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**Nature of Corporate Bond Yield Curves:
The case of India**

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During the second quarter of the fiscal year 2013–2014, continuous rupee depreciation haunted the Indian securities markets. The fear of inflation together with the dealers’ expectations about active rupee-support from the Reserve Bank of India affected the yield curves and hence trading in the bond market. Against this backdrop, this study examines the shapes and the behaviors of corporate (bond) yield curves in the Indian market. In the process, the study (i) assesses the credit profiles of various corporate bond issuers, (ii) compares corporate and sovereign yield curves, (iii) analyzes the psychology of a dealer facing rising yields, and (iv) examines the sources of data in India vis-à-vis those available abroad. The paper recommends a number of measures towards increasing the depth of the corporate bond market.

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Nature of Corporate Bond Yield Curves: The case of India

1. Introduction

As a solution to the agency problem between shareholders and management, the option of converting stocks into bonds (as suggested by Professor Michael Jensen of Harvard Business School) may motivate the management to work in the interest of the shareholders. This reflects the need for a well-developed corporate bond market in the country. However, the financial community still considers the Indian corporate bond market to be underdeveloped because the emergence of a continuous yield curve extending from short to long maturity is a pre-condition of the development of a bond market and the Indian corporate bond market does not have this yet, as was found in this study. As is usual in this situation, the number of issues of corporate bonds bearing diverse credit ratings traded on a business day is so small that a dealer does not have much choice in designing her investing portfolio in a situation of macroeconomic turbulence where the USD value of the domestic currency is crashing. As a result, either trade comes to a halt or a security that is in high demand in the absence of any other security that is in equal or greater demand monopolizes the dealer's choice. It is against the above backdrop that this study was conducted on the Indian corporate bond yield curve.

The rest of the study is organized into sections dealing with the theoretical background, hypothesis, methodology, construction of the yield curve, analysis of the constructed yield curves during the sample period, and inquiry into the factors determining the same.

2. Theoretical Background

2.1 Classification of Investment Products

The investment products in financial markets may be classified into two broad categories in terms of their riskiness—risk-free products and risky products. The interest rate products in the investment portfolios of banks and financial institutions may contain loans, gilt-edged securities (G-secs), asset-backed securities, and so on depending on the nature of businesses of the banks. The officers in banks who perform trading in the interest rate market are called interest rate dealers. Among interest rate dealers, those who deal with domestic treasury are called rupee¹ interest rate dealers and those who deal with foreign exchange (forex) treasury are called forex dealers. This study deals with the psychology of a rupee interest rate dealer in the corporate bond market.

2.2 Benchmark Rate

As the issuer of financial products, the Government of India (GOI) and the state governments have the highest credit rating of all issuers in India. As a result, the expected

¹ Throughout this study, 'rupee' refers to the Indian Rupee (INR).

rate of return from investments in G-secs is the lowest of all investment products. This risk-free lowest rate of return plus a premium below which no one is motivated to invest in a non-treasury security is called the benchmark rate. Alternatively, the discount rate at which the central bank repurchases government securities from the banks is also called the benchmark rate.

2.3 Users of the Benchmark Rate

Every dealer needs to have an estimate of the risk she/he likes to bear with investment products, and hence, should have knowledge of the benchmark rate. The riskier the investment product, the greater would be difference of her/his expected return over the benchmark rate and vice-versa. However, in India, the commercial banks (henceforth ‘banks’) are required to know and use the benchmark rate as part of their normal business activities because of the statutory liquidity ratio (SLR) norm imposed by the Reserve Bank of India (RBI). The SLR norm advises banks to invest around a quarter of their net demand and time liabilities in those products approved by the RBI. These products are also called SLR products. Of course, there are exemptions from SLR requirements for rural regional banks and state co-operative banks. Further, in the context of foreign currency non-resident deposits and non-resident external deposits, treasury bills (T-bills) and G-secs belong to the category of SLR products and are considered by banks to be the most profitable of all SLR products. Corporate bonds are in the non-SLR portfolios of the banks.

2.4 Safest Investment Products

The expected rate of return on any risk-free security increases with the maturity period under normal circumstances because longer maturity of an investment product means blocking the funds in that product. Hence, the safest investment product is the shortest-term product issued by the GOI, such as a T-bill with a maturity period of 91 days or a G-sec with remaining maturity as short as possible. Thus, T-bills may be preferable to G-secs, because T-bills are issued via auction by the RBI every working Wednesday. On the other hand, it is difficult to get a G-sec with remaining maturity of maximum 3 months from the secondary market at a reasonable price since all banks would rush for the same. It may be added in this context that there are some traded corporate bonds that pay coupon annually such as Muthoot Finance Limited 13% 2017 and there are also some traded corporate bonds that pay coupon only on redemption, such as PFC² 8.3% 2021 with ISIN INE134E0708, unlike G-secs. These are similar to long-term zero coupon (ZC) bonds and hence are riskier than commercial papers or certificates of deposits.

2.5 Zero Coupon Yield

A G-sec that has remaining maturity of a maximum of six months becomes equivalent to a T-bill of 182 days’ maturity in India in terms of safety. In India, G-secs generally pay coupon at a semi-annual frequency, i.e., at an interval of six months. Any G-sec that has only the last coupon remaining to pay is akin to a T-bill since both are now zero coupon

² Power Finance Corporation.

(ZC) products and are issued by issuers with top credit rating, i.e., the GOI and the state governments. The expected returns from both these products are considered to be same and are called the ZC yield of 3-month maturity. The yield of a T-bill or a G-sec with remaining maturity of 1 day is called the ZC yield of 1 day maturity. Thus, there are ZC yields for maturity periods of up to 30 years because the GOI issues G-secs of maximum 30-year maturity such as the IN0020020106 7.95% 2032 (CCIL, 2013), but such yields do not exist over the entire maturity spectrum for corporate bonds. In the U.S., corporate bond yields extend up to 20 years of maturity (KCG Bondpoint and Yahoo Finance, 2013).

