

The US Convertibles Risk Model

The US Convertibles Risk Model, available in POINT, the Barclays Capital portfolio analytics and modeling platform, is a multi-factor approach that models convertibles as a hybrid of a credit bond and an equity option. The relative weight of each component is highly dynamic and depends on the particular conditions of the convertible.

1. Introduction¹

A convertible security offers unique advantages to investment managers. It provides participation in the unlimited upside potential of the underlying equity, while also affording downside protection due to its bond feature. It offers income advantage over the underlying equity and diversification benefits for equity and fixed income investors. It also offers various advantages to the issuing company, as it is less dilutive than a common stock offering, less costly than a pure debt offering, and expands the investor base. See Krishna, Shivdasani, and Gioielli (2009) for a primer on convertible securities.

A wide range of portfolio managers invest in convertible securities with different objectives. Fixed income investors are generally more interested in busted/out-of-the-money convertibles. Equity investors and convertible arbitrage funds invest majorly in the equity-like/in-the-money convertible securities.

The US Convertibles Risk Model in POINT covers convertible securities issued by US companies that trade in USD. A convertible is a hybrid instrument that behaves both like a bond and a stock. A convertible behaves more like a bond when its underlying equity price is lower and its credit spread is higher, whereas it behaves more like a stock when the underlying stock price is higher or more volatile. Hence, in the Global Risk Model, a convertible security loads onto a set of pre-existing fixed income and equity factors, driven by the credit and the equity options risk models respectively. Specifically, a convertible security loads onto the following set of risk factors in the POINT Global Risk Model:

■ US Equity Option Risk Model:

- US Cash Equity
- US Equity Volatility
- US Equity Convexity

■ USD Credit Risk Model:

- USD Treasury
- USD Swap Spread
- USD Credit

Cenk Ural
+1 212 526 3790
cenk.ural@barcap.com

www.barcap.com

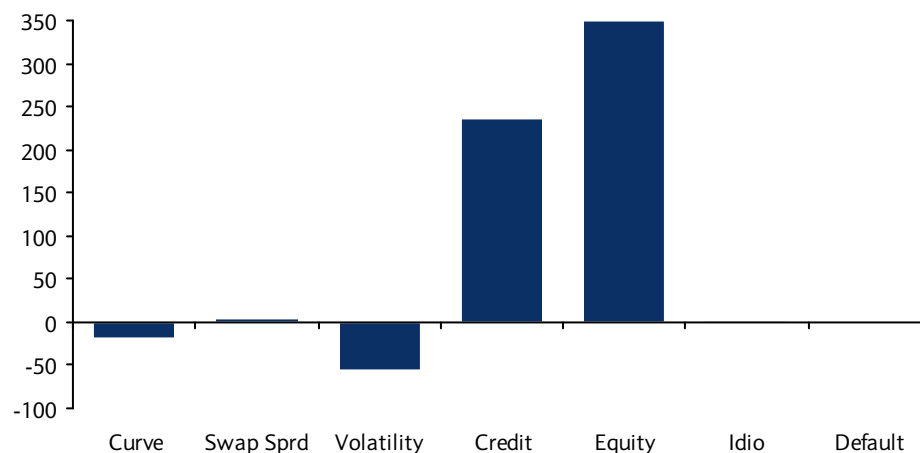
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For large/diversified convertible portfolios, the major contributors to volatility are the credit and cash equity components. Figure 1 shows that almost all risk can be attributed to these two components for the Barclays Capital US Convertibles Index.

Figure 1. Contribution to the Volatility of the Barclays Capital US Convertibles Index (bp), 30 September 2009



Source: Barclays Capital POINT

To compute the analytics needed to assess risk for US convertibles, POINT uses a pricing model in which the stock price is modeled as a jump diffusion process. Inputs to the model include the term structure of interest rates, implied volatility of the underlying stock, credit spread, call/put schedule, underlying/conversion price, and coupon payment structure. We use trader marks for the implied volatility and the credit spread, but there are automated processes to calculate them if they are not updated regularly by Barclays Capital traders. The solution to the model is achieved by means of the Crank-Nicolson (Crank and Nicolson (1947)) finite difference method.

