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Testing the Elasticity of Corporate Yield Spreads

Gady Jacoby, Rose C. Liao, and Jonathan A. Batten*

Abstract

What drives the compensation demanded by investors in risky bonds? Longstaff and Schwartz (1995) predict that one key factor is the time-varying negative correlation between interest rates and the yield spreads on corporate bonds. However, the effects of callability and taxes also need to be considered in empirical analyses. Canadian bonds have no tax effects, yet, after controlling for callability, the correlation between riskless interest rates and corporate bond spreads remains negligible. Our results provide support for reduced-form models that explicitly define a default hazard process and untie the relation between the firm's asset value and default probability.

I. Introduction

Structural models for the valuation of corporate bonds assume an asset-based default process with default occurring once the stochastic value of the firm's assets hits a default threshold.[1] In these models, this threshold is conveniently expressed as the relation between the market value of the firm's assets and its debt. One of the more notable predictions of these models is that credit spreads, expressed as the yield spread between a risky bond and a near maturity riskless bond, are negatively correlated to the return on risky assets and changes in default-free interest rates. The former are usually proxied by equity returns and the latter by the change in a near maturity government bond rate.

*Jacoby, jacobyg@ms.umanitoba.ca, Asper School of Business, University of Manitoba, 181 Freedman Crescent, Winnipeg, MB, Canada, R3T 5V4 and Seton Hall University; Liao, liao_102@cob.osu.edu, Fisher College of Business, Ohio State University, 2100 Neil Ave., Columbus, OH 43210 and Rutgers University; Batten, jabatten@ust.hk, Hong Kong University of Science & Technology, Clear Water Bay, Kowloon, Hong Kong. The authors thank Stephen Brown (the editor), Pierre Collin-Dufresne, Jean Helwege, Andrew Karolyi, Francis Longstaff, Maureen O'Hara, Gordon Roberts, and René Stulz for their comments and Ilona Shiller for research assistance. We especially thank Gregory Duffee (the referee), whose insights have greatly improved the exposition of the paper. All errors are the exclusive fault of the authors. In addition, Jacoby thanks the Stuart Clark Professorship in Financial Management and the Social Sciences and Humanities Research Council of Canada for its financial support. Liao acknowledges the Asper School of Business and the Fisher College of Business for their financial support.

[1]For example, see Merton (1974), Black and Cox (1976), Longstaff and Schwartz (1995), and Ericsson and Renault (2006).

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The objective of this paper is to once again revisit the theme of pricing corporate yield spreads. There are a number of important grounds for doing so. First, despite extensive empirical examination, the expected negative correlations predicted by the structural models are not necessarily present in risky bonds of all credit classes, maturities, and markets (e.g., Longstaff and Schwartz (1995), Duffee (1998), and Collin-Dufresne, Goldstein, and Martin (2001)). Differences in the tax treatment of coupon interest, bond callability, tax timing, and capital structure adjustments have all been identified as possible causes for the time variation that is seen to exist in corporate yields and their spreads over risk-free bonds (e.g., Jordan and Jordan (1991), Duffee (1998), Elton, Gruber, Agrawal, and Mann (2001), Demchuk and Gibson (2006), and Zhdanov (2007)).

The view that credit spreads are negatively related to asset returns is consistent with the stylized facts evident in the pricing of risky bonds by market participants: Credit spreads are higher for bonds of declining credit quality; they increase when news negatively affects underlying corporate asset values and when there is a lack of liquidity (Covitz and Downing (2007), Chen, Lesmond, and Wei (2007), and Plantin (2009)). The other conclusion—of a negative relation to the riskless rate—is, however, not so apparent, and it has remained the subject of extensive empirical verification. Ceteris paribus, under risk-neutral valuation, an increase in the riskless rate implies a higher expected future value for the firm's assets relative to the default threshold and a lower risk-neutral probability of default. This results in a lower credit spread and the expected negative relation between the yield spread and riskless interest rates.

In this paper, we use a unique database of Canadian, investment-grade, corporate bond indices devoid of tax effects, since Canadian corporate and government bonds, unlike U.S. bonds, are subject to the same tax treatment. Canadian government bonds are also highly liquid and, not being a reserve currency, are rarely sought by international investors, notably foreign central banks and financial institutions, whose market actions have the potential to distort pricing along the term structure. This database also contains a unique provision allowing for identification of callable and noncallable indices. Yet, our results are similar to those found by Duffee (1998). The negative yield spread–riskless rate relation found in Canadian callable bond indices is largely due to the call premium, while this relationship is negligible for noncallable bonds. This result is robust for a variety of empirical models.

The remainder of this paper is organized as follows: Section II introduces previous studies and their empirical methods, then Section III presents the unique characteristics of the Canadian bond market. The regression methodology is presented in Section IV, and the empirical results in Section V. Section VI offers concluding remarks.

