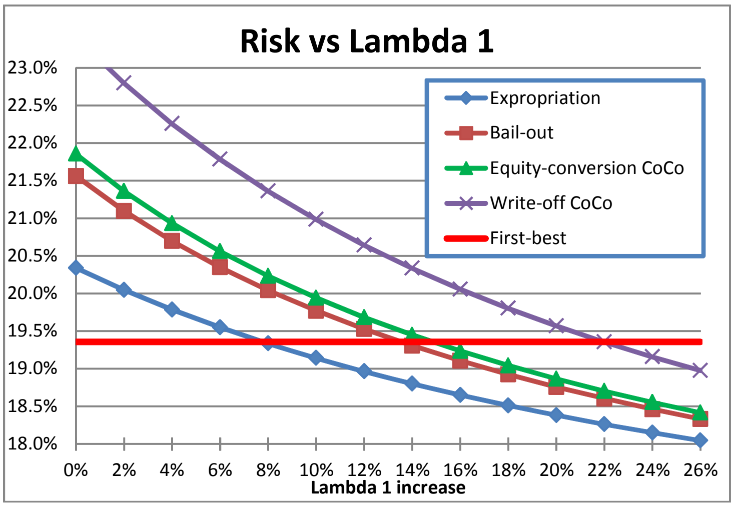

Figure 10: Risk chosen with Monitoring Cost

shareholders' choice of risk.

Proof. To show this, consider two downward-sloping curves as a function of a variable x, $f(x;\phi)$ and $g(x)$. ϕ is an exogenous parameter. Let the derivatives of the functions be such that $f_x < 0$, $g_x < 0$, $f_{xx} < g_{xx}$, $f_{xx} < 0$ and $f_{x\phi} < 0$. This implies that, (i) $f(x;\phi)$ is strictly concave in x; (ii) $g(x)$ is less concave than $f(x)$ and can even be linear or convex; and (iii) $f(x;\phi)$ becomes steeper (more downward-sloping) with an increase in ϕ. Let now x^* be the value of x where the two curves are tangent, i.e. $f_x(x^*;\phi) = g_x(x)$. Then as ϕ increases,

$$\frac{d}{d\phi} f_x(x^*;\phi) = f_{xx}\frac{dx^*}{d\phi} + f_{x\phi}. \tag{44}$$

For the two curves to be tangent again, this must equal $\frac{d}{d\phi} g_x(x^*) = g_{xx}\frac{dx^*}{d\phi}$. Thus,

$$\frac{dx^*}{d\phi} = \frac{f_{x\phi}}{g_{xx} - f_{xx}} < 0. \tag{45}$$

This is negative from the conditions on the derivatives. Our tangency analysis between the concave project plan curves $(f(x;\phi))$ and the quasi-concave ICs $(g(x))$ satisfy these conditions, where $x = \sigma$ and $\phi = \lambda_1$. Hence the choice of σ decreases with higher λ_1. ■

Moreover, the size of this effect depends on how far the bank's balance sheet is from the restructuring point (the minimum capital ratio $\underline{E}$ for the government bail-out case and the trigger level τ for the CoCo bond bail-in cases),

Proposition 8 *The shareholders react more to the rise in the riskier project's required rate of return, the further away the bank is from the restructuring point.*

Proof. We have seen in Properties 1 that the ICs are concave when V_0 is far above the restructuring point but turns convex closer to it. This means that g_{xx} turns from negative to positive as V_0 falls towards the restructuring point, implying decreasing $\frac{dx^*}{d\phi}$. ■

Given these results, we can now propose financial and non-financial covenants as the best way to articulate the monitoring effort.

3 Covenants

We have established above that the agency costs can, to a certain extent, be mitigated by rising required rate of return when riskier project plan is chosen. In practice this equates to the bondholders demanding higher cost of debt to compensate for their monitoring cost. In this section we propose covenants within the CoCo indentures to implement this idea.

Covenants are regularly inserted in corporate bonds (especially from high yield issuers) to monitor more effectively the investment and financial policies of the company. Corporate covenants have successfully attenuated investment distortions and risk-taking incentives in the corporate bond market through higher monitoring and bond costs, reducing agency costs between shareholders and bondholders (see for example, Gamba and Triantis (2014)[10]). In a similar manner we propose covenants in the CoCo indentures to promote financial and investment discipline in banks to curb risk-taking appetite.

We suggest *financial accounting covenants* with a "ratchet coupon" system whereby the CoCo bond coupon rate gradually increases as the fundamentals of the bank debilitate and the covenants are breached. The ratchet system is suggested as the empirical literature on

[10] They show how effective debt covenant restrictions can shift shareholders' financing and investments towards value maximisation.

corporate bond covenants (e.g. Bradley and Roberts (2004), Gamba and Triantis (2014)) tend to indicate that the conventional covenants are usually fixed at relatively low levels and fail to exert the necessary financial discipline on the company. Introducing a ratchet with different covenant levels enables the bondholders to monitor and control the bank's risk-taking more effectively. With the rising risk-taking bondholders are compensated through a coupon increase that mirrors the increasing risk premium. Similarly through a comprehensive covenant ratchet that maps the financial ratio with different coupon levels, the regulator can prevent shareholders from taking actions that would further extract wealth from bondholders as the solvency ratios heads towards the CoCo trigger or the PONV. The covenant will exert discipline on managers and shareholders due to onerous coupon increases which will automatically dent shareholders' returns. Our result in Proposition 8 suggests that this type of covenant based-discipline is more effective during times of stable solvency, away from the point of restructuring. Later, for covenants close to restructuring point we suggest different kind of covenants, namely *asset sweep* and *debt sweep covenants*.

3.1 Ratchet Coupon Financial Accounting Covenants

Following empirical evidence (for example Bradley and Roberts (2004), Billet, King and Mauer (2007), Chava and Roberts (2008), Roberts and Sufi (2009), Gamba and Triantis (2014)) of covenants on corporate bonds, we suggest three candidates for the index for the ratchet trigger in our proposed financial accounting covenants:

- Fully loaded Core Tier 1 Ratio: $\frac{CT1}{RWA}$
- Leverage Ratio: $\frac{Equity+AT1}{Assets}$, where AT1 is the Tier 1 CoCo
- Interest Coverage / ADI[11] interest coverage: $\frac{ADI}{CoCo\ coupon\ payment}$

Financial accounting covenants are suggested as it is difficult to use income statement based covenants due to the ongoing presence of exceptional and one-off items in the banks' profit and loss account. The choice of the CT1 ratio would be a natural one, as both the CoCo

[11] Maximum Amount of Distributable Items linked to the holding company or the distance to coupon suspension on the Combined Buffer (minimum CT1 including all additional buffers).

trigger and the coupon payments are then linked to the Core Tier 1 of the bank, allowing bondholders to evaluate the degree of headroom versus CoCo trigger and coupon suspension (on AT1s). The leverage ratio covenant would allow bondholders to monitor bank's indebtness to restrict balance sheet expansion and constrain managers to constantly pursue shareholders friendly investments.[12] The interest coverage covenant (to monitor the buffer on AT1s coupon payments) is a common covenant in corporate bonds to assess the ability of the company to service the coupons. These covenants would have to be calibrated to suit the nuances of each CoCo bond class. Specifically, CoCo T2s have a specific maturity and mandatory coupon payments, and hence the introduction of covenants and ratchets would be easier as these bonds are similar to unsecured corporate bonds. On the other hand CoCo AT1s are perpetual and their coupons payments are not mandatory,[13] and so imposing a ratchet covenant structure on these may be more challenging.[14]

We now describe the covenant's mechanism with a simple model using the leverage ratio. The value of the asset A_t at period $t \in \{0, 1\}$ is the sum of the equity E_t, the plain vanilla bond D_t and the T2 CoCo bond C_t,

$$A_t = E_t + D_t + C_t. \tag{46}$$

The leverage ratio L_t at period t is then,[15]

$$L_t = \frac{E_t}{A_t}. \tag{47}$$

The costs of debt of the plain vanilla bond and the CoCo bond are r_D and r_C, respectively. The return on equity of the asset is $r_A > 0$. Then at the end of the period 0 the firm produces

[12] For example the sovereign bond "carry trade", as sovereign bonds are zero risk weighted asset.

[13] AT1 CoCo bond coupons can be partially or totally suspended if there is not enough Distributable Amounts within the equity (set by the MDA - Maximum Distributable Amount) or if the Combined Buffer (made up of the Countercyclical, Conservation and Systemic equity buffers) is breached.