2.6 Zero Coupon Yield Curve

2.6.1 Construction of ZCYC

When the maturity periods and the corresponding ZC yields are plotted on a graph, the resultant line is called the zero coupon yield curve³ (ZCYC). Modeling or determining this mathematical expression of the curve for purposes of forecasting is an important task facing the users (i.e., the banks). The modeling is done using different methodologies in different countries. These methodologies belong to two broad classes—the arbitrage-free approach and the equilibrium analysis. In India, the methodology used is the Nelson-Siegel-Svensson (NSS) method, which is an arbitrage-free approach (Christensen et al., 2008). The lack of depth of the Indian corporate bond market prevents arbitrage-free modeling. There are many models to estimate yield curves in an economy and the NSS is one of them. The way the models are developed, the yield curves can be estimated with the current market liquidity condition in the corporate bond market. Hence, the methodology consisting of bootstrapping and interpolation is used here. The bootstrapping procedure was pioneered by Fama and Bliss (1987). This approach involves sequentially extracting forward rates from bond prices with successively longer maturities; it exactly prices all bonds included in the procedure and assumes that the forward rate between observed maturities is constant (Pooter, 2007).

The shape of the ZCYC is never identical for two business days. It varies in accordance with different market conditions and global macro-economic circumstances. The variation in the shape of the ZCYC from the expected one—which may cause losses in the value of the security—constitutes the interest rate risk facing the interest rate dealers on both the buy side as well as the sell side. The ZCYC has strong implications for capital and banks are required to make provisions for this as per the magnitude of the interest rate risk embedded in each interest rate product in their investment portfolio (RBI, 2013). The shift of the ZCYC is important in this context because it is considered the basis of the benchmark rates in this study. Thus, in order to estimate the market risk capital associated with the corporate bonds held in the non-SLR portfolios of the banks, the corporate ZCYC would be useful, which is why a corporate ZCYC needs to be built up.

³ The terms ‘yield curve’ and ‘term structure’ are alternatively used.

2.6.2 Graphical exposition of ZCYC

The ZCYC is the locus of the unique combination of the applicable return or yield to maturity (YTM) and a particular maturity period of some interest rate product such as loan, deposit, bond, or debenture. In India, it is available for every business day from agencies such as the Clearing Corporation of India Limited (CCIL) and the National Stock Exchange of India (NSE) pertaining to the products available in the G-sec market.

When this locus is plotted on a graph, it is called the term structure of interest or sovereign ZCYC. It takes an upward shape (Figure 1) when macroeconomic conditions are normal and there is no turmoil in the financial markets, because the act of locking funds for longer time is associated with an expectation of a higher rate of interest. When financial markets are in turmoil, the sovereign ZCYC assumes an inverted shape (Figure 2).

When the stock market is in turmoil, investors look towards the interest rate market (i.e., the market of fixed-income products) because by definition, the returns from these products are more certain than stocks (Drainville et al., 2011). It may be noted in this context that corporate bonds are not as risky as stocks, but offer higher rate yield than G-secs. Therefore, the rupee interest rate dealers in India who are not risk-averse may be happy to see a vibrant corporate bond market with a yield curve.

The rate of credit default increased during the economic slowdown during the post crisis period (CRISIL, 2010). The concept of ZC yield helps in computing the probability of default of a corporate bond based on the concept that the expected yield from a corporate bond is the YTM of a G-Sec of similar maturity plus the applicable risk premium (Table 1).

2.6.3 Uses of ZCYC

Regarding investment activities, the ZCYC is primarily used for the valuation of fixed-income products and also for the measurement of interest rate risks inherent in these products because the ZCYC method takes into consideration the actual yields of the cash flows, which are different across the points of time of the cash flows. The alternative method of valuation using YTM assumes a uniform yield for the cash flows occurring at different points of time. In asset liability management, the interest rate risk may take either or both of the two forms—basis risk and yield-curve risk. Basis risk arises out of the difference between the asset yield (return) and the liability yield (cost) corresponding to a particular maturity. Yield-curve risk arises out of a change in the shape of the asset yield curve or liability yield curve.

Since the sovereign ZC yield is the benchmark rate, it is considered to be the standard for gauging what excess returns an investor can obtain from investments in a risky product or in a longer-maturity product of the same risk profile. Based on the ZC yields, the approximate term structure for fixed-coupon corporate bonds may be derived, provided there is data available on the cash flows from coupons and redemptions from the short end to the long end of the maturity spectrum. (This is attempted in Section 4.2 of this

study.) Then, adding some credit risk premium as per an expert's wisdom, the corporate bond yield curve may be obtained.

Similar to the case of fixed-rate bonds, yield curves may be constructed for fixed-rate loans. An increase in the maturity of the loan reduces the rate of return or yield on the loan, all other things remaining unchanged. Similarly, a reduction in the equated monthly installment (EMI) may do the same, all other things remaining unchanged. Here, loans with EMI payment options are considered to be equivalent to a risky fixed-rate bond. The yield of a corporate bond of the same credit rating as a business loan provides an estimate of the rate of return from this asset.

Therefore, corporate ZCYCs similar to the sovereign ZCYC may be built up in the Indian context, which was one of the objectives of this study.

2.6.4 Existing corporate ZCYCs

In India, the average traded spreads of corporate bonds over the FIMMDA-PDAI gilt curve on a monthly basis for the purpose of valuation of the outstanding position in corporate bond repo is provided by the Fixed Income Money Market and Derivatives Association of India (FIMMDA). This data is not suitable for the construction of a yield curve. Like Reuters in India, Hargreaves Lansdown provides the data on daily traded corporate bonds in the U.K., but not a yield curve. The data on the daily corporate bond yield curve for maturities from 2 years to 20 years for the credit rating categories AAA, AA, and A is provided by KCG BondPoint and Yahoo Finance for the U.S. market. This seems to be the ideal format; it is imperative that Reuters also provides the data in this format for India.

3. Objectives, Hypotheses, and Methodology

Against the backdrop of rising bond yields, the lack of market appetite facing the RBI auctions, and the dealers' expectations from the RBI to support the domestic currency during July 2013, three issues emerge—the dealers' choice; the nature of traded corporate bond yield curve; and the behavior of this yield curve. The objectives of this study were as follows:

1. To construct corporate bond yield curves on three consecutive business days and compare their shapes; and
2. To investigate the changes in their shapes.

