Bail-in Capital: The New Box

Manu Krishnan, Phil Jacoby

Abstract— In this paper, we discuss the paradigm shift in bank capital from the "gone concern" to the "going concern" mindset. We then propose a methodology for pricing a product of this shift called Contingent Capital Notes ("CoCos"). The Merton Model can determine a price for credit risk by using the firm's equity value as a call option on those assets. Our pricing methodology for CoCos also uses the credit spread implied by the Merton Model in a subsequent derivative form created by John Hull *et al* . Here, a market implied asset volatility is calculated by using observed market CDS spreads. This implied asset volatility is then used to estimate the probability of triggering a predetermined "contingency event" given the distance-to-trigger (DTT). The paper then investigates the effect of varying DTTs and recovery assumptions on the CoCo yield. We conclude with an investment rationale.

***Keywords*—:** CoCo, Contingent capital, Bank Capital, Tier1 Capital.

I. Introduction

THERE is a positive paradigm shift underway for the safety and soundness of the financial system and for yield investors in the capital securities market for global banks. The shift is from the old "gone concern" mindset for corporate resolution to a new "going concern" vision for an industry continuum. Basel-III is the impetus behind this vision which we discuss in more detail below. The term "bail-in capital" is used in its plan along with contingent capital which, in itself, is a form of bail-in capital. The term "bail-in" refers to any form of external funding that is not core capital at is origin, but that can become core capital in the future pursuant to the design of its covenants. We view bail-in capital as a de-facto hazard or catastrophe insurance policy that is contingently available to internally fund an issuer's living will with core equity in order to foster the "going concern". This core equity can come from either a write-up of paid-in capital (e.g., through the elimination of debt or preferred stock) or from a switch of non-common stock capital (e.g., debt or preferred stock) into common stock capital -- some combination of both actions would achieve the same outcome.

The Basel Committee on Banking is very interested in integrating bail-in constructs into the capital requirements for systemically important banks. Contingent capital (generally accepted as bail-in capital that could specifically switch into common equity) will be a central theme, among others, in this emerging change in the science of capital markets. We will walk you through a general road map of the mathematical pricing transportation of CoCos premised on the prized intellectual foundations of well known authors. We then add a new wing of expansion derived from this blue print, but applied specifically to the new materials from the "going concern" paradigm.

The recent (and successful) placement of$2 billion of contingent capital for Credit Suisse (the 7.875% Tier-2 Buffer Capital Notes due 2041) acts as a beacon of future issuance and investment opportunity in the hybrid capital markets. Some dealer visionaries forecast the market for contingent capital to grow to more than $1 trillion over the next decade. We believe this to be possible and will discuss some supportive rationale. Unlike prior trends in hybrid capital which have fostered innovation through clever investment banking designs, this new paradigm for bail-in hybrid securities is seeded by regulatory vision. History has shown that regulators get what regulators want.

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II. The Driving Forces of "Going Concern" Science

Unlike normal "gone-concern" capital that has no trigger to push losses except through a bankruptcy proceeding, the force behind "going concern" capital would be triggers contingent upon specified events intended to be set in advance of terminal illness. In some cases, there may be two triggers: 1) to stop payment, and 2) to absorb a capital loss; perhaps at different times. In the case of a contingent capital event, the issue would be automatically switched into common equity shares or alternatively, written down through a mechanism which allocates a loss to the stakeholder -- in each case, under a pre-defined formula in order to assist the issuer in maintaining viability. On the other hand, "gone-concern" capital can be carried on the balance sheet beyond the "point of non-viability" and into receivership – in this case, a liquidation regime would prevail and determine any recovery through priority ranking including a possible exchange for common stock of little value. The common central objective of global regulators is to strengthen the resiliency of the banking sector so that non-viability and subsequent tax-payer bailouts don't happen (again). How this will be accomplished is the product of vision, discovery and implementation.

Basel-III initiatives seek to harmonize the global bank capital structure of both Tier2 and Tier1 capital by indentifying specific criteria which are intended to be supportive of the issuing entity and as such, stabilizing to the broader financial system. Minimum Tier2 capital (i.e., subordinated debt) will be set at 2%. Minimum common equity will be set at 4.5%. In addition, banks will be required to hold a Conservation Buffer of 2.5% -- thus, total common equity capital will need to be 7%. Non-common Tier1 (the sleeve where hybrids will naturally fit) will be 1.5%, thus making the Total Tier1 requirement equal to 8.5% and the Total Capital requirement equal to 10.5% (after the conservation buffer). There is another buffer capital sleeve called the Counter-cyclical Buffer equal to 2.5% which may be filled with some hybrids, as well. Irrespective of the bucketing, future non-common Tier1 issuance (i.e., new Basel-III hybrids) will need to satisfy entry criteria that foster the "going-concern" rather than the traditional norm of the "gone concern". The criteria that comprise "going concern" capital will redefine the hybrid capital market -- the primary features are:

1. Financial or regulatory mechanisms embedded into the contracts that would either objectively (through triggers) or subjectively (through regulatory determination) require the issuer to absorb losses with the hybrid security while the firm is still solvent (i.e., still a "going concern") – these mechanisms would typically be in advance of non-viability and would thus, be supportive of enterprise (and recovery) value.