[14] Moreover, if the capital ratios fall below the Basel III combined buffer (the buffer above the minimum capital ratio), the coupon payments can be reduced or even suspended. Furthermore, the indenture does not contemplate any dividend stopper (CoCo bond coupons can be suspended whilst dividends are paid out) or pushers (dividends payments can be resumed whilst CoCo bond coupons can still be missed).

[15] The Basel III leverage ratio allows for the AT1 CoCo bond (effectively a deeply perpetual subordinated Tier 1 bond) to be included.

the EBIT of $r_A A_0$. Assuming zero tax rate the bank's net income is then,

$$n_0 = r_A A_0 - r_D D_0 - r_C C_0. \tag{48}$$

The bank's return on equity (ROE) is,

$$r_E = \frac{n_0}{E_0}. \tag{49}$$

We assume that this net income is added to capital in whole as retained earnings. The period 1 asset and the leverage are then given by (46) and (47) above with $D_1 = D_0$, $C_1 = C_0$ and

$$E_1 = E_0 + n_0 \text{ and } A_1 = A_0 + n_0. \tag{50}$$

This implies an increasing leverage ratio $L_1 = \frac{E_1}{A_1} > \frac{E_0}{A_0} = L_0$ for a profit-making bank with $n_0 > 0$, as $\frac{E_0+n_0}{A_0+n_0} > \frac{E_0}{A_0} \Leftrightarrow A_0 E_0 + n_0 A_0 > A_0 E_0 + n_0 E_0 \Leftrightarrow A_0 > E_0$.

Consider now a new risky investment I_0 at period 0 with an uncertain return r_I. The investment is funded by an increase in the plain vanilla bond issuance, $I_0 = D_0^{'} - D_0$. The funding cost is assumed unaffected at r_D despite the decrease in the leverage ratio to,

$$L_0^{'} = \frac{E_0}{A_0^{'}} = \frac{E_0}{A_0 + I}. \tag{51}$$

The leverage ratio in period 1 is now,

$$L_1^{'} = \frac{E_0 + n_0 + (r_I - r_D) I}{A_0 + I + n_0 + (r_I - r_D) I} = \frac{E_1 + (r_I - r_D) I}{A_1 + I + (r_I - r_D) I}. \tag{52}$$

The covenant specifies the ratchet trigger leverage ratios and the corresponding CoCo bond coupon levels $\{f^i, r_C^i\}$, $i = 1, 2, ...$, with $L_0 > f^1 > f^2 > ...$ and $r_C < r_C^1 < r_C^2 < ...$. Consider the first trigger level f^1. This is breached when $L_1^{'} < f^1$, or

$$r_I < r_D - \frac{E_1 - (A_1 + I) f^1}{(1 - f^1) I} = r_I^1, \tag{53}$$

where r_I^i is the realised rate of return of the risky investment corresponding to the ratchet trigger rate f^i. Note where the right-hand side is positive this implies that the ratchet would be triggered even when the risky investment returns a positive rate. Similarly the second ratchet is triggered when,

$$r_I < r_D - \frac{E_1 - \left(r_C^1 - r_C\right) C_0 - \left[A_1 + I - \left(r_C^1 - r_C\right) C_0\right] f^2}{\left(1 - f^2\right) I}. \tag{54}$$

The shareholders' realised ROE also depends on the ratchet trigger,

$$r_E' = \begin{cases} r_E + \left(r_I - r_D\right) \frac{I}{E_0}, & \text{if} \quad r_I^1 < r_I \\ r_E + \left(r_I - r_D\right) \frac{I}{E_0} - \left(r_C^1 - r_C\right) \frac{C_0}{E_0}, & \text{if} \quad r_I^2 < r_I \leq r_I^1 \\ r_E + \left(r_I - r_D\right) \frac{I}{E_0} - \left(r_C^2 - r_C\right) \frac{C_0}{E_0}, & \text{if} \quad r_I^3 < r_I \leq r_I^2 \\ \vdots & \qquad \vdots \end{cases}. \tag{55}$$

Fig 11 depicts the effect of the ratchet coupon covenant on the shareholders' return. This financial accounting covenant then encourages lower risk-taking through two channels. Firstly, the step-down nature of the ROE as r_I falls introduces concavity in the return profile of the shareholders. In much the same way as the convexity in the shareholders' payoff at bail-out / bail-in trigger points creates incentive for higher risk-taking (due to a long vega position), the concavity at the ratchet trigger points (i.e. a short vega position) discourages risk-taking. Secondly, once the ratchet is triggered the higher CoCo coupon means higher cost of debt for the bank, which leads to lower risk-taking being chosen as the shareholders' optimal choice as discussed in Proposition 7.

However, both of these two channels become less effective as the bank's balance sheet nears the PONV or the CoCo trigger. For the first channel this is because the concavity at the ratchet triggers are offset by the convexity at the CoCo trigger. For the second channel, we already saw in Proposition 8 that the convexity of the shareholders' indifference curve near the CoCo trigger point reduced its effectiveness. Intuitively, the appeal of "gamble-for-resurrection" or "looting" more than offsets the effectiveness of these covenants. We therefore suggest introducing these financial accounting covenants at the inception of CoCo bonds when, by assumption, the solvency ratios of the bank are healthy.

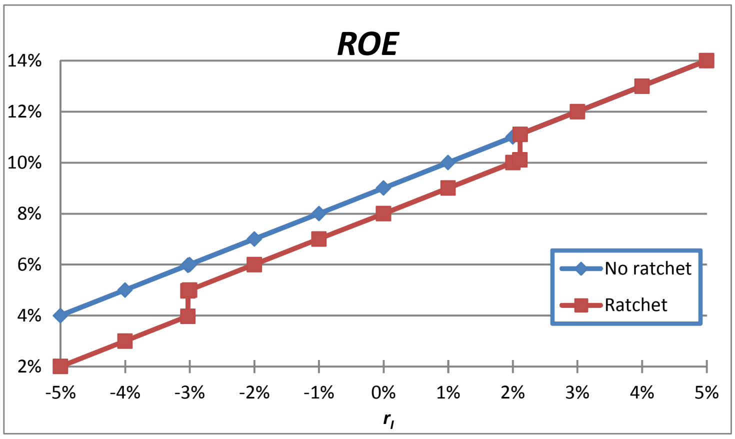

Figure 11: ROE vs r_I with Ratchet Coupon Covenant

3.2 Asset Sweep / Debt Sweep Covenants

In a falling solvency scenario where risk-taking and "gamble-for-resurrection" incentives are high (as demonstrated by Hori and Martin Ceron (2014)), we instead propose the following types of covenants:

- Asset Sweep Covenant
- Debt Sweep Covenant

Asset sweeps are common in private debt placements (see, for example, Bradley and Roberts (2004)). Once triggered, the bank is forced to sell assets to pay down debt, and thus increasing the leverage ratio. This prevents shareholders from liquidating assets to receive a large dividend (i.e. "looting") or take on new debt in order to finance a risky investment ("gamble-for-resurrection"), reducing the agency cost of bail-in near the CoCo trigger point / PONV.[16]

Let now β be the proportion of the asset that has to be divested, post-risky investment A_1'. We assume that the whole of this is used to pay down the debt, in which case the debt is

[16] This type of covenant could dissuade shareholders from pursuing asset divestitures, as the proceeds will accrue to bondholders. However, if the market price of the CoCo has fallen to a level where a buy back could lead to a capital gain (we suspect the price of the CoCo could drop by 30%-50% if these covenants are triggered), then shareholders will benefit from a lower leverage ratio, via lower assets (less debt) and higher equity (capital gain).

reduced to $D_1' - \beta A_1'$.[17] The bank will seek to sell those assets in which it can materialise a capital gain, i.e. $b > 1$ where b is the ratio of the asset's market value and its nominal value. The profit from this divestiture is therefore $(b-1)\,\beta A_1'$, which is added to the bank's capital as retained earnings. As a result the equity is increased to $E_1' + (b-1)\,\beta A_1'$, while the final value of the asset is $(1-\beta)\,A_1' + (b-1)\,\beta A_1' = A_1' + (b-2)\,\beta A_1'$. Therefore the bank's leverage ratio becomes,

$$L_1' = \frac{E_1' + (b-1)\,\beta A_1'}{[1+(b-2)\,\beta]\,A_1'}. \tag{56}$$

When $b < 2$ this is clearly less than $\frac{E_1'}{A_1'}$, where the leverage ratio is bolstered by both a lower denominator (asset) and a higher numerator (equity).[18] The trigger level $\frac{E_1'}{A_1'}$ and the divestiture ratio β are designed such that the leverage ratio is likely to be restored to a minimum level required by the regulator, though this will clearly depend on the capital gain ratio b. However in the case that the asset sale fails to restore the leverage ratio to the required level, the regulator can impose further non-core asset sales and dividend / CoCo bond payouts[19] cancellations to bolster solvency and reinstate the leverage ratio back to the compulsory level.

