Major Revision of the Everything Everywhere Model Methodology

From Emilian Belev, CFA

Dear Northfield Client,

Northfield's team has been committed to a continual effort of enhancing our methodology and incorporating the latest ideas and research into the tools and models that we offer. As part of this commitment, we have released a major revision of the Everything Everywhere model. The revision concerns the approach to credit risk of corporate bonds.

Our new methodology is based on the corporate sustainability framework as described by Dan diBartolomeo in the Journal of Investing[1]. This framework uses as premise that credit risk is brought about by the fact that stockholders hold an implicit call option which the bondholders are short, which has a strike price equal to the level of the firm debt and where the underlying is the total of the firm's assets. The put-call parity further implies that for the de facto owners of the portfolio consisting of the firm's assets, and a short position in the firm debt [i.e. the stockholders], there is a corresponding put option, the exercise of which is essentially the event of default. The idea of using this implicit firm option has existed in prior work in this area, notably by Merton[2] and Leland and Toft[3], and implemented by firms like KMV[4], later acquired by Moody's, to infer default probabilities.

Northfield's contribution in this area has a couple of aspects. The first one is advancing the idea of "market implied expected life of firms," which views the stockholder option as a perpetual American put "default" option and solves for the optimal time of exercise of this option. In an elegantly tractable way this approach incorporates both probability and severity of default, and can be used to effectively measure the credit-worthiness of firms, demonstrated among other places in Northfield's newsletter article of March 2011, http://www.northinfo.com/Documents/413.pdf. The article also describes interesting empirical results for equity investors where strategies are framed using the expected life concept. It should be noted that our work on the expected lives of firms is a downward biased estimate of our true expectation for firm survival. This is because the option pricing process assumes that the asset values of firms moves randomly. In the real world, actions of corporate managements should (we hope) reduce the potential for severe declines in values of a firm's assets.

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[1] dDiBartolomeo, Dan, "Equity Risk, Credit Risk, Default Correlation, and Corporate Sustainability", *The Journal of Investing*, Winter 2010, Vol. 19, No. 4: pp. 128-133

[2] Merton, R.C., "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates", *Journal of Finance*, 29 (1974), pp. 449-470

[3] Leland, Hayne, and Klaus Bjerre Toft, "Optimal Capital Structure, Endogenous Bankruptcy, and the Term Structure of Credit Spreads", *Journal of Finance*, 51 (1996), pp 987-1019

[4] Zeng, B., and J. Zhang, "An Empirical Assessment of Asset Correlation Models.", Moody's KMV Working Paper, 2001.

Our next contribution is the application of the implied default option in a factor risk model. We derive a solution of corporate bond's credit factor exposures which are directly related to the factor exposures of the associated company's stock. The relation has the form:

Factor Exposure Bond = -(E/B) * (delta put/delta call) * Factor Exposure Of the Stock of the Bond Issuer

Where E is the market capitalization of the firm, B is the market value of the firm's debt, and the put and call are calculated with respect of the time horizon of the particular bond tranche.

This expression is appealing to intuition. First, it states that, everything else the same, the closer the firm is to default (deeper into junk status) the higher the delta of the put will be relative to the delta of the call. Given that option gamma is the same for puts as for calls the approach to junk status will tend to proportionately increase the ratio of two deltas more than it will decrease the ratio E/B per unit of decline in the firm asset value. That will make the bond's factor exposures more similar to that of the stock and this reflects the empirical evidence that junk bonds w behave like equities.

The relation also reveals some properties of bond credit volatility that are somewhat surprising but important and intuitive upon review. It can be demonstrated that apart from volatility due to movements in the risk-free yield curve, short term bonds of the same company can be more volatile than the longer term bonds of the same firm. Algebraically this translates into the statement that the puts of shorter dated option having the same strike can be higher (and call deltas are respectively lower) than those of longer dated options. This statement is provable using most conventional option pricing models. This resonates with the conventional logic that the longer term provides more room than short term towards unbounded improvement than bounded decline. Despite that simple logic, the anecdotal bias in the industry has is that longer term bonds are necessarily more credit risky than shorter term ones, partly due to bond duration vis-à-vis spread considerations, and confusion of higher periodic volatility with higher total premium charged for default risk (firm put option value). Our finding sets the record straight and is one of the contributions of the model to a better accord of mathematical rigor and conventional intuition in the area of finance.

While the analytical framework of the model has changed, we made sure that the structure of the data delivery and format is going to remain the same. This would entail that no system or programmatic changes would be required on the side of the risk model user due to the model enhancement.

Should you have any questions about the EE model please do not hesitate to let us know. We will further keep you promptly informed about future enhancements as they develop.