2. The predetermined loss absorption mechanism can follow three general paths: 1) mandatory write down of par value, 2) forced cash recovery of a set amount that is materially less than par value, and/or 3) conversion into common equity.

The roles that contingent capital can play in servicing the Conservation Buffer and the Counter-cyclical Buffer are being studied by the Basel's Financial Stability Board and advocated, in particular, by the Swiss, Canadian and UK regulators – we expect others to follow because its bail-in features offer strong prospective internally funded support. The subsequent question becomes, "How should CoCos be priced such that both issuers and investors can understand the cost and benefit of them?"

III. THE MERTON MODEL

In this section, we will examine the tenets of Robert Merton's credit risk model [6] and the extension made to it by John Hull et al. [4] as a methodology to price CoCos.

The basic idea behind Merton's model is that equity (E) can be thought of as a call option on the assets (A) of the firm, net of liabilities (D) through the following equation:

$$E_T = \max[A_T - D, 0] \tag{1}$$

Where E_T and A_T is the value of the equity and assets at time T, less the face value of debt in this case at time T. Similarly, let E_0 and A_0 represent the values today. Using the Black-Scholes [1] formulation we get:

$$E_0 = A_0 N(d_1) - De^{-rT} N(d_2) \tag{2}$$

Where, d_1 and d_2 (which represent the probabilities of the options expiring in-the-money based on a normal distribution function) are:

$$d_1 = \frac{\ln(A_0 e^{rT}/D)}{\sigma_A \sqrt{T}} + 0.5\sigma_A \sqrt{T}; d_2 = d_1 - \sigma_A \sqrt{T} \tag{3}$$

σ_A is the asset volatility and D is the value of liabilities. Jones et al [5] used Ito's Lemma to link asset volatility and equity volatility based on leverage (L) to get:

$$\sigma_E = \frac{\sigma_A N(d_1)}{N(d_1) - LN(d_2)}; L = (\frac{De^{-rT}}{A_0}) \tag{4}$$

Therefore, the asset volatility can be obtained from the equity volatility. From this, it follows that the probability of default (P) is now the probability that the call option goes unexercised, which is given by:

$$P = N(-d_2) \tag{5}$$

Note: probability depends on leverage, asset volatility and time.

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IV. IMPLIED CREDIT SPREAD FROM THE MERTON MODEL

As shown by John Hull et al [4], let's define B_0 as the market value of debt today, which gives us:

$$B_0 = A_0 - E_0 \tag{6}$$

Using equation (2) we get:

$$B_0 = A_0[N(-d_1) + L\, N(d_2)] \tag{7}$$

Using,

$$B_0 = De^{-yT}$$

In equation (7) we get the yield to maturity (y), where r is the risk-free rate, as:

$$y = r - \ln\left[N(d_2) + \frac{N(-d_1)}{L}\right]/T \tag{8}$$

The implied credit spread of the Merton Model is now,

$$s = y - r = -\ln\left[N(d_2) + \frac{N(-d_1)}{L}\right]/T \tag{9}$$

V. CALCULATING CONTINGENT CAPITAL SPREAD

We solve for CoCo yield using a 2 step process. For the first step, we solve the Merton model to get the implied market value of Assets A_0 and σ_A. The Merton model lets us calculate A_0 and σ_A from E_0, σ_E.

In order to do this we use D = CL + 0.5*LD, where CL is the book value of Current Liabilities and LD is the book value of long term debt.
We use,

$$\sigma_A = \frac{\sigma_E E}{(E+D)} \quad (10)$$

We use this value of σ_A and equation (2) to infer the market value of the assets every day for the previous year and calculate a new estimate σ_A. The procedure is repeated until the new σ_A computed converges.We then calibrate the volatility of assets to the market by using the observed market spread and solving equation (9) using the market value of assets obtained earlier. Equation (9) is solved by using an iterative process as shown in the sample MATLAB code below:

```
 ObservedSpread = 70;
 sigmaA = 0.0001; %%% Initial seed value
 spread = 150*10^-4; %% Initial guess
 T = 5;
 %%% This calculates the sigmaA value calibrated       to the
market.

 while abs(ObservedSpread-spread*10^4) > 5
    sigmaA = sigmaA + 0.001
    d1 = (log(A0/X)+(r+sigmaA^2*0.5)*T)/(sigmaA*sqrt(T));
    d2 = d1 - sigmaA*sqrt(T);
    L = D*exp(-r*T)/Ao;
    spread = - (log(normcdf(d2) + normcdf(-d1)/L))/T ;
end
```

where A_0 is the market value of Assets as obtained by solving the Merton model and D is the book value of Liabilities.