II. Previous Studies

The two-factor valuation model of Longstaff and Schwartz (1995) applies the closed-form solution of Merton (1974), where default is a function of the value of the firm at maturity, to a simple continuous-time valuation framework that allows for both default and interest rate risk. This structural model captures

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the stochastic nature of interest rates, where for simplicity the dynamics of the interest rate are explained using a simple term structure model based on Vasicek (1977). Other perspectives include the reduced-form models of Jarrow, Lando, and Turnbull (1997) and Duffie and Singleton (1999), where the payoff upon default is specified exogenously. The asset level that triggers default can also be imposed endogenously by having the shareholders optimally liquidate the firm as in Leland (1994), Leland and Toft (1996), and Anderson and Sundaresan (1996). As noted by Giesecke (2006), these models do not consider the way information is revealed over time, and they implicitly assume that investors can observe the inputs to the model's definition of default.

In the Longstaff and Schwartz (1995) model an ordinary least squares (OLS) regression analysis is applied to both yield spreads (the difference between the risky and riskless yields) and the ratio of the risky to riskless yield (termed a relative spread). They predict that all else being constant, the relation between the spread and the interest rate should be negative since firm assets grow at a faster rate under the equivalent martingale measure when the risk-free rate is higher. Nonetheless, the alternate positive sign for this relation would arise when the risk-free rate is positively correlated with asset-value volatility or when cash flow shocks are negatively correlated with risk-free interest rate shocks.

Using Moody's corporate bond yield indices, they find a significant negative yield spread–riskless rate relationship for yield spreads and a stronger negative relationship for relative spreads, which supports their two-factor model.[2] However, Duffee (1998) points out that owing to the construction of the Moody's index, which uses both callable and noncallable bonds, such a conclusion is unwarranted. Instead, he finds that the negative relationship between credit spreads and interest rates is much weaker once the call option effects are removed from the data. Note that Campbell and Taksler (2003) show that since idiosyncratic firm-level volatility affects credit spreads, it could also affect any embedded options in debt.

In a related study using Australian Eurobonds, Batten, Hogan, and Jacoby (2005) find results consistent with the implications of the Longstaff and Schwartz (1995) theoretical model. Their contribution lies in providing an insight into why the relative measure tends to be statistically more significant than the alternate measure based upon the difference. They do so by introducing a simple theoretical framework that explains the effect of callability on the interest rate factor and that by construction, relative spreads should bring about a stronger yield spread–interest rate factor relation.

Collin-Dufresne et al. (2001) identify additional factors that may determine changes in credit spreads. For example, Duffee (1998) omits important factors such as the Longstaff and Schwartz (1995) asset factor in his regression analysis. Collin-Dufresne et al. (2001) combine the explanatory variables offered by Longstaff and Schwartz (1995) and Duffee (1998), in addition to a convexity term and firm leverage variable. They conclude that credit spread changes are primarily

[2]Batten, Hogan, and Jacoby (2005) use a sample of Australian Eurobonds and find evidence supporting the predictions of the two-factor Longstaff and Schwartz (1995) model. Nonetheless, the preference by international investors for the withholding-tax-exempt yields of Eurobonds may distort the pricing relationship between high credit quality Eurobonds and government bonds.

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driven by local supply or demand shocks, which are independent of both credit risk factors and liquidity factors.

Recent extensions to these studies include Thuraisamy, Gannon, and Batten (2008), which identifies various macroeconomic factors (such as exchange rates) that affect the yield spreads of sovereign Latin American issuers, and Cremers, Driessen, Maenhout, and Weinbaum (2008), which shows that the level of individual implied stock volatilities and implied-volatility skew also affect the pricing of credit spreads. David (2008) provides an insight into the basis of the credit spread puzzle, the large spread between low investment-grade and high-quality corporate bonds not explained by historical defaults, risk aversion, or trading frictions (Plantin (2009)), by demonstrating that the effects of macroeconomic shocks on expected default losses are more sensitive to changes in the price of risk than are credit spreads. This results in higher credit spreads even though average default losses are maintained at historical levels.

III. The Uniqueness of Canadian Bond Data

A. Tax Effects

Critically for this study, Canadian bond data enable controlling for the tax effects that arise from the different tax rates in U.S. corporate and Treasury bond markets. Duffee (1998) notes that U.S. corporate bonds are subject to taxation at the federal, state, and local levels, while U.S. Treasury bonds are subject only to federal tax.[3] To determine the potential effect of these distortions on credit spreads, Elton et al. (2001) decompose yield spreads (calculated from estimated zero curves) for U.S. investment-grade corporate bonds into three components: default-risk premium, systematic-risk premium, and state-tax premium. Their analysis shows that the state-tax premium is significantly more important relative to the default-risk premium (36.1% vs. 17.8% of the yield spread for 10-year A-rated bonds, respectively). Since Canadian corporate and Government of Canada bonds are subject to an identical tax rate, tax effects should not play a role in the estimated relation between these bonds or their spreads.

Another advantage of using the Canadian bond data relates to both the level of coupons and the tax system. Constantinides and Ingersoll (1984) show that a dynamic bond trading strategy, aimed at minimizing tax liabilities, produces bond prices significantly higher than when using a buy-and-hold strategy. They attribute this difference in value to a tax-timing option. Jordan and Jordan (1991) provide strong evidence supporting the existence of a tax-timing option for U.S. Treasury bonds.

