

**SOVEREIGN DEBT AND THE COST OF MIGRATION: INDIA 1990-  
1992**

Ephraim Clark\* and Geeta Lakshmi\*\*

**\*Contact Author:**

Dr Ephraim Clark  
Professor,  
Accounting and Finance  
Middlesex University Business School  
The Burroughs, Hendon  
London NW4 4BT  
Tel: +44(0) 208-3625130  
E.Mail: [E.Clark@mdx.ac.uk](mailto:E.Clark@mdx.ac.uk)

\*\*Dr Geeta Lakshmi  
Visiting Lecturer  
Nottingham University  
Nottingham  
UK  
Email: [Geeta.Lakshmi@nottingham.ac.uk](mailto:Geeta.Lakshmi@nottingham.ac.uk)

March 25<sup>th</sup>, 2003

## ***ABSTRACT***

In this paper we look at the Indian financial crisis of 1990-1992 that included three credit rating downgrades of two notches each in the short space of 9 months. We measure to what extent India's financial difficulties were the result of conditions prevailing on the international capital markets at the time, reflected in changes in the risk free international term structure of interest rates, and to what extent they were linked to credit risk specific to the country's political environment and its economic and financial management as reflected in the three ranking migrations.<sup>1</sup> We find that most of the changes in Indian Eurobond prices over the period were due to conditions on the international capital markets. Migration effects were surprisingly small. Interestingly, our results show that there are no maturity, currency or bond specific effects of migration on percentage changes in the bond prices. However, when we measure the cost of migration in terms of basis points on the yield to maturity, we find that migration is relatively more costly for shorter maturities. Averaging over all bonds, the first migration added about 106 basis points to the bonds' yields to maturity while the third migration added about 42. The second migration was very small and not statistically significant, indicating that it was anticipated by the markets and priced in the first downgrade.

**JEL Classification:** O530, O160, G150, P330, F340

**Key Words:** Credit risk, market risk, term structure of interest rates, duration, ratings migration.

---

<sup>1</sup> In the credit risk literature, migrations refer to changes in credit rating in the sense that a country "migrates" from a rating of A2, for example, to a rating of Baa3.

## 1. Introduction

Over the period 1990-1992, the world economy was going through a rough patch exacerbated by the Iraqi invasion of Kuwait and the Gulf War and its aftermath. At the same time, public reports of India's financial problems generated rumors of an impending crisis and caused the rapid downgrading of Indian Eurobonds from A2 to Baa1 to Baa3 to Ba2 within the short space of a year.<sup>2</sup> The situation was further complicated by political turmoil surrounding the general elections of 1991, the assassination of Rajiv Gandhi, a prominent candidate, in May 1991 by Sri Lankan guerillas and a stock market scam involving government and banking officials in April-May of 1992. As a result of all this, international credit became scarce and shorter-term rollover debt became more costly. Indeed, bond issues ceased completely for several years. However, India never defaulted or rescheduled its debt. In spite of its foreign exchange difficulties, it put a brake on its foreign borrowings and with the help of foreign exchange loans and advice from the IMF, after 44 years of socialism, proceeded with a structural, market oriented reform of the economy.<sup>3</sup> By 1993 the crisis had passed. The question that we ask in this paper is to what extent India's financial difficulties were the result of conditions prevailing on the international capital markets at the time as reflected in the international, risk-free term structure of interest rates and to what extent they were linked to credit risk specific to the country's political environment and its economic and financial management as reflected in the three ranking migrations.

This paper makes a first contribution with respect to the literature on India's economy. First of all, we show that economic and financial conditions prevailing in the

---

<sup>2</sup> Defined by Moodys. A2 indicates a good ability to repay while Baa3 is indicative of junk bonds and Ba2 is speculative.

rest of the world, reflected in the international, risk-free term structure of interest rates, are the major determinants in changes in Indian Eurobond prices and its component cost of borrowing. Secondly, we show the impact of changes in India's internal political environment and its economic and financial management, reflected in the three downgrades in less than a year - from A2 to Baa1 on October 4, 1990, from Baa1 to Baa3 on March 26, 1991 and from Baa3 to Ba2 on June 24, 1991 – on the country's bond prices and component cost of borrowing were relatively small.

This paper makes a second contribution with respect to the literature on credit ratings and sovereign debt. In fact, very little work has been done on pricing the impact of migration on sovereign and quasi-sovereign debt. One of the reasons for this is that few sovereigns and almost no low credit quality sovereigns have ratings histories longer than a decade. Therefore, estimating the transition matrices is difficult, especially in so far as very few government bonds have a history of sufficient in-sample rating migrations.<sup>4</sup> For example, Duffie et al. (2001) have only one event in their study. In this paper, there are three migrations and the effect of each one is measured explicitly.

The effect of credit ratings is important because credit ratings play a major role in determining a borrower's cost of credit and access to the capital markets.<sup>5</sup> They now constitute the basic infrastructure for many models designed to measure credit risk, such as CreditMetrics from JP Morgan or the KMV methodology from KMV Corporation

---

<sup>3</sup> See Appendix 1 for details of the reform program.

<sup>4</sup>Hu, Kiesel and Perraudin (2001) attempt to extract information from sovereign defaults observed over a longer period and a broader set of countries to derive estimates of sovereign transition matrices. However this is only an estimate for a broad group of countries and hence may not be precise.

<sup>5</sup> Globalization of the world's capital markets has intensified their importance.

(now part of Moody's).<sup>6</sup> Furthermore, ratings, migration and transition probabilities<sup>7</sup> play a prominent role in credit risk management and the pricing of credit derivatives.<sup>8</sup> They are also prominent in plans for the next step in the regulatory capital standard for banks, which currently admits internal models for market risk and now calls for the development of a value-at-risk (VAR) framework for credit risk.

The specific relationship between credit ratings and sovereign debt is important because sovereign debt differs from corporate debt in several fundamental ways, which are likely to influence investors' perceptions of ratings where sovereigns are concerned and their reaction to sovereign rating changes when they occur:

1. There is no recognized legal framework for sorting out sovereign defaults.<sup>9</sup> Because of this and the principle of sovereignty, in a sovereign default creditors have very little scope for seizing assets as is the case in corporate defaults.
2. Largely as a result of 1, the resolution of sovereign defaults has usually included the rescheduling of outstanding contractual maturities, i.e., the transformation of contractual maturities into longer-term liabilities. This introduces an element of uncertainty regarding the actual maturities of the contractual cash flows.
3. The uncertainty regarding the cash flow maturities is compounded by what is known as the sovereign's "willingness" to pay. The creditworthiness of a corporate borrower depends, for all practical purposes, on its ability to pay, whereas for a sovereign borrower, besides the ability to pay, creditworthiness depends on the

---

<sup>6</sup> Other methods for credit risk measurement include expert systems and subjective analysis, and accounting based credit-scoring systems. See Altman and Saunders (1998) for a review of credit risk measurement techniques over the last 20 years.

<sup>7</sup> Transition probabilities refer to the probabilities that a country will migrate from its current rating to another rating over a given period of time, usually one year.

<sup>8</sup> See Kao (2000) for a review of the development of modeling and pricing credit risk and the statistical properties of credit spread behavior over time.

<sup>9</sup> There are semi-official organizations such as the Paris Club for sovereign creditors and the London Club for private creditors.

government's willingness or unwillingness to pay even if it has the ability.<sup>10</sup> A variable like this is very difficult to measure and integrate in a systematic manner into a rating system, which is based fundamentally on the ability to pay. Thus, default and transition probabilities for sovereigns are less reliable and more difficult to interpret than they are for corporates.

The paper also makes a contribution to the literature on credit risk analysis in that it provides an innovative methodology for measuring the pure impact of migrations on bond prices and interest rate spreads. The difficulty in doing this is linked to the difficulty of disentangling pure credit risk from market risk. As Jarrow and Turnbull (2000) point out, market and credit risk are intrinsically related to each other and are not inseparable.<sup>11</sup> Market risk generated by an unexpected change in the firm's assets also affects the probability of default, thereby generating credit risk as well. Conversely, credit risk generated by an unexpected change in the probability of default also affects the value of the firm, thereby generating market risk. Furthermore, market participants often anticipate forthcoming credit events before they actually happen so that prices adjust to the new credit status before the rating agencies have been able to effectively change the ratings. Where sovereign debt is concerned these problems are complicated by the fact that the concept of asset values that underpin the debt do not apply, as we have seen above.

Research looking at separating market risk and credit risk is substantial and growing. The main approach, based on Merton (1974, 1977), views bonds as contingent

---

<sup>10</sup> See, for example, Clark and Zenaidi (1999).

claims on the borrowers' assets. The credit event is modeled as timing risk when the assets of the borrower reach a threshold. In Merton (1974, 1977), Black and Cox (1976), Ho and Singer (1982), Chance (1990) and Kim, Ramaswamy and Sundaresan (1993) default is modeled as occurring at debt maturity if the assets of the borrower are less than the amount of the debt due. More recent models starting with Longstaff and Schwartz (1995) have randomized the timing of the default event determined by when the value of the assets hits a pre-determined barrier. Other papers such as Jarrow and Turnbull (1995), Madan and Unal (1998) and Duffie and Singleton (1999) model the timing of the default event as a Poisson process or a doubly stochastic Poisson process (Lando, 1994).