We then assume a normal distribution for the issuer's asset values and use the asset volatility ($\boldsymbol{\sigma_A}$) to obtain a z-value based on the distance-to-trigger (DDT) of the CoCo. For example, if the Core Tier1 ratio is 11% and the trigger is set at 7%, the DTT is 4% which would represent the decline in asset values required to cause a triggered conversion into common equity shares. From this, we can estimate the probability of asset values declining the full distance-to-trigger amount given the current real time implied asset volatility in CDS. Once the z-value is obtained, the probability of "default" can be obtained. This probability value can then be converted into a spread [2-3] using the Spread Triangle where:

Spread = Probability of Default * (1- Recovery)

Here, "default" means the contingency event being triggered rather than a (more severe) bond default. As recovery (R) value will also change CoCo spread requirements, prospective views on recovery value (R) can now be made depending on the type of bail-in consideration in the CoCo (e.g., virtually zero, some cash percentage of par value or common equity shares).

The MATLAB code to model recovery (R) assumptions and DTT is:

```
DTT = 0.028; %%% Assumes 9.80 to 7% Common  T1
change
Recovery = 0.5;
 zval = ((1-DTT).*Ao-Ao)./(Ao*sigmaA)
 p = normcdf(zval,0,1) %%% Cumulative probability over T
 LossAbsorption = 1-Recovery;
Spread = (p*(1-Recovery))/T*10^4+ObservedSpread
CoCoYield = Spread*10^-2+4.20;  %%% 4.20  30yr swap rate
assumed
```

VI. MODEL RESULTS: COMPARED AMONG 5 BIG BANKS

We run the model for a few different credits such as Credit Suisse (CS), Union Bank of Switzerland (UBS), BankAmerica (BAC), JP Morgan (JPM), and Citigroup (C). We first provide a base case trigger level of 7% Core Tier1 with a loss given trigger of 50% and then extend it to other scenarios.

	Coco Yield	DTT	Trigger	Recovery	Core T1	5 year CDS*
CS	8.15%	4.15%	7%	50%	11.15%	83
UBS	7.50%	5.70%	7%	50%	12.70%	83
BAC	10.09%	1.60%	7%	50%	8.60%	140
JPM	8.73%	2.80%	7%	50%	9.80%	70
C	9.28%	3.70%	7%	50%	10.70%	129
*Data as of 03/22/2011, 30 year swaps = 4.20%						

We ran the model for March 22nd 2011 and October 5th 2011. The model results imply that the Credit Suisse Coco is oversold as of the 5th of October 2011.

Credit Suisse	Senior Spread*	Model CoCo Spread*	CT1	DTT	30 day Equity Vol	Coco Mkt Spread*
March 22nd 2011	83	323	11.15%	4.15%	28%	340
October 5th 2011	194	525	13.10%	6.10%	70%	600

*LIBOR Spread

Fig. 1 Model Pricing outputs

Notice that, given the distance-to-trigger (DTT) for Citi as 2.1 units higher than BAC's DTT, our methodology determined a lower fixed rate perpetual CoCo yield for Citi than for BAC. To some extent, a shorter DTT is implied by the higher CDS spread for BAC. However, the CoCo spread is not a linear relationship to CDS spread because asset volatility moves at varying speeds within significantly different ranges of DTT values. In other words, the bigger the "warning track", the lower the risk of crashing into the wall. The BAC CoCo prices 81 basis points wider than the Citi CoCo, but their CDS differential is only 11 basis points – the DTT and volatility differentials primarily explain this difference. This higher risk of trigger on BAC requires more current income to compensate for the higher probability an undesirable outcome. Fig. 2 below illustrates this inverse relationship between distance-to-trigger and the perpetual CoCo yield.

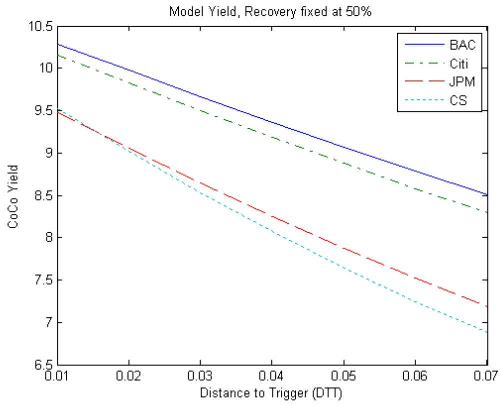

Fig. 2 Model output of selected CoCo yields with varying DTT and fixed recovery.

