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# The effect of interest rate volatility and equity volatility on corporate bond yield spreads: A comparison of noncallables and callables ☆

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ABSTRACT

This research investigates the impact of interest rate volatility upon corporate bond yield spreads. We first consider the impact of interest rate volatility upon noncallable bond spreads. Because greater interest rate volatility likely increases the volatility of the firm's debt, we hypothesize that the relation will be positive. Given that we do find a positive relation, we thus investigate whether the positive effect of interest rate volatility on yield spreads is stronger or weaker for callable bonds. We find that the effect is weaker for callable bonds. This result indicates that there is a negative relation between default spreads and call spreads, which is consistent with the theory of Acharya and Carpenter (2002), but in contrast to the theory of King (2002). Furthermore, our results for the relationship between equity volatility and yield spread tend to support Acharya and Carpenter (2002) more than King (2002).



## 1. Introduction

The volatility of interest rates plays numerous important roles in finance theory and practice. Sophisticated ways to measure exposure to interest rate volatility such as value at risk (VAR) have been developed. The potential for significant adverse changes in interest rates has caused banks, insurance companies, mutual funds and other financial institutions to devise strategies, such as immunization, to protect their fixed income portfolios. As described below, we answer important questions regarding the impact of interest rate volatility upon yield spreads. Our answers are useful for bond investment strategies intended to enhance returns and strategies to hedge portfolio value.

Alternative theories of how interest rate volatility affects default-free bond pricing have been developed by numerous authors. For example, default free bond pricing theory typically includes interest rate volatility as an important factor where a stochastic process for continuous changes in the short rate is given in terms of a drift term and a volatility term. Continuous changes in bond prices are derived from the short rate process. Veronesi (2010) and others derive expected default-free bond returns as a function of interest rate volatility. In a classic article, Heath et al. (1990) derive a bond pricing model where the drift in the short (forward) rate is, in fact, a function of the volatility of short rates.

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Empirical estimations of interest rate volatility have investigated alternative specifications of default-free short rate volatility. For example, classic interest rate theories of Merton (1973)[1] and Vasicek (1977) suggest that short rate volatility is independent of the level of interest rates while, in contrast, later models such as Cox et al. (1985), Black and Karasinski (1991), and Pearson and Sun (1994) maintain that the volatility of interest rates depends on the level of interest rates. Brenner et al. (1996) have found evidence that volatility depends on the level of rates and, also, GARCH processes.

Like interest rate volatility, yield spreads have similarly played numerous important roles in finance theory and practice. For example, the spread between long and short rates has been of great interest where some think that this spread predicts economic growth. More relevant to this research, the yield spread between instruments of equal maturity is also a topic of great importance. If one considers two equal maturity corporate debt instruments, what is the market determined yield spread and what underlying features determine this spread? Perhaps the most obvious factor is any differential in credit quality (default risk). Recently, the importance of other factors has also been stressed.

Duffee (1998), in testing the Longstaff and Schwartz (1995) model on both callable and noncallable bonds, found that a greater *level* of interest rates suggests a stronger growth in firm value and thus reduces the spread over U.S. Treasury bonds. Elton et al. (2001) find that expected default explains a smaller part of spreads than commonly assumed. Chen et al. (2007) find that default risk does not fully explain spreads and stress that liquidity explains a large part of corporate bond spreads. Bao et al. (2011) find that liquidity is a determinant of spreads. (Although Lin et al. (2011) do not address yield spreads, they do find that liquidity is an important determinant of expected bond returns.) However, these papers have not addressed the impact of interest rate volatility on yield spreads.

The purpose of this research is to investigate the effect of both interest rate volatility and equity volatility on corporate yield spreads for both noncallable and callable bonds. Specifically, interest rate volatility is defined as the standard deviation of the daily one-month Treasury constant maturity rate for the 12 months prior to the bond transaction date.[2] We answer two important and broad questions: 1) How does interest rate volatility affect the yield spread for noncallable corporate bonds?; 2) How do the effects of interest rate volatility and equity volatility on yield spreads differ for noncallable corporate bonds versus callable corporate bonds? While some bond pricing theories suggest that interest rate volatility should be priced in corporate yield spreads, surprisingly, there is no empirical work testing the effect of interest rate volatility on the above types of yield spreads.