The four basic approaches for estimating the impact of a rating change on the price of a bond are summarized in Altman (1998). The first involves multiplying the change in the yield spread between the initial rating and the new rating by the bond's modified duration. This approach mixes market risk and credit risk and makes the unrealistic assumptions of no changes in the term structure of interest rates or in duration. A second approach applies event study methodology to directly observe the price changes of a large sample of bonds from different rating categories. The problem here is to ascertain the correct event date because by the time the rating has changed, it is probably too late. Furthermore, no distinction is made between changes due to market conditions and pure credit changes. A third approach discounts the bond's cash flows using the forward zero coupon curve for bonds in the new rating class. Again, no distinction is made between market risk and pure credit risk and the assumption is that

---

<sup>11</sup>Without distinguishing between market risk and credit risk, Aronovich (1999) and Erb, Harvey and Viskanta (1996) show a strong negative relationship between the country credit rating and international borrowing cost.

differentials between yield curves in the different rating categories are due exclusively to credit risk. Finally, the fourth approach decomposes the observed market spreads of bonds in various rating classes and uses the historical rating drift patterns to estimate the consequences of a rating change. The problem here again is that neither the spreads nor the drift patterns distinguish between market risk and credit risk.

Our approach distinguishes explicitly between market fluctuations and rating changes. It involves estimating the cost of both simultaneously. It also incorporates a time varying term structure of interest rates. Thus, the paper contributes to the empirical side of the sovereign debt literature. However, our goal is more modest than most studies. Rather than testing a bond pricing model such as Merrick (1999) for Argentine and Russian bonds or Keswani (1999) and Pagès (2000) on Latin American Brady bonds or Dullman and Windfuhr (2000) on European government credit spreads, we seek simply to measure the effect of rating migration on sovereign bond prices and yields. To this end, we proceed in 3 steps:

1. We establish the relationship in the absence of migration between a risky bond and a theoretical bond similar in every way to the risky bond except that it is riskless.
2. We compute the riskless term structure of interest rates and use it to calculate the price of the theoretical bond.
3. We use regression analysis to estimate the relationship between the risky and theoretical bonds to compute the price changes in the risky bond due to changes in the riskless term structure (market risk) along with dummy variables timed to the downgrade to measure the effect of migration on the price of the risky bond.



When this methodology is applied to the case of Indian Eurobonds 1990-1992, our results show that there are no maturity, currency or bond specific effects of migration on percentage changes in the bond prices. However, when we measure the cost of migration in terms of basis points on the yield to maturity, we find that migration is relatively more costly for shorter maturities. Averaging over all bonds, the first migration added about 106 basis points to the bonds' yields to maturity while the third migration added about 42. The second migration was very small and not statistically significant, indicating that it was anticipated by the markets and priced in the first downgrade.

The rest of the paper is organized as follows. In section 2 we develop the relationship between the risky and theoretical riskless bonds. Section 3 describes the data and outlines the methodology for testing. Section 4 presents the results, which include cubic spline estimates, the Im, Pesaran, and Shin (1995) T-bar test for stationarity in the dependent and independent variables as well as control tests of the migration coefficients controlling for currency effects, maturity effects and specific bond effects. Section 5 concludes.

## **2. Modeling the Relationship between the Risky and Theoretical Bonds**

In order to measure price changes in the risky bond due to changes in the term structure of interest rates, we construct a theoretical bond or series of bonds identical in every way to the bond(s) under consideration except that the price(s) of the theoretical bond(s) are determined by the riskless zero coupon term structure of interest rates. In the absence of credit risk, changes in the price of the theoretical bond(s) will be due

exclusively to changes in the term structure. We then determine the relationship between the price of the theoretical bond and the observed bond. We define changes in the price of the observed bond that are due to this relationship as market risk.

Consider the following notation:

$T_0^i$  = the price of theoretical bond  $i$  at time 0.

$r_t$  = 1 + the riskless zero coupon rate for period  $t$ .

$C_t$  = the cash flow for period  $t$ .

$P_0^i$  = the observed price of bond  $i$  at time 0.

$R_t$  = 1 + the risk adjusted zero coupon rate for period  $t$ .

$n_i$  = maturity date of bond  $i$ .

The observed and theoretical prices of bond  $i$  are given as

$$P_0^i = C_1^i R_1^{-1} + C_2^i R_2^{-2} + \dots + C_{n_i}^i R_{n_i}^{-n_i} \quad (1)$$

$$T_0^i = C_1^i r_1^{-1} + C_2^i r_2^{-2} + \dots + C_{n_i}^i r_{n_i}^{-n_i} \quad (2)$$

First differencing gives

$$dP^i = -1C_1^i R_1^{-1} \frac{dR_1}{R_1} - 2C_2^i R_2^{-2} \frac{dR_2}{R_2} - \dots - n_i C_{n_i}^i R_{n_i}^{-n_i} \frac{dR_{n_i}}{R_{n_i}} \quad (3)$$

$$dT^i = -1C_1^i r_1^{-1} \frac{dr_1}{r_1} - 2C_2^i r_2^{-2} \frac{dr_2}{r_2} - \dots - n_i C_{n_i}^i r_{n_i}^{-n_i} \frac{dr_{n_i}}{r_{n_i}} \quad (4)$$

To simplify the demonstration but with very little loss of generality we assume that changes in the term structures are linked to the short term riskless rate by functions of time such that

$$\frac{dR_t}{R_t} = G(t) \frac{dr_1}{r_1} \quad (5)$$

$$\frac{dr_t}{r_t} = g(t) \frac{dr_1}{r_1} \quad (6)$$

Divide equation 3 by  $P_0^i$  and equation 4 by  $T_0^i$  and substitute equations 5 and 6

$$\frac{dP^i/P_0^i}{dr_1/r_1} = - \frac{\sum_{t=1}^{n_i} t C_t R_t^{-t} G(t)}{P_0^i} \quad (7)$$

$$\frac{dT^i/T_0^i}{dr_1/r_1} = - \frac{\sum_{t=1}^{n_i} t C_t r_t^{-t} g(t)}{T_0^i} \quad (8)$$

Equation 7 gives the elasticity of the observed bond with respect to the short-term riskless interest rate while equation 8 gives a measure of the duration of the theoretical bond, which is also its elasticity with respect to the short term riskless rate. Denote the right hand side (RHS) of equation 7 as  $E_i$  and the RHS of equation 8 as  $D_i$ , isolate  $dr_1/r_1$ , equate the two and rearrange. This gives

$$\frac{dP}{P_0^i} = \frac{E_i}{D_i} \frac{dT}{T_0^i} \quad (9)$$

Equation 9 measures percentage changes in the observed bond's market value as proportional to percentage changes in the theoretical bond. The proportion is equal to the ratio of the elasticities of the observed and theoretical bonds with respect to the short-term riskless interest rate, which is, by definition, exclusive of credit risk. Since pure term structure changes reflect changes in the equilibrium conditions on the capital markets, equation 9 captures the market risk for bond  $i$ .

### **3. Data and Methodology**

#### ***3.1 Estimating the Riskless Term Structure of Interest Rates***

In order to estimate the market risk, we need to estimate the riskless zero coupon term structure of interest rates. Although several models such as Carleton and Cooper (1976), Schaefer (1981), Vasichok and Fong (1982), Chambers, Carleton and Waldman (1984), Mastronikola (1991) exist to estimate the term structure, Shea (1985) compares them and finds McCulloch's cubic spline model empirically tractable, easily computable by OLS and parsimonious.<sup>12</sup> Furthermore, Litzenberger and Rolfo (1984), Luther and Matatko (1992), Deacon and Derry (1994 a and b) and Bradley (1991) have successfully applied this model in their empirical studies. In this study we use the McCulloch cubic spline.<sup>13</sup>

---

<sup>12</sup> The advantage of this is the presence of a global optimum instead of a multitude of local optima generated by a highly non-linear model such as Cox, Ingersoll and Ross (1985).

<sup>13</sup> We also estimate the Cox, Ingersoll Ross (1985) model as a control. Our results show that both methods give very similar results.

The model involves fitting a smooth discount function to information obtained from observed prices of straight bonds with various coupons and maturities by estimating the coefficients for a linear combination of smooth approximating functions forming a cubic spline. This estimated discount function can then be inverted to obtain the term structure of interest rates. It can be used to price bonds, obtain the par yield curve, zero coupon yield curve and other related data and is the standard procedure in term structure theory.<sup>14</sup> The equation we estimate has the form

$$P + AI = C \left[ n + \alpha \sum h_i + \beta \sum h_i^2 + \gamma \sum h_i^3 + \gamma_1 \sum DV_1 h_i (h_i - t_1^*)^3 + \gamma_2 \sum DV_2 h_i (h_i - t_2^*)^3 \right] + e$$

$$100 \left[ 1 + \alpha h_n + \beta h_n^2 + \gamma h_n^3 + \gamma_1 DV_1 h_n (h_n - t_1^*)^3 + \gamma_2 DV_2 h_n (h_n - t_2^*)^3 \right] + e \quad (10)$$

where  $P$  is the clean price,  $AI$  is the accrued coupon,  $C$  is the coupon,  $n$  is the total number of coupons left,  $h_i$  is the date to the first coupon,  $i=1$  to number of coupons left to maturity, i.e  $n$ , and  $h_n$  is the date of the last cash flow.  $DV$  represents dummy variables representing the spline knots if time left to maturity of the bond is greater than  $t_{(.)}^*$ . Taking a large cross section of bonds in a market at a point in time with differing market prices, diverse coupons and times to maturities and using regression allows the estimation of  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\gamma_1$  and  $\gamma_2$  using ordinary least squares in (10). The error term in the regression ensures that random effects are captured. Repeating this exercise over time generates a time series of  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\gamma_1$  and  $\gamma_2$ .