The *debt sweep* covenant[20] resembles the asset sweep covenant, but the proceeds from newly issued debt is used to repay existing debt when the leverage ratio has fallen below the last ratchet (or any other financial covenant) trigger level. This sets a floor in the bank's leverage ratio, curbing shareholders' appetite for leveraging up as the bank's solvency deteriorates.

We believe through a combination of these three types of covenants the agency costs can be contained. Financial covenants are useful to keep risk and leverage appetite down (especially in a low profitability environment) from the bond inception, enabling bondholders to monitor the banks and incorporate the increasing risk premium in the market price of the bonds as soon as the risk profile of the bank creeps up. We have proposed a ratchet coupon structure which

[17] Going forward all unsecured debt will be loss absorbing (including senior) but the regulator is targeting a minimum loss absorbing capacity (TLAC). Since the regulator would never allow a CoCo to be repaid nor any loss absorbing debt that makes up the TLAC, we argue that the asset sweep should work for any non-TLAC debt (both secured and unsecured).

[18] L_1' is increased for all values of $b > 1$ as $\frac{E_1' + (b-1)\beta A_1'}{[1+(b-2)\beta]A_1'} > \frac{E_1'}{A_1'} \Leftrightarrow A_1'E_1' + (b-1)\,\beta\,(A_1')^2 > [1+(b-2)\,\beta]\,A_1'E_1' \Leftrightarrow (b-1)\,A_1' > (b-2)\,E_1'$, which is true as $b-1 > b-2$ and $A_1' > E_1'$.

[19] The bond indenture should contemplate this event, especially in AT1 CoCo bonds.

[20] This covenant could be intertwined with the financial covenant ratios to offset the increasing appetite for leverage.

we believe is an effective way of doing this. Both asset and debt sweep covenants contribute to the diminishing of the appetite for debt when risky investment opportunities become appealing for the bank, as they alleviate the incentives of the banks to issue new debt to extract wealth from existing bondholders. These two covenants should be triggered when the solvency ratios are decreasing (but still high enough[21]) and financial covenants are no longer effective near the PONV or the CoCo trigger point.

4 Cost of Capital

In this section we investigate the impact of the new regulatory capital measures, namely bail-in and CoCo bonds, on the cost of capital (WACC) of the banks. So far, we have argued that in order to counter the agency costs of wealth transfer and value destruction, bondholders, facing going concern losses, need to continuously monitor the risk appetite of the bank. This is not free; for instance a traditional passive fund will now have to hire a team of analysts to monitor their financial bonds. Similarly, the use of covenants we advocated in Section 3 also comes with a cost, as bondholders are now required to monitor the status of the covenants and the banks' fundamentals (as is typical of the high yield corporate bond market). These additional costs borne by the bondholders are passed on to the shareholders via higher cost of debt. For the current market, we believe that the prices of the existing CoCo and Senior bonds do not reflect this monitoring cost, especially for banks where senior bonds qualify for the total loss absorbing capacity (TLAC) of the banks. The low yielding environment and the financial repression has allowed banks to place these bonds at very low rate levels which also do not incorporate the increasing agency costs of bail-in. This will change over time as yields rise and bondholders come to grips with the reality of bail-in and the DAPR.

Banks' WACC are affected by the new regulatory framework that requires higher equity and loss absorbing debt. Admati, DeMarzo, Hellwig and Pfleiderer (2011) argue that higher equity requirements would lower both the cost of equity and the cost of debt, and therefore despite the change in the funding mix (more equity which has the higher cost), the WACC should remain unchanged. In contrast we believe that the WACC would meaningfully rise. To demonstrate

[21] We suggest, for example, 9% CT1. In the upcoming paper we foresee the regulator (and the market) imposing a 11.5% minimum CT1 for Global Systemic banks.

this, we now estimate the pre- and post-Basel III WACC for the 16 largest European banks using the September 2014 quarterly reports and the market data as of beginning of October 2014. Later, a sensitivity analysis is then undertaken to test the impact that our assumptions on the main variables have on the WACC to derive a range of possible WACC estimates.

4.1 Pre-Basel III WACC

We estimate the pre-Basel III WACC by estimating its components, the COE and the COD. The COE is estimated by the CAPM using,[22]

- Risk free rate - 10 year sovereign bond yield of the country where the bank has its main operations;[23]
- β - 2 year adjusted β for each bank; and
- Equity risk premium - the embedded ERP in the equity market of the bank where it has its main operations.[24]

The most critical factor here is the β. The β of a bank is driven by three factors: operating leverage ($=\frac{\text{fixed costs}}{\text{total costs}}$), financial leverage ($=\frac{\text{debt}}{\text{equity}}$) and earnings volatility (= volatility of ROE), with the financial leverage being the most relevant. The table in Fig 12 shows these main drivers for different banks.[25] All three factors are shown to be high at this point, especially the operating and financial leverages. The operating leverage should drop in the volatile investment banking business of banks due to the onerous capital charges stemming from Basel III (indeed many banks are scaling down or even dismantling their investment banking operations, such as

[22] As our sample of banks comprises big banks, we exclude any risk premium for small size or idiosyncratic risk for the bank. Despite the main limitations of CAPM, including homogeneous expectations and no transaction costs, we still believe that the model is useful for a good "proxy" of the cost of capital of banks.

[23] The correlation between sovereign and financial bond yields are still very high, and thus financial bond spreads still incorporate the sovereign bond premium.

[24] There are many approaches to calculate ERP (e.g. Damodaran (2013), Graham and Dodd (2011)). We follow a Gordon discount dividend model (DDM), accounting for share repurchases, using Bloomberg market consensus expected dividends payouts for the stock exchange of the bank. DDM models perform better in predicting future equity returns than Residual Income Models. It is also forward-looking rather than based on historical data.

[25] The last column "Type of Business" is the proportion of retail business within the banks' global earnings and represents the earnings volatility - the higher the retail business (as opposed to wholesale or investment banking), the lower the earnings volatility.

Beta Analysis	Beta Determinants Operating leverage	Financial leverage	Type of business
BARCLAYS	71%	22.8x	42%
HSBC	60%	16.1x	55%
LLOYDS	51%	20.0x	40%
RBS	94%	20.4x	57%
STANDARD	54%	16.1x	60%
COMMERZBANK	73%	26.9x	66%
DB	88%	30.3x	48%
CS	80%	26.0x	22%
UBS	88%	21.4x	21%
SANTANDER	53%	19.7x	65%
BBVA	59%	15.8x	61%
UNICREDIT	72%	17.8x	50%
ISPM	70%	16.6x	64%
BNP	67%	24.9x	53%
CASA	70%	30.0x	87%
SG	72%	25.1x	46%

Figure 12: Pre-Basel III β determinants, October 2014. Source: Bloomberg and author

RBS). On the other hand it should not meaningfully fall in the retail banking business which is characterised by a high fixed cost base (offices, NPL related provisions, etc). Therefore we will see later that even if the financial leverage decreases post-new financial regulation, there are some intrinsic features of the banking industry that makes the β of the banks higher than the market average of one. Applying these to the CAPM we derive the current estimates of COE in Fig 13. The average is shown as 13%.

The pre-Basel III COD is estimated using the average interest spread of the banks' liabilities (such as deposits, covered, senior, subordinate bonds, etc.), shown in Fig 14. The average pre-tax COD is computed to be 2.1%.

Finally the pre-tax WACC is estimated in Fig 15, which shows the current average of 2.7% for the 16 European banks.

