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Empirical analysis of credit spread changes of US corporate bonds

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ABSTRACT

In this paper we investigate the short-term credit spread dynamics of quality US corporate bonds, building on the Longstaff and Schwartz (1995) two-factor model. We find that changes in credit spreads usually display a significant negative relationship with changes in both the risk-free short interest rate and equity index returns as a proxy for asset values. Somewhat puzzlingly, however, we find that these variables do not yield a significant contribution to variations in spreads at maturities between 10 and 15 years. We also argue that the relative illiquidity of the secondary market for corporate bonds may not generally allow for the immediate incorporation of information into bond prices, which affects spreads significantly.

1. Introduction

The objective of this paper is to empirically investigate the short-term credit spread dynamics of quality US corporate bonds, building on the Longstaff and Schwartz (1995) two-factor model. As in the studies by Longstaff and Schwartz (1995), Duffee (1998) and Barnhill, Joutz, and Maxwell (2000), for example, we utilize (i) returns on a well-diversified market index as a proxy for the asset value factor i.e. the risk of issuer default and (ii) changes in a government bond rate as the proxy for changes in the default-free interest rate level. Contrary to the above studies, however, we use daily data, which allows us to examine whether such relationships also hold under short-term volatility conditions.

There are a number of other articles focusing on the explanation of corporate credit spread changes that allow for both default risk and interest rate risk. The empirical evidence found in these works is rather mixed. Originally, in US bond markets Longstaff and Schwartz (1995) found evidence of a negative relation for both changes in the short-term interest rate and changes in corporate asset value. This contradicts the traditional approach, which implies that credit spreads depend only on an asset value factor i.e. the risk of default by the issuer. A weak but significant negative relation between changes in credit spreads and interest rates was also found by Duffee (1998), while Neal, Rolph, and Morris (2000) identified a negative relationship only for the short-term and a reversal to a positive relationship in the long run. Examining quality Deutsch Mark-denominated Eurobonds, Batten, Hogan, and Wagner (2005) reported that interest rates yield a significant negative contribution to variations in spreads, but interestingly concluded that stock returns do not, and in fact found a puzzling significant positive relation for long maturity bonds. Batten, Hogan, and Jacoby (2005)on the other hand document a significant negative effect of stock returns on credit spreads for non-callable Australian Dollar-denominated Eurobonds. Bedendo, Cathcart, and El-Jahel (2007) also look at the slope of the term structure of credit spreads (the differences in credit spreads of bonds of different maturities) and find similar effects of interest rate variables and equity market volatility on credit spreads of different maturity bonds, but the economic importance of these factors differs between bonds of shorter and those of longer maturities.

Eom, Helwege, and Huang (2004) look at the predictive power of various bond pricing models and find that all but one model (Leland & Toft, 1996) underestimate credit spreads, which demonstrates the importance of other risk premiums incorporated in the credit spreads, among which liquidity risk premium and default jump risk are among the most important ones. Driessen (2005) decomposes credit spread into premium for default risk, liquidity risk and tax factors and finds them to important determinants of the expected returns on bonds.

Our findings not only indicate broadly similar results to those in Longstaff and Schwartz (1995) and Duffee (1998), but also yield some surprising outcomes. Consistent with theory and previous

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empirical findings, changes in the short rate and asset prices turn out to be negatively correlated to changes in credit spreads at most maturities. However, at maturities between 10 and 15 years we find that spread changes are not significantly correlated with either the short rate or asset values. We also show that information in general is not immediately incorporated in bond prices, which is most likely due to a secondary market that is relatively illiquid. These findings are relevant not only to credit spread traders and sellers of credit spread derivatives, but also for example to corporate borrowers judging the impact of possible changes in monetary policy.

The paper is structured as follows. Section 2 outlines the economic implications of our study for fixed-income markets. Section 3 depicts the methodological framework and the theoretical model. Sections 4 and 5 describe the dataset and discuss the empirical results. The policy implications and economic conclusions are provided in Section 6. Section 7 allows for some concluding remarks.

2. Economic significance

The dynamic behavior of corporate bond credit spreads remains little understood. This is despite the fact that extensive research has been undertaken in this field for decades, which has yielded a plethora of multivariate econometric models seeking to predict credit spread movements. This keen interest is well justified. Assessing and managing the credit spread risk of corporate bond portfolios are at the core of internal risk control, investment performance and regulation concerns for investors in the corporate bond market. For example, hedge funds often take highly levered positions in corporate bonds while hedging away interest rate risk by shorting Treasury bonds, and as a result become extremely sensitive to changes in credit spreads rather than changes in bond yields. Credit spread risk, which is defined as a general measure of exposure to changing credit spreads, usually between government and non-government debt yields, essentially incorporates downgrade risk and default risk as special cases, and is an important component of corporate debt return. The credit spread dynamics of a well-diversified portfolio is a measure of the systematic risk in corporate bond credit spreads. The Bank for International Settlements (BIS) (2003) explicitly requires a bank's internal risk measurement system for capital charge to incorporate risk factors capturing the spread risk of non-government fixed income securities in their trading book over a 10-day horizon.