### 3.2 Data Set

---

<sup>14</sup> The detail of the methodology is available on request.

The market prices of Indian bonds and data for modeling the term structure was obtained from the Handbooks published by the International Securities Market Association (ISMA), formerly known as the Association of International Bond Dealers (AIBD).

Our data is quarterly and the observation period runs from June 29, 1990, four months before the first downgrade, to September 30, 1992, the end of the crisis, a total of 10 observations for each bond. The quarterly window was chosen, based on the timing of the downgrades, as the smallest window wide enough to encompass price variations due to anticipated changes in pure credit risk that had not yet been formalized by a downgrade. Our sample is the subset of eight Indian bonds with varying amounts and maturities issued by public sector and quasi public sector borrowers - 3 in USD, 4 in DEM and 1 in JPY - that remained outstanding over the entire observation period. We also considered the Fung and Rudd (1986) argument that the time period should be not be too close to the issue date of any bond, since these prices often mirror issue costs along with interest-rate driven price movements. There were no direct sovereign issues made but all the above issuers were under the control, management and ownership of the Government of India and were guaranteed by it. Apart from ONGC, they are all financial institutions. The details of these bonds are given in Table 1.

**(Insert Table 1)**

To estimate the riskless term structure in the unregulated, tax-free Eurobond market of 1990-1992, we constructed sample sets for each observation date of not less than 50

bonds<sup>15</sup> issued by officially backed supranationals, for each of the three currencies constituting India's external debt - US dollars, German marks, and Japanese yen.<sup>16</sup> We use the supranationals to estimate the international riskless term structure rather than the corresponding treasuries in order to avoid biases that can creep into national credit markets through taxes, regulations, government intervention and the like. The supranationals included in our sample are guaranteed at least *de facto* by their member governments and borrow at terms equivalent to, and at times better than, the treasuries of the currencies in question. Thus, they are effectively riskless and give the best picture of the international riskless term structure of interest rates. The large number of bonds in each sample was necessary to ensure the desirable asymptotic qualities of consistency and sufficiency. To ensure a balanced sample over the whole term structure, bonds in equal numbers were chosen with term left to maturity of less than three years, between three and six years, and over six years.

### ***3.3 The Methodology***

We proceed in three steps.

- We estimate the riskless term structure for each time period, developed from McCulloch's cubic spline methodology, on the cross section of supranational bonds in the USD market, the JPY market and the DEM market. This gives us three time series for the riskless term structure, one in USD, one in DEM, and one in JPY.

---

<sup>15</sup> Most studies like Brown and Dybvig (1986) use the same dataset. However, even when the currency market was the same, in this study, the data set was varied to enable the use of very short bonds. This was to prevent the underestimation of the very short end of the yield curve to the extent of the time between June 1990 and September 1992. The June 1990 observations would have had to otherwise include observations at least 27 months away from maturity.

<sup>16</sup> These issuers include the World Bank, Eurofima, the European Investment Bank, the African Development Bank, the Asian Development Bank etc.,

In the estimation of the riskless yield curve, we used two spline<sup>17</sup> knot points of three and six years. The choice of these two points was based on the observation that the Eurobond market typically deals in shorter maturities than their respective domestic bond markets. Thus, we reasoned that the break points for investor perceptions of uncertainty, liquidity and risk in the Eurobond market could reasonably be represented as relatively short term: up to three years, relatively medium term: between three and six years, and relatively long term: above six years.

Although bond prices are quoted clean in the Eurobond market, i.e. they are quoted free from any accrued coupon in order to facilitate yield comparisons, the actual sale is on the basis of the dirty price, i.e. the clean price cum accrued interest.<sup>18</sup> In order to take this into account, dirty prices were computed accordingly on the basis of days the bond was not held by the buyer.<sup>19</sup> The ask prices were used to compute the dirty prices.<sup>20</sup>

Using observed values of prices, coupons and times to maturity, Ordinary Least Squares (OLS) regressions were run on SHAZAM to estimate the term structure parameters, which were then used to compute the discount curve and the spot rate curve.

---

<sup>17</sup>A spline is a model which incorporates switching coefficients of regression in two or more periods of time. To make this a smooth transition and to estimate it, it is essential that two regression lines meet at a switching point (knot) in a manner that in the example of a cubic spline satisfies the following:

$$Y_t = \alpha_1 + \beta_1 X_t + \gamma_1 X_t^2 + d_1 X_t^3 + \epsilon_t \quad (t=1, 2, \dots, t^*)$$

$$Y_t = \alpha_2 + \beta_2 X_t + \gamma_2 X_t^2 + d_2 X_t^3 + \epsilon_t \quad (t=t^*+1, t^*+2, \dots, n)$$

The requirement is that at point  $t=t^*$  the first and second derivative of these curves be the same.

<sup>18</sup> See equation 10.

<sup>19</sup> Unlike more imprecise methods like Chambers et al (1984) who computed interest accrued to the nearest quarter, dirty prices used in this study were precise to the day.

<sup>19</sup> There were two other choices in this matter :

1) Bid prices could have been used on the argument that they are prices the market makers are ready to buy at, or

2) The midpoint of the two, i.e. the mean of the bid and ask price could have been used. However it was found that the bid-ask spread was very narrow in the market. In view of this we found it reasonable to calculate the prices on the basis of ask quotations along with the accrued coupon.



The discount curve was computed for twelve years to allow comparability between data sets.

- We then apply the corresponding riskless term structure for each time period to each of the Indian Eurobonds in our sample to estimate their “theoretical riskless price”. This gives us eight time series, one for each bond, of the theoretical riskless price of the Indian Eurobonds in the sample. The theoretical riskless price represents what the market price of the bonds would be at each period if they were devoid of pure credit risk: their prices would vary only with changes in the conditions of capital market equilibrium reflected in the term structure.<sup>21</sup>
- Next, we use the “theoretical riskless prices” in the relationship developed in equation 9 to measure to what extent variations in the observed prices of the Indian bonds are explained by market risk, that is, by variations in the riskless term structure reflected in variations in the theoretical bond prices. We test the equation

$$\frac{dP^i}{P_t^i} = a_1 + a_2 \frac{dT^i}{T_t^i} + \varepsilon_t \quad (11)$$

where  $a_1$  is a constant,  $a_2$  is the coefficient (which may be time varying) corresponding in equation 9 to  $E_i/D_i$ , the ratio of the elasticity of the observed bond with respect to the short term riskless interest rate and the duration of the theoretical bond. The symbol  $\varepsilon$  represents the error term.

- Finally, after checking for robustness, we introduce a dummy variable for each migration along with the theoretical bond prices to estimate the magnitude and significance of pure credit risk. The assumption here is that the quarterly window is

wide enough to capture price changes due to anticipated migrations. After controlling for robustness, we then use the estimated coefficients to calculate the cost of the pure credit risk measured in basis points.

## **4. Results**

### ***4.1 Estimates of the Term Structure***

Five parameters were estimated for the cubic spline regressions. The results, not reported here but available on request, of the 30 regression coefficients, i.e., the three currency markets over ten time periods, are very good, although not all the parameters are always statistically significant.<sup>22</sup> The  $\alpha$  coefficient is always significant and always negative for all three currencies. The results are best for the dollar. The  $\beta$  and  $\gamma$  coefficients are usually significant at the 5% level. Otherwise, except in one case, they are significant at the 10% level. The curvature coefficients represented by  $\gamma_1$  and  $\gamma_2$  are also often significant at the 5% level and usually significant at the 10% level, more so for  $\gamma_1$  than  $\gamma_2$ , thereby indicating more curvature effect at the short end of the structure than the long end. For the yen, the  $\beta$  and  $\gamma$  coefficients are usually significant at the 10% level. However,  $\gamma_1$  and  $\gamma_2$  are clearly significant together in only three periods: June 1990, March 1991, and December 1991. In March 1992 short-term curvature is significant and in June 1992 long term curvature is significant. For the mark no parameters except  $\alpha$  are significant at the beginning of the observation period. However, starting in March 1991  $\beta$  becomes significant at the 5% level and  $\gamma$  at the 10% level. Except for June 1991, they stay significant until the last period, September 1992. The curvature coefficients are only significant in December 1991 and June 1992.

---

21 We also estimate the yield curve using the Cox, Ingersoll and Ross (1985) model, which gives similar results. These results are not reported here but are available on request.

We used the parameters estimated above to compute the yield curves and discount functions and compared the results with those estimated with the Cox, Ingersoll and Ross (1985) model.<sup>23</sup> They are almost indistinguishable, which is strong evidence for their accuracy. The shape of the yield curve showed a consistently upward sloping curve for the dollar market. The yen long-term rate fell below the short-term rate from September 1991 to March 1992, down to almost 0, in the last two mentioned time periods. In two cases it was almost the same as the short-term rate i.e. in September 1990 and March 1991. During this period i.e. from June 1990 to March 1991, it was only marginally above the short rate. During the remaining last period however, the difference widened. The DEM yield curves showed either the interest rate at the long end to be roughly of the same magnitude as the short, or inverted. During this period, Germany was also undergoing the event of reunification and the yield curve was inverted. In summary, the shape of the two ends of the yield curves seems satisfactory.