Note that the COE can also be derived as the market implied COE from the current share price, using the market consensus 2016 ROE (taken from Bloomberg) and a terminal growth rate of 1.5%. The table in Fig 16 shows both the CAPM COE derived above and the market implied COE. The latter is lower than the former due to technical reasons (abundant liquidity, central bank interventions, Quantitative Easing, etc.) The table shows that the banks' ROE

COE	RFA	Beta	ERP	COE	Equity	Equity Weighting
BARCLAYS	2.51%	1.28	9.03%	14.1%	65,025	4.9%
HSBC	2.51%	1.07	9.03%	12.2%	198,722	7.2%
LLOYDS	2.51%	0.99	9.03%	11.5%	45,878	5.4%
RBS	2.51%	1.29	9.03%	14.1%	60,963	6.0%
STANDARD	2.51%	1.02	9.03%	11.8%	48,562	7.0%
COMMERZBANK	1.06%	1.07	8.94%	10.6%	24,629	4.2%
DB	1.06%	1.09	8.94%	10.8%	68,401	4.1%
CS	0.52%	1.27	8.31%	11.1%	42,027	4.7%
UBS	0.52%	1.25	8.31%	11.0%	51,449	5.2%
SANTANDER	2.33%	1.09	10.26%	13.5%	85,716	7.2%
BBVA	2.33%	1.19	10.26%	14.6%	46,867	7.6%
UNICREDIT	2.45%	1.34	10.61%	16.7%	52,172	6.2%
ISPM	2.45%	1.29	10.61%	16.1%	44,773	7.1%
BNP	1.44%	1.21	9.23%	12.6%	88,270	4.6%
CASA	1.44%	1.30	9.23%	13.5%	51,946	3.4%
SG	1.44%	1.53	9.23%	15.5%	56,860	4.3%
Average				13.1%		

Figure 13: Pre-Basel III COE, October 2014. Source: Bloomberg and author

COD	Current RFA	Spread	Pre tax COD	Debt Weighting
BARCLAYS	2.51%	0.5%	2.1%	95.1%
HSBC	2.51%	0.6%	2.2%	92.8%
LLOYDS	2.51%	1.7%	3.0%	94.6%
RBS	2.51%	0.6%	2.2%	94.0%
STANDARD	2.51%	1.0%	2.5%	93.0%
COMMERZBANK	1.06%	1.4%	1.7%	95.8%
DB	1.06%	0.7%	1.2%	95.9%
CS	0.52%	1.3%	1.3%	95.3%
UBS	0.52%	0.8%	0.9%	94.8%
SANTANDER	2.33%	2.3%	3.2%	92.8%
BBVA	2.33%	1.7%	2.8%	92.4%
UNICREDIT	2.45%	1.5%	2.7%	93.8%
ISPM	2.45%	1.3%	2.6%	92.9%
BNP	1.44%	1.0%	1.7%	95.4%
CASA	1.44%	1.1%	1.8%	96.6%
SG	1.44%	1.4%	2.0%	95.7%
Average			2.1%	

Figure 14: Pre-Basel III Pre-tax COD, September 2014. Source: Banks' quarterly reports

WACC	
BARCLAYS	2.7%
HSBC	2.9%
LLOYDS	3.4%
RBS	2.9%
STANDARD	3.1%
COMMERZBANK	2.1%
DB	1.6%
CS	1.8%
UBS	1.4%
SANTANDER	4.0%
BBVA	3.7%
UNICREDIT	3.6%
ISPM	3.6%
BNP	2.2%
CASA	2.2%
SG	2.5%
Average	2.7%

Figure 15: Pre-Basel III Pre-tax WACC, Sep-Oct 2014. Source: Banks' quarterly reports and author

will struggle to cover their COE in the current environment.[26]

4.2 Post-Basel III WACC Estimation

We now compute the post-Basel III estimates of the cost of debt using Basel III and bail-in guidelines. The analysis is based on some assumptions regarding the future solvency rules for banks. At the end of this section we run some sensitivity test on the main assumptions to determine a potential WACC range for our sample of banks.

We start with the estimated Basel III RWA for the banks based on their last quarterly update. There is only a 7% increase versus the phase-in Basel III RWA,[27] highlighting the banks' potential leeway to continue their deleveraging strategy to boost solvency ratios. First

[26] The ROE should remain subdued due to reasons such as capital bolstering (deleveraging), onerous capital charges on traditional high ROE businesses (derivatives, off balance sheet businesses), low interest rates and operating leverage (income is decreasing whereas fixed costs remain stubbornly stable).

[27] The phase-in Basel III is the current Basel III RWA or CT1 without making all the adjustments of the fully-loaded Basel III figure. Bansk are currently reporting this number to show investors how they are building their solvency towards achieving the fully-loaded Basel III CT1.

Excess Returns	2016 ROE	CAPM COE	Implied COE	ROE-CAPM COE	CAPM/COE /Implied COE
BARCLAYS	8.2%	14.1%	11.1%	-5.87%	1.3x
HSBC	10.0%	12.2%	14.2%	-2.18%	0.9x
LLOYDS	13.2%	11.5%	11.6%	1.66%	1.0x
RBS	6.0%	14.1%	8.1%	-8.11%	1.8x
STANDARD	10.5%	11.8%	15.2%	-1.28%	0.8x
COMMERZBANK	4.8%	10.6%	5.7%	-5.75%	1.8x
DB	7.8%	10.8%	9.5%	-2.97%	1.1x
CS	12.6%	11.1%	10.5%	1.45%	1.1x
UBS	10.0%	11.0%	8.8%	-0.96%	1.2x
SANTANDER	11.9%	13.5%	8.2%	-1.60%	1.7x
BBVA	10.6%	14.6%	7.9%	-3.98%	1.8x
UNICREDIT	6.9%	16.7%	7.6%	-9.82%	2.2x
ISPM	7.8%	16.1%	7.1%	-8.29%	2.3x
BNP	9.2%	12.6%	10.4%	-3.35%	1.2x
CASA	7.6%	13.5%	10.5%	-5.87%	1.3x
SG	8.6%	15.5%	12.2%	-6.91%	1.3x
Average	**8.8%**	**12.4%**		**-3.6%**	

Figure 16: Pre-Basel III COE, October 2014. Source: Author

we estimate the existing amount of AT1 (Tier 1 CoCo) and T2 (Tier 2) CoCo bonds, as well the average T1 (Tier 1) and T2 coupon, and we convert them to the base currency of the bank. We note that while some banks have not issued CoCo bonds yet, they can still issue up to 1.5% RWA of T1s and 2% RWA of T2s that will count towards the total capital ratio.[28] The total regulatory capital available for loss absorption is then derived by summing up the amount of equity, T1 CoCo bonds and T2 CoCo bonds. To simplify the analysis, we assume that all current plain vanilla T1 and T2 bonds will be called or replaced by CoCo bonds over time.[29] Then on the assumption that the banks have to achieve a TLAC of 23% – 25% RWA (or 10% liabilities), we compute the current capital deficit. The banks have four options to

[28] We estimate the total capital ratio for systemic banks at 15% – 16% RWA versus a TLAC close to 23% – 25% RWA (or 10% liabilities).

[29] Many of these bonds are either non-Basel III compliant (they have a step-up after the call or incentives to redeem) or they will be amortised through the next ten years and thus they will lose regulatory capital eligibility over time. They still count as regulatory capital, but we believe that those eligible for amortisation will be gradually replaced or called as they become obsolete and illiquid (already the bid-ask spreads of these bonds are in excess of three to four points). This move will be further fuelled by the fact that owning CoCo bonds rather than traditional T1 bonds will become a sign of franchise strength and sophistication as the CoCo bond sector thrives.

plug the deficits, incurring a cost funding premium:

- Equity: this will be the most expensive funding source given the high COE in a falling ROE environment.
- CoCo bonds: it will be an expensive source as these bonds come with high triggers and contractual loss absorbing capacity and hence higher coupons.
- Plain vanilla T2 bonds: a cheaper option at the moment, but we believe that the funding cost of these instruments will rise from the current levels, especially if used as bail-in-able debt to comply with the TLAC.[30]
- Senior bonds: this will be the cheapest option, but the cost of funding will obviously increase significantly as it potentially undermines the status of the senior bond market as a funding market (becoming a regulatory capital market).[31]

For the sake of our analysis, we here assume that our sample banks choose the senior bonds, due to the ongoing issuance of CoCo bonds, equities or the likes becoming financially unviable. With the senior bonds becoming bail-in-able from 2016, we use a standard $25bp$ premium (equivalent to a reasonable monitoring cost) above the existing five year senior CDS for the banks.[32] We use then an additional premium in excess of this $25bp$ that ranges between $10bp - 50bp$ according to the magnitude of the capital deficit, reflecting the fact that banks with a bigger capital deficit will be required to pay higher yield to issue senior debt to comply with the TLAC. To estimate the future cost of the CoCo bonds to achieve the 1.5% RWA and 2% RWA for T1 and T2 CoCo bonds respectively, we use the current average coupons to estimate the reasonable premium to capture the agency cost of bail-in for CoCo bonds.[33] Using $200bp$ for T1, subtracting $150bp$ (the current average spread difference between T1 and T2 CoCo

[30] French banks are now issuing plain vanilla T2 to boost the loss absorbing capacity of the bank.