Prisman, Roberts, and Tian (1996) demonstrate that, given the different tax treatment for bonds in Canada, the tax-timing option in Canada is unlikely to have an economic value to bond traders. In addition, they show that when the range of

[3]According to Duffee (1998), following a given rise in Treasury yields, everything else being equal, the yield on a corporate bond will have to increase by a higher rate, so that the after-tax yield spread will remain unchanged. This implies that the pretax yield spread will widen following an increase in Treasury yields.

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coupon rates in the portfolio contracts, the value of the tax-timing option will be even lower. Historically, Scotia Capital Markets (SCM) imposed constraints on the range of coupon rates permitted for corporate bonds to be included in its indices.[4] These constraints were designed to eliminate the coupon bias from the yield spread of the included bonds over the yield on Government of Canada bonds, so that this spread is as close as possible to the true yield spread. Given these constraints and the tight range of coupon rates at present, the value of the tax-timing option for these indices is expected to be even lower, and its impact on the estimated relation minimal.

B. The Canadian Doomsday Call Provision

To control for callability, Duffee (1998) suggests stratifying data by forming two portfolios for each rating category, one consisting of only callable bonds and the other of noncallable bonds. However, there may be a selection bias in callability related to risk differences between callable and noncallable bonds. For example, Bodie and Taggart (1978) claim that firms with more growth opportunities are more likely to issue callable bonds. If the firm's expectations of growth are confirmed, its shareholders can avoid sharing this good fortune with bondholders by simply having the firm's managers call the entire bond issue. Berk, Green, and Naik (1999) also show that the systematic risk of asset returns is related to the firm's growth opportunities. This implies that stratifying bond data based on callability may create two different risk classes within each rating category.

Canadian corporate bonds have a feature that allows for the mitigation of the potential selection bias associated with callability. Most Canadian corporate bonds issued since 1987 carry a call provision called the "doomsday" call provision. This call provision makes it possible to control for callability for some bonds, facilitating the study of a set of corporate bonds broader than just noncallable bonds. Similar to the U.S. "make-whole" call option, a doomsday call provision sets the call price at the maximum of the par value of the bond, or the value of the bond calculated based on the yield on a Government of Canada bond (with a matching maturity) plus a spread (the doomsday spread). Thus, a make-whole call price is calculated in the same manner as that of the doomsday call, but the bond's remaining cash flows are discounted with the yield of a comparable maturity treasury security plus a contractually specified "make-whole premium." We demonstrate that BBB-rated Canadian bonds are always traded with yield spreads much wider than the doomsday spread set in their call provision. Thus, the exercise of the doomsday call for BBB-rated bonds will rarely cause financial damage to the bondholders, and these bonds may be considered economically noncallable.[5]

To substantiate this feature, we collect doomsday spreads for all Canadian corporate bonds carrying the doomsday call for each month during the

[4]The reader may refer to Jacoby and Roberts (2003) for a detailed description of the SCM indices.

[5]Note that there is still a small probability that a BBB-rated bond will be upgraded in the future and that its doomsday call will be in the money. However, given the small rate of upgrades, the expected value of this state is trivial.

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01:1993–12:1999 period from the *Financial Post* Corporate Bond Record. Since in this study we focus on SCM's long-term bond indices, we limit our sample to data corresponding to bonds with a maturity greater than 10 years. We stratify our data by credit rating, and for every month, we calculate the average and standard deviation of doomsday spreads across bonds within each rating category. Since data for the AAA bonds are unavailable for most of the sample period, we obtain statistics only for bonds rated AA, A, and BBB. Corporate bonds with these credit ratings account for most issued bonds and have the unique property that they can be used to infer properties of credit risk pricing without needing to control state taxes, callability, and tax timing.[6]

To determine the moneyness of the doomsday call provision, one must compare the doomsday spread to the yield spread. In Figure 1, for each rating category, we plot the yield spread on the corresponding long-term index (S), the average doomsday spread (μ), the average doomsday spread plus one standard deviation ($\mu + \sigma$), and the average doomsday spread plus two standard deviations ($\mu + 2\sigma$).[7] In Graph A of Figure 1, note that for AA-rated bonds the yield spread is lower than the average doomsday spread in a large number of cases, and it is almost always lower than the doomsday spread plus one standard deviation. Similarly, in Graph B of Figure 1 the yield spread of A-rated bonds is often lower than the average doomsday spread, and in a significant number of cases it is lower than the doomsday spread plus one standard deviation.

Based on this seven-year sample, the probability of the doomsday call being in the money is substantial for both AA- and A-rated bonds, with that of AA-rated bonds being significantly larger. In Graph C of Figure 1 we see that the yield spread of BBB-rated bonds is always significantly higher than the average doomsday spread plus two standard deviations. Thus, based on our sample, we conclude that the probability of the doomsday call being in the money for a BBB-rated bond is virtually zero. Thus, BBB-rated bonds are economically noncallable.

