A New Perspective for Solving the Credit Spread Puzzle

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Abstract

Traditional theory suggests that the expected default losses should be the sole determinant of credit spreads, the gap between yields on default-able corporate bonds and those on default free U.S. Treasury bonds. However, both theoretical credit default models and empirical studies reveal that expected default losses are too small to explain the observed credit spread and that other factors may contribute to the credit spreads, such as state level taxes on corporate bonds, illiquid corporate bond market, correlation between risk-free spot rate and default risk, slope of term structure of risk free short rates, common market risk factors, and other firm specific factors. Current literature barely explores the impact of corporate governance structure, such as corporate monitoring mechanism, on corporate bond credit spreads. A new perspective to examine the role of bondholders' controlling and monitoring mechanisms on the corporate bond spread is laid out in this article.

Keywords: Credit spread puzzle; default risk; corporate controlling and monitoring mechanism

I. Credit Spread Puzzle

Pricing of default-able corporate bonds and understanding of credit spreads are important issues to corporate finance and corporate governance. In real world, we observe the yield spread between the yield on corporate bonds and the yield on Treasury bonds with the same maturity. For a default-able corporate bond and a risk-free treasury bond with the same maturity, the default-able corporate bond should be priced with higher yield than that of the Treasury bond to compensate for bearing the default risk. The expected default losses should be the sole determinant of credit spreads, the gap between yields on default-able corporate bonds and those on default free Treasury bonds. However, empirical studies show that spreads on corporate bonds tend to be many times greater than what would be implied by expected default losses alone. For example, the average spread on BBB rated corporate bonds with 3-5 years to maturity was about 170 bps, while the average yearly loss from default amounted to only 20bps. The wide gap between spreads and expected default losses is so called credit spread puzzle.

II. Literature Review

Corporate default risk has been studied since 1970s. Early methods include discriminate analysis, logit model, and mortality tables. (Altman et Al., 1977, and Altman,1989).Later, both the structural model and the reduced-form model are developed to examine the dynamics of default risk. Structural models of default provide an intuitive framework for identifying the determinants of credit spread changes. Structural models begin with Black-Scholes (1973), Merton (1974), and Black and Cox (1976), where corporate liabilities are modeled as contingent claims to the firm's assets and a closed form solution in continuous time case are found. Geske (1977) shows that debt holders' payout structure can be modeled and solved as a sequence of compound options. Furthermore, Leland (1995), Leland and Toft (1996), Longstaff and Schwartz (1995), and Collin-Dufresne and Goldstein (2001) develop several models to relax the assumptions in Merton (1974)'s model, such as non-stochastic interest rates, no transaction costs, no bankruptcy costs, no liquidity effects, no jump effects, and no market risk factors. Structure models tell us what bond spread should be. Structure models are better for explaining the determinants of bond spreads, but lack the power of forecasting because the initial observed bond spread term structure does not automatically fit into the models. In contrast, reduced form models treat the default time as determined by a counting Poisson (jump) process with state-dependent intensity process. Reduced-model such as Das and Tufano(1996), Jarrow et al (1997), Duffie and Singleton (1997), and Duffee (1999) take observed bond price as a give input in calibrating the model. Reduced form models match bond spreads by construction generally require less data, therefore, notably are better for forecasting than explaining.

III. Structural Models of Default Risks

The seminal work of Black and Scholes (1973) and Merton (1974) build the original insight on the corporate bond pricing. They utilize the option pricing methodology to demonstrate that equity and debt can be valued using contingent-claims analysis. In Merton (1974) model, a three assets portfolio is constructed in a way that it is consist of long and short position of firm value, risk free debt, and a security depend on firm's value. The firm value follows a diffusion stochastic process

$$dV = (\alpha V - C)dt + \sigma V dz \tag{1}$$

The security follows the process described in the following partial differential equation:

$$\frac{1}{2}\sigma^2 V^2 F_{vv} + rVF_v - rF - F_r = 0 \tag{2}$$

The closed form solution, then, can be derived from this equation subject to boundary conditions and initial condition which embedded in bond provisions.