[31] Note a senior bondholder is effectively holding a CoCo bond going forward (any unsecured bond is now a loss absorbing going concern liability). In any case senior bonds will become bail-in-able from 2016. This market would most likely develop into one where issuers differentiate between TLAC senior bonds and non-TLAC senior bonds.

[32] JP Morgan in their last investor survey (2013) on senior bail-in shows that investors expect between $75bp - 100bp$ additional compensation for holding a bail-in-able senior bond.

[33] Our estimated T1 CoCo bond coupon is close to our estimated future pre-tax COE, which in our view is where T1 CoCo bonds yield should trade at.

bonds) from this yields the T2 CoCo bond coupon. For those banks which have not issued CoCo bonds so far, we extrapolate the future CoCo bond coupon using a fundamental-bottom up approach.[34] The total bail-in-able funding cost is then computed using the future cost for the CoCo bonds and the regulatory senior debt. This is shown in Fig 17.

To calculate the post-Basel III estimates of COD we use the five year normalised risk-free asset yield which is derived from the ten year normalised risk-free asset yield based on the futures options market, taken from Bloomberg (Fig 18). The computed post-Basel III pre-tax COD is shown in Fig 19 as to have more than doubled to 4.4% on the back of the new bail-in rules.

To estimate the post-Basel III COE, we use again the CAPM. First, the banks' β are estimated from the adjusted two year Bloomberg β and conducting an unlevering / relevering exercise.[35] TA/TE in Fig 20 stands for the ratio of tangible assets to tangible equity and it is the measure of the banks' financial leverage. As shown, on average the sample is levered by 22 times with the average β of 1.21. We unlever this β and relever it using a 12 times TA/TE. This bodes well with a 7 times Basel III leverage ratio[36] which is the regulator's guidance for Systematically Important Banks. This yields a β of 0.88, below the market β of one.[37] Using the normalised ten year risk-free asset and the same ERP as previously, we derive the average post-Basel III COE to be 10.6% (Fig 21). Note that given the 2016 ROE Bloomberg consensus, this implies that banks are still unable to cover their COE for the foreseeable future (Fig 22).

Finally to estimate the post-Basel III WACC, we require the estimates for the future funding mix weighting between equity and debt. For this we assume that the minimum Basel III leverage ratio[38] will be set at 7%, so in taking the current leverage ratio for each bank and stripping out the T1 CoCo bonds, we can compute the necessary equity levels to fulfill this

[34] For example, HSBC and Standard should have similar CoCo bond coupons given their similar fundamentals. Similarly for BNP and UBS.

[35] Here Harris-Pringle formula is used.

[36] $\frac{Equity\ +\ AT1\ CoCos}{Assets}$

[37] It is conservative to assume the banks' β of below one. The financial industry, due to its lending and maturity transformation role in the real economy, are characterised by higher leverage and lower equity than the corporate industry. Though Basel III aims to reduce the amount of leverage and increase equity, banks would always run a higher degree of leverage than corporates. Further, banks will still remain as a volatile undertaking owing to NPLs (making them very much pro-cyclical), trading income / losses as well as potential operational or financial risks (such as fraud, scandals and short selling bans).

[38] $\frac{Equity\ +\ T1\ CoCos}{RWA}$

COD Analysis	Liabilities	RWA	Estimated B3 RWA	T1 CoCos	T2 CoCos	%T1 CoCo/RWA	%T2 CoCo/RWA	Average T1 Coupon	Average T2 Coupon	AT1 top up to 1.5%	T2 top up to 2%	Estimated Basel 3 Regulatory Capital	Bail in Requirement at 10%	B3 8% Requirement Deficit	Senior Bonds	5yr Sen CDs	Bail in able Senior Premium	Normalized 5yr RFA	Bail in able Senior Funding Cost	Future T1 Coupon	Future T2 Coupon	Total Bail in able Funding Cost	Total non Bail in able Funding Cost	Total COD
BARCLAYS	1,249,874	354,809	442,471	4,244	2,424	1.2%	0.7%	5.5%	4.7%	2,393	6,425	80,511	131,490	50,978	49,721	84	50 bps	1.3%	2.8%	7.5%	6.0%	2,479	61,511	63,990
HSBC	2,554,871	1,092,653	1,100,000	2,500	-	0.2%	0.0%	4.5%	3.5%	14,000	22,000	237,222	275,359	38,137	68,767	69	50 bps	1.3%	2.7%	6.5%	5.0%	3,197	125,373	128,570
LLOYDS	798,062	263,850	271,100	5,340	13,978	2.0%	5.3%	6.4%	10%	(1,274)	(8,556)	55,367	84,394	29,028	28,425	94	50 bps	1.3%	2.9%	8.4%	6.9%	1,573	39,252	40,825
RBS	950,145	385,500	429,000	-	-	0.0%	0.0%	8.5%	6.5%	6,435	8,580	75,978	101,111	25,133	48,885	116	50 bps	1.3%	3.2%	10.5%	9.0%	2,242	46,697	48,939
STANDARD	641,576	322,251	325,196	-	-	0.0%	0.0%	5.0%	4.0%	4,878	6,504	59,944	69,014	9,070	23,909	99	10 bps	1.3%	2.6%	7.0%	5.5%	934	31,491	32,425
COMMERZBANK	555,274	190,588	250,000	-	-	0.0%	0.0%	8.5%	6.5%	3,750	5,000	33,379	57,990	24,611	19,976	85	50 bps	0.5%	2.3%	10.5%	9.0%	1,422	22,378	23,799
DB	1,597,009	350,143	400,000	3,524		1.0%	0.0%	6.6%	5.0%	2,476	8,000	82,401	166,541	84,140	93,208	85	50 bps	0.5%	2.3%	8.6%	7.1%	3,056	64,371	67,427
CS	849,553	273,846	266,000	4,750	5,542	1.7%	2.0%	6.9%	6.4%	(760)	(222)	51,337	89,158	37,821	67,988	70	50 bps	0.3%	2.2%	8.9%	7.4%	1,579	34,218	35,796
UBS	931,155	228,557	225,000	-	9,667	0.0%	4.2%	6.0%	5.7%	3,375	(5,167)	59,324	98,260	38,936	39,601	57	50 bps	0.3%	2.1%	8.0%	6.5%	1,368	37,480	38,848
SANTANDER	1,102,327	489,736	450,000	4,154	-	0.8%	0.0%	5.6%	5.0%	2,596	9,000	101,466	118,804	17,338	58,681	85	50 bps	1.2%	2.3%	7.6%	6.1%	1,466	44,259	45,724
BBVA	570,264	323,605	355,966	2,654	-	0.8%	0.0%	7.0%	5.0%	2,686	7,119	59,326	61,713	2,387	22,448	88	10 bps	1.2%	2.0%	9.0%	7.5%	1,057	22,885	23,942
UNICREDIT	786,518	423,739	450,000	1,962		0.5%	0.0%	6.5%	5.0%	4,788	9,000	67,922	83,869	15,947	132,178	122	50 bps	1.2%	2.7%	8.5%	7.0%	1,630	31,619	33,249
ISPM	583,532	276,291	303,920	-	-	0.0%	0.0%	7.0%	5.0%	4,559	6,078	55,410	62,831	7,420	117,141	91	10 bps	1.2%	2.0%	9.0%	7.5%	1,015	23,432	24,447
BNP	1,818,355	559,632	600,000	-	-	0.0%	0.0%	6.0%	5.0%	9,000	12,000	109,270	190,663	81,393	85,654	78	50 bps	0.7%	2.3%	8.0%	6.5%	3,353	73,246	76,599
CASA	1,466,180	299,600	329,560	2,649	789	0.9%	0.3%	6.2%	6.3%	2,294	5,822	63,481	151,813	88,332	93,578	81	50 bps	0.7%	2.3%	8.2%	6.7%	2,893	59,147	62,040
SG	1,265,757	315,500	342,600	4,462		1.4%	0.0%	5.9%	5.0%	677	6,852	68,851	132,262	63,411	59,292	87	50 bps	0.7%	2.4%	7.9%	6.4%	2,353	51,007	53,360

Figure 17: Post-Basel III COD. Source: author

RFA	Normalized 5yr RFA	Normalized 5yr RFA
BARCLAYS	1.5%	3.0%
HSBC	1.5%	3.0%
LLOYDS	1.5%	3.0%
RBS	1.5%	3.0%
STANDARD	1.5%	3.0%
COMMERZBANK	1.0%	2.0%
DB	1.0%	2.0%
CS	1.0%	2.0%
UBS	1.0%	2.0%
SANTANDER	1.0%	2.0%
BBVA	1.0%	2.0%
UNICREDIT	1.0%	2.0%
ISPM	1.0%	2.0%
BNP	1.0%	2.0%
CASA	1.0%	2.0%
SG	1.0%	2.0%