Mann and Powers (2003) study U.S. bonds with make-whole call provisions. They analyze 318 bonds carrying this provision, issued between October 1995 and September 1999. Similar to our findings for Canadian doomsday bonds, Mann and Powers (2003) show that at issuance the make-whole call option for U.S. bonds is out of the money. Although this is true for all ratings, lower-rated bonds are deeper out of the money. Note that the history of the make-whole call provision in the U.S. is significantly shorter relative to that of the doomsday call in Canada (the first U.S. issue is from 1995, while the first Canadian issue is from 1987). If the make-whole or doomsday call option is initially issued out of the money, the bond yield spread has to shrink over time for the option to move in the money. In other words, the bond credit rating has to ameliorate, or the overall market

[6]The Reuters Fixed Income Database records 465 Canadian rated corporate bonds, with the following distribution of ratings in 2001: 1.5% AAA; 15.9% AA; 54.9% A; 23.4% BBB; 2.5% BB; and 1.8% B.

[7]In a small number of cases, the cross-sectional standard deviation of the doomsday spread is zero, which implies that $\mu = \mu + \sigma = \mu + 2\sigma$. This is due to the small number of bonds available during the given month, usually issued by the same company, all sharing the same doomsday spread. In other cases, specifically in the 06:1993–07:1994 period, the reported doomsday spread for BBB-rated bonds is zero.

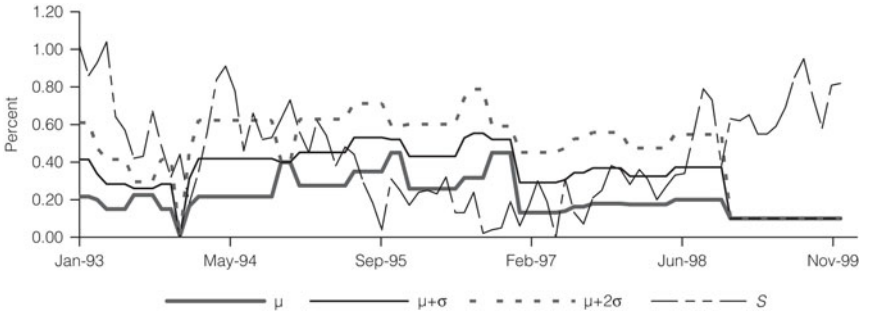
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FIGURE 1

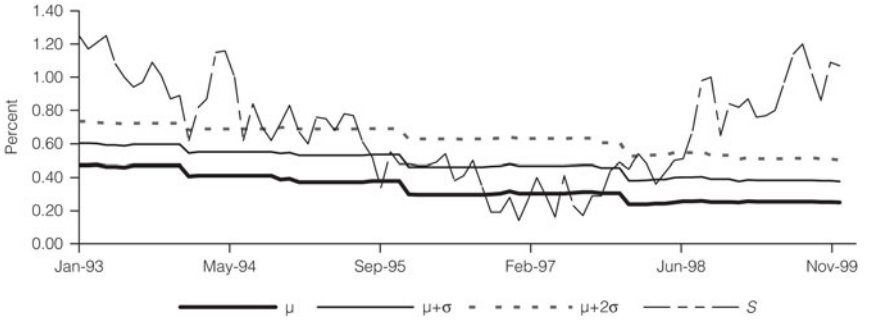
Moneyness of the Doomsday Call Provision

To determine the moneyness of the doomsday call provision, we compare the doomsday spread to the yield spread. Based on a sample of doomsday spreads of long bonds for each month during the 01:1993–12:1999 period, for each rating category, we plot the yield spread on the corresponding long-term index (S), the average doomsday spread (μ), the average doomsday spread plus one standard deviation ($\mu + \sigma$), and the average doomsday spread plus two standard deviations ($\mu + 2\sigma$).

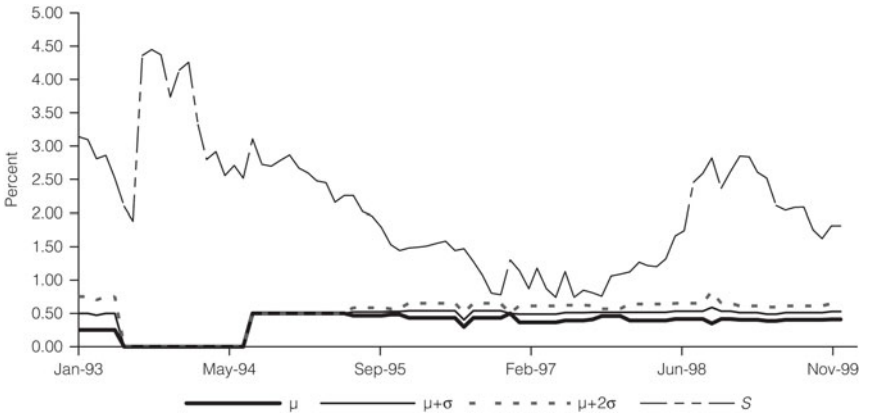
Graph A. AA-Rated Bonds



Graph B. A-Rated Bonds



Graph C. BBB-Rated Bonds



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conditions have to change significantly. Given the longer history of this option in our Canadian data, we indeed find that the doomsday option for our higher-rated Canadian bonds is sometimes in the money.