With respect to these objectives, this study aimed to test the following hypotheses:

1. The corporate bond yield curve is nothing but the sovereign yield curve together with the credit-risk premium.
2. Domestic currency depreciation steepens the yield curve.

The smoothness of a well-behaved yield curve requires it to be continuous. This is explained by academicians such as Lim and Xiao (2000) and professionals such as Diller (1981). Weisstein (2013) described a smooth function as a function that has continuous

derivatives up to some desired order over some domain, which can therefore be said to be smooth over a restricted interval such as (a, b) or $[a, b]$. The interval needs to be reasonably long; otherwise, it is difficult to design portfolio strategies based on duration and convexity, and also to assess the long-term horizon return or total return and variance. A portfolio strategy involving both short-term as well as long-term tenors is a ‘barbell’ strategy. It is, however, convenient for a dealer to find the long-term (say, n -year) horizon return and variance as functions of their 1-year counterparts (Grandville, 2001). This implies a unique relationship between a value in the domain (i.e., the tenor of the zero coupon cash flow) and a corresponding value in the range (i.e., the yield). If the yield curve is not continuous, it is difficult to conceive the shift of the yield curve for the purpose of formulating a butterfly strategy.

The methodology used in this study was to explore a continuous as well as a one-to-one relationship between the ZC yields and the residual maturities of corporate bonds of AAA or equivalent rating using the zero coupon bond pricing functions available in the spreadsheet of Microsoft Office 2013 (henceforth ‘spreadsheet’), applying interpolation to find the missing zero coupon yields for the all different maturity points available up to the longest available traded zero coupon maturities. This process of exploration was applied over a sample of eighteen days for those business days on which the corporate ZCYC emerged at least in the short end. This process was followed by a comparison of the shapes of the corporate ZCYCs; the factors driving the differences were then detected.

3.1 Utility of this Study

3.1.1 For banks and financial institutions

This study was designed to assist

- i the rupee interest rate dealers of banks and financial institutions (FIs) in India dealing with non-SLR products;
- ii the Risk Management Committees (RMCs) of banks and FIs in India in formulating appropriate interest rate risk policy; and
- iii the Asset Liability Management Committees (ALMC) of banks and FIs in India in immunizing the net interest rate income (NII) against interest rate fluctuations.

3.1.2 For the Central Bank

This study was designed to provide valuable insights to the central bankers about

- i. the arbitrage opportunities in the corporate bond market;
- ii. the behavior of the corporate ZCYC in a volatile macroeconomic environment such as the continually sliding rupee; and
- iii. the risk preferences of the rupee interest rate dealers in banks and FIs on the buy side.

3.1.3 For academics

This study aimed to contribute to the existing academic literature on Quantitative Finance in terms of insights into the nature and behavior of corporate bond yields.

4. Nature and Sources of Data

The trading of corporate bonds takes place via the online platforms of the NSE, the Bombay Stock Exchange (BSE, 2013), and the FIMMDA. The online report of the traded bonds is available from Reuters. Hence, the sources of primary data for this study were the NSE, the BSE and FIMMDA, and the source of secondary data was Reuters. This study worked on the reports of the daily traded corporate bonds of eighteen days from June 17 to July 10, 2013. Apart from Saturdays and Sundays, there were no other holidays during this period (NSE, 2013e).

4.1 Nature of Sampling

In this study, the sample was collected in stages, as exemplified below.

Stage I: The news on the trading of corporate bonds on a specific date (say June 10, 2013) from *Reuters* is examined (Reuters, 2013a).

Stage II: A zero coupon corporate bond (such as HDFC⁴ 8.95% 2014) is selected (HDFC, 2013).

Stage III: Information is collected about the issue from the NSE.

Stage IV: Information is collected from the BSE regarding the credit rating of the issue because credit rating information is not provided by the NSE in the previous stage.

4.2 Construction of the Corporate ZCYC

In industrialized Western economies where the G-sec markets are mature enough to use up all arbitrage opportunities, the Nelson-Siegel-Svensson (NSS) approach is used. For instance, Darbha et al. (2000) used it in the Indian context; Kladivko (2010) used it for the Czechoslovakia; and Anneart et al. (2012) worked with this model using the Euro denominated rates. However, there are several unutilized opportunities in India (Das, 2011). Das and Wong (2013) demonstrated the suitability of bootstrapping with cubic splines for the construction of the sovereign ZCYC in the Indian market that has a lot of unutilized arbitrage opportunities. Das (2013b) computed corporate bond yields for the purpose of assessing the relationship between credit risk premium on loans and risk free rates.

The ZCYC may also be called the term structure of spot returns or yields. It is extracted by solving the bond yields in an iterative process. It is used in a situation where there is lack of data due to the depth of the market. This procedure is commonly used by a derivatives trading desk to calculate zero-coupon treasury interest rates; starting with short-term cash flows and progressively moving towards long-term cash flows, the spot yields are calculated at each stage (Hull, 2012).

⁴ Housing Development Finance Corporation.

In the construction of a yield curve from traded bonds, the underlying assumption is that a continuum or continuous sequence exists in the redemption of zero coupon bonds, where the adjacent time-points of redemption are not perceptibly different from each other, although the shortest and the longest points are far from each other. If a bond is not traded at all redemption time-points, the continuum is worked out with the process of bootstrapping. Any break in such a continuum does not allow the construction of the yield curve beyond the point of the break. Hagan and West (2008) stressed that in the case of bootstrapping yield curves, the interpolation method is intimately connected to the bootstrap, as the bootstrap proceeds with incomplete information. They argued that in the case of a reasonably small set of bonds that they want to use to bootstrap the yield curve, deciding which bonds to include can be a non-trivial exercise because excluding too many would run the risk of disposing of market information that is actually meaningful, while including too many could result in a yield curve that is implausible, with a multitude of turning points, or even a bootstrap algorithm that fails to converge. The above continuum (when clubbed with smoothness) may need to have the properties of differentiability and second-order differentiability. In order to detect the properties of continuity and smoothness of a yield curve, the yield curve need not be constructed till the longest end because even in the short time span (i.e., below one year), these properties are visible. Figure 1 and Figure 2 show that in the short run, the ZCYCs slope downwards but are continuous and differentiable.