Figure 18: Normalised Risk-free Asset. Source: Bloomberg and author

COD Analysis	Total COD	Pre tax COD	% Change
BARCLAYS	5.1%	5.3%	150%
HSBC	5.0%	5.3%	141%
LLOYDS	5.1%	5.3%	80%
RBS	5.2%	5.4%	146%
STANDARD	5.1%	5.3%	115%
COMMERZBANK	4.3%	3.7%	117%
DB	4.2%	3.7%	205%
CS	4.2%	3.3%	153%
UBS	4.2%	3.3%	258%
SANTANDER	4.1%	4.5%	40%
BBVA	4.2%	4.6%	63%
UNICREDIT	4.2%	4.7%	70%
ISPM	4.2%	4.6%	78%
BNP	4.2%	4.0%	131%
CASA	4.2%	4.0%	124%
SG	4.2%	4.0%	102%
Average		4.4%	

Figure 19: Post-Basel III Pre-tax COD Estimates. Source: Banks' quarterly reports and author

Beta Analysis	Market Cap	Adjusted Beta	TA/TE	Unlevered Beta	Relevered Beta at 12x TA/T2
BARCLAYS	37,889	1.28	22.8x	0.08	0.87
HSBC	125,945	1.07	16.1x	0.09	1.01
LLOYDS	53,052	0.99	20.0x	0.07	0.76
RBS	40,237	1.29	20.4x	0.08	0.97
STANDARD	30,251	1.02	16.1x	0.08	0.96
COMMERZBANK	14,425	1.07	26.9x	0.05	0.62
DB	37,330	1.09	30.3x	0.05	0.56
CS	40,653	1.27	26.0x	0.07	0.76
UBS	62,855	1.25	21.4x	0.08	0.90
SANTANDER	91,529	1.09	19.7x	0.07	0.85
BBVA	56,464	1.19	15.8x	0.10	1.14
UNICREDIT	36,841	1.34	17.8x	0.10	1.15
ISPM	39,577	1.29	16.6x	0.10	1.17
BNP	67,096	1.21	24.9x	0.07	0.75
CASA	30,633	1.30	30.0x	0.06	0.68
SG	32,885	1.53	25.1x	0.08	0.95
Average		1.21	21.9x	0.08	0.88

Figure 20: Post-Basel III β Estimates. Source: Bloomberg and author

COE Analysis	RFA	Beta	ERP	COE	% Change
BARCLAYS	3.00%	0.87	9.03%	10.9%	-23%
HSBC	3.00%	1.01	9.03%	12.1%	-1%
LLOYDS	3.00%	0.76	9.03%	9.9%	-14%
RBS	3.00%	0.97	9.03%	11.7%	-17%
STANDARD	3.00%	0.96	9.03%	11.7%	-1%
COMMERZBANK	2.00%	0.62	8.94%	7.5%	-29%
DB	2.00%	0.56	8.94%	7.0%	-35%
CS	2.00%	0.76	8.31%	8.4%	-25%
UBS	2.00%	0.90	8.31%	9.5%	-13%
SANTANDER	2.00%	0.85	10.26%	10.7%	-21%
BBVA	2.00%	1.14	10.26%	13.7%	-6%
UNICREDIT	2.00%	1.15	10.61%	14.2%	-15%
ISPM	2.00%	1.17	10.61%	14.5%	-10%
BNP	2.00%	0.75	9.23%	9.0%	-29%
CASA	2.00%	0.68	9.23%	8.3%	-38%
SG	2.00%	0.95	9.23%	10.7%	-31%
Average				10.6%	

Figure 21: Post-Basel III COE Estimates. Source: Bloomberg and author

Excess Returns	2016 ROE	COE	ROE-COE
BARCLAYS	8.2%	10.9%	-2.63%
HSBC	10.0%	12.1%	-2.07%
LLOYDS	13.2%	9.9%	3.28%
RBS	6.0%	11.7%	-5.71%
STANDARD	10.5%	11.7%	-1.17%
COMMERZ BANK	4.8%	7.5%	-2.68%
DB	7.8%	7.0%	0.77%
CS	12.6%	8.4%	4.22%
UBS	10.0%	9.5%	0.50%
SANTANDER	11.9%	10.7%	1.20%
BBVA	10.6%	13.7%	-3.11%
UNICREDIT	6.9%	14.2%	-7.28%
ISPM	7.8%	14.5%	-6.65%
BNP	9.2%	9.0%	0.28%
CASA	7.6%	8.3%	-0.69%
SG	8.6%	10.7%	-2.11%
Average	**8.8%**	**10.6%**	**-1.8%**

Figure 22: Post Basel III ROE − COE. Source: Bloomberg and author

leverage ratio (Fig 23). With the estimated COE, COD and the equity weighting, we finally arrive at the post-Basel III pre-tax WACC estimates shown in Fig 24. The average WACC is estimated to be 4.8%, or 85% higher than the current level.

4.3 Robustness Analysis

Due to the sensitivity of the analysis to the multiples variables and assumptions, we run some tests on the WACC by setting different values for our main assumptions on senior bail-in premium, agency cost of bail-in for CoCo bonds, Basel TA/TE and Basel III leverage ratio. The potential value range for the post-Basel III WACC for our sample banks are shown in Figures 25 and 26. As can be observed in the tables, the range of WACC estimates is given as between 4.54% to 5.22%, equating to a 75% to 110% increase on the current WACC.

To conclude, we have shown here that in even using conservative assumptions, we foresee the WACC of banks rising meaningfully on the back of the new Basel III rules (contractual bail-in, i.e. the CoCo bonds, and statutory bail-in, i.e. the senior debt bail-in) with potentially negative ramifications to the real economy. We believe the cost of equity could drop from the existing levels via lower β (though it is difficult to see the long term β below one) and lower

Equity Weighting	Equity Weighting	Current Leverage Ratio	Equity Deficit to Target Lev Ratio	Assets	Target B3 Leverag e Ratio
BARCLAYS	6.0%	4.4%	14,631	1,314,899	7%
HSBC	6.5%	6.2%	-19,832	2,753,593	7%
LLOYDS	5.9%	5.0%	4,288	843,940	7%
RBS	6.6%	4.9%	6,072	1,011,108	7%
STANDARD	6.4%	6.2%	-4,828	690,138	7%
COMMERZBANK	5.9%	3.7%	10,415	582,590	7%
DB	6.2%	3.3%	36,572	1,665,410	7%
CS	6.3%	3.9%	14,707	891,580	7%
UBS	6.0%	4.7%	8,155	982,604	7%
SANTANDER	7.6%	5.1%	4,934	1,188,043	7%
BBVA	6.8%	6.3%	-5,227	617,131	7%
UNICREDIT	6.1%	5.6%	-956	838,689	7%
ISPM	6.6%	6.0%	-3,366	628,305	7%
BNP	6.0%	4.0%	28,276	1,906,625	7%
CASA	5.5%	3.3%	32,893	1,518,126	7%
SG	5.7%	4.0%	20,018	1,322,617	7%

Figure 23: Equity Required for Minimum Basel III Leverage Ratio. Source: author

B3 WACC	COE	Equity Weighting	Pre tax COD	Debt Weighting	WACC	Pre B3 WACC	% Change
BARCLAYS	10.9%	6.0%	5.3%	94.0%	5.7%	2.7%	108%
HSBC	12.1%	6.5%	5.3%	93.5%	5.7%	2.9%	97%
LLOYDS	9.9%	5.9%	5.3%	94.1%	5.6%	3.4%	63%
RBS	11.7%	6.6%	5.4%	93.4%	5.8%	2.9%	99%
STANDARD	11.7%	6.4%	5.3%	93.6%	5.7%	3.1%	83%
COMMERZBANK	7.5%	5.9%	3.7%	94.1%	4.0%	2.1%	89%
DB	7.0%	6.2%	3.7%	93.8%	3.9%	1.6%	143%
CS	8.4%	6.3%	3.3%	93.7%	3.6%	1.8%	105%
UBS	9.5%	6.0%	3.3%	94.0%	3.7%	1.4%	153%
SANTANDER	10.7%	7.6%	4.5%	92.4%	5.0%	4.0%	25%
BBVA	13.7%	6.8%	4.6%	93.2%	5.2%	3.7%	40%
UNICREDIT	14.2%	6.1%	4.7%	93.9%	5.3%	3.6%	45%
ISPM	14.5%	6.6%	4.6%	93.4%	5.3%	3.6%	48%
BNP	9.0%	6.0%	4.0%	94.0%	4.3%	2.2%	92%
CASA	8.3%	5.5%	4.0%	94.5%	4.2%	2.2%	94%
SG	10.7%	5.7%	4.0%	94.3%	4.3%	2.5%	71%
Average	10.6%		4.4%		4.8%	2.7%	85%