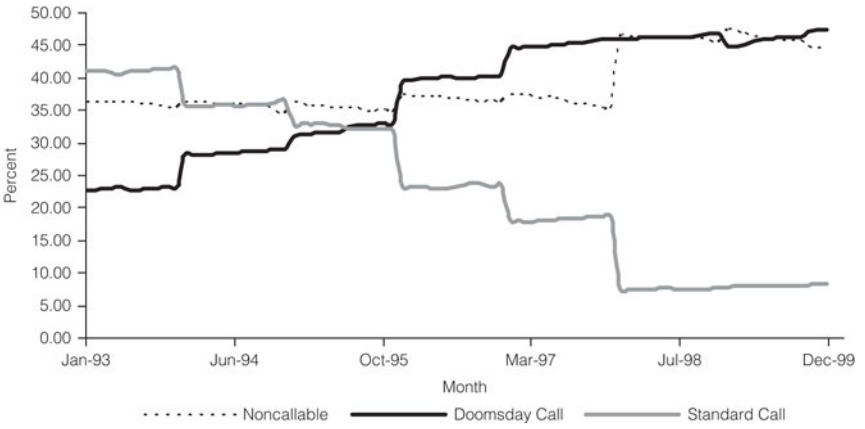
The presence of the doomsday call has important implications for studying the yield spread–riskless rate relation. For a standard call provision carried by most U.S. corporate bonds, lower riskless rates imply a higher probability of the issuer calling the bond. For the doomsday call of BBB-rated bonds, the effect of lower riskless rates is defused by the call price floating upwards. Thus, the existence of the doomsday call provides a useful instrument for the isolation of the effect of default risk and its significance.

This result allows us to control for callability for the long-term BBB-rated SCM bond index during the later period of our 25-year sample. To determine the duration of this period, for each month during the 01:1993–12:1999 seven-year period we count the number of corporate bonds issued with a doomsday call provision, the number of bonds issued with a standard call provision, and the number of noncallable bonds, as reported in the *Financial Post* Corporate Bond Record. In Figure 2 we plot the proportion of each of the above categories calculated with respect to the total number of bonds within each month. As most Canadian corporate bonds issued after 1986 either are noncallable or carry a doomsday call, in Figure 2 we see that the proportion of doomsday call bonds increases considerably during the seven-year period, from 22.82% in 01:1993 to 47.48% in 12:1999. At the same time, the proportion of bonds carrying a standard call provision decreases dramatically, from 41.03% in 01:1993 to 8.25% in 12:1999. The proportion of noncallable bonds fluctuates between 34.46% and 47.29%.

FIGURE 2

Distribution of Canadian Corporate Bonds Based on Callability (in percentages), 01:1993–12:1999

For each month during the sampled seven-year period, we count the number of corporate bonds issued with a doomsday call provision, the number of bonds issued with a standard call provision, and the number of noncallable bonds, as reported in the *Financial Post* Corporate Bond Record. In Figure 2, we plot the proportion of each of the above categories calculated with respect to the total number of bonds within each month.



The above proportions are calculated for the entire Canadian corporate bond universe as covered by the *Financial Post* Corporate Bond Record. One can expect the proportion of long-term doomsday bonds, with over 10 years to maturity, to be much higher compared to that of medium-term and short-term bonds. Since most Canadian corporate bonds are issued fixed, with 10 to 20 years to maturity, it is more likely that the number of newly issued short- and medium-term bonds in SCM's medium- and short-term indices is dominated by the number of seasoned bonds. Thus, for those indices, it is more likely that most bonds are those originally issued prior to 1987 with the standard call provision.

The Canadian Socio-Economic Information Management System (CANSIM) reports that as of 01:1987, the weighted average maturity for SCM's long-term AA, A, and BBB indices is 14.61 years, 14.80 years, and 13.34 years, respectively. Note that these maturities represent the maturity of the last Canadian corporate bonds issued with a standard call provision prior to 1987. Thus, four years or so later, the "average" bond, issued originally with a standard call provision, is expected to become a medium-term bond, with a maturity below 10 years. Since these are averages, to be safe, we feel that it is reasonable to wait eight years instead and to assert that starting in 01:1995, the vast majority of bonds included in SCM's long-term bond indices carry a doomsday call rather than a standard call provision. Therefore, we conclude that SCM's long-term bond indices are suitable for our study, and we discard the medium- and short-term indices. Furthermore, we conclude that the 01:1995–07:2001 period, in which these long-term indices consist mainly of bonds carrying a doomsday call, is an adequate estimation period to control for the callability of the BBB-rated index.

In summary, analyzing yield spreads using the SCM Canadian corporate bond indices has the advantage of controlling for callability and effects arising from taxation. Such an analysis provides a clearer picture of the role of the default-risk adjustment in measuring the sensitivity of investment-grade bond yield spreads to changes in the riskless rate.