#### ***4.2 Indian Bonds, Market Risk and Migration***

We then applied the foregoing riskless term structures to each of the Indian bonds in our sample for each observation period in order to estimate their theoretical prices. In all, 80 observations were collated (10 quarters  $\times$  8 bonds) from the thirty yield curves (3 currency markets  $\times$  10 quarters). When we compare the theoretical price with the observed price, we find that there are only four instances out of 80 where the theoretical price was below the observed price. This is further evidence that we have

---

<sup>22</sup> The results of the Breusch Pagan Test, not reported here, show that the null hypothesis of homoscedasticity could not be rejected in most cases at the 10% significance level.

<sup>23</sup> Results available on request.

accurately captured the riskless term structure. Table 2 shows that for every bond, the average theoretical prices were higher than those of the corresponding market prices.

**(Insert Table 2)**

In graphs 1-8 we can see the evolution of the theoretical bond price, the actual bond price and the 6-month LIBOR of the corresponding currency.

**[insert graphs 1-8]**

It is interesting that short-term interest rates were generally decreasing for the dollar and the yen while mark rates were mixed. It is also interesting that the discount on the actual bond prices with respect to the theoretical price was at first increasing and then decreasing over the period. The change in the discount could be due to variations in the risk premium. On the other hand, it could also be due to variations in the term structure or some combination of the two. Since there is no risk premium associated with the theoretical price because it is estimated with the riskless term structure, the theoretical price will vary only with respect to the particular bond characteristics or variations in the term structure. To see to what extent the discount is due to the structure of the yield curve and the particular bond characteristics, we test the actual prices with respect to the theoretical prices (8 bonds x 10 time periods) proposed in equation 9.

First we test for stationarity in the panel data series  $dP/P_t$  and  $dT/T_t$  using the Im, Pesaran, and Shin (1995) T-bar test as applied in Wu and Chen (1999). The Z scores

are  $-18.76$  and  $-14.33$  respectively. The corresponding 95% critical values are  $\pm 3.09177$  generated by the Monte Carlo simulations.<sup>24</sup> Thus we reject non-stationarity.

We use equation 11,  $dP/P_t = a_1 + a_2 dT/T_t + \varepsilon$ , to test the relationship developed in equation 9. To overcome the problems of heteroskedasticity and cross sectional correlation arising from the data pooled over 8 bonds and 10 time periods, we used the Kmenta (1990) full cross-sectionally correlated and time-wise autogressive model.<sup>25</sup> We expect  $a_1$  to be equal to zero and  $a_2$  to be positive.<sup>26</sup> The results are reported in table 3. They show that  $a_1$  is very small and not statistically different from zero with a  $p$ -value of 0.3.<sup>27</sup> On the other hand,  $a_2$  is highly significant with a  $p$ -value of 0.00 and, as expected, it is positive.<sup>28</sup> Furthermore, the overall equation is very good with an  $R^2$  of over 99% and no evidence of autocorrelation in the residuals. This suggests that the variation in the international risk-free term structure of interest rates explains almost all of the price variations in the Eurobonds. There is, however, the possibility that the  $E_i/D_i$ , reflected in  $a_2$ , may vary over the time period under consideration. Given that we expect the actual and theoretical bond prices to be non-stationary but co-integrated, as indicated in figures 1-8, by regressing first differences upon each other without the error correction term, the point estimates potentially suffer bias. More specifically, if we use equation 9 with a potentially time varying coefficient, the estimates for  $a_2$  may suffer from omitted variable bias. To test for this we re-estimate equation 11 and include the error correction term. The results suggest that there is nothing to be gained by including this term. The coefficient  $a_1$  remains

---

<sup>24</sup> Details of the simulations are available on request.

<sup>25</sup> We found that the Kmenta model worked best with no correction for autocorrelation.

<sup>26</sup> See equations 7 and 8.

<sup>27</sup> Tests for bond specific fixed effects were also negative at conventional levels of significance

small and insignificant,  $a_2$  is of the same order of magnitude (0.71 as opposed to 0.77) and significance ( $p = 0.00$ ) as when the error correction term is omitted but the adjusted  $R^2$  falls to 0.55. Thus, we conclude that our results in table 3 do not suffer from the absence of the error correction term.

**(Insert Table 3)**

To account for the effect of migration, we add three dummy variables, one for each downgrade, with the value of 1 for the quarter that the downgrade occurred and zeros everywhere else and test the equation<sup>29</sup>

$$dP/P_t = a_3 + a_4 dT/T_t + b_1 D1 + b_2 D2 + b_3 D3 + \varepsilon_t \quad (12)$$

where  $D1$ ,  $D2$ , and  $D3$  represent the dummy variables for the first, second and third downgrades respectively. With the inclusion of the dummy variables, we have no expectations about  $a_3$ , which will capture any constant effects associated with pure credit risk. We expect that  $a_4$  will be similar to  $a_2$  and that  $b_1$ ,  $b_2$ , and  $b_3$  will be small and negative.

**(Insert Table 4)**

---

28 Tests for bond specific slope effects confirm that the slopes for the individual bonds are all positive at conventional levels of significance.

29 Though the downgrades were only for rated bonds we used the downgrade to apply to all Indian bonds, including those that were non-rated. Later we tested through a regression whether there was any difference between the rated and non rated bonds and found no significant difference. The regression was

$$dP/P = a_3 + a_4 dT/T + b_1 D1 + b_2 D2 + b_3 D3 + b_{34} D4 + \varepsilon$$

where D34 was the dummy for non rated issuer. The coefficient b34 insignificant for D34. Full regression results are available on request.

Table 4 shows the results. As expected,  $a_4$  is similar to  $a_2$ , changing by only 0.01872 with an undiminished  $p$ -value and suggests that a 1% change in the price of the theoretical bond causes about a 0.79% change in the price of the Eurobond. All three dummy variable coefficients are small and have the right sign but only the first and third downgrades are significant. The explanation for this is probably that the second downgrade was anticipated when the first downgrade occurred. The lower adjusted  $R^2$  of 0.9831 reflects the inclusion of the insignificant dummy variable.

We ultimately intend to use the migration coefficients to estimate the cost of migration for the individual bonds in the sample. The coefficients in Table 4 are averages for all the bonds but the migration effect will very possibly be influenced by other factors that differ across bonds, such as currency of issue, the maturity of the issue and characteristics specific to individual bonds such as coupon rate, payout schedules, embedded options and the like. To get a more nuanced estimate of the cost of migration, we test for each of these effects.

First, we check for special effects associated with the individual currencies. Variables  $D4$ ,  $D5$ , and  $D6$  take the value of 1 for downgrades 1, 2, and 3 respectively for the USD and zeros everywhere else. Variables  $D7$ ,  $D8$ , and  $D9$  are the same but refer to the DEM. We test the equation

$$dP/P_t = a_3 + a_4 dT/T_t + b_1 D1 + b_2 D2 + b_3 D3 + \sum_{i=4}^9 b_i D_i + \varepsilon_t \quad (13)$$

From the results given in Table 5 we see that none of the new dummies are significant and conclude that there is no currency effect.

**(Insert Table 5)**

Next, we check for a maturity effect by adding dummies  $D10$ ,  $D11$ , and  $D12$  that take the value of 1 for migrations 1, 2, and 3 respectively for bonds with maturities greater than 3 years and zeros everywhere else. We test the equation

$$dP/P_t = a_3 + a_4 dT/T_t + b_1 D1 + b_2 D2 + b_3 D3 + \sum_{i=10}^{12} b_i D_i + \varepsilon_t \quad (14)$$

From the results given in Table 6 we see that the coefficients for dummies 10 and 12 are not significant. The coefficient for dummy 11 is significant but is associated with downgrade 2, which is not significant. We conclude that there is no maturity effect.

**(Insert Table 6)**

Finally, we check whether there are any other special effects associated with the individual bonds. Dummy variables  $D13$  to  $D19$  take the value of 1 for the first downgrade for bonds 1 through 7 and zero everywhere else. Dummy variables  $D20$  to  $D26$  take the value of 1 for the second downgrade for bonds 1 through 7 and zero everywhere else. Dummy variables  $D27$  to  $D33$  take the value of 1 for the third downgrade for bonds 1 through 7 and zero everywhere else. We test the equations

$$dP/P_t = a_3 + a_4 dT/T_t + b_1 D1 + \sum_{i=13}^{19} b_i D_i + \varepsilon_t \quad (15)$$



$$dP/P = a_3 + a_4 dT/T_t + b_2 D2 + \sum_{i=20}^{26} b_i Di + \varepsilon_t \quad (16)$$

$$dP/P_t = a_3 + a_4 dT/T_t + b_3 D3 + \sum_{i=27}^{33} b_i Di + \varepsilon_t \quad (17)$$

Panels A, B, and C of Table 7 give the results for equations 15, 16, and 17 respectively. None of the coefficients for the new dummy variables is significant.

Therefore, we conclude that there are no individual bond effects.

**(Insert Table 7)**

Overall, we conclude that the coefficients for rating changes estimated in equation 12 accurately measure the effect of migration on Indian bond prices over the sample period. The first downgrade was highly significant and caused a fall of a little more than 3% in the price of the bonds. The second downgrade, which occurred in the period immediately following the first downgrade, was not significant, probably because its effects were anticipated in the coefficient of the first downgrade. Anticipation of the second downgrade would explain why the coefficient of the first downgrade is almost three times higher than the coefficient of the third downgrade, which is also highly significant, causing a fall of a little more than 1% in the price of the bonds. When we control for other factors that might influence the effect of migration on the bond prices, i.e. currency of issue, maturity and other factors specific to individual bonds, none are significant.