The yield on CoCos should fall as the Common Equity Tier1 ratio of the banks improves *ceteris paribus*. We would expect the yield to fall as the DTT increases until it hits the subordination limits which should act as a floor for the CoCo yield (and spread). Therefore, if the CoCo bond is structured as a Lower Tier2 note (as they have been in Europe), it should approach the gone concern subordinated debt spread to senior debt as the distance to trigger increases. Consequently:

CoCoYield = max(Model Yield, Sub debt yield)

We now consider the implications of varying recovery assumptions keeping the DTT fixed. In Fig. 1, we show that the perpetual CoCo yield for Credit Suisse is 8.15%. This is very close to the secondary market current yield of 7.60% (As of March 22nd 2011) for the existing Credit Suisse Buffer Capital Note. This 55 basis point premium on the actual CS CoCo versus our modeled CS CoCo can be explained by a combination of things: 1) the actual CS CoCo is the only CoCo trading of its kind, 2) it is a 5yr fixed-to-floating issue with a 30 year term which mitigates long run interest rate term structure risk, and 3) the market may be implying a greater than 50% expected recovery value on the actual CS CoCo due to its structure -- we explore recovery beta in Fig. 3 below.

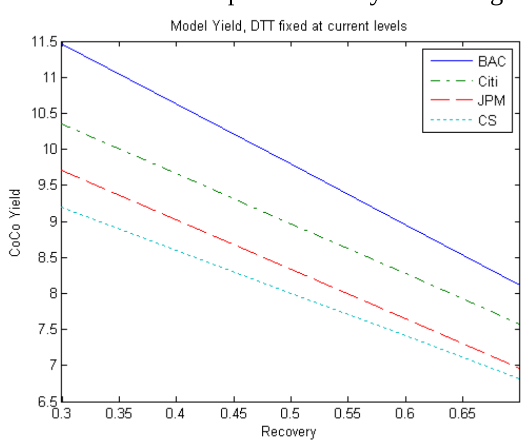

Fig. 3 Varying recovery assumptions and fixed DTT

Clearly, it can be seen that increasing recovery built into the CoCo structure will require a lower yield from investors. As we have shown, the recovery mechanism built into the CoCo is a key driver to long run value. There are two terms to the recovery equation that investors should be mindful of on CoCos: 1) what recovery is expected to be as a percent of CoCo face value, and 2) how the common stock price is determined which ultimately calculates the number of shares that will be received. History tells us that common equity volatility is well into its outer quartile (i.e., very high) when distress happens, so it is important to get as broad a distribution of common stock price experience as possible for calculating the number of common shares paid as exchange consideration on the CoCo. A fair conversion mechanism will improve the prospect of actually recovering close to what was initially expected.

VII. CONCLUSION

We expect CoCos to be labeled as debt, preference shares or preferred stock depending on the issuer's unique preferences, regulation, and sovereign tax allowances. "Going-concern" capital is meant to be supportive of an institution sufficient to forestall it from ever reaching the nadir of being "gone" (i.e., reorganized or dissolved in a bankruptcy proceeding). There is an inherent behavioral risk reduction incentive impelled by CoCos that should bias management to reduce operating risk in advance of a "contingency event" because equity dilution is typically undesirable when prices decline. A Moody's study, Preferred Stock Impairments and Recovery Rates 1983-2008, revealed that recovery rates on preferred stock improved as the severity of circumstances that caused the initial dividend impairment declined. It seems reasonable to expect, therefore, that recovery rates on equity based contingent capital can be well supported by the "going concern" operative of the instrument. Furthermore, due to numerous distressed exchanges over the past two years, the market has learned much more about hybrid preferred recoveries. Empirical data shows that the median recovery for distress bank hybrid exchanges with a dividend default was $40; while the median recovery for distress exchanges without a dividend default was $67.50. This experience adds incremental insight into the Moody's study which found distress exchanges to recover a median price of (just) $22 over almost three decades of data. Interestingly, the average recovery of a distressed exchange in preferred securities during the Subprime Crisis was roughly similar to the average recovery for senior debt ($55) in the Moody's study – certainly, government liquidity support was helpful. New going concern capital standards from Basel-III are intended to prevent a crisis replay and forestall the need for future government support. Indeed, bail-in debt and contingent capital will be relied upon to assume the role of public support. We view the crisis driven preferred exchanges as real-time previews of what CoCos should do -- eliminate payments and absorb losses to guard systemic integrity if extreme stresses were to come again. CoCos that are structured properly (or that are re-priced in the secondary market if they weren't) ought to have a unique combination of high income due to consistently objective deferral risk, yet respectable recovery expectations aided by the very bail-in features that are intended to foster a soft landing for the impairment event. We believe that the contingent capital pricing methodology discussed in this paper can help not only investors, but also issuers to better quantify "going concern" risk, thus nurturing the long run development of bail-in capital as The New Box.

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