This study used bootstrapping combined with spline-based interpolation—a method to interpolate between two redemption points specifically, even when the temporal distance between these points is a positive number smaller than any positive number however small when the data points are small. When such a method is worked upon a large database, it may approximate a polynomial spline function (BIS, 2005).

During the second weekend of July 2013, the latest data available on trading of corporate bonds belonged to July 11, 2013. There was no traded debt instrument below maturity of 3 years on this date.

The next data available belonged to July 10, 2013. Here, the shortest term to maturity belonged to three different series of Reliance Infrastructure Bonds (RIB) with same residual maturity but different yields. This indicates the existence of unutilized arbitrage opportunities; hence, the yield curve construction cannot start from this point.

The bond of the next shortest maturity was HDFC 9.97% 2013. The yield is 8.3028% corresponding to the residual maturity of 0.075 years.

The next shortest term maturity belonged to REC⁵ 10.9% 2013. On July 10, 2013, the last traded price was INR 100.2205. As per moner.in (2013), it pays an annual coupon. This means the redemption value on the date of maturity is 110.90 INR. The price was 100.2205 INR corresponding to the yield 7.8133%.⁶ There are minor differences between

⁵ Rural Electrification Corporation.

⁶ The following formula in the spreadsheet was used: =PRICE(date(2013, 7, 10), date(2013, 8, 14), 10.9%, 7.8133%, 100, 1, 3)

In the spreadsheet, the price is calculated to be 100.2205 corresponding to the yield 7.8133%.

the yields reported by Reuters (2013a) and what was obtained in the spreadsheet using the description of the corporate bond; for the sake of convenience and speed of work, the yields reported by Reuters were considered in this context. The day count convention as per NSE (2008) is 'Actual/365'. (This is indicated by the number '3' at the end of the formula before the closing of the parenthesis.) This contradicts RBI (2011) that the day count convention in India is '0'. In the absence of any information about the credit rating of a bond, the corporate rating of the issuer may be presumed to be the minimum rating of the issue as per Capital Intelligence (2013). The credit rating of the above bond was CRISIL AAA+ because as per the issuer, (REC, 2008), it enjoyed the same credit rating around the time of the issue. Thus, the yield was 7.8133% corresponding to the residual maturity of 0.0944 years.⁷ The yield reported by Reuters (2013) for this bond was 7.99%.

The bond of the next shortest maturity was LICHFL⁸ 9.8% 2014. The yield was 9.9136% corresponding to the residual maturity of 0.55 years. It paid coupon annually (NSDL, 2013a).

The fixed-rate bond with the next shortest maturity but which paid half-yearly coupon on an intermittent date was IRFC⁹ 8.4% 2013. The next coupon date was October 15, 2013, i.e., after 0.26 years of the date of settlement (NSE, 2008). The date of maturity is December 26, 2013. Through linear interpolation, one could compute the yield of the above coupon to be 8.9302%.¹⁰ On the date of maturity, the yield would be 8.3740% corresponding to the residual maturity of 0.46 years. The utility of linear interpolation is explained in Das (2010).

The fixed-rate bond with the next maturity date was LICHFL 9.76% 2014. It had two intermittent dates of annual coupon payment before maturity—July 11, 2013 and July 11, 2014—and on the date of maturity—December 11, 2014 (NSDL, 2013a). Since there was no traded security of the residual maturity falling between December 2013 and July 2014, it was not possible to obtain the yield of the coupon on July 11, 2014.

The short end of the yield curve constructed in the above process is given in Figure 3. All the issuers in Table 2 corresponding to Figure 3 had the highest credit rating.

The immediate date of trading of corporate bonds before July 10, 2013 was June 24, 2013. As per Reuters (2013b), the relevant zero coupon yields belonged to HDFC 9.55% 2013, discount bond NKEL¹¹ 2013(indiainforline.com, 2010), and IDFC¹² 9.44% 2014. As per Reuters (2010), NKEL had the highest credit rating. As per IRIS (2012), IDFC had the highest credit rating. As per NSE (2013a), it paid an annual coupon. Figure 4 depicts the June 24, 2013 counterpart of July 10, 2013. The issuers in Table 3 corresponding to Figure 4 had the highest credit rating.

⁷ The following formula in the spreadsheet was used: =yearfrac(date(2013, 7, 10), date(2013, 8, 14))

⁸ LIC Housing Finance Limited.

⁹ Indian Railway Finance Corporation.

¹⁰ The interpolation was performed using the function '=forecast(.....)' in the spreadsheet.

¹¹ North Karnataka Expressway Limited.

¹² Infrastructure Development Finance Corporation.

As per NSE (2013b), HDFC 8.65% 2013 pays annual coupon. IDFC 9.95% 2014 traded in different prices in FIMMDA and NSE, but with the same residual maturity. The situation was similar for HDFC 9.62% 2014. As per NSE (2013c), HDFC 9.40% 2014 pays annual coupon.

The short end of the corporate bond yield curve on June 17, 2013 is given in Figure 5. All the issuers in Table 4 corresponding to Figure 5 had the highest credit rating.

The short ends of the corporate bond yield curves were constructed in Figures 3, 4, and 5 for July 10, 2013, June 24, 2013, and June 17, 2013, respectively. These days were consecutive in the sense that because of the absence of continuity between the yield-maturity relationships on the intermediate trading days, the corporate bond yield curve did not exist thereon. Thus, in the corporate bond market, out of a sample of size of 18 consecutive business days, only three were filtered out to produce a yield curve, whereas in the G-sec market, there is a yield curve for every business day. This means if a corporate bond dealer were to formulate a strategy of riding the yield curve based on the information of some business day (for example), she/he might not get the opportunity to apply that strategy on the very next business day. Further, if an econometrician wanted to formulate a time-series econometric model (such as a vector auto-regression model of the daily yield for a particular residual maturity of 91 days), this would be possible in the G-sec market but not in the corporate bond market. She/he may need to conduct unit root tests or check the order of integration (which calls for data of all working days within the sample), since a gap of one or more working days does not allow the periodicity of data to be uniform.