The implication is that there are no currency, maturity or bond specific effects associated with migration. While this outcome might be considered somewhat

counterintuitive, the explanation can probably be found in the *de facto* nature of sovereign debt. Contrary to the corporate sector, outright sovereign defaults or repudiations are rare because there is no scope for asset recovery. Restructuring and renegotiation is more common. In fact, Bulow and Rogoff (1989) report that the same bond may be renegotiated repeatedly. Consequently, contractual cash flow maturities are negotiable with a random element, thereby making it difficult to discriminate between shorter and longer-term maturities. Furthermore, the sovereign “willingness to pay” factor is insensitive to maturity, currency and individual bond covenants and thereby reduces distinctions across bonds.

The effect of migration on the individual bonds can be estimated in terms of yield to maturity. To make this estimation, we multiply the value of each bond in the period preceding downgrades 1 and 3 by coefficients  $b_1$  and  $b_3$  respectively.<sup>30</sup> The result gives the change in the price of the bonds due to migration. We then subtract this amount from the price of the bond in the period preceding the downgrade and recalculate the yield to maturity using this new price. The difference between the yields in maturity is the estimate of the cost of migration in terms of basis points. The results of this exercise are presented in Table 8.

**(Insert Table 8)**

On average, the first migration cost about 106 basis points (bp) and the third about 42 bp. However, for both downgrades the cost in yields varies from bond to bond. In fact,

---

<sup>30</sup> The second downgrade was not significant and therefore is not included in the estimation.

because of the common migration effect, the cost is higher the shorter the maturity.<sup>31</sup> This is true both within and across currencies and regardless of the coupon rate. The longer dollar and mark maturities have higher costs. The 5.25% yen issue, which matures in 21/06/93, has a cost 10 bp higher than the 9.75% dollar issue maturing five months later. The 7% mark bond maturing four months before the 5.25% yen issue carries a cost of 23 bp above the yen issue. This outcome suggests that bonds with shorter maturities are relatively more exposed to migration risk than those of longer maturities.

## **6. Conclusions**

In this paper we propose a methodology for measuring to what extent India's financial difficulties were the result of conditions prevailing on the international capital markets at the time, reflected in changes in the risk free international term structure of interest rates, and to what extent they were linked to credit risk specific to the country's political environment and its economic and financial management as reflected in the three ranking migrations. We find that most of the changes in Indian Eurobond prices over the period were due to conditions on the international capital markets. A 1% change in the price of the theoretical bond caused about a 0.79% change in the price of the Indian Eurobonds. The effect of credit risk specific to the country's political environment and its economic and financial management were relatively small. Averaging over all bonds, the first migration added about 106 basis points on to the bonds' yields to maturity while the third migration added about 42. The second migration was very small and not statistically significant, indicating that it was anticipated by the markets and priced in the first downgrade.

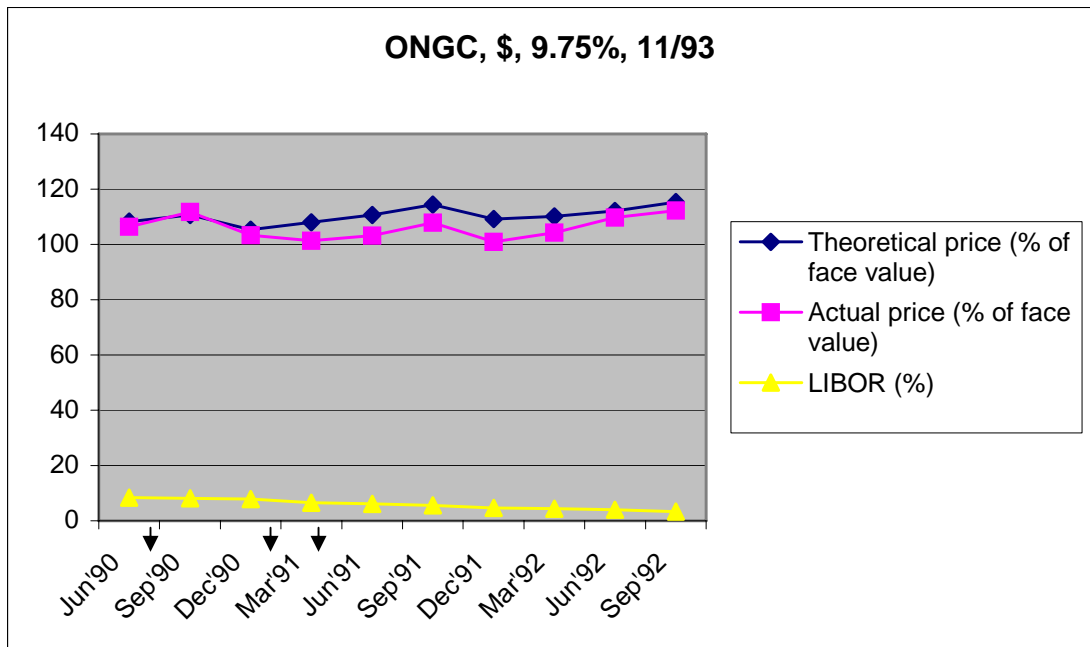
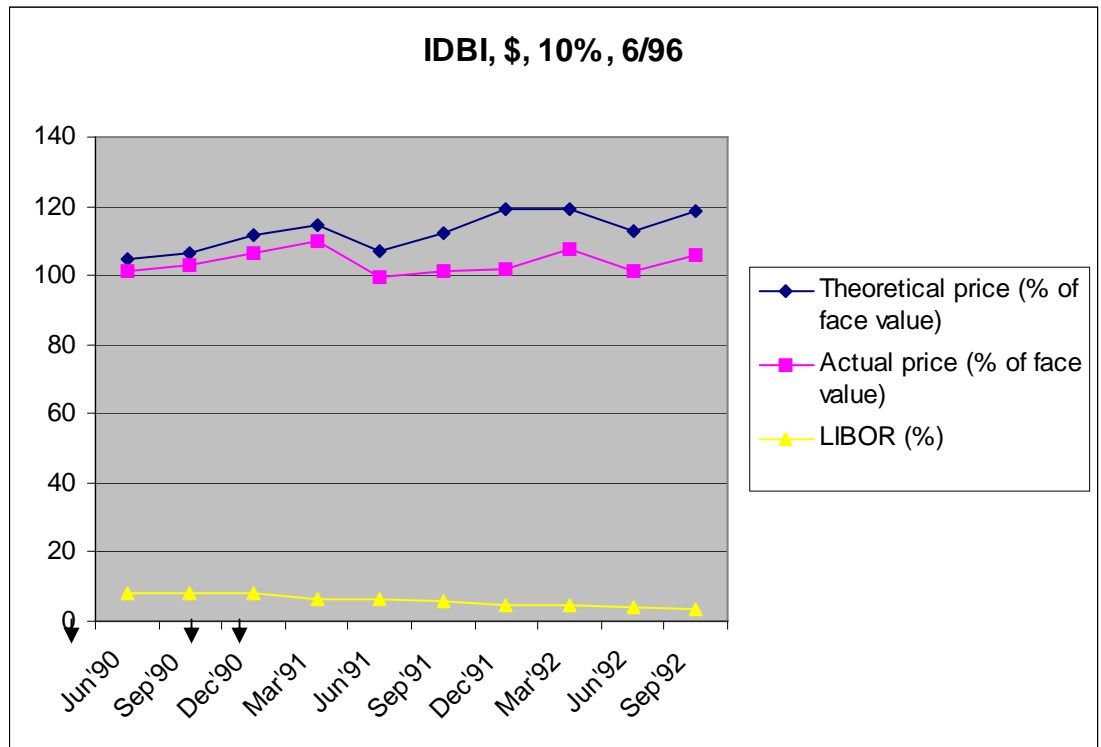
---

