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PORTFOLIO INSIGHTS

Solvency II Capital Treatment of Convertible Bonds under the Standard Formula

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IN BRIEF

- Convertible bonds combine the features of conventional corporate bonds and equity options; insurers can use a variety of approaches to capture these features in their Solvency II market risk capital calculations
- Among the three alternative approaches considered in this paper, full re-valuation under the regulatory stress scenarios allows for a more accurate quantification of the capital requirement
- Other methods can lead to substantial misestimation of the capital requirement, especially for at-the-money convertible bonds.

1 REGULATORY GUIDELINES

The guidelines for calculation of Solvency Capital Requirements (SCR) for convertible bonds are provided in the Solvency II delegated act[1]

Under the EIOPA guidelines, where an asset can be considered as a composite of discrete components, relevant stresses should be applied to each of these components separately when appropriate.[1]

2 MARKET RISK SCR CALCULATION

Solvency regulations do not prescribe a specific method for deriving the standard formula market risk SCR for convertible bonds. We consider three approaches:

(1) Bond decomposition: splitting the value of a convertible bond into a "bond floor" component and an equity option component and stressing these components separately

(2) Sensitivity-based re-valuation: estimating the changes in the convertible bond value using risk factor sensitivities

(3) Full re-valuation: using a convertible bond pricing model (jump-diffusion option pricing model implemented in Bloomberg, in our instance) to re-value the convertible bond under the regulatory stress scenarios

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[1] https://eur-lex.europa.eu/eli/reg_del/2015/35

J.P.Morgan Asset Management

FIGURE 1: BARCLAYS BANK USD 0% 02/04/2025 CONVERTIBLE BOND AS AT 30 NOVEMBER 2020

BOND SUMMARY	
ISIN	US06738G8A15
Issuer	Barclays Bank PLC
S&P Rating	A+
Maturity	02/04/2025
Conversion Price	196.99
PRICE AND VALUE	
Market Price	124.93
Fair Value	122.82
Parity	108.67

VALUATION MODEL ASSUMPTIONS	
Yield curve	EIOPA No-VA Nov-2020 USD
BBG valuation model	Jump Diffusion
Spread[1] (bps)	58.74
Stock Price	214.07
Stock Volatility (%)	29.76
SENSITIVITIES[2]	
Delta (%)[3]	52.00
Gamma	0.619
IR Sensitivity[4]	-2.421
Spread Sensitivity[5]	-3.79
Effective Duration[6]	1.949

Source: Bloomberg as at 30 November 2020.

Once the standard formula sub-module stresses (interest rate, credit spread and equity) are calculated using one of the three approaches, they are aggregated using the relevant market stress correlation matrix.

To illustrate the differences between these approaches, we calculate market risk SCR of a market-traded convertible bond (ISIN: US06738G8A15)[7] and compare the results. Our analysis demonstrates that bond decomposition and sensitivity-based re-valuation can yield inaccurate results for around-the-money convertible bonds. In light of this result, we are in favor of full re-pricing for calculating market SCR capital charges for convertible bonds.

2.1 Example bond

We consider a zero-coupon convertible bond issued by Barclays Bank[7] and maturing in April 2025. The bond characteristics reported in **FIGURE 1** were retrieved through Bloomberg OVCV menu. The analysis is based on the market data as at 30 November 2020, so that the bond has nearly 4.5 years remaining until maturity.

The option to convert includes a soft call when the stock price reaches 196.99. The option is in the money, with a delta of 52.00%. The implied default spread is the Bloomberg 5Y implied default spread available through the DRSK menu upon loading the security. The 'Stock Volatility' is the implied volatility that aligns bond fair value under Bloomberg convertible bond valuation model with its observed market price.

The bond is valued using the EIOPA USD risk free curve without volatility adjustment as at 30 November 2020. For this curve, the standard formula interest rate upward shock is a +100bps parallel shift[8].

[1] Bloomberg 5Y implied default spread used by the jump-diffusion model in Bloomberg.
[2] Risk factor sensitivities reported by Bloomberg are calculated by re-valuing the bond under small changes to model inputs.
[3] Relative change in bond price given a 1% in underlying stock price.
[4] Change in the value of the convertible bond per 100 basis point change in the risk-free yield curve.
[5] Change in the value of the convertible bond per 100 basis point parallel shift of the credit default spread (CDS) curve, expressed as percentage of the bond price.
[6] Percentage change in bond value in response to 1% change in interest rate curve level.
[7] The companies/securities above are shown for illustrative purposes only. Their inclusion should not be interpreted as a recommendation to buy or sell
[8] See Article 166(2) of the Solvency II Delegated Act.