If the time path of the yield of a corporate bond with 91 days residual maturity is $y = f(t)$, a well-fitting econometric model of auto-regressive moving average (ARIMA) under the Box-Jenkins methodology requires $f(t)$ to be continuous for any value of 't' in the domain, i.e., within the sample period. The continuity of $f(t)$ on July 3, 2013 (for instance) needs that $t \rightarrow 13 \Rightarrow f(t) \rightarrow f(13)$, but $f(13)$ does not exist or $\lim_{t \rightarrow 13} f(t) \neq f(13)$.

This causes the error term to be white noise (Box et al., 2006).

The domain of the sample period of this study is given in Table 8. According to C'Vitancic and Zapatero (2004), a process $X(\cdot)$ is adapted to the filtration F if the random variable $X(t)$ is measurable with respect to σ -algebra F_t , for every $t \geq 0$, where a collection of the σ -algebras $F := \{F(t)\}_{t \geq 0}$ is called a filtration. Here, σ -algebra $F(t)$ represents the yields of 91 days residual maturity available up to time t . If more information is available by time t than what is available by time s , $F(s) \subset F(t)$ for $s < t$. The term 'for every $t \geq 0$ ' demands the variable to be continuous. Finally, if one considers a pure diffusion process of interest rate, Attaoui and Six (2012) reported that the obtained dynamics do not meet the empirical evidence because of discontinuities in the process of interest rates.

5. Analysis

The issue as to the shapes of these yield curves pertains to the abrupt fall of the yield of HDFC 9.90% 2014 in Figure 2. An investigation into the issuers related to the bonds of

short remaining maturities on those trading dates revealed that only the bond issued by the Housing Development Finance Corporation (HDFC) was among the top 10 debt securities demanded by various fund managers such as ING Life Insurance (ING life insurance, 2013) and Peerless on 24 June 2013; on the other two days, there were competitors such as REC, LICHF, and other issues of HDFC in the top 10 category¹³. The bond market situation was characterized by the waiting of the dealers for the results of treasury bill sales and the expectation of some of them about the possible rejection of very high bids by the RBI (*Reuters*, 2013d) and the upward movement of the yields in the wake of the RBI's intervention to support the rupee (*Reuters*, 2013e). The fear of a further hike in the yields existed on the preceding day as well (*Reuters*, 2013f). Thus, in the absence of competition from others among the top 10 debt securities and the absence of confidence on the G-sec market, the demand for HDFC 9.90% 2014 soared. The sovereign counterparts of the corporate ZCYCs for common residual maturity points in terms of year 0.425, 0.421667, 0.46, and 0.55 were for the dates 10 July 2013, 24 June 2013, and 17 June 2013 in Figures 6, 7, and 8, respectively. These are roughly equivalent to the corporate bond ZCYCs that shifted down to the extent of issuer-specific risk premium. These generally had an inverted shape during the second half of June 2013 owing to a weak rupee. The data tables associated with Figures 6, 7, and 8 and the comparison with their corporate bond counterparts are given in Tables 5, 6, and 7.

While investigating why the dealers came to a halt on 24 June, 2013, two questions cropped up. Apart from the market factor, was there any factor specific to HDFC that pushed the yield of HDFC 9.90% 2014 down to zero? What was the expectation that drove the dealers to stop bond trading on that day?

In our search for the answer to the first question, we found that in London, bonds whose returns were derived from property prices experienced crashing yields when property prices shot up (*Reuters*, 2013c). HDFC is a property-loan institution. An investigation into the same in India resulted in the following findings from *makaan.com* (2013).

Between July 2012 and July 2013, the price per square foot rose by 6.32% in Mumbai, 22.13% in Kolkata, 1.25% in Delhi, 18.43% in Chennai, 7.22% in Bangalore, 20.39% in Hyderabad, 5.95% in Pune, 8.1% in Indore, and 20.86% in Jaipur. It fell meagerly by 0.32% in Ahmedabad during the period. Thus, the upward trend of property prices in India may be considered to be the issuer-specific factor driving the HDFC bond yield.

While searching for answers to the second question, we found the discussion in Gagnon (2008) to be relevant. Depreciation in the domestic currency leads to inflationary expectation, which drives up the bond yield. If the bond dealers on the buy side are categorized into (i) risk-lover category, (ii) risk-neutral category, and (iii) risk-averse category, then in terms of Figure 11.1 on page 178 of Varian (1992), the linear chord segment below the concave utility curve represents the utility function of a risk-neutral dealer who is most likely to purchase the HDFC 9.90% 2013, where x represents any negative yield and y represents any positive yield.¹⁴ The risk-lover dealers were awaiting

¹³ The mutual funds available for Indian investors at a glance is available at fundsindia.com (2013).

¹⁴ The detailed risk preference of a dealer is available in Das and Wong (2013).

the RBI's initiative to support the rupee, which could prop up the yield and make some savings on the price of the bond. For the risk-averse dealers, buying a security without any return does not make sense. On the selling side, theoretically, the risk-lover dealer needed to wait for a further fall in yield below zero, but that never happens because the maximum loss from a security is the purchase price. While the risk-neutral dealer could need time to decide on selling or holding, the risk-averse dealer would consider it the best opportunity to make capital gain after 28 February 2013 (NSE, 2013d) because this was the first time the yield was nil.

Therefore, apart from competition in the same category and some issuer-specific factors, there was no other stimulus to respond to for the corporate bond yield corresponding to the residual maturity of 0.7139 year on 24 June 2013.

In summary, this study found the existence of arbitrage opportunities and the non-existence of yield curve for most of the business days in a sample size of three weeks and at times a nil yield. Increasing the sample does not work out because of discontinuity in the time-series data that the yield curves provide. On a few days, the yield curve that existed did not have a time horizon extended to the long end comparable to the yield curve in the G-sec market. These aspects of the corporate bond yield curve hinders the formulation of any comprehensive portfolio strategy such as an immunization strategy, an index matching strategy, or a dedicated and active strategy, except for buying and holding since none of the bonds under consideration were callable.