The US Convertible Risk Model covers different types such as cash pay, zero coupon, preferred, and mandatory convertibles. The latter two behave more like equity than do the other types. Accordingly, we use equity conventions for mandatory and preferred convertibles and fixed income conventions for all other types of convertibles in POINT. For example, the price for equities is quoted as share price, whereas it is a percentage of par for fixed income securities.

In Section 2, we discuss the set of systematic risk factors for a convertible security. Section 3 explains the idiosyncratic risk model for convertible securities. In Section 4, we illustrate the implementation of the model in POINT for a couple of broad convertible portfolios.

2. The Systematic Risk Model

As mentioned above, in the Global Risk Model, US convertibles load onto a set of equity and fixed income risk factors. How much the convertible behaves like a bond or a stock determines the relative magnitude of loadings to these two sets of factors. Appendix 1 outlines the list of all equity and fixed income factors and their loadings used in the US Convertibles Risk Model. In this section, we provide a brief description of these factors.

USD Treasury/Swap Spread Factors

All US convertibles load onto the USD interest rate and swap spread factors. To populate the interest rate factor loadings, we map the option-adjusted duration of the convertible to the two neighboring key rate durations (in POINT, we have six KRDs: 6m, 2y, 5y, 10y, 20y and 30y). Regarding the swap spread factors, we use a similar approach. Please refer to Joneja/Dynkin *et al.* (2005) for a detailed description of these factors.

USD Credit Factors

The forecasted volatility of non-distressed convertible bonds depends on the industry classification, rating, and subordination. They load onto a combination of Ultra High Grade, Industry, High Yield, and Long/Short Maturity factors. For convertibles, we use the same factor assignment rules and loadings that were originally implemented in the USD Credit Risk Model (see Silva (2009)).

On the other hand, distressed convertible bonds load onto the Distressed Average Return factor with a unit loading. Credit factors become a more significant part of the total risk for convertible portfolios that contain a large amount of distressed or busted convertible bonds.

US Cash Equity/Equity Convexity Factors

Since a convertible security provides the investor a conversion option to common equity, its price exhibits sensitivity to the underlying stock price movements. This component of the model becomes a larger contributor to risk when the convertible is more in the money (stock price > conversion price). The loading of a convertible to the underlying equity factors is a function of its price, the underlying stock price, delta (the sensitivity of the convertible price to the changes in the underlying stock price), and the loading of its underlying equity to the US equity risk factors. See Silva, Staal, and Ural (2009) for a detailed description of the factors in the US Equity Risk Model.

When the underlying equity price moves, the change in the convertible price cannot be explained by just a linear function of the underlying price move. Gamma, the second derivative of the convertible price with respect to the underlying price, captures this non-linearity in the relationship between the price of the convertible and its underlying equity. The loading to the US Equity Convexity Factor is a function of gamma, market beta, the underlying price, and the convertible price (Silva and Ural (2009)).

US Equity Volatility Factors

The conversion option of the convertible security becomes more valuable when the volatility of the underlying equity price increases. In the Global Risk Model, a convertible loads onto the equity volatility factors originally employed in the US Equity Options Risk Model, the implied volatility industry factors defined with respect to the GICS level 2 classification of the issuer. The loading of a convertible to the equity volatility factors is a function of vega (the sensitivity of the convertible price to the changes in the underlying equity volatility), the implied volatility of the underlying equity, the convertible price, and the maturity adjustment factor. More details on the equity volatility factors can be found in Silva and Ural (2009).

The following equations demonstrate the systematic return decomposition of a convertible in the US Convertibles Risk Model with respect to its exposure to the aforementioned set of equity (EQ) and fixed income (FI) factors.

$$r_c = r_{EQ} + r_{FI}$$

$$r_{EQ} = \frac{\Delta S}{c} * r_S + \frac{\Lambda \sigma f(T)}{c} * r_\sigma + \frac{\Gamma S^2}{2c} * r_S^2$$

where the equity return is decomposed into underlying, volatility, and convexity components. See Silva and Ural (2009) for a detailed explanation of these components.

$$r_{FI} = r_{\text{carry}} + \sum_{i=1}^N \text{KRD}_i * (-\Delta \text{KR}_i) + \sum_{i=1}^N \text{SSKRD}_i * (-\Delta \text{SS}_i) + \text{OASD} * (-\Delta \text{LOAS})$$

where the fixed income return is decomposed into carry, yield curve, swap spread, and credit spread components.