IV. Data and Methodology

A. Data

Our sample is based on month-end yield-to-maturity data from the SCM investment-grade Canadian corporate bond indices, reported by CANSIM. This index does not enable an accurate assessment to be made of outstandings, trading volume for use as a proxy for liquidity, or quantities of bonds with differing coupon types or ratings.[8] The SCM corporate bond indices are stratified into four

[8]Information on Canadian corporate bond characteristics obtained from the Reuters Fixed Income Database for issues up to July 2001 shows that of the then-issued 3,242 bonds, 65% were traded as strips, 32% were fixed rate, and only 3% carried floating rate coupons. Of the rated bonds, the most common were those rated BBB (24%), A (55%), or AA (16%); the high credit quality (AAA) and high-yielding (junk) bond segments comprised less than 5% of issues. These proportions remain similar today for coupon type, although the market has improved in terms of credit quality. As of December 2006, 7,766 bonds were listed, with 40% traded as strips, 51% fixed rate, and 9% with floating rate coupons. Investment-grade bonds (BBB, A, AA, and AAA) now comprised 17%, 37%,

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different investment-grade rating categories: AAA, AA, A, and BBB. These categories respect those with the greatest number of bonds issued and liquidity. In this study, we use SCM's long-term corporate bond indices, reported for 08:1976–07:2001, a 25-year period. Data for the AAA index are available only until March 1993, as no bonds fit this category for the later period. A long-term *i*-rated corporate bond index (*i* = AAA, AA, A, BBB), consists of all bonds in SCM's *i*-rated corporate bond universe, with remaining terms to maturity greater than 10 years.

Our yield spreads for these long-term indices are calculated with respect to the constant maturity, long-term Government of Canada index, reported by CANSIM. Following Longstaff and Schwartz (1995), to proxy firm assets' returns we use the (continuously compounded) monthly return on the Toronto Stock Exchange 300 index.[9]

Table 1 reports the summary statistics for the time series of the yield spreads stratified by credit rating. The table is divided into two panels that represent the earlier sample from 08:1976 to 12:1994 and the later period from 1:1995 to 07:2001. Similar to the statistics reported by Longstaff and Schwartz (1995) for their U.S. data, the means of the credit spreads expressed as either the yield or relative spread monotonically increase as credit quality decreases for all indices. The same is true for the standard deviation.

TABLE 1

Summary Statistics for Yield Spreads in SCM Long-Term Corporate Bond Indices

The yield spread is the difference between the yield on a long-term index and the yield on the constant maturity, long-term Government of Canada index. The relative spread is the ratio of the yield on a long-term index to the yield on the constant maturity, long-term Government of Canada index. Panel A of Table 1 reports the summary statistics for AAA, AA, A, and BBB bonds for the earlier sample, covering the 08:1976–12:1994 period. Panel B reports the statistics for AA, A, and BBB bonds, covering the 01:1995–07:2001 period. Data for the AAA indices are available only until March 1993.

	No. of Obs.	Mean of Credit Spread	Std. Dev. of Credit Spread	Mean of Relative Spread	Std. Dev. of Relative Spread
Panel A. 08:1976–12:1994					
AAA	200	0.5761	0.3050	1.0559	0.0331
AA	221	0.6766	0.2988	1.0665	0.0321
A	221	0.8925	0.3163	1.0878	0.0365
BBB	221	1.4537	0.8419	1.1501	0.1135
Panel B. 01:1995–07:2001					
AAA	N/A				
AA	79	0.5187	0.3438	1.0859	0.0634
A	79	0.7734	0.4310	1.1264	0.0816
BBB	79	1.7659	0.5746	1.2795	0.1123

B. Regression Methodology

Our focus is on testing the regression models introduced by Longstaff and Schwartz (1995) and the two-factor model of Duffee (1998). For the sake of brevity, we report only the results for the yield spread, defined as the difference

33%, and 10% of issues, respectively. High-yielding bonds (BB- and B-rated) now comprise less than 3% of the market.

[9]Note that since our sample is not stratified into different sectors, there is no need in the current study to use sector-specific stock indices as in Longstaff and Schwartz (1995).

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between the yield on the relevant SCM index and that of the constant maturity, long-term Government of Canada index. Only yield spreads are of interest, since relative yields, based upon the ratio to the risk-free rate, must move inversely with risk-free yields.[10] The Longstaff and Schwartz (1995) model for the yield spread is given by:

$$\Delta S = a + b\Delta Y + cI + \varepsilon, \tag{1}$$

where ΔS is the monthly change in the yield spread, ΔY is the monthly change in the constant maturity, long-term Government of Canada yield, which proxies changes in the riskless rate, and I is the monthly return on the Toronto Stock Exchange 300 index, which proxies firm assets' returns.

Duffee (1998) uses a regression approach different from that of Longstaff and Schwartz (1995). He regresses spread changes on changes both in the short yield and in a term structure slope variable. Kamara (1997) presents evidence that the slope of the riskless term structure is positively related to expected economic growth, while Bedendo, Cathcart, and El-Jahel (2007) show that the slope of the credit spread provides useful information on the direction of future short-term credit spreads. Harvey (1997) presents similar results for Canada. This finding implies a negative relation between default risk and changes in the slope of the riskless term structure. Following Duffee (1998), we estimate the following regression model for every index:

$$\Delta S = \beta_0 + \beta_1 \Delta Y_{\text{T-BILL}} + \beta_2 \Delta\text{SLOPE} + \varepsilon, \tag{2}$$

where ΔS is the monthly change in the absolute yield spreads, $\Delta Y_{\text{T-BILL}}$ is the monthly change in the yield on a three-month Government of Canada Treasury bill, and ΔSLOPE is the monthly change in the spread between the constant maturity, long-term Government of Canada yield and the three-month Treasury bill yield.