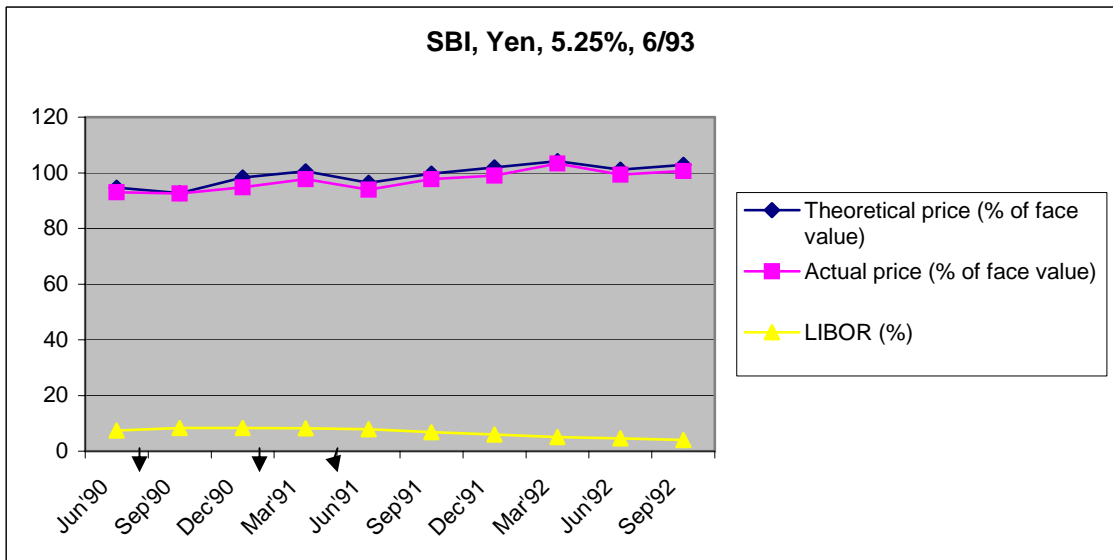
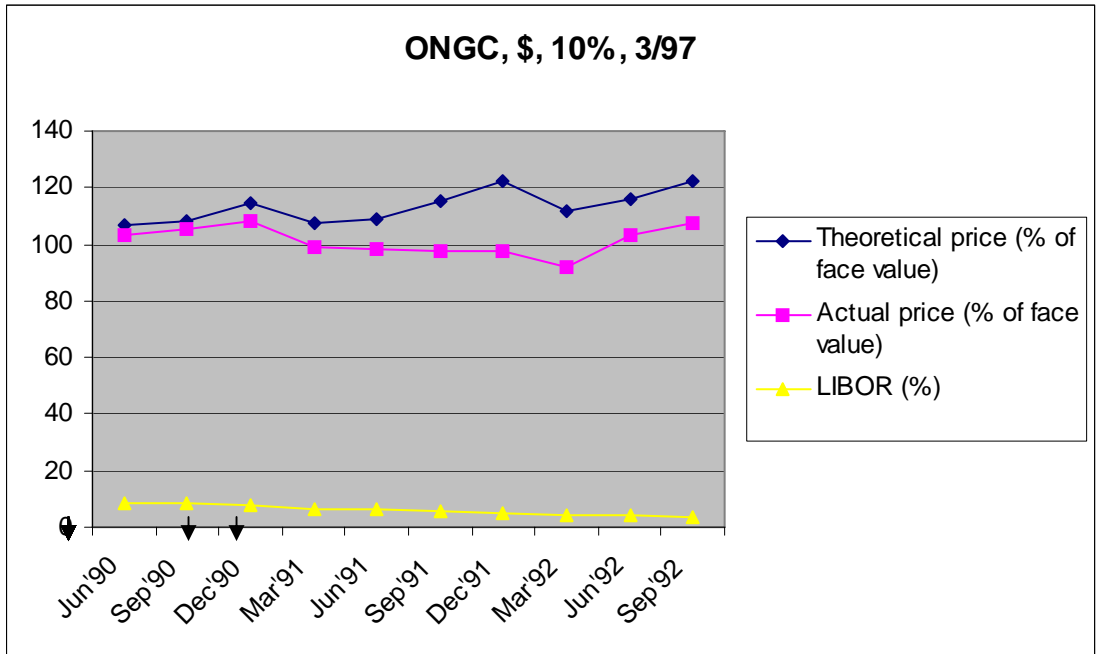
<sup>31</sup> This stands in contrast to the results of Elton et al. (2001), which suggest that this result does not apply to their selection of corporate bonds

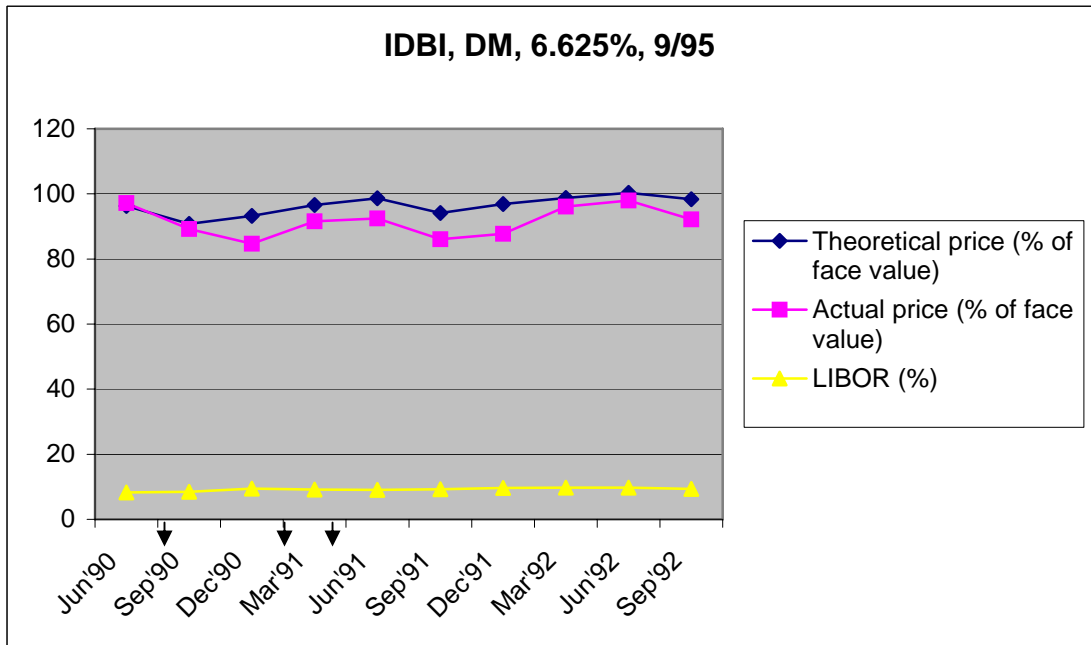
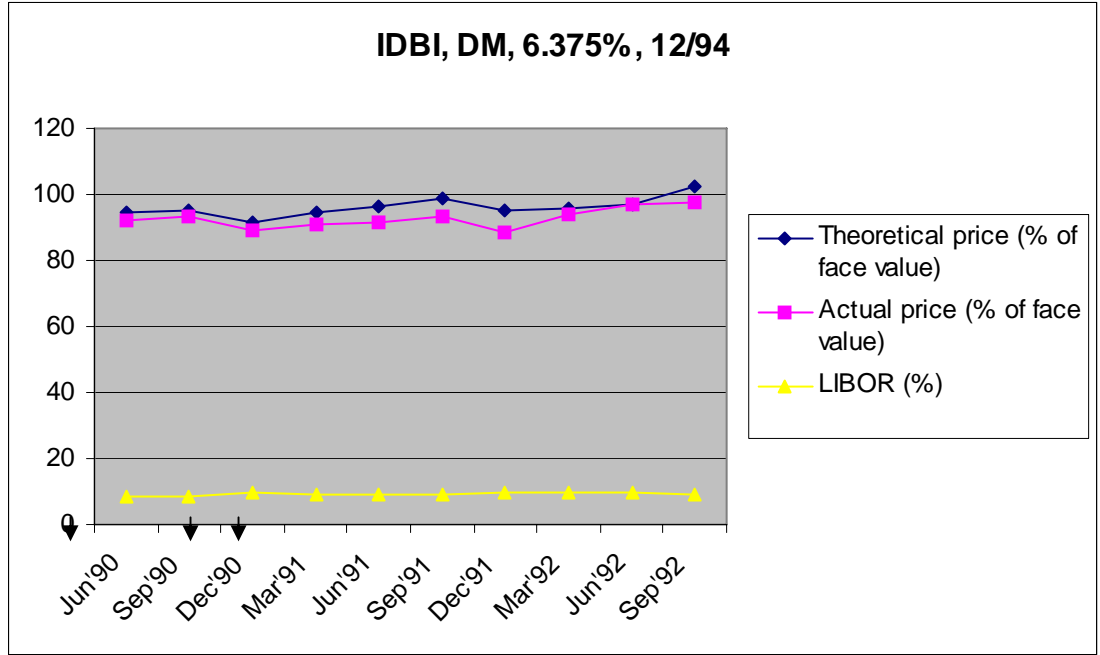
Our results are significant and robust. We find that the effect of migration on bond prices is not affected by currency, maturity or bond specific factors. Interestingly, however, shorter maturities are more sensitive to migration risk in that downward migration increases yields to maturity for shorter maturities more than for longer maturities.