3. The Idiosyncratic Risk Model

As in the case of the systematic part of the model, the idiosyncratic risk of a convertible security is a function of the idiosyncratic risk of its equity and fixed income components. The following equation formulates the idiosyncratic return of a convertible:

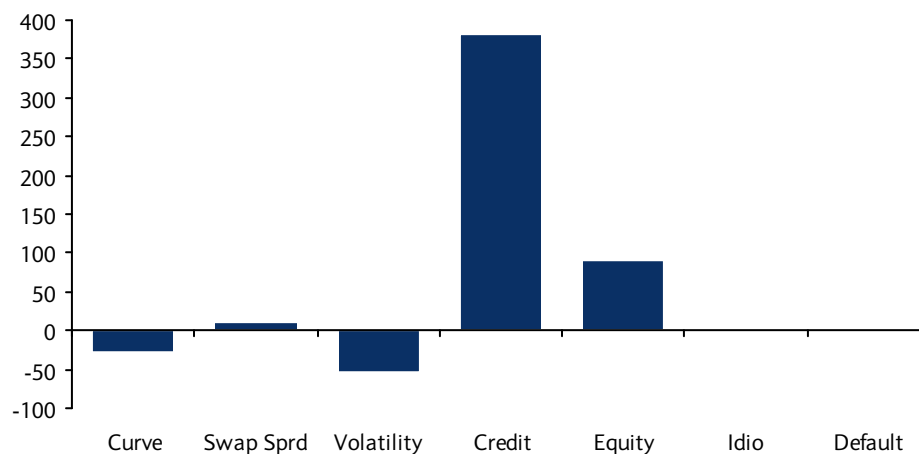
$$\varepsilon_c = \frac{\Delta S}{c} * \varepsilon_S + \frac{\Lambda \sigma f(T)}{c} * \varepsilon_\sigma + \varepsilon_B$$

Where ε_c is the idiosyncratic return of the convertible, ε_S is the idiosyncratic return of its underlying stock, ε_σ is the idiosyncratic return of its equity volatility component, and ε_B is the idiosyncratic return of a hypothetical non-convertible corporate bond with the same parameters. In the calculation of the idiosyncratic volatility, we take into account potential correlations between these terms.

4. Illustrations

In this section, we illustrate the implementation of the US Convertibles Risk Model in POINT. We use two sub-indices of the Barclays Capital US Convertibles Index, Busted and Equity Sensitive, and show how the risk model captures the equity and fixed income characteristics of these two indices.

Figure 2 depicts the contribution of different factors to the total volatility of the US Convertibles Busted Index as of September 30, 2009. Figure 3 provides summary statistics regarding the volatility and sensitivities for the same index. This is a sub-index of the US Convertibles Index, for which the conversion options of the constituents are far out of the money. We see that the contribution of credit factors is dominant in the portfolio, and the majority of this comes from the high yield factors. The contribution of the equity factors is much smaller, as convertibles in this index tend to have low equity sensitivity.

Figure 2. Contribution of Different Factor Classes to Volatility for the US Convertibles Busted Index (bp)

Source: Barclays Capital POINT

Figure 3. Summary Statistics for the US Convertibles Busted Index

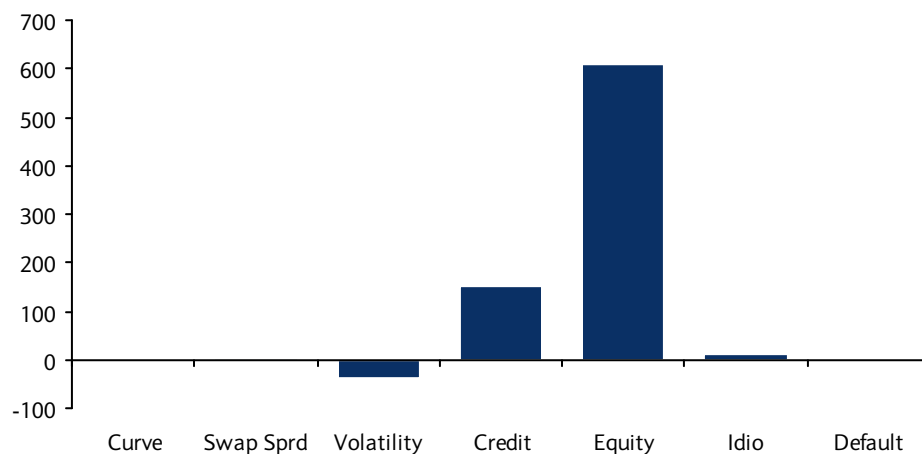
TEV Summary (bp)		Constituent Statistics (Median)	
Total TEV	408.8	OAS	711
Systematic TEV	405.1	OAD	2.03
Idiosyncratic TEV	36.8	OASD	1.72
Default TEV	41.0	Delta	0.13
		Vega	0.09