V. Empirical Results

A. Longstaff and Schwartz's (1995) Two-Factor Model

We first estimate the OLS estimates for the Longstaff and Schwartz (1995) model. Note that the results of this model conducted for the earlier period 08:1976 to 12:1994 are in agreement with the results of Longstaff and Schwartz (1995) for their U.S. bonds: The estimated coefficient for b and c are negative and statistically significant. The coefficient c is also found to decrease monotonically with credit quality, and it is economically significant. This supports the importance of Longstaff and Schwartz's (1995) asset factor (i.e., ceteris paribus, higher firm values result in lower probability of default and consequently lower yield spreads).

[10]Longstaff and Schwartz (1995) estimate their regression models using OLS. Note that while a combined autoregressive and GARCH(1, 1) model fits our data better, it does not change the economic or statistical significance of the coefficients.

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Recall that corporate bonds carrying a standard call provision have been shown to dominate this data, which, in line with Duffee's (1998) results, suggests that the finding for the interest rate variable (the coefficient b) may be compromised by the negative impact of callability on the estimated relationship. To test this hypothesis, we apply regression model (1) to all indices for the 01:1995–07:2001 period, a period dominated by bonds carrying the doomsday call. These results are reported in Table 2. Recall that for BBB-rated bonds, the doomsday call will always be out of the money, making them economically noncallable. This leaves the default term as the only factor potentially affecting the sign of b for the BBB index. Longstaff and Schwartz (1995) previously conclude that the interest rate factor is more important for lower-rated bonds. Given that the BBB index is the lowest-rated index in our sample, one can expect the default factor, manifested by the interest rate factor in Longstaff and Schwartz (1995), to have the strongest impact on the yield spread–riskless rate relation estimated for this index.

TABLE 2

Regressions of Changes in the Yield Spread of SCM Long-Term Corporate Bond Indices on Changes in the Yield of the Constant Maturity, Long-Term Government of Canada Index and the Return on the Toronto Stock Exchange 300 Index

The regression model is of the following form: $\Delta S = a + b\Delta Y + cI + \varepsilon$, where ΔS is the monthly change in the yield spread; ΔY is the monthly change in the yield of the constant maturity, long-term Government of Canada index; and I is the monthly return on the Toronto Stock Exchange 300 index. The t-values are in parentheses. Table 2 reports the estimates for the results for the 01:1995–07:2001 period in which bonds carrying the doomsday call dominate all indices.

Index	a	b	c	R^2
AA	−0.0041	−0.2106	−0.6623	0.14
	(−0.27)	(−3.12)	(−2.26)	
A	0.0015	−0.1927	−0.6160	0.13
	(0.10)	(−3.02)	(−2.22)	
BBB	0.0022	0.0442	−1.2557	0.11
	(0.10)	(0.44)	(−2.87)	

Of critical importance, we find the estimated coefficient b for the BBB index is statistically insignificant. This result implies no relation between credit spreads and the riskless rate for the economically noncallable corporate bonds rated BBB. It indicates that the default factor, which represents Longstaff and Schwartz's (1995) interest rate factor, is trivial for BBB-rated bonds, for which it is expected to be most important within our sample. Given the reported finding for the earlier sample (08:1976 to 12:1994), it becomes clear that what drives the negative sign of b is the negative impact of the callability factor.

In Figure 1 we show that the probability of a call for the doomsday call provision in the AA- and A-rated indices is significant. Thus, one should expect the doomsday call for these indices to induce a negative yield spread–riskless rate relation, as in the case of bonds carrying the standard call provision. A higher probability of a call for corporate bonds carrying the doomsday call provision reduces their effective duration, or price sensitivity to changes in the riskless rate. This implies that following an upward shift in the riskless rate, the corporate bond yield will rise by a lower rate, and yield spreads will contract. This negative relation

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is confirmed by the other results reported in Table 2. Our estimated coefficients *b* are negative and statistically significant for the economically callable AA- and A-rated indices during the 01:1995–07:2001 estimation period.

Figure 1 demonstrates that the probability of a call is significantly higher for AA-rated bonds compared with A-rated bonds. Thus, one may expect the negative impact of the callability term on the sign of *b* to be greater for the AA index than for the A index. The results reported in Table 2 support this hypothesis. Above, we report that, in line with Longstaff and Schwartz (1995), for the earlier sample period the estimated coefficient *b* monotonically decreased with credit quality. However, for the 01:1995–07:2001 period, this monotonicity is reversed in line with the moneyness of the doomsday call. Finally, the estimates for the coefficient *c* for the 01:1995–07:2001 period in Table 2 are all still negative and statistically significant. In general, the coefficient *c* decreases with credit quality and is similar in magnitude to that estimated for each index for the earlier sample period. This clearly shows that Longstaff and Schwartz's (1995) asset factor is robust.