$$\begin{aligned} &F(V,\tau) = Be^{-r\tau}\{\Phi[h_2(d,\sigma^2\tau)] + 1/d\Phi[h_1(d,\sigma^2\tau]\}, \\ &where, d = Be^{-r\tau}/V \\ &h_1(d,\sigma^2\tau) = -[1/2\sigma^2\tau - \log(d)]/\sigma\sqrt{\tau} \\ &h_2(d,\sigma^2\tau) = -[1/2\sigma^2\tau + \log(d)]/\sigma\sqrt{\tau} \end{aligned} \tag{3}$$

The credit spread can be derived as the following:

$$\begin{aligned} &R(\tau) - r = -1/\tau \cdot \log\{\Phi[h_2(d,\sigma^2\tau)] + 1/d\Phi[h_1(d,\sigma^2\tau]\}, \\ &where, F(V,\tau)/B = \exp[-R(\tau)\cdot\tau] \end{aligned} \tag{4}$$

In Merton (1974)'s model, holding a debt claim is analogous to holding a similar risk free debt and having sold to equity holders an option to put the firm value. This model reveals that credit spread is determined by two variables: (1) the variance of a firm's operation value, (2) the ratio of debt to the firm value. Merton's model can not generate sufficiently high yield spread to match those observed on the market. Jones et al. (1984) empirically examine the Merton's model, and find that predicted price from the model are too high, by 4.5% on average, and that the model works better for investment grade bonds than for speculative grade firm. Thus recent theoretical literature includes a variety of extensions and improvements, such as allowing for coupons, default before maturity, and stochastic interest rate. For example, Geske (1977) values coupon bond as a sum of compounded option. Leland (1994), Leland and Toft (1996) assume endogenous default and show that structural models are capable of generating a large range of credit spread which spans the observed corporate yield spreads. Anderson and Sundaresan (1996), Mella-Barrl and Perraudin (1997), and Anderson et al. (1996) argue that incorporating strategic default by equity-holders who try to extract concession from bondholders can explain why credit spread should be higher. Longstaff and Schwartz (1995) incorporate bankruptcy costs, the violation of absolute priority rule, and stochastic interest rate into the structural model. Collin-Dufresne and Goldstein (2001) argue that firms with good credit quality are likely to issue more debt, which leads to higher yield spreads. They incorporate the mean-reverting leverage ratio policy into the model. Similarly, Duffie and Lando (2001) incorporate the incomplete accounting information and jump-diffusion stochastic process into the model to generate high credit spreads. Huang and Huang (2002) capture the effects of business cycles on credit risk premia. They introduce an analytical tractable jump-diffusion structure to capture the effects on credit risk premia of future states with both high default risks and abnormally high stochastic discount factors. The structural model can be generalized as the following: all structural models assume firm value follows a diffusion process with a constant volatility plus a jump.

$$dV_t = (\pi_t^v + r_t - \delta_t) \cdot V_t \cdot dt + \sigma_v V_t \cdot dW_t^v + dJ \quad (5)$$

The risk neutral measure can be written as:

$$dV_t = (r_t - \delta_t) \cdot V_t \cdot dt + \sigma_v V_t \cdot dW_t^{vQ} + dJ^Q \quad (6)$$

Stochastic interest rates follow Vasicek (1977)'s process:

$$dr = (\alpha - \beta r)dt + \sigma \cdot dZ \quad (7)$$

The total liability follows the process:

$$d \ln K = K[\ln(V / K) - v - \Phi(r - \theta)]dt \quad (8)$$

IV. Reduced Form (Intensity-Based) Models of Default Risk

In practices, structural models are difficult to use. First, the firm values are often not observable, causing the difficulty in constructing three assets non-arbitrage portfolio. Second, the complex priority structure of the payoffs to all of the firm's liabilities needs to be specified and be included in the valuation procedure, which generates significant computational difficulties. Thirdly, this approach does not use credit rating information. Therefore, it cannot be used to price credit derivatives whose payoffs depend on credit rating. Finally, empirical studies do not provide strong support for structural models.