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2.2 Bond decomposition

Under this approach, the convertible bond is split into a "regular" bond with no convertible features – known as the bond floor – and an equity option.

The bond floor value is the present value of future cash flows discounted using the EIOPA No-VA USD curve and credit Z-spread. The latter is interpolated from the quoted issuer's Z-spread.

FIGURE 2: BARCLAYS BANK[9] QUOTED CREDIT SPREAD

	MATURITY	SPREAD
Spread 4y (bps)	4.00	50.34
Spread 5y (bps)	5.00	58.74
Spread bond (bps)	4.40	53.70

Source: Bloomberg as at 30 November 2020.

The option component is valued using the Black-Scholes model: exotic option features such as embedded soft or hard call and put options, periodic calls and puts and dividend protections, are disregarded. The Black-Scholes model inputs are tabulated in **FIGURE 3** below. The strike price of the option is the conversion price of the convertible bond.

FIGURE 3: OPTION COMPONENT VALUATION INPUTS

INPUT	VALUE
S (Stock Price)	214.07
K (Strike Price)	196.99
ΔT (Time to Maturity)	4.40
Risk Free rate (S0042)	0.08%
Implied Volatility*	30.16%
Dividend Yield*	0.25%

* J.P. Morgan Asset Management calculations

Option maturity is assumed equal to convertible bond maturity; generally, this is only true if there is no option to convert the bond before maturity. The risk-free rate is interpolated from the EIOPA No-VA USD curve. Implied volatility is backed out from option value and other model parameters using the Black-Scholes formula.

To calculate market risk SCR, we apply market risk sub- module shocks separately to the bond floor and to the equity option. The results are shown in **FIGURE 4**. The SCR for each market risk sub-module is calculated as the relative change in bond and equity option value in response to a change in the corresponding input parameter. Risk factor changes are specified by the Solvency II Delegated Act:

- **SPREAD STRESS** is 140bps added to the initial spread curve. This corresponds to the spread applied for an A+ rated bond with duration up to five years as per Article 176(3) of the Delegated Act. The option component is insensitive to spread stress.
- **EQUITY STRESS** is an instantaneous loss on underlying stock of 39% (Type II equities with a nil symmetric adjustment). The bond floor component is insensitive to equity stress.
- **INTEREST RATE STRESS** consists of a series of interest rate shocks at different tenors along the USD EIOPA risk free curve without volatility adjustment. Both bond and option components are sensitive to interest rate stress.

FIGURE 4: COMPONENT-BASED CALCULATION OF CONVERTIBLE BOND MARKET SCR

MARKET RISK SUB-MODULE	INPUT PARAMETER	EIOPA SHOCK	FAIR VALUE LOSS (SCR)
SCR Spread	Spread	140.00	5.42%
SCR Equity	Stock Price	-39.00%	17.74%
SCR Interest Rate	EIOPA USD Curve	EIOPA UP Shocks	1.57%
SCR Total			22.16%

Source: J.P. Morgan Asset Management calculations based on Bloomberg convertible bond input data as at 30 November 2020 and USD EIOPA risk free curve without volatility adjustment dated 30 November 2020 and EIOPA Delegated Act 10 Oct 2014.

[9] The companies/securities above are shown for illustrative purposes only. Their inclusion should not be interpreted as a recommendation to buy or sell. J.P. Morgan Asset Management may or may not hold positions on behalf of its clients in any or all of the aforementioned securities. Past performance is not necessarily a reliable indicator for current and future performance.

2.3 Sensitivity-based re-valuation

• EQUITY SCR

Under this approach, change in convertible bond price under the equity stress is approximated using the second order (delta-gamma) approximation and the risk factor sensitivities ("Greeks") reported in **FIGURE 1**.

$$SCR_{EQ} = \frac{\partial V}{\partial S} = \Delta \frac{\partial S}{S} + \frac{\Upsilon}{2}\left(\frac{\partial S}{S}\right)^2$$

$$SCR_{EQ} = 52\% * 39\% + \frac{0.619}{2} * 39\%^2$$

$$SCR_{EQ} = 25\%$$

Where ***V*** is the convertible bond value and ***S*** is the stock price.

• INTEREST RATE SCR

Interest rate stress is approximated using a first order approximation:

$$SCR_{IR} = \frac{\partial V}{\partial r} = IR_{Sensi} * \partial r$$

$$SCR_{IR} = -2.421 * 0.59\% = 1.42\%$$

Where ∂r is the change in interest rate at tenor corresponding to the duration of the bond following the application of the EIOPA shock.