5.2 Revisiting the Findings in Section 4.2

To check the feasibility of constructing the corporate yield curve for a business day one year ago compared with the sample of this study, the date July 12, 2012 was chosen. It was found that the yield curve construction is feasible up to a period of 0.33 years, i.e., the redemption date of IOC 7% 2012. The security of the next nearest redemption date was EXIM Bank¹⁵ 9.25% 2012. However, the sources that disseminate detailed information (including the frequency of coupon) about the listed securities such as the National Securities Depository Limited (NSDL) and the Central Depository Services (India) Limited (CDSL, 2013) were not updated till October 13, 2013 regarding the ISIN INE514E08464. The information was also not available from the NSE (as on October 13, 2013) perhaps because it was not traded on the NSE platform. The information about the frequency of coupon of the security is imperative here because the redemption date (December 13, 2012) is more than six months ahead of the settlement date (July 12, 2012). The problem is similar for EXIM Bank 9.25% with redemption date December 26, 2012 and for HDFC 9.5% with the next redemption date February 28, 2013 traded on the same day.¹⁶

¹⁵ Export Import Bank of India.

¹⁶ The reader is suggested to check whether a similar problem arises in the construction of the corporate yield curve on July 11, 2012.

6. Policy Implications

The academia had accepted that the higher the leverage ratio, the greater is the motivation of the management to perform better because the corporate bond holders may drive the issuer towards liquidation in the worst case, but the shareholders cannot (Jensen, 1986). The shareholders pressurize management to work hard. Academics deem the corporate bonds to be worth the present value of equivalent discount bonds minus the value of a European put option of the same maturity on the assets with a strike price equal to the aforesaid present value. It may be noted in this context that many of the traded corporate bonds are zero-coupon bonds, such as the IDFC 2013 traded in BSE on August 6, 2013 (Reuters 2013c). The agency costs of debt related to asset substitution are also found to be much less than the tax advantages of debt (Leland, 2002). The tax advantages of retail investments in corporate bonds by the general public should also be a routine affair. These tax advantages should be higher for individuals in high-income groups. The Household, Income, and Labour Dynamics in Australia Survey revealed that household risk appetite increases with the level of income, where high-income categories invest in stocks while low-income categories prefer deposits (Black et al., 2012). In India, it is understood that a person belonging to the high-income category without much liabilities can have a high risk appetite (SEBI, 2013). However, Jensen (1986) cautioned against the agency cost of risky investments by shareholders after the corporate bonds are issued. He recommended pricing the inherent risks in these bonds. The policy implication here would be framing the regulatory guidelines motivating the firms to issue option-embedded bonds, if necessary, in the offshore markets, if the onshore investors are not educated about the complex valuation processes of option-embedded bonds or are not willing to subscribe because of insufficient risk appetite. For example, many Indian banks issued bonds in the offshore Asian currency market (Das, 2013a).

7. Conclusion

Given the continuous rupee depreciation, fear of inflation, expectations about the RBI's active rupee-support, and scarcity of corporate zero-coupon yields corresponding to different short, medium, and long residual maturities, this study constructed the short end of the corporate yield curves via zero-coupon pricing and linear interpolation in the Indian market where arbitrage opportunities abound. It compared the curves for three consecutive business days when these curves existed with their sovereign counterparts. The shapes of the corporate bond yield curves were generally found to reflect the issuer-risk premium compared to their sovereign counterparts. The issuer-risk is driven by factors such as the performance of the sector the issuer belongs to, the composition of debt portfolios of the corporate bond market participants, and their risk preference. There is a suggestion for Reuters India that it should provide the daily corporate bond trade data in a format similar to that provided by KCG BondPoint and Yahoo Finance. Another suggestion is for NSDL and CDSL for real-time update of the full description of the traded securities on every business day. Another suggestion for the income tax authority is to give more tax benefits to the taxpayers of the high-income category for investing in corporate bonds. The policy implication here for thickening the depth of the Indian corporate bond market is to frame regulations in such a manner as to motivate the

corporates to issue option-embedded bonds in onshore or offshore markets keeping in view the nature of risks these instruments carry.

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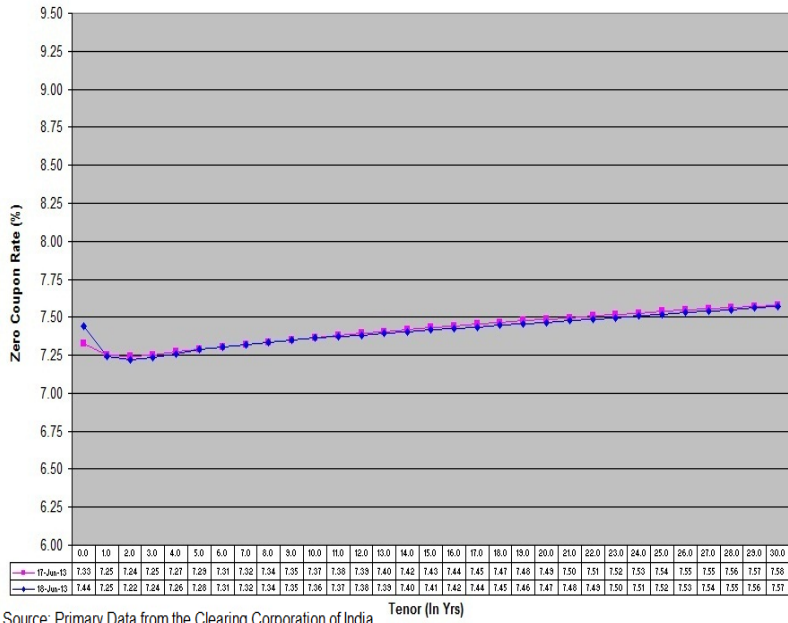
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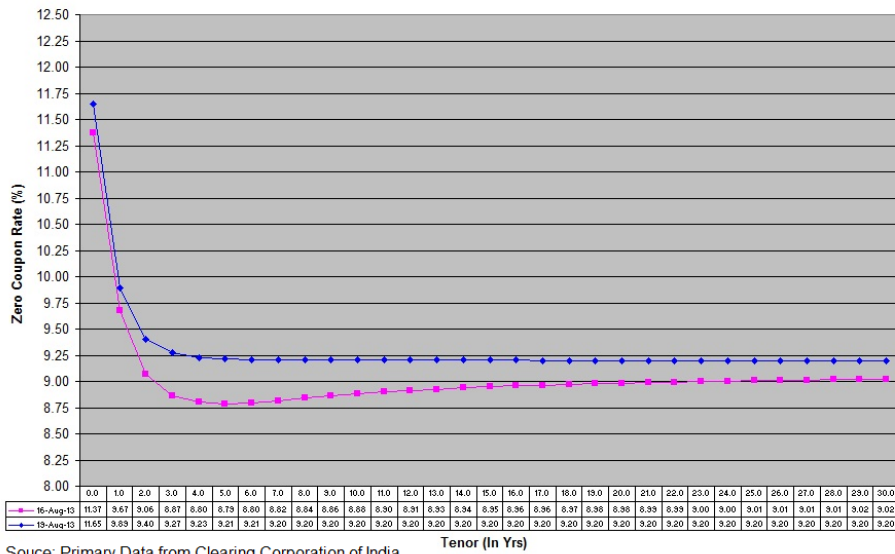
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Figure 1: Upward Sloping Yield Curve