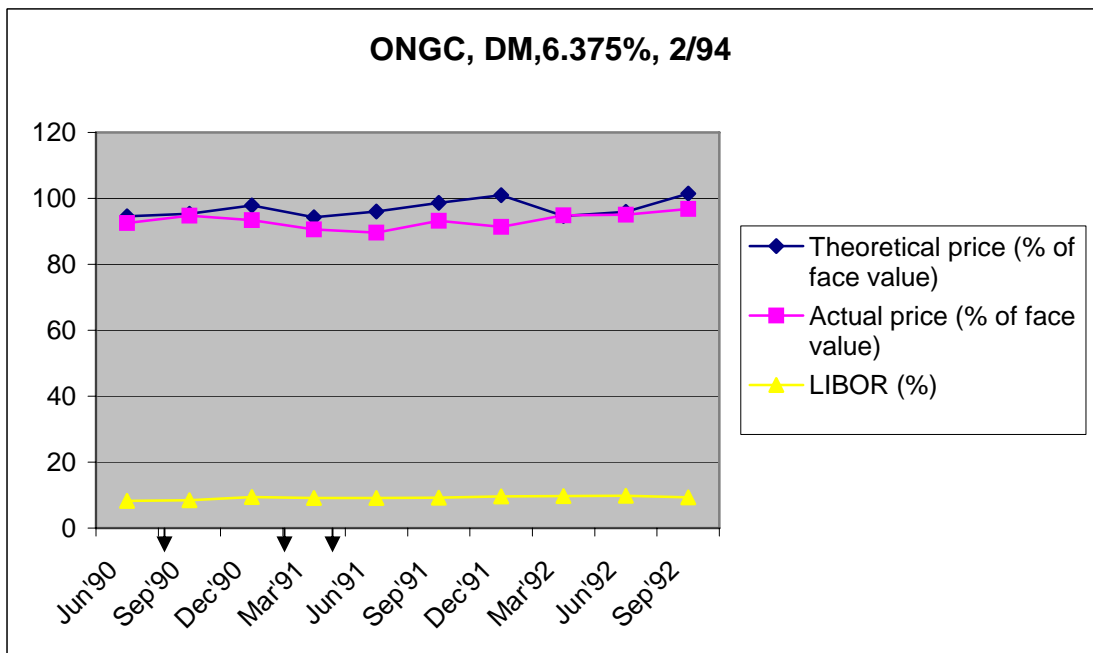
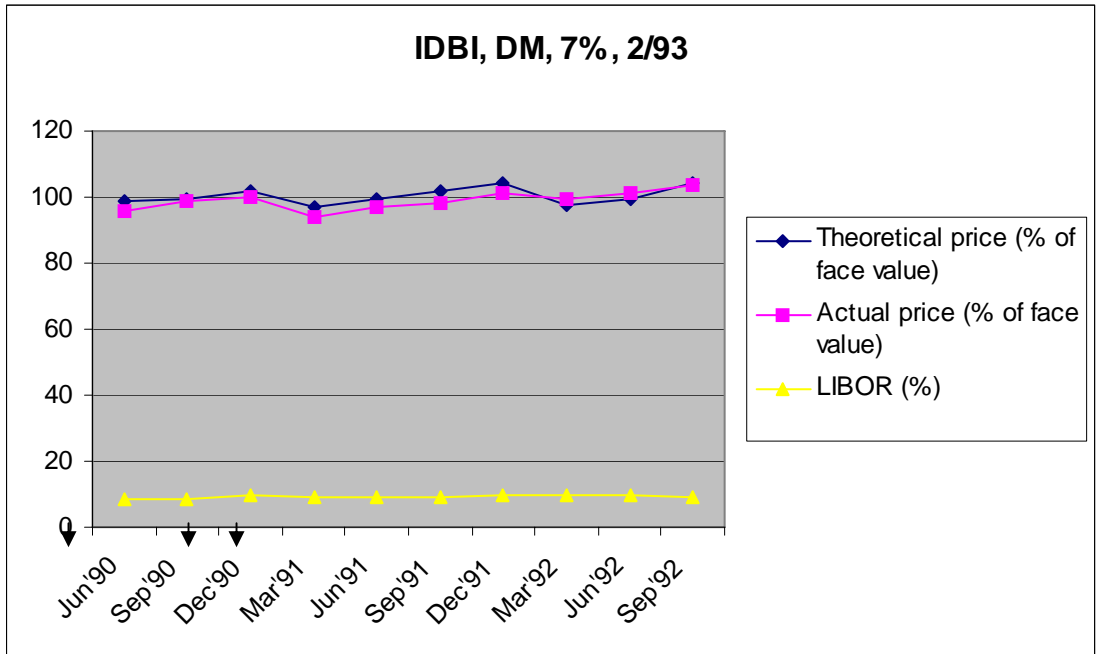
**Graphs 1-8**  
**Relationship Between Theoretical Prices, Actual Prices and LIBOR of**  
**Selected Indian Bonds**

**Note:** Arrows on horizontal time axis indicate downgradings on 4th October 1990, 26th March 1991 and 24th June 1991.











## BIBLIOGRAPHY

Aronovich S., (1999), Country Risk Premium, Theoretical Determinants and Empirical Evidence For Latin American Countries, Revista Brasileira de Economia, Oct-Dec 1999, Vol. 53, No 4, 463-498

Altman E.I, (1998), The Importance and Subtlety of Credit Risk Migration, Journal of Banking and Finance, Vol. 22, Nos 10-11, 1231-47.

Altman E.I and Saunders, A., (1998), Credit Risk Measurement: Developments over the Last 20 Years, Journal of Banking and Finance, Vol. 21, 1721-1742.

Black, F. and J. Cox, (1976), Valuing Corporate Securities: Some Effects of Bond Indenture Provisions, Journal of Finance, Vol.31, 351-367.

Bradley F., (1991), Neglected Factors In The Market Pricing Of Eurodollar Bonds, Journal of Portfolio Management, Vol.17, No.2, 62-73.

Brown S.J and Dybvig P.H., (1986), The Empirical Implications of the Cox, Ingersoll and Ross Theory of The Term Structure of Interest Rates, The Journal of Finance, Vol.41, 3-42

Bulow, J. and K. Rogoff, (1991), A Constant Recontracting Model of Sovereign Debt, Journal of Political Economy, Vol.97, 155-178.

Carleton W.T. and Cooper I.A., (1976), Estimation And Uses Of Term Structure Of Interest Rates, The Journal of Finance, Vol.31, No.4, 1067-83.

Chambers D.R., Carleton W.T. and Waldman D.W., (1984), A New Approach To Estimation Of The Term Structure Of Interest Rates, Journal of Financial and Quantitative Analysis, Vol.19, No.3, 233-52.

Chance, D., (1990), Default Risk and the Duration of Zero Coupon Bonds, Journal of Finance, Vol.45, 265-274.

Clark E. and Zenadi A. (1999), Sovereign Debt Discounts and the Unwillingness to Pay, Revue Finance, 20, No. 2, 185-199.

Cox, J.C., Ingersoll J.C. and Ross S.A., (1985), A Theory Of Term Structure Of Interest Rates, Econometrica, Vol.53, No.2, 385-407.

Crouhy, M., Galai, D., Mark, R., 2000. A Comparative Analysis of Current Credit Risk Models. Journal of Banking and Finance, Vol.24, 59-117.

Deacon M. and Derry A., (1994a), Deriving Estimates of Inflation Expectations From The Prices Of UK Government Bond, Bank of England, Working Paper Series No. 23.

Deacon M. and Derry A., (1994b), Estimating Market Interest Rate And Inflation Expectations From The Prices Of UK Government Bonds, Bank of England Quarterly Bulletin, 232-240.

Duffie D., Pedersen L.H and Singleton K.J (2001), Modelling Sovereign Yield Spreads: A Case Study of Russian Debt, Working Paper, Stanford University, September, Stanford.

Duffie, D. and Singleton K., (1999), Modeling Term Structures of Defaultable Bonds, Review of Financial Studies, Vol.12, 687-720.

Dullman, K. and Windfuhr M., (2000), Credit Spreads between German and Italian Sovereign Bonds: Do Affine Models Work?, Working Paper, University of Mannheim.

Elton, E. E., M. J. Gruber, D. Aggarwal and C. Mann, (2001), Explaining the Rate Spread on Corporate Bonds, Journal of Finance, vol. LVI, n° 1, 247-277.

Erb C.B., Harvey C.R. and Viskanta T.E., (1996), The Influence of Political, Economic, and Financial Risk on Expected Fixed-Income Returns, Journal of Fixed Income, Vol.6, No 1, 7-30

Fung W.K.H. and Rudd A., (1986), Pricing New Corporate Bond Issues: An Analysis Of Issue Cost And Seasoning Effects, The Journal of Finance, Vol.41, No.3, 633-43.

Govt. of India, Economic Survey, New Delhi.

Ho, T. and Singer R., (1982), Bond Indenture Provisions and the Risk of Corporate Debt, Journal of Financial Economics, Vol.10, 375-406.

Hu Y.T, Kiesel R., Perraudin W., (2001), The Estimation of Transition Matrices for Sovereign Credit Ratings, Working Paper, October 2001, Birkbeck College, U.K

Im K.S, Persaran H.M and Shin Y. (1995), Testing for Unit Roots In Heterogeneous Panels, Working Paper, Cambridge University

International Securities Market Association (ISMA), Weekly Eurobond Guide, Various issues.

Jarrow, R. A., Turnbull S. M., (1995), Pricing Derivatives on Financial Securities Subject to Credit Risk, Journal of Finance, 50, 1, 53-85.

- (2000). The Intersection Of Market And Credit Risk. Journal of Banking and Finance, Vol.24, 271-299.

Kao D.I., (2000), Evaluating and Pricing Credit Risk: An overview, Financial Analysts Journal, Vol 56, No 4, 50-66.

Keswani, A., (1999), Estimating a Risky Term Structure of Brady Bonds, London Business School.

Kim, J., Ramaswamy K. and Sundaresan S., Does Default Risk in Coupons Affect the Valuation of Corporate Bonds?: A Contingent Claims Model, Financial Management, 117-131.

Kmenta J., (1990), Elements Of Econometrics, 2nd Ed., Maxwell Macmillan International Editions, New York, 2<sup>nd</sup> ed.

Lando, D. (1994), On Cox Processes and Credit Risky Bonds, Working Paper, Institute of Mathematical Statistics, University of Copenhagen.

Litzenberger R.H. and Rolfo J., (1984), An International Study Of Tax Effects On Government Bonds, Journal of Finance, Vol. 39, No.1, 1-22.

Longstaff , F. and Schwartz E., (1995), A Simple Approach to Valuing Risky Fixed and Floating Rate Debt, Journal of Finance, 50, 3, 789-819.

Luther R.G. and Matatko J., (1992), Tax Effects In Gilt Edged Security Valuation , in Cooke T.E., Matatko J. and Stafford D.C., Risk Portfolio Management And Capital Markets, 81-89, Macmillan.

Madan, D. and. Unal H, (1998), Pricing the Risks of Default, Review of Derivatives Research, Vol.2, 79-105.

Mastronikola K., (1991), Yield Curves For Gilt Edged Stocks: A New Model, Bank of England Discussion Paper (Technical Series), No 49.

McCulloch H.J., (1971), Measuring The Term Structure Of Interest Rates, Journal of Business, Vol.44, 19-31.

