Effective Duration, Effective Convexity and Option Adjusted for Bonds from different Term Structure of Interest Rates Models in the Spanish Market

Antonio Díaz and Marta Tolentino

Departamento de Análisis Económico y Finanzas
Universidad de Castilla La Mancha
Facultad de Derecho y CC Sociales de Ciudad Real,
Ronda de Toledo, s/n - Campus Universitario, 13071 – Ciudad Real (Spain)
Antonio.Diaz@uclm.es
Marta.Tolentino@uclm.es

The aim of this paper is to analyse the effectiveness of the most popular interest rate risk management measures for bonds with embedded options and study the factors it depends on. We price two Spanish corporate bonds during all their lifetime applying two consistent models of interest rates models (Ho and Lee, 1986, and Black, Derman and Toy, 1990). We estimate different risk measures and examine the main factors which determine their behaviour, such as volatility of interest rates, shape of the yield curve and yield curve changes.

The two most common types of embedded options are call provisions and put provisions. Callable bonds may be redeemed by the issuer before the scheduled maturity date. The call feature benefits the borrower since it permits to replace the bond issue with a lower-interest-cost issue when market rates fall. Thus, callable bonds carry higher yields than bonds that cannot be retired before maturity. In contrast, a putable bond grants the bondholder the right to sell the issue back to the issuer at par value on designed dates.

Traditional sensitivity measures of interest rare risk are not suitable for option-embedded bonds because they do not consider the possibility of option exercise. The performance of callable or putable bonds is analysed looking at their risk due to changes in the underlying variables, such as volatility or yield curve changes. Effective Duration or Option Adjusted Duration (ED), and Effective Convexity or Option Adjusted Convexity (EC), are used. On the other hand, the yield-to-maturity is replaced by the yield-to-worst and the Option Adjusted Spread (OAS). OAS is the constant spread over all the short-term interest rates on the binomial interest rate tree that equates the theoretical price of a bond to its market price.

This methodology is analysed in several recent papers as Kupiec y Ka (1999), Brown (1999), Koutmos (2002), Heidari y Wu (2004). In our case, we make two contributions to the literature. Firstly, we extend the study analysing the factors which determine the bond pricing and the effectiveness of the sensitivity measures using real and extensive sample data. Secondly, we apply this widely employed by practitioners methodology in more develop markets to price and analyse bonds with embedded options in the Spanish case.

We analyse the two most actively traded corporate bond issues with embedded provisions in the Spanish corporate fixed income market AIAF along the period 1993-2004. One of them contains a call option and the other bond a put option. Both provisions are European options.

To price the assets we apply two consistent term structure of interest rates models, Ho and Lee (1986) and Black, Derman and Toy (1990). Both models are the most popular models among investors and academics in the financial industry. Ho and Lee (1986) is the first consistent term structure of interest rates model and is presented as an alternative to equilibrium models (Vasicek, 1977; Cox, Ingersoll and Ross, 1985). It proposes a general methodology to price a wide range of interest rates contingent claims. The inputs of the model are the yield curve and the short rate volatility. The main limitation is that interest rates are normally distributed so we can get negative values. The Black, Derman and Toy (1990) model assume that interest rates follow a lognormal distribution. It considers a term structure of volatilities.

Models implementation is made from the binomial method. We construct binomial trees with monthly time steps consistent to the estimated Spanish yield curve. Estimates are made from the daily trading of Spanish Treasury debt securities using the Nelson and Siegel (1987) model weighted by duration.

To calculate sensitivity measures for bonds with embedded options we apply the Fabozzi (2002) procedure, similar to Martellini, Priaulet, Priaulet (2003). First, we calculate the theoretical price of the bonds from the two yield curve models. Second, we obtain the OAS for all days which issues are traded along the period 1993-2004. Third, we shift the on-the-run yield curve up and down by a small number of basis points and construct new binomial interest rate trees. Forth, we add the constant OAS to each knot of the new trees of short term interest rates. Fifth, we use the adjusted trees to determine the value of bonds from which we calculate ED and EC.

Our conclusions open avenues for further research, extending the analysis to the MBS market.