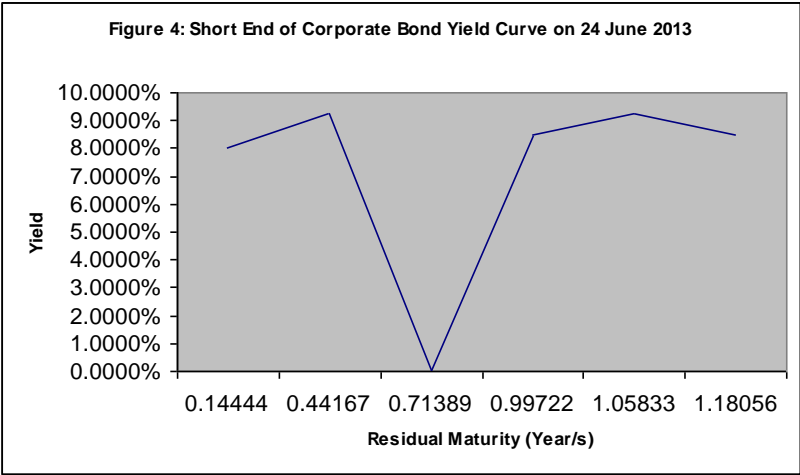
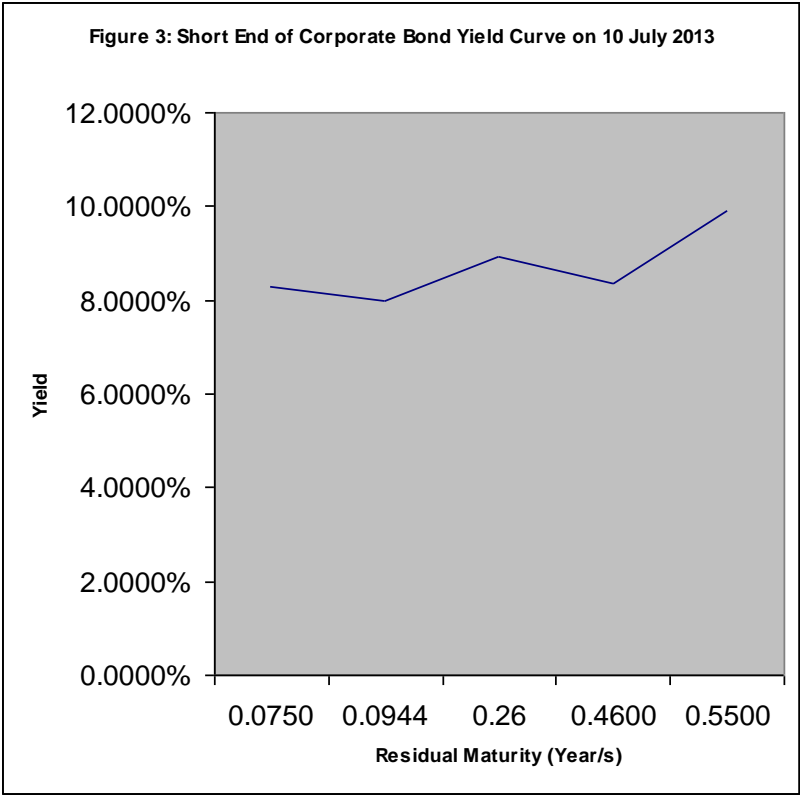