• SPREAD SCR

Similarly, the spread stress is calculated as

$$SCR_{CreditSpd} = \frac{\partial V}{\partial Cspd} = Cspd_{Sensi} * \partial spd$$

$$SCR_{CreditSpd} = -3.79 * 140bps = 5.31\%$$

Where $\partial Cspd$ is the change in the credit spread prescribed by the Solvency II Delegated Act.

The results are tabulated in **FIGURE 5** below. Although the delta-gamma approximation can work reasonably well for deep in-the-money convertibles (that have a similar payoff profile to equity) and deep out-of-the-money convertibles (that have a similar payoff profile to plain, non-convertible bonds), it offers a poor approximation for convex payoff of at-the-money convertibles. Given that the typical moneyness[10] of convertible bond indices is around 0.3-0.6, the delta-gamma approximation should be avoided.

Similarly, sensitivity-based approximation offers poor accuracy for standard formula interest rate and spread stresses; they are by design approximations for small changes in values of risk factors.

2.4 Full re-valuation

The market risk SCR charges reported in Figure 6 are derived by changing the relevant model inputs and re-calculating the bond fair value under Bloomberg jump-diffusion convertible bond valuation model.

FIGURE 5: CALCULATION OF CONVERTIBLE BOND MARKET SCR THROUGH SENSITIVITY-BASED RE-VALUATION

MARKET RISK SUB-MODULE	INPUT PARAMETER	EIOPA SHOCK	FAIR VALUE LOSS (SCR)
SCR Spread	Spread Sensitivity	140.00	5.31%
SCR Equity	Delta, Gamma	-39.00%	25.00%
SCR Interest Rate	IR Sensitivity	EIOPA UP Shocks	1.42%
SCR Total			**27.24%**

Source: J.P. Morgan Asset Management calculations based on Bloomberg convertible bond input data as at 30 November 2020 and EIOPA risk free curve without volatility adjustment dated 30 November 2020 and EIOPA Delegated Act 10 Oct 2014.

FIGURE 6: CALCULATION OF CONVERTIBLE BOND MARKET SCR THROUGH FULL RE-VALUATION

MARKET RISK SUB-MODULE	INPUT PARAMETER	EIOPA SHOCK	FAIR VALUE LOSS (SCR)
SCR Spread	Spread	140.00	6.25%
SCR Equity	Stock Price	-39.00%	17.04%
SCR Interest Rate	EIOPA USD Curve	EIOPA UP Shock	0.41%
SCR Total			**22.13%**

Source: J.P. Morgan Asset Management calculations based on Bloomberg convertible bond valuation outputs as at 18 February 2016 and EIOPA CHF discount curve dated 31 Jan 2016 and EIOPA Delegated Act 10 Oct 2014.

[10] In this paper, moneyness is the ratio of spot price of the convertible bond to the conversion price ("strike").

3 SUMMARY

The results of the three alternative methods are summarized in Figure 7 below. Full re-valuation approach yields the lowest overall SCR charge.

The full re-valuation method does not require the additional assumptions of the bond decomposition or the small-change assumptions of the sensitivity-based re-valuation. Bond sensitivities, such as duration and delta, are local approximations of changes in value that are reasonably accurate for small changes in risk factors. By design, Solvency II market risk stresses represent extreme risk factors changes; using local approximations in conjunction with these extreme stresses is bound to produce inaccurate results.

Convertible bond valuation models are available in most third-party valuation and risk management tools used in the insurance industry (e.g. Bloomberg, MSCI RiskMetrics, FINCAD). Given a complete set of inputs, full re-valuation of convertible bond positions should not create significant extra overhead relative to a sensitivity-based approximation. We are therefore in favor of utilizing a full re-valuation model for calculating market SCR capital charges.