Figure 24: Post-Basel III Pre-tax WACC Estimates. Source: Bloomberg and author

		Basel 3 TA/TE					
		6x	**8x**	**10x**	**12x**	**14x**	**16x**
Senior Bail in Premium	**10 bps**	4.54%	4.60%	4.66%	4.73%	4.79%	4.85%
	20 bps	4.54%	4.60%	4.67%	4.73%	4.79%	4.86%
	30 bps	4.54%	4.60%	**4.67%**	**4.73%**	4.79%	4.86%
	40 bps	4.54%	4.61%	**4.67%**	**4.73%**	4.80%	4.86%
	50 bps	4.54%	4.61%	4.67%	4.74%	4.80%	4.86%
	60 bps	4.55%	4.61%	4.67%	4.74%	4.80%	4.86%

Figure 25: Post-Basel III WACC Estimates for Different Values of Senior Bail-in Premium and Basel III TA./TE. Source: author

		Basel 3 Leverage Ratio					
		4%	**6%**	**8%**	**10%**	**12%**	**14%**
CoCo Agency Cost of Bail in	**150 bps**	4.64%	4.76%	4.88%	4.99%	5.10%	5.20%
	200 bps	4.65%	4.77%	4.88%	4.99%	5.10%	5.20%
	250 bps	4.65%	4.77%	**4.89%**	**5.00%**	5.10%	5.21%
	300 bps	4.66%	4.78%	**4.89%**	**5.00%**	5.11%	5.21%
	350 bps	4.66%	4.78%	4.90%	5.01%	5.11%	5.21%
	400 bps	4.67%	4.79%	4.90%	5.01%	5.12%	5.22%

Figure 26: Post-Basel III WACC Estimates for Different Values of CoCo Agency Cost of Bail-in and Basel III Leverage Ratio. Source: author

equity risk premium, but this is more than offset by the higher cost of debt driven by the monitoring cost of the agency costs of bail-in, resulting in higher WACCs.

5 Conclusions

We believe bail-in will prove not to solve the moral hazard problem that is the short-fall of bail-out schemes. Moreover, it incorporates an additional problem which is the lurking agency costs that lie behind the new relationship between shareholders and bondholders. The DAPR brought about by bail-in will change the profile of the trade-off between value and risk for shareholders. The relationship between risk and value becomes less concave and eventually convex as the solvency "flirts" with PONV, and shareholders can boost the riskiness of the assets without sacrificing too much of the value of the bank (in technical term the ratio of vega to delta decreases, and hence more volatility can be traded for less value). This is more acute with write-off CoCo bond bail-in than with equity-conversion CoCo, but, under both structures, the high risk-taking appetite of shareholders are higher relative to the traditional bail-out (let alone full equity expropriation) as demonstrated in this paper. As a result we believe that bondholders' monitoring costs would rise, as they will not passively wait to be reimbursed while the DAPR induced agency costs lurk under the surface.

We also believe that covenants in CoCo bonds proposed in this paper are an effective way to curb risk-taking. When solvency is high, contractual covenants will swiftly incorporate the additional risk premium via upward coupon resetting that exerts discipline on banks and dents shareholder returns. The shareholders are not able to trade easily the bank value off against volatility for two reasons: the concave nature of the shareholders' return on equity at each ratchet trigger point, and the higher cost of capital once triggered. As solvency deteriorates towards the CoCo trigger or the PONV these become less effective as, as well as the fact that higher coupons erode solvency even more, the shareholders' incentive to "gamble-for-resurrection" negate the above effects. Thus at this point, when CoCo bonds trade at distress, the monitoring effort becomes no longer fruitful. In these cases we propose a different type of covenants, namely asset and debt sweeps. Further investigations of other solutions to alleviating moral hazard and agency costs, especially near the PONV / CoCo trigger point, are left to future research.

Lastly, we also believe that the cost of capital for banks is poised to rise on the back of the required monitoring costs and the peculiarities of the bail-in framework. The former arises as the traditional banks' debt investors, such as mutual funds, insurers, long only funds etc., will be forced to strengthen their research capabilities (more fundamental analysts) as they will be exposed to going concern losses. Moreover, in reality any unsecured debts are effectively contingent convertible via regulatory powers, and hence passive or indexed funds will not be able to buy and hold a bank bond expecting to be fully repaid or bailed-out. They will also need to monitor the fundamentals of the banks and the costs of which will in the end be borne by the shareholders via higher risk premium. As far as the latter are concerned, we foresee both subordinate and senior debt coupon rising as investors factor in the agency cost and the change in payout of their embedded option (debt in the upside, equity or full write-off in the downside). The compulsory solvency and leverage ratios, including the TLAC (RWA), will force the banks to issue more CoCo bonds or unsecured debts which will increase the overall cost of debt. Moreover, as soon as interest rates normalise from the current historical lows and investors' appetite for these high yielding bonds attenuate in a rising yielding environment, we envisage CoCo bonds (and to a lesser extent other unsecured debt) coupons moving closer to the pre-tax cost of equity.[39] Even if one assumes, as we do, a lower cost of equity on the back of a decreasing β[40] (via lower financial leverage and earning volatility), this will not keep the WACC from rising. This trend, coupled with decreasing ROE (as a result of higher equity, lower leverage, less ROE intensive businesses etc.) should put a "dent" in banks' share prices. This may even accentuate shareholders' risk appetite. Such possible impacts of higher WACC on the real economy are a topic for future research.

[39] Specially AT1 CoCo bonds that do not have the equity upside (a fixed income instrument) but have the equity downside (coupons can be suspended and their capital impaired on a going concern basis).

[40] Our unlevering and relevering β analysis shows the β of some banks falling below one. This is still a very optimistic outcome as we believe the β of the banks in general, due to the intrinsic operating / financial leverage and earnings volatility, should warrant a β above one. This should render a higher COE and thus a higher WACC under our framework.

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6 Appendix

A Properties of $N(x)$

$N(x)$ is the cumulative distribution function for a standard normally distributed random variable $X \sim N(0,1)$ such that $N(x) = \Pr(X \leq x)$. Then $N'(x)$ is the probability density function $N'(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{X^2}{2}}$.

Property A1

$$\begin{aligned} \lim_{x\to\infty} \tfrac{N'(x)}{N(x)} &= 0 \\ \lim_{x\to-\infty} \tfrac{N'(x)}{N(x)} &= -x. \end{aligned} \tag{57}$$

Proof. The first limit is trivial as $\lim_{x\to\infty} N'(x) = 0$ and $\lim_{x\to\infty} N(x) = 1$. For the second, note first that $\lim_{x\to-\infty} N'(x) = 0$ and $\lim_{x\to-\infty} N(x) = 0$. The limit can therefore be found using L'Hôpital's rule,

$$\lim_{x\to-\infty} \frac{N'(x)}{N(x)} = \lim_{x\to-\infty} \frac{N''(x)}{N'(x)} = \lim_{x\to-\infty} \frac{-xN'(x)}{N'(x)} = -x. \tag{58}$$

■

Property A2

$$\frac{d}{dx}\left(\frac{N'(x)}{N(x)}\right) < 0 \ \forall x. \tag{59}$$

Proof. Expanding,

$$\frac{d}{dx}\left(\frac{N'(x)}{N(x)}\right) = -\frac{xN'(x)}{N(x)} - \left(\frac{N'(x)}{N(x)}\right)^2 = -\frac{N'(x)}{N(x)}\left(\frac{xN(x)+N'(x)}{N(x)}\right). \tag{60}$$

This is negative if and only if $xN(x) + N'(x) > 0$. This is obvious for $x \geq 0$. For $x < 0$, first check the limits,

$$\begin{aligned} \lim_{x\to 0} xN(x) + N'(x) &= N'(0) = \tfrac{1}{\sqrt{2\pi}} > 0 \\ \lim_{x\to-\infty} xN(x) + N'(x) &= \lim_{x\to-\infty} N(x)\left(x + \tfrac{N'(x)}{N(x)}\right) = 0 \end{aligned} \tag{61}$$

using Property A1. Now,

$$\frac{d}{dx}\big(xN(x)+N'(x)\big)=N(x)+xN'(x)-xN'(x)=N(x)>0\ \forall x \tag{62}$$

which proves that $xN(x)+N'(x)>0\ \forall x<0$. ■

B Limiting Properties of Call and Put Options

Properties B1 (Properties at the limits of call and put option values)

1. For large σ,

$$\left.\begin{array}{lll}\lim_{\sigma\to\infty} d_1=\infty & \Rightarrow & \lim_{\sigma\to\infty} N(d_1)=1\\ \lim_{\sigma\to\infty} d_2=-\infty & \Rightarrow & \lim_{\sigma\to\infty} N(d_2)=0\end{array}\right\}\Rightarrow\left\{\begin{array}{l}\lim_{\sigma\to\infty} C(K)=V_0\\ \lim_{\sigma\to\infty} P(K)=Ke^{-rT}\end{array}\right. . \tag{63}$$

   Therefore a call option behaves like the underlying asset while a put option behaves like a bond.