An alternative approach has been developed by many for pricing derivative securities involving credit risk (Madan and Unal, 1994; Leland,1994; Lando,1998; Jarrow and Turnbull (1995), Jarrow, et al., 1997; Duffie and Singleton, 1999; and Duffee,1998). The reduced form of credit risk modeling views the default of corporate bond issuers as an unpredictable event. At each instant, there is some probability that a firm defaults on its debts. The probability and the recovery rate in the event of default may vary stochastically through time. The stochastic processes determine the price of credit risk. The key advantage of this method is that it brings into the machinery of classical term structure modeling techniques, namely, affine-structure machinery of Vasicek (1977) and the equivalent martingale measure results of Harrison and Kreps (1976). It is convenient for the econometrics specification as well as for the pricing of credit derivatives.

Incorporating the relaxed assumptions into structural model has led to the computational difficulty. Reduced-form models utilize the techniques in interest rate term structure modeling, especially, the equivalent martingale measure Q. It reaches a simple form of default-able corporate bond valuation model. The initial market value of the default-able claim to X is,

$$V_0 = E_0^Q[\exp(-\int_0^T R_t dt) \cdot X] \quad (9)$$

where E_0^Q denotes the risk neutral conditional expectation at time zero. $h_t L_t$ is the risk neutral mean-loss rate of the bond due to default. h_t is the hazard rate for default at time t and L_t. (1-L_t) is the recovery rate. Equation (9) indicates that default-able bond can be valued as the present value of promised payoff X, treated as if it were default free, discounted by the default-adjusted short rate of R. Equation (10), $Rt = r + h_t \cdot L_t$ offers great freedom in choosing various stochastic processes followed by risk free short rate r, hazard rate h, and conditional loss rate L. The key assumption in reduced-form model is that default event was treated as exogenous, which means that $h_t L_t$ does not depend on the value of the default-able claim itself. Duffie and Huang (1996), Duffie and Singleton (1997), and Duffie and Singleton (1999) discuss the case where this assumption is violated. They show that the absence of arbitrage implies that bond price is the solution to a nonlinear partial differential equation in the case of price-dependency.

Reduced form models become more popular than structural models, because, on average, they fit the corporate bond yield better. Although it has weak implications in explaining the compositions of yield spreads, reduced form models have strong power in forecasting yield spread and corporate bond prices. For example, Duffee(1998) shows that for a typical firm, the root mean squared error in yields is less than 10 basis points. The second advantage of reduced form model is that it can accommodate the relaxing of assumptions of perfect market more easily than structural models. Duffie and Singleton (1999) show the case where the Markov diffusion process and jump-diffusion state process were incorporated.

V. Empirical Evidence

Elton, et al. (2001) examine the effect of state taxes on corporate bond and the risk premium that caused by bond price volatility itself. They show that for 10-yrs A rated bonds, taxes accounted for 36.1% of the yield spread while expected loss accounted for 17.8% of the yield spread. They also show that the remaining spread can be explained by common equity market risk factors, indicating the existence of risk premium in bond yield spread. Delianeds and Geske (2001) examine the determinants of credit spread based on a modified Merton's model, which incorporates the concerns of recovery costs, taxes, jump in negative default probability, liquidity effect, and market risk factors. They show that interest rate, liquidity, stock market volatility, and market returns, rather than the default risk, explain the majority part of credit spreads. Collin-Dufresne et al. (2001) empirically examine the determinants of credit spreads implied in structural models. They find that the factors suggested by traditional models of default risk explain only about 25% of variation in credit spreads as measured by the adjusted R square. Given the non-arbitrage feature of the structural model, this R square seems extremely low. The principal components analysis indicates that the residuals are highly correlated, suggesting a common risk factor contribute to the residual spreads. As they incorporate the proposed common risk factors, such as Fama-French market risk two factors (adopted by Elton et al., 2001), and liquidity effect, into the regression, the R square is still at low level. Thus, they suggest that demand and supply condition in local market may contribute to the unexplained residual spreads. Collin-Dufresne et al. (2001) investigate changes in credit spread on bond yield. They find that factors suggested by traditional structural models of default risk, such as, interest rates, yield curve slope, leverage, volatility, jump, and business climate, explain only 25% of the variation in credit spreads, and show that the residuals are highly correlated, indicating a unknown common risk factor may contribute a large part of yield spread. Contrary to Elton et al's finding, they show that macro market risk factors such as Fama-French two factors and liquidity effects are not the common risk factor. Driessen (2005) provides a decomposition of corporate bond returns into several factors under intensity-based reduced-from models framework. He shows that taxes and liquidity effects, and a risk premium on market wide credit spread movements are important determinants of investment grade bonds, but jump risk premium may not exist due to the its non-diversifiable feature. More recently, Amato and Remolona (2005) argue that the answer to the credit spread puzzle might lie in the difficulty of diversifying default risk. They suggest that the distribution of returns on corporate bonds is highly negatively skewed. Such skewness would require an extraordinary large portfolio to achieve full diversification. By showing that such large portfolio are unattainable, they argue that spreads are so wide because they are pricing un-diversifiable credit risk.