Our research is useful for those bond portfolio managers attempting to enhance returns and, also, those attempting to hedge portfolio value. With respect to return enhancement, consider our finding that interest rate volatility is, in fact, priced into the spreads between U.S. Treasury bonds and corporate bonds. Given our finding and the predictability of interest rate volatility documented by, among others, Brenner et al. (1996) and Poon and Granger (2003), one could develop strategies for the optimal mix of U.S. Treasury and corporate bonds. As one example, if interest rate volatility is predicted to increase, the spread will also tend to increase. Thus, a portfolio manager should then likely reduce holdings of corporate bonds relative to Treasuries. With respect to hedging, note that corporate bond hedging strategies frequently consider yield changes relative to Treasury yield changes.[3] Our findings suggest that corporate bond yield changes, relative to Treasury yield changes, are dependent upon interest rate volatility. Hedging strategies that incorporate this finding should provide improved hedging performance.

We first investigate the effect of interest rate volatility on yield spreads of noncallable bonds. Merton (1974) relates a firm's default risk to the firm's total asset volatility. Many studies have considered a firm's equity volatility in the investigation of the yield spread of its bonds by assuming that a firm's (total) asset volatility is determined by its equity volatility. However, as noted by Campbell and Taksler (2003), the asset volatility of a firm with risky debt is determined by both its equity and debt. For example, if a firm has a high level of interest rate volatility and therefore a likely high level of debt volatility, the firm is more likely to reach a critical value for default, thereby resulting in a high probability of default. Thus, interest rate volatility should be priced in corporate yield spreads.

Acharya and Carpenter (2002) also provide theoretical support for the positive effect of interest rate volatility on noncallable bond spreads. Assuming that the firm has a single bond outstanding, they model a defaultable bond where its spread increases with the volatility of the difference between the host bond price and the firm value. The host bond is a coupon paying bond with no default risk and no call risk. The details of their model are given in the theory and hypotheses section.

We also investigate whether the effect of interest rate volatility on yield spreads is greater or smaller for callable bonds than for noncallable bonds. Since interest rate volatility affects both the firm's option to default and refunding call option values, the effect of interest rate volatility on yield spreads is complex. We note that default and (refunding) call options are interactive because, for example, a bond default, which may be more likely when interest rate volatility is high, makes the call option value disappear. That is, call option value declines with interest rate volatility. As a result, the effect of increasing interest rate volatility on total yield spreads may be smaller for callable bonds than for noncallable bonds.

On the other hand, interest rate volatility may increase call option values because greater interest rate volatility logically increases the volatility of the underlying instrument and thus increases the likelihood that the bond price reaches the call price. That is, a call option value may rise with interest rate volatility. Thus, the impact of interest rate volatility on the spread may be larger for callable bonds compared to noncallable. In sum, the differential effect of interest rate volatility on yield spreads for callable bonds is not immediately obvious and alternative theories suggest alternative (positive and negative) effects.

[1] In contrast to Merton (1973), the Merton (1974) structural default risk model has no interest rate process, only a firm value process.

[2] In their investigation of call policy, King and Mauer (2000) measure interest rate volatility as the standard deviation of the 30-year Treasury constant maturity rate over the preceding 12 months. In her investigation of call values, King (2002) measures interest rate volatility as the standard deviation of the 10-year Treasury constant maturity rate over the preceding 12 months. In contrast, our research models *spreads* where we draw upon short rates given in structural models which we cite below. Long rates are frequently modeled as function of expected future short rates.

[3] More specifically, corporate bond yield changes are frequently regressed on yield changes of cheapest to deliver Treasury futures.