2. For $\sigma\to 0$,

$$\lim_{\sigma\to 0} d_1=\lim_{\sigma\to 0} d_2=\left\{\begin{array}{lll}-\infty & \text{if} & V_0<Ke^{-rT}\\ 0 & \text{if} & V_0=Ke^{-rT}\\ \infty & \text{if} & V_0>Ke^{-rT}\end{array}\right. \Rightarrow \lim_{\sigma\to 0} N(d_1)=\lim_{\sigma\to 0} N(d_2)=\left\{\begin{array}{l}0\\ \frac{1}{2}\\ 1\end{array}\right. . \tag{64}$$

   Thus,

$$\begin{array}{l}\lim_{\sigma\to 0} C(K)=\max\left[V_0-Ke^{-rT},0\right]\\ \lim_{\sigma\to 0} P(K)=\max\left[Ke^{-rT}-V_0,0\right].\end{array} \tag{65}$$

   Intuitively the options approximate their intrinsic values.

C Bond and shareholders' Payoffs under Different Restructuring Scenarios

The derivations of the following payoffs and valuations are given in detail in Hori and Martin Ceron (2015).

C.1 Expropriation (No Bail-out / Bail-in)

The payoffs at time T are,

$$\begin{aligned} PayOff_E^N &= \max\left[V_T - F, 0\right] \\ PayOff_D^N &= \min\left[V_T, F\right]. \end{aligned} \tag{66}$$

The values at $t = 0$ under the Merton (1974) framework are then given by,

$$\begin{aligned} V_E^N &= C\left(F\right) \\ V_D^N &= Fe^{-rT} - P\left(F\right) \end{aligned} \tag{67}$$

where $C\left(K\right)$ and $P\left(K\right)$ are call and put option values with strike K given by (19) and (32), respectively.

C.2 Government Bail-out

The bondholders are guaranteed their face value F at time T. Given the minimum capital ratio $\underline{E}$, this means that the government will have to restore the balance sheet to $\frac{F}{1-\underline{E}}$. With the common equity floor of $\underline{E_C}$, the shareholders are then guaranteed the minimum of $\frac{\underline{E_C}F}{1-\underline{E}}$.

$$\begin{aligned} PayOff_E^{BO} &= \max\left[V_T - F, \frac{\underline{E_C}F}{1-\underline{E}}\right] \\ PayOff_D^{BO} &= F. \end{aligned} \tag{68}$$

The values at $t = 0$ are given by,

$$\begin{aligned} V_E^{BO} &= \frac{FE_C}{1-\underline{E}} e^{-rT} + C\left(F + \frac{FE_C}{1-\underline{E}}\right) \\ &= C(F) + \left[P\left(F + \frac{FE_C}{1-\underline{E}}\right) - P(F)\right] \\ V_D^{BO} &= Fe^{-rT}. \end{aligned} \tag{69}$$

C.3 Equity-conversion CoCo Bond Bail-in

Here we assume that, in the extreme case that the CoCo bond is not enough to cover the whole of the loss, the plain vanilla bonds will also be forced to write-down the remaining loss. The shareholders are then guaranteed the minimum of τV_T at which point the CoCo conversion is triggered. The bondholders will hold the remaining $(1-\tau)V_T$ in the forms of either plain vanilla bond, CoCo-converted equity or unconverted CoCo bond.

$$\begin{aligned} PayOff_E^C &= \max\left[V_T - F, \tau V_T\right] \\ PayOff_D^C &= \min\left[F, (1-\tau)V_T\right]. \end{aligned} \tag{70}$$

The values at $t = 0$ are,

$$\begin{aligned} V_E^C &= \tau V_0 + (1-\tau)C\left(\frac{F}{1-\tau}\right) \\ &= C(F) + \left[(1-\tau)P\left(\frac{F}{1-\tau}\right) - P(F)\right] \\ V_D^C &= \left[Fe^{-rT} - P(F)\right] - \left[(1-\tau)P\left(\frac{F}{1-\tau}\right) - P(F)\right]. \end{aligned} \tag{71}$$

C.4 Write-off CoCo Bond Bail-in

Write-off bonds are triggered in its entirety once the trigger level τ is breached. Then,

$$\begin{aligned} PayOff_E^W &= \max\left[V_T - F_B, \tau V_T\right] - F_W \chi_{V_T \geq \frac{F}{1-\tau}} \\ PayOff_D^W &= \min\left[F_B, (1-\tau)V_T\right] + F_W \chi_{V_T \geq \frac{F}{1-\tau}}. \end{aligned} \tag{72}$$

where $\chi_{V_T \geq \frac{F}{1-\tau}}$ is the indicator function,

$$\chi_{V_T \geq \frac{F}{1-\tau}} = \begin{cases} 1 & \text{if} \quad V_T \geq \frac{F}{1-\tau} \\ 0 & \text{if} \quad V_T < \frac{F}{1-\tau} \end{cases}. \tag{73}$$

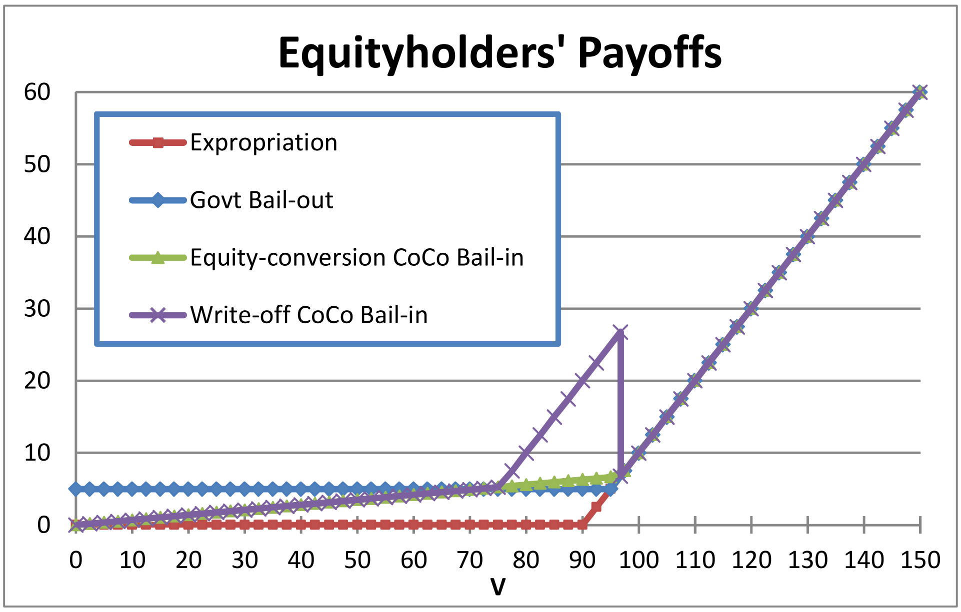

Figure 27: Equityholders' Pay-offs

The values at $t = 0$ are,

$$
\begin{aligned}
V_E^W &= \tau V_0 + (1-\tau)\, C\left(\tfrac{F_B}{1-\tau}\right) - F_W B_C\left(\tfrac{F}{1-\tau}\right) \\
&= C\left(F\right) + F_W B_P\left(\tfrac{F}{1-\tau}\right) - \left[P\left(F\right) - (1-\tau)\, P\left(\tfrac{F_B}{1-\tau}\right)\right] \\
V_D^W &= \left[Fe^{-rT} - P\left(F\right)\right] - F_W B_P\left(\tfrac{F}{1-\tau}\right) + \left[P\left(F\right) - (1-\tau)\, P\left(\tfrac{F_B}{1-\tau}\right)\right].
\end{aligned}
\tag{74}
$$

The shareholders' payoffs for all four restructuring scenarios are depicted in Fig 27.