Source: Barclays Capital POINT

Figure 4 shows the contribution of different factors to total volatility for the US Convertibles Equity Sensitive Index as of September 30, 2009. Figure 5 provides summary statistics regarding the volatility and the sensitivities for the same index. This is also a sub-index of the US Convertibles Index, for which the conversion options of the constituents are in the money. We see that the total volatility estimate is almost double that of the Busted Index, and the equity factors are the major contributors to volatility. The contribution of interest rate and credit factors are relatively smaller. As in the case of in-the-money equity options, the equity volatility component is relatively insignificant compared with the underlying equity component. As the conversion options for convertibles in this index are in the money, their prices exhibit high sensitivity to the movements in the underlying equity prices. We also see that the default TEV is smaller, as issuers in this index tend to be financially healthier.

Comparing the constituent statistics in Figure 3 and Figure 5 reveals that the median durations in the Busted Index are significantly higher, due to the dominant fixed income characteristics of its constituents. On the other hand, not surprisingly, we see that an average convertible in the Equity Sensitive Index demonstrates considerably higher equity sensitivities (delta and vega).

Figure 4. Contribution of Different Factor Classes to Volatility for the US Convertibles Equity Sensitive Index (bp)



Source: Barclays Capital POINT

Figure 5. Summary Statistics for the US Convertibles Equity Sensitive Index

TEV Summary (bp)		Constituent Statistics (Median)	
Total TEV	734.0	OAS	571
Systematic TEV	727.1	OAD	0.47
Idiosyncratic TEV	98.9	OASD	0.67
Default TEV	19.2	Delta	0.86
		Vega	0.25

Source: Barclays Capital POINT

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APPENDIX 1: FACTOR SPECIFICATION