B. Duffee's (1998) Model

The Duffee (1998) regression model (2) was also applied to the two sample periods used to test the Longstaff and Schwartz (1995) model. The results of the later 01:1995–07:2001 period are reported in Table 3. As expected, for the earlier sample yield spreads are also found to be negatively related to both the three-month T-bill yield and the slope of the riskless term structure for all ratings. In general, both T-bill and slope coefficients monotonically decrease with credit quality. These results also agree with Duffee's (1998) results for his callable U.S. bond portfolios.

TABLE 3

Regressions of Changes in Yield Spreads of SCM Long-Term Corporate Bond Indices on Changes in Government of Canada Treasury Bill Yield and Term Spread

The regression model is of the following form: $\Delta S = \beta_0 + \beta_1 \Delta Y_{\text{T-BILL}} + \beta_2 \Delta\text{SLOPE} + \varepsilon$, where ΔS is the monthly change in the yield spread, $\Delta Y_{\text{T-BILL}}$ is the monthly change in the three-month Treasury bill yield, and ΔSLOPE is the monthly change in the spread between the constant maturity, long-term Government of Canada index and the three-month Treasury bill yield. The *t*-values are in parentheses. Table 3 reports the estimates for the 01:1995–07:2001 period in which bonds carrying the doomsday call dominate all indices.

Index	β_0	β_1	β_2	R^2
AA	−0.0076 (−0.48)	−0.1732 (−2.34)	−0.1751 (−2.44)	0.08
A	−0.0016 (−0.11)	−0.1519 (−2.17)	−0.1645 (−2.42)	0.08
BBB	−0.0037 (−0.15)	0.1361 (1.21)	0.0947 (0.87)	0.02

For the later period (01:1995–07:2001), for the economically callable AA- and A-rated indices, both T-bill and slope coefficients are also found to be negative and statistically significant. For the BBB-rated bonds, which are economically noncallable during this period, our estimated T-bill and slope coefficients for the BBB index are both statistically insignificant. Applying regression model (2) to his U.S. noncallable bond data, Duffee (1998) still finds both level and slope

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coefficients to be significantly negative, although weak. He attributes this result to the coupon-level effect (or coupon bias). Our results support this assertion. Since the coupon bias is not prevalent in our SCM data, the negative sign for both slope coefficients disappears.

Recall that Figure 1 demonstrates that the probability of a call is significantly higher for AA-rated bonds compared with A-rated bonds. The results reported in Table 3 are in line with this hypothesis. While for the earlier period the estimated T-bill and slope coefficients monotonically decrease with credit quality, for the reported 01:1995–07:2001 period, this monotonicity is again reversed in line with the moneyness of the doomsday call. Thus, applying Duffee's (1998) regression analysis to our data strengthens the hypothesis that callability drives the negative sign of both T-bill and slope coefficients.

To sum up, irrespective of the model tested, namely, the Longstaff and Schwartz (1995) two-factor model or Duffee's (1998) model, we find evidence that the negative relationship between the yield spread and the government yield is due mainly to the effects of the call provision. Once the impact of the call option is accommodated for the BBB-rated economically noncallable bonds, the yield spread–government yield relation is not significant.

VI. Summary and Conclusions

Time variation in the compensation demanded by investors when investing in corporate bonds remains a critical theoretical and empirical issue. To explain this relation, Longstaff and Schwartz (1995) model the valuation of corporate bonds with reference to effects from interest rates and the firm's asset value. One of the most notable predictions of this and other structural models with an asset-based default process is that credit spreads are negatively related to the riskless rate. However, as noted by Duffee (1998) and Elton et al. (2001), empirical applications require the consideration of the effects of taxes, callability, and tax timing on the yields of corporate bonds.

Uniquely, Canadian corporate bond indices are devoid of tax effects, since Canadian corporate and government bonds, unlike U.S. bonds, are subject to the same tax treatment. These indices also contain a call provision that allows for identifying callable and economically noncallable bonds. Using this Canadian bond index data, in a model based on Longstaff and Schwartz (1995), we find an insignificant yield spread–government yield relation for economically noncallable bonds. For bonds with an economically viable call option, the negative relation we find increases with the moneyness of the call option.

Of importance, the Canadian BBB bonds index in recent years has not been exposed to callability and tax effects. Consequently, it is safe to assume that their yield spread is mainly driven by credit risk. Moreover, BBB bonds serve as an excellent test case for the question of whether default risk generates the negative yield spread–riskless rate relation. That is because this risk is quite substantial for bonds of this rating category.

We find that when callability and tax effects are controlled for, there is no significant yield spread–riskless rate relation. Thus, contrary to what previous studies conclude (e.g., Longstaff and Schwartz (1995), Duffee (1998)), our results

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cast doubt on one of the most notable predictions of structural models: that credit spreads are negatively related to the riskless rate.

We conclude that when present, call risk dominates the negative yield spread–riskless yield relation. These findings indicate that a gap remains in our understanding of the default process. Theoretically, structural models suggest that an increase in the riskless rate implies a higher expected future value for the firm's asset relative to the default threshold, and a lower risk-neutral probability of default and risk-neutral credit spread. Empirically, we show that bondholders do not adjust their required default premium for an increase in the riskless rate. Our results provide support for reduced-form models that explicitly define a default hazard process and untie the relation between the firm's asset value and default probability.

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