

BOND VALUATION AND THE PRICING OF INTEREST RATE OPTIONS IN INDIA

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ABSTRACT

In recent years, Indian corporate and institutions have issued a large number of exotic bonds with a variety of embedded interest rate options. Pricing the embedded interest rate options is a pre-requisite for valuing these bonds. The pricing of interest rate options is quite complex and depends crucially on the dynamics of interest rates. International studies show that no model of these dynamics is valid world-wide. Drawing on the author's earlier study of Indian interest rate dynamics (Varma, 1996), this paper expounds a practical methodology for pricing interest rate options in India and valuing bonds with embedded interest rate options. The Black-Derman-Toy model (Black et al., 1994) is shown to be the most attractive tool for valuing interest rate options in India.

KEYWORDS: *Bond Valuation, Exotic Bonds, Embedded Interest Rate, Stock Prices, Black-Scholes Formula.*

Introduction

For the last few years, India has been preparing for the introduction of full-fledged markets for stock and stock index options. While these markets have yet to see the light of day, options on interest rates have become increasingly important in the country's fledgling debt market. Though there is no trading in interest rate options *per se*, there has been a lot of activity in the issue of bonds with various embedded interest rate options. The pricing of the embedded call and put options, is essential to arrive at a rational valuation of these bonds. Valuation of options on bonds is considerably more complex than the pricing of options on stocks and stock indices mainly because of the vastly greater complexity of the bond price dynamics as compared to the dynamics of stock prices. The probability distribution of stock prices closely resembles a log-normal distribution generated by a random walk. In other words, the distribution of stock market *returns* approximates the familiar bell-shaped normal distribution. The famous Black-Scholes option pricing formula (Black and Scholes, 1973) for valuing options on stocks is based on this distribution and is known to perform quite well in practice. Bond prices, on the other hand, do not follow a random walk at all. In fact, as the bond approaches maturity, its price approaches the redemption value and all uncertainty rapidly disappears. Interest rates do not follow a simple random walk, but exhibit the well known phenomenon of mean reversion. This phenomenon refers to the tendency of interest rates to revert to a normal rate over the long run. Whenever the interest rate drifts too far away from the normal rate, it is pulled back towards it. It is also well known that interest rates are more volatile when rates are high than when they are low. (To pursue our previous analogy, the drunkard's swagger increases sharply when he drifts towards the left hand side of the road and is less pronounced when he drifts towards the other end.) This means that the Black-Scholes option pricing formula is of limited applicability in pricing options involving interest rates. Another, though somewhat less serious, problems of the Black-Scholes formula is that it assumes that interest rates are constant - a very odd assumption to make while valuing options on interest rates!

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