FACTOR	LOADING	FACTOR	LOADING	FACTOR	LOADING
KEY RATES AND CONVEXITY		EQUITIES DEVELOPED MARKETS		EQUITY VOLATILITY	
USD 6M key rate	KRD (Yr)	USD Equity Energy	Empirical Beta	USD Equity Implied Vol Energy	Equity Volatility
USD 2Y key rate	KRD (Yr)	USD Equity Materials	Empirical Beta	USD Equity Implied Vol Materials	Equity Volatility
USD 5Y key rate	KRD (Yr)	USD Equity IND Capital Goods	Empirical Beta	USD Equity Implied Vol IND Capital Goods	Equity Volatility
USD 10Y key rate	KRD (Yr)	USD Equity IND Commercial	Empirical Beta	USD Equity Implied Vol IND Commercial	Equity Volatility
USD 20Y key rate	KRD (Yr)	USD Equity IND Transportation	Empirical Beta	USD Equity Implied Vol IND Transportation	Equity Volatility
		USD Equity CYC Automobiles	Empirical Beta	USD Equity Implied Vol CYC Automobiles	Equity Volatility
SWAP SPREADS		USD Equity CYC Consumer Durables	Empirical Beta	USD Equity Implied Vol CYC Consumer Durables	Equity Volatility
USD 6M swap spread	SSKRD (Yr)	USD Equity CYC Consumer Services	Empirical Beta	USD Equity Implied Vol CYC Consumer Services	Equity Volatility
USD 2Y swap spread	SSKRD (Yr)	USD Equity CYC Media	Empirical Beta	USD Equity Implied Vol CYC Media	Equity Volatility
USD 5Y swap spread	SSKRD (Yr)	USD Equity CYC Retailing	Empirical Beta	USD Equity Implied Vol CYC Retailing	Equity Volatility
USD 10Y swap spread	SSKRD (Yr)	USD Equity NCY Retailing	Empirical Beta	USD Equity Implied Vol NCY Retailing	Equity Volatility
USD 20Y swap spread	SSKRD (Yr)	USD Equity NCY Food	Empirical Beta	USD Equity Implied Vol NCY Food	Equity Volatility
		USD Equity NCY Household	Empirical Beta	USD Equity Implied Vol NCY Household	Equity Volatility
CREDIT NON-DISTRESSED (AAA-B) SPREAD & VOL.		USD Equity HLT Health Care	Empirical Beta	USD Equity Implied Vol HLT Health Care	Equity Volatility
USD Ultra High Grade Industrials	OASD (Yr)	USD Equity HLT Pharmaceuticals	Empirical Beta	USD Equity Implied Vol HLT Pharmaceuticals	Equity Volatility
USD Ultra High Grade Utilities	OASD (Yr)	USD Equity FIN Banks	Empirical Beta	USD Equity Implied Vol FIN Banks	Equity Volatility
USD Ultra High Grade Financials	OASD (Yr)	USD Equity FIN Diversified Financials	Empirical Beta	USD Equity Implied Vol FIN Diversified Financials	Equity Volatility
USD IND Metals	DTS (Yr*)	USD Equity FIN Insurance	Empirical Beta	USD Equity Implied Vol FIN Insurance	Equity Volatility
USD IND Capital Goods	DTS (Yr*)	USD Equity FIN Real Estate	Empirical Beta	USD Equity Implied Vol FIN Real Estate	Equity Volatility
USD IND Div. Manufacturing	DTS (Yr*)	USD Equity TEC Software	Empirical Beta	USD Equity Implied Vol TEC Software	Equity Volatility
USD IND Auto	DTS (Yr*)	USD Equity TEC Hardware	Empirical Beta	USD Equity Implied Vol TEC Hardware	Equity Volatility
USD IND Consumer Cyclical	DTS (Yr*)	USD Equity TEC Semiconductors	Empirical Beta	USD Equity Implied Vol TEC Semiconductors	Equity Volatility
USD IND Retail	DTS (Yr*)	USD Equity Telecommunication	Empirical Beta	USD Equity Implied Vol Telecommunication	Equity Volatility
USD IND Cons. Non-cyclical	DTS (Yr*)	USD Equity Utilities	Empirical Beta	USD Equity Implied Vol Utilities	Equity Volatility
USD IND Health Care	DTS (Yr*)	USD Equity Core	Empirical Beta	USD Equity Implied Vol Core	Equity Volatility
USD IND Pharmaceuticals	DTS (Yr*)	USD Equity Total Yield	Total Yield		
USD IND Energy	DTS (Yr*)	USD Equity Hybrid Default Probability	HDP	EQUITY CONVEXITY	
USD IND Technology	DTS (Yr*)	USD Equity Share Turnover Rate	Share Turnover	USD Equity Option Convexity	Equity Convexity
USD IND Transportation	DTS (Yr*)	USD Equity Momentum (9m)	Momentum		
USD IND Wireless	DTS (Yr*)	USD Equity Discretionary Accruals	Accruals		
USD UTI Electric	DTS (Yr*)	USD Equity Market Value	Size		
USD UTI Gas	DTS (Yr*)	USD Equity Realized Volatility	Realized Volatility		
USD FIN Banking	DTS (Yr*)	USD Equity Earnings to Price	Earnings/Price		
USD FIN Finance Companies	DTS (Yr*)	USD Equity Book to Price	Book/Price		
USD FIN P&C Insurance	DTS (Yr*)	USD Equity Earnings Forecast	Earnings Forecast		
USD FIN Reits	DTS (Yr*)	USD Equity Other Market Volatility	MW		
USD Credit Core	DTS (Yr*)				
USD High Yield Industrials	DTS (Yr*)				
USD High Yield Utilities	DTS (Yr*)				
USD High Yield Financials	DTS (Yr*)				
USD IND Short Maturity	OASD*(OASD-AvgOASD) (Yr*2)				
USD UTI Short Maturity	OASD*(OASD-AvgOASD) (Yr*2)				
USD FIN Short Maturity	OASD*(OASD-AvgOASD) (Yr*2)				
USD IND Long Maturity	OASD*(OASD-AvgOASD) (Yr*2)				
USD FIN Long Maturity	OASD*(OASD-AvgOASD) (Yr*2)				
CREDIT DISTRESSED (CAA-D) & VOL.					
Distressed Average Return	MW%				

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