Source: Primary Data from the Clearing Corporation of India

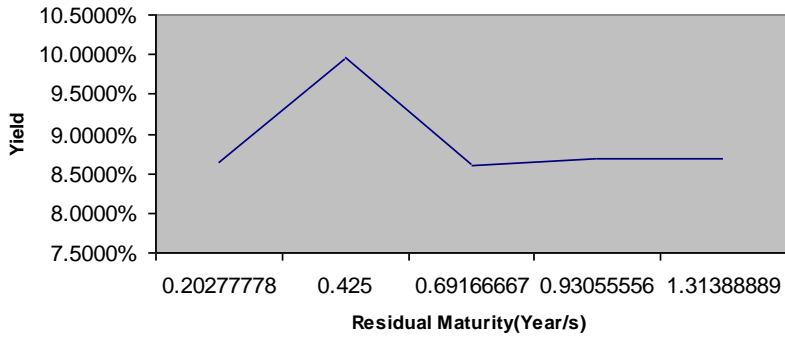
Figure 2: Inverted Yield Curve



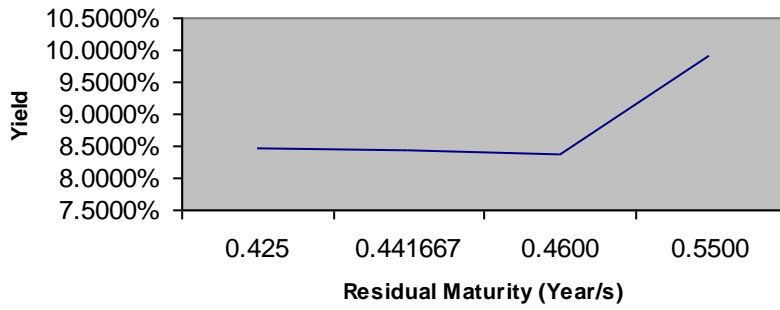
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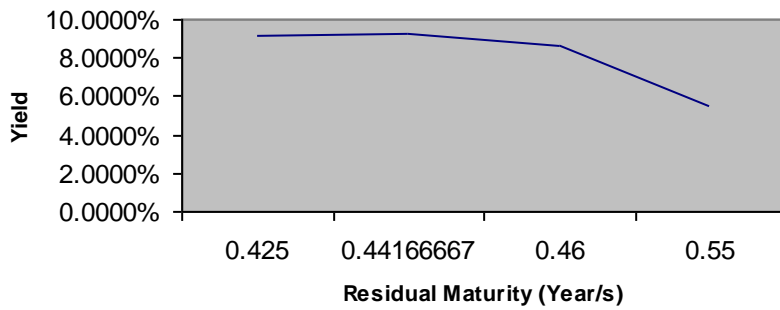
**Figure 5: Short End of the Corporate Bond Yield Curve
on 17 June 2013**



**Figure 6: Short End of the Sovereign Yield Curve
on 10 July 2013**



**Figure 7: Short End of the Sovereign Yield Curve
on 24 June 2013**



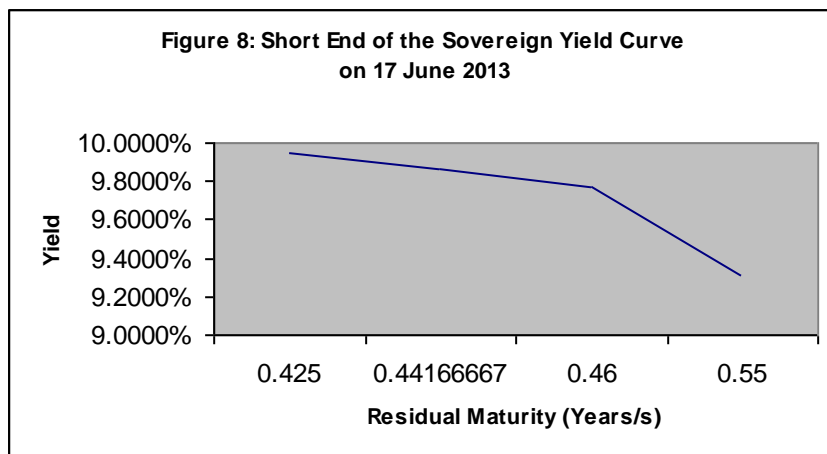


Table 1: Default Probability of Corporate Bonds

Year/TTM	2009	2010	2011
1	0.8716%	0.9317%	1.2156%
2	0.5246%	0.7703%	0.8657%

Source: Rituparna (2013b)

Table 2: Short End of the Corporate Bond Yield Curve on 10 July 2013

Yield	Residual Maturity	Issuer
8.3028%	0.0750	HDFC
7.9900%	0.0944	REC
8.9302%	0.26	IRFC
8.3740%	0.4600	IRFC
9.9136%	0.5500	LICHF

Table 3: Short End of the Corporate Bond Yield Curve on 24 June 2013

Yield	Residual Maturity	Issuer
8.0284%	0.144444	HDFC
9.2513%	0.441667	NKEL
0.0000%	0.713889	HDFC
8.4900%	0.997222	HDFC
9.2513%	1.058333	NKEL
8.5000%	1.180556	IDFC

Table 4: Short End of the Corporate Bond Yield Curve on 17 June 2013

Yield	Residual Maturity	Issue
8.6500%	0.202778	HDFC
9.9500%	0.425	IDFC
8.6000%	0.691667	HDFC
8.6861%	0.930556	HDFC
8.6800%	1.313889	HDFC

Table 5: Sovereign Counterpart of Corporate ZCYC on 10 July 2013

Corporate Bond Yield	Residual Maturity	Sovereign Yield
8.4713%	0.425	7.381389191 %
8.4250%	0.4416667	7.384207163 %
8.3740%	0.4600	7.387274554 %
9.9136%	0.5500	7.401852044 %

Table 6: Sovereign Counterpart of Corporate ZCYC on 24 June 2013

Corporate Bond Yield	Residual Maturity	Sovereign Yield
9.1827%	0.425	7.384147361 %
9.2513%	0.441666667	7.384218098 %
8.6283%	0.46	7.384297396 %
5.5697%	0.55	7.384708992 %

Table 7: Sovereign Counterpart of Corporate ZCYC on 17 June 2013

Corporate Bond Yield	Residual Maturity	Sovereign Yield
9.9500%	0.425	7.255091754 %
9.8656%	0.441666667	7.252239477 %
9.7728%	0.46	7.249278271 %
9.3172%	0.55	7.237184285 %

Table 8: Sample Period of the Study

Date	Day	<i>t</i>
17-06-2013	Monday	1
18-06-2013	Tuesday	2
19-06-2013	Wednesday	3
20-06-2013	Thursday	4
21-06-2013	Friday	5
24-06-2013	Monday	6
25-06-2013	Tuesday	7
26-06-2013	Wednesday	8
27-06-2013	Thursday	9
28-06-2013	Friday	10
01-07-2013	Monday	11
02-07-2013	Tuesday	12
03-07-2013	Wednesday	13
04-07-2013	Thursday	14
05-07-2013	Friday	15
08-07-2013	Monday	16
09-07-2013	Tuesday	17
10-07-2013	Wednesday	18