FIGURE 7: SUMMARY OF MARKET RISK SCR CALCULATION RESULTS UNDER THE THREE METHODS

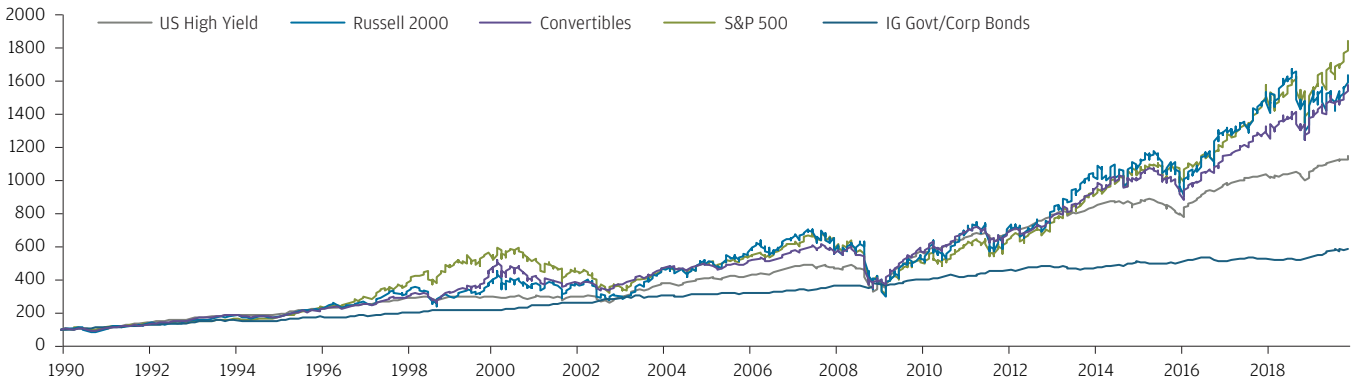
MARKET RISK SUB-MODULE	BOND DECOMPOSITION	SENSITIVITY BASED RE-VALUATION	FULL RE-VALUATION
SCR Spread	5.42%	5.31%	6.25%
SCR Equity	17.74%	25.00%	17.04%
SCR Interest Rate	1.57%	1.42%	0.41%
SCR Total	**22.16%**	**27.24%**	**22.13%**

Source: J.P. Morgan Asset Management calculations based on Bloomberg convertible bond input data as at 30 November 2020 and EIOPA risk free curve without volatility adjustment dated 30 November 2020 and EIOPA Delegated Act 10 Oct 2014.

APPENDIX: HISTORICAL PERFORMANCE ANALYSIS

- The figure below illustrates the cumulative total return of equities, US IG Government and corporate bonds, US high-yield bonds, US equities and US convertible bonds over Jan-1990 to Dec-2019. Asset classes are represented by the following indices:
- US IG Government and corporate bonds – ICE BofA US Corporate and Government Index (BOAO Index)
- US high-yield bonds – ICE BofA US High Yield Index (HOAO Index)
- US equities – S&P index (SPX Index) & Russel 2000 (RTY Index)
- US convertible bonds – ICE BofA All US Convertibles excluding Mandatory Index (VOAO Index)

FIGURE 8A: CUMULATIVE TOTAL RETURN OF BOND AND EQUITY INDICES, JAN-1990 TO DEC-2019



Convertible bonds are relatively more common in the lower-rating, lower-duration quadrant of the corporate fixed income space. As a consequence, convertible bond returns are more aligned with those on shorter-dated high-yield bonds (HUCC) than those of the broad All Corp index (COAO): monthly return correlations are 0.35 and 0.69, accordingly. Over 1996-2016, bonds have significantly outperformed equities both in absolute terms and on the risk-adjusted basis. Convertible bonds have delivered higher returns than high-yield bonds; at the same time, their historical volatility has been in between equities and high yield bonds.

FIGURE 8B: STATISTICS OF BOND AND EQUITY INDICES, JAN-1990 TO DEC-2019

	ANNUALIZED RETURN	ANNUALIZED VOLATILITY	ANNUALIZED SHARPE RATIO	CORRELATION	SCR
Convertibles	9.6%	11.3%	0.7	1.0	21%
S&P 500	10.2%	16.0%	0.5	0.8	39%
Russell 2000	9.7%	19.8%	0.4	0.9	39%
US High Yield	8.5%	6.3%	1.1	0.6	~18-25%
IG Govt/Corp Bonds	6.1%	4.2%	1.1	-0.1	~15%

- Convertible Bonds have demonstrated less risk, lower SCR and achieved a higher Sharpe Ratio versus equities over time.

Source: J.P. Morgan Asset Management., Bloomberg. Data rebased to 100 as at 31/01/1990 to 31/12/2019. IG Govt/Corp = BOAO ICE Bofa Merrill Lynch Corporate and Government Master Index. HY = HOAO ICE Bofa Merrill Lynch US High Yield Index. Converts = VOAO ICE Bofa Merrill Lynch All US Convertibles Index excluding Mandatories. S&P 500 = S&P 500 Index. Risk free rate is average of the 3 Month Treasury rate.

Past performance is not necessarily a reliable indicator for current and future performance.

In simple terms, convertible bonds may be considered as a hybrid of corporate bonds and equities – benefiting from the features of both asset classes. As such, convertibles offer a return pick-up compared to corporate bonds through their sensitivity to equities, while they have a low capital requirement compared to traditional equity investments.

Although insurers are increasingly looking to gain exposure to convertible bonds, the asset class does not yet represent a large share of the typical insurance balance sheet. However, from an asset liability management (ALM) point of view, convertibles can help provide insurers with exposure to equities in a capital efficient manner.

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