Meanwhile, over the most recent years, a burgeoning credit derivatives market has come into place, where the value of the financial products directly depends on the credit risk dynamics of the underlying debt portfolio. As a result, the evaluation of credit risk is obviously relevant to an increasing number of credit spread traders and sellers of credit spread derivatives. Given its short history, the pricing methodologies of credit derivatives are still evolving, however, and credit risk management itself remains a nascent science in the finance industry. Consequently, thorough understanding and characterization of the empirical behavior of corporate bond portfolio credit spreads are necessary tasks for both risk management and pricing purposes. And, the understanding of credit spread movements is also very useful to corporate borrowers looking to judge the impact of possible changes in monetary policy.

In this paper, we present an econometric model of credit spreads on corporate bond portfolios using Merrill Lynch's Investment Grade Corporates Index. There are a few reasons for focusing the study on such a corporate bond index. First, the Merrill Lynch indexes are representative portfolios of a given rating and maturity criteria, and often serve as benchmarks for corporate bond funds. Second, among the growing products in the credit derivatives market, credit portfolio products that are directly based on credit indexes have been introduced into the market. And third, the credit spread data is available on a daily basis, and for portfolio managers the understanding of the day-to-day spread risk embedded in their portfolio is pivotal.

3. The empirical model

Following Merton (1974), assuming frictionless markets in which securities are traded in continuous time, Longstaff and Schwartz (1995) develop a valuation framework for risky bonds that allows for both default and interest rate risk. Default is modeled based on firm value following a geometric Brownian motion and a given constant threshold value. In case default is triggered, i.e. firm value falls below the threshold during the bond's time to maturity, corporate debt holders receive a fraction of the face value at maturity while, of course, otherwise the full proceeds are paid back at maturity. Interest rate risk is modeled by a Vasicek-type mean reverting process with Brownian noise for the short-term riskless rate. In summary, the model has a two-factor structure with firm value and the interest rate level representing the risk factors.

In their empirical investigation, Longstaff and Schwartz (1995) perform tests of a regression equation to explain changes in credit spreads. Given corporate yields $C_t^{i,j}$ and government yields G_t^j for several different rating classes i and maturities j, one may define $S_t^{i,j}=lnC_t^{i,j}-lnG_t^j$ as the logarithmic relative credit spread at time $t=1,\ldots,T$. Then, changes in relative credit spreads $\Delta S_t^{i,j}$ are regressed against changes in logarithmic government yields $\Delta lnG_t^k=lnG_t^k-lnG_{t-1}^k$ with maturity k and market I index returns $R_t=lnI_t-lnI_{t-1}$ as a proxy for changes in aggregate firm value. Note that the log transformation is used to normalize the series, which is a somewhat different approach than that in the theoretical model of Longstaff and Schwartz (1995), where absolute differences in credit spreads and changes in government yields are used. Hence, our basic regression model is of the form:

$$\Delta S_t^{i,j}=\beta_0+\beta_1\Delta lnG_t^k+\beta_2R_t+\varepsilon_t. \quad (1)$$

To capture potential nonlinear effects due to convexity, we also include the squared level of changes in government yields. This should be useful to the extent that structural models of default predict that changes in credit spreads should be nonlinear functions of changes in interest rates.

$$\Delta S_t^{i,j}=\beta_0+\beta_1\Delta lnG_t^k+\beta_2\left[\Delta lnG_t^k\right]^2+\beta_3R_t+\varepsilon_t \quad (2)$$

We also test the model for structural differences by introducing a new dummy variable for three subperiods within the sample. This appears to be more than justified, since we use high-frequency data, and the values show potential structural breaks in the time series (see Fig. 1), especially in light of the events of September 11, 2001 and the subsequent prolonged increase in volatility in financial markets around the world. We estimate the following model:

$$\begin{aligned}\Delta S_t^{i,j}=&\beta_0+\beta_1\Delta lnG_t^k+\beta_2\left[\Delta lnG_t^k\right]^2+\beta_3R_t+\beta_4D_1+\beta_5\Delta lnG_t^kD_1\\&+\beta_6\left[\Delta lnG_t^k\right]^2D_1+\beta_7R_tD_1+\beta_8D_2+\beta_9\Delta lnG_t^kD_2+\beta_{10}\left[\Delta lnG_t^k\right]^2D_2\\&+\beta_{11}R_tD_2+\varepsilon_t.\end{aligned} \quad (3)$$

The three subperiods are: November 14, 2000 to September 10, 2001 ($D_1=0$ and $D_2=0$), September 11, 2001 to October 13, 2002 ($D_1=1$ and $D_2=0$) and October 14, 2002 to October 14, 2003 ($D_1=0$ and $D_2=0$). Note that the choice of subperiods is rather intuitive and is based mainly on the movement of credit spreads in the sample period ().

There are at least three points to mention with this approach when considering the classical distributional assumptions made for the innovations:

1. Time-series dependence in spread changes $\Delta S_t^{i,j}$ will typically result in autocorrelated innovations ε_t. Note that dependence in spread changes may result from the low liquidity, mentioned above, in the bond markets in general as well as the relatively low liquidity of