VI. A New Perspective

Both theoretical credit models and empirical evidences reveal that expected default losses are too small to explain the observed credit spread and other factors may contribute to the credit spreads, such as state level taxes on corporate bonds, illiquid corporate bond market, risk-free spot rate and term structure of risk free short rates, common market risk factors, and other firm specific factors. Current literature barely explores the impact of corporate governance structure, such as corporate monitoring mechanism, on corporate bond credit spreads. Examining the role of bondholders' lack of control and monitoring mechanisms on the corporate bond spread may offer an alternative venue to tackle the credit risk puzzle.

Unlike firms' shareholders who can actively and continuously monitor the managers via board of director, executive compensation contracts, and shareholder activism, holders of corporate bonds do not enjoy such privileges. Based on the real-option nature of the equity, to increase shareholders' wealth and managers' compensation, shareholder and managers may intentionally raise the volatility of firm value by adopting risky projects. This will increase the firm value volatility and increase the default probability. In this scenario, bondholders have no effective means to prevent those activities from damaging their bond market value. In other words, bondholders are lack of control on firm's residual claims associated with corporate bonds. The monitoring provision of corporate bond has been written into the bond covenants at bond initial issuance date. While shareholders could take actions to continuously re-negotiate and re-contract with managers to align their interests with those of managers, bondholders are lack of those rights, thus have no control on firm's assets to alter the probability of default during the bond holding period given there is no default event before the maturity.

On equity markets, we observe the control premium for controlling shareholders, especially, in the cases of merger and acquisitions. For bondholders, to compensate for the lack of control and monitoring mechanism, it is rational to demand a higher return on their bond investment, which can be defined as control discount or monitoring discount.

Once control/monitoring discount factors are incorporated into credit spread analysis, an important question to ask is whether this factor has already submerged into the expected default loss component of the credit spread. There are two possibilities, one is that control/monitoring discount is fully incorporated in the expected default loss. In this case, we would like to know the magnitude of control discounts. Is control discount different for on-the-run corporate bonds and off-the-run corporate bonds? What are determinants of magnitude of control discount? Does managerial compensation have impact on control discount? Does ownership structure influence the control discount? Does control discount disappear in distressed firm where bond holders regain the controlling and monitoring power? The second possibility is that control/monitoring discount may not be fully reflected in the expected default loss. If so, we may use control/monitoring discount argument to explain the credit spread puzzle and various credit risk stylish facts, such as the increase of credit spread after 1998, non-zero credit spread approaching maturity, larger percentage of unexplained spreads for higher grade corporate bonds, and so on.

According to the reduced-from model of Deriessen (2002), the risk-neutral default intensity can be modeled as:

$$\lambda_t = \alpha + \beta_1 r_t + \beta_2 v_t + \gamma_1 F_{1,t} + \gamma_2 F_{2,t} + G_t \tag{11}$$

Where r and v are short-rate factors in an affine Treasury term structure model, Fs are factors common to every firm, and G is the firm specific factor. One can incorporate the firm specific factor associated with corporate governance, such as the concentration of ownership, or managers' stock and option incentives, into this model.

The new approach that emphasizes importance of corporate governance can also provide solutions to the following research issues: using innovative econometrics models to test either the structural models or reduced models for default risk; exploiting the unknown risk factor that may contribute to the residual spread; extending the study into non-investment grade bonds, especially, the distressed bonds or the high yield bonds; and applying behavioral finance methodology to study credit spread components.

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