McCulloch H.J., (1975a), An Estimate Of The Liquidity Premium, Journal of Political Economy, Vol.83, No.1, 95-119.

McCulloch H.J., (1975b), The Tax Adjusted Yield Curve, Journal of Finance Vol.30, 811-29.

Merrick, J., (1999), Crisis Dynamics of Implied Default Recovery Ratios: Evidence from Russia and Argentina, Stern School of Business, New York University.

Merton, R. C., (1974), On the Pricing of Corporate Debt: The Risk Structure of Interest Rates, Journal of Finance, Vol.2, 449-470.

- (1977), On the Pricing of Contingent Claims and the Modigliani-Miller Theorem, Journal of Financial Economics, 5, 241-249.

Moody's, Information Service on India, London.

-, Moody's Global Credit Information Centers (March 1991).

Pagès, H., (2000), Estimating Brazilian Sovereign Risk from Brady Bond Prices, Working Paper, Banque de France.

Schaefer S.M., (1981), Measuring A Tax-Specific Structure Of Interest Rates In The Markets For British Government Securities, The Economic Journal, 91, 415-38.

Shea G.S., (1985), Term Structure Estimations With Exponential Splines, The Journal of Finance, Vol.40, No.1, 319-25.

Vasicek, O.A. and Fong H.G., (1982), Term Structure Modeling Using Exponential Splines, The Journal of Finance, Vol.37, No 2, 339-48.

Wu J.L. and Chen S.L. (1999), Are Real Exchange Rates Stationary Based On Panel Unit Root Tests?, International Journal of Finance and Economics, Vol.4, 243-252

## **Appendix 1. Major Reforms And Liberalisation Measures Since 1991**

Financial	<ul style="list-style-type: none"> <li>• Banking system shedding its socio-political links and conducting its activities more on the lines of viability and profitability.</li> <li>• Misdirected investments and bad debts identified earlier and the Statutory Liquidity Ratio (the compulsory purchase of Government securities by the banking sector) reduced.</li> <li>• Credit on concessional terms to a multitude of priority areas laid down dismantled and the administered interest rate regime should be replaced by more market-determined rates.</li> <li>• The financial sector building up its health by putting prudential capital-adequacy norms, increased provision for non-performing assets and stricter income and asset classification, leading to the ultimate adoption of accounting norms and practices in line with the international community.</li> <li>• Greater financial autonomy to banks and other financial enterprises, promoting competition amongst them and rapid induction of a work culture based on automation and computerization.</li> </ul>
Industrial	<ul style="list-style-type: none"> <li>• Delicensing paving the way for easy entry to industries, which were hitherto regulated.</li> <li>• The Office of the Controller for Capital Issues, which used to formerly grant permission for the floating of an issue in the market, was abolished in May 1992.</li> <li>• The Monopolies and Trade Practices Act, which regulated the growth of the size of industry, has been changed drastically, to allow automatic clearance to companies expanding existing units or setting up new units.</li> <li>• Locational policies have been liberalized.</li> <li>• The role of the stock market has been strengthened by the introduction of several supervisory bodies overseen by Stock Exchange Board of India (SEBI) and an over the counter market is in operation. A National Stock Exchange of India, connecting all the major exchanges electronically is now in operation.</li> <li>• The Convertibility clause, which allowed a financial institution which had lent debt to an enterprise, convert its loans into equity and thus assume voting power has been repealed.</li> </ul>
Public sector	<ul style="list-style-type: none"> <li>• Privatization by the reduction in the list of industries reserved for the public sector and the divestment of shares,</li> <li>• The policy of treating sick public sector units in line with such private sector units</li> <li>• Allowing managers greater autonomy.</li> <li>• Introduction of selective competition in the reserved area</li> </ul>
Fiscal Policy	<ul style="list-style-type: none"> <li>• Lower rates of taxation</li> <li>• Narrower spread between the entry rate and the maximum marginal rate</li> <li>• Fewer exemptions and deductions.</li> <li>• The indirect taxation system was also to be cut</li> <li>• Simplification in areas of capital, corporate, wealth, income and indirect taxes.</li> </ul>

--	--

**Table 1. BONDS ISSUED IN THE EUROMARKET BY INDIA (1980-92)**

NAME	DATE OF ISSUE	CURRENCY	AMOUNT	MATURITY	COUPON
Industrial Development Bank of India	6/1989	dollar	100 million	6/6/1996	10%
Oil and Natural Gas Commission	12/1988	dollar	125 million	16/11/1993	9.75%
Oil and Natural Gas Commission	3/1990	dollar	125 million	16/03/1997	10%
State Bank of India	6/1988	yen	15 billion	21/06/1993	5.25%
Industrial Development Bank of India	3/1987	DM	200 million	21/12/1994	6.375%
Industrial Development Bank of India	9/1988	DM	250 million	1/9/1995	6.625%
Industrial Development Bank of India	2/1986	DM	100 million	1/2/1993	7%
Oil and Natural Gas Commission	2/1987	DM	150 million	25/02/1994	6.375%

**Table 2 AVERAGE THEORETICAL AND OBSERVED PRICES**

<b>Bond</b>	<b>Mean theoretical price</b>	<b>Mean observed price</b>
IDBI,10%,\$, 6/96	112.5944	103.8519
ONGC,9.75%,\$, 11/93	110.4357	106.1006
ONGC, 10%,\$, 3/97	113.4141	101.2814
SBI, 5.25%, Y, 6/93	99.24192	97.21224
IDBI, 6.375%, DM, 12/94	96.06871	92.68858
IDBI, 6.625%, DM, 9/95	96.40324	91.50577
IDBI, 7%, DM, 2/93	100.2424	98.81608
ONGC,6.375%, DM, 2/94	96.97537	93.20704
Average For All Bonds	103.17198	98.08295



**Table 3 REGRESSION RESULTS USING CHANGE IN THEORETICAL PRICES**

$$1. dP/P = a_1 + a_2 dT/T + \varepsilon$$

BUSE [1973] R-SQUARE = 0.9931, , BUSE RAW MOMENT R-SQUARE = 0.9932

DURBIN-WATSON = 1.9101

AKAIKE (1973) INFORMATION CRITERION - LOG AIC = -0.25509

SCHWARZ (1978) CRITERION - LOG SC = -0.19255

<b>Variables</b>	<b>T ratio</b>	<b>P value</b>
<b>a<sub>1</sub></b> = 0.0018837	1.045	0.300
<b>a<sub>2</sub></b> = 0.77426	100.7	0.000

**Table 4 REGRESSION RESULTS USING CHANGE IN THEORETICAL PRICES AND RATING CHANGES**

$$2. dP/P = a_3 + a_4 dT/T + b_1 D1 + b_2 D2 + b_3 D3 + \varepsilon$$

BUSE [1973] R-SQUARE = 0.9831 , BUSE RAW MOMENT R-SQUARE = 0.9834

DURBIN-WATSON = 1.9082

AKAIKE (1973) INFORMATION CRITERION - LOG AIC = -0.80024

SCHWARZ (1978) CRITERION - LOG SC = -0.64214

<b>Variables</b>	<b>T ratio</b>	<b>P value</b>
<b>a<sub>3</sub></b> = 0.0060580	4.429	0.000
<b>a<sub>4</sub></b> = 0.79298	62.2	0.000
<b>b<sub>1</sub></b> = -0.031244	-8.455	0.000
<b>b<sub>2</sub></b> = -0.0021178	-0.5759	0.567
<b>b<sub>3</sub></b> = -0.010812	-3.22	0.02

**Table 5 REGRESSION RESULTS USING CHANGE IN THEORETICAL PRICES,  
RATING CHANGES AND CURRENCY EFFECTS**

$$3. \frac{dP}{P} = a_3 + a_4 \frac{dT}{T} + b_1 D1 + b_2 D2 + b_3 D3 + \sum_{i=4}^9 b_i D_i + \varepsilon$$

BUSE [1973] R-SQUARE = 0.9796. , BUSE RAW MOMENT R-SQUARE = 0.9805

DURBIN-WATSON = 1.8130

AKAIKE (1973) INFORMATION CRITERION - LOG AIC = 0.14199

SCHWARZ (1978) CRITERION - LOG SC = 0.48982

Variables	T ratio	P value
$a_3 = 0.0033839$	3.084	0.003
$a_4 = 0.75248$	39.84	0.000
$b_1 = -0.025425$	-5.002	0.000
$b_2 = 0.0052218$	1.020	0.312
$b_3 = 0.0082257$	3.596	0.001
$b_4 = 0.0045697$	0.4237	0.673
$b_5 = -0.019094$	-1.777	0.081
$b_6 = -0.014152$	-1.289	0.202
$b_7 = -0.0022683$	-0.1708	0.865
$b_8 = -0.021425$	-1.592	0.117
$b_9 = -0.0079308$	-0.8948	0.374

**Table 6 REGRESSION RESULTS USING CHANGE IN THEORETICAL PRICES,  
RATING CHANGES AND MATURITY**

$$4. \frac{dP}{P} = a_3 + a_4 \frac{dT}{T} + b_1 D1 + b_2 D2 + b_3 D3 + \sum_{i=10}^{12} b_i D_i + \varepsilon$$

BUSE [1973] R-SQUARE = 0.9547, BUSE RAW MOMENT R-SQUARE = 0.9560

DURBIN-WATSON = 1.8910

AKAIKE (1973) INFORMATION CRITERION - LOG AIC = -2.1413

SCHWARZ (1978) CRITERION - LOG SC = -1.8884

Variables	T ratio	P value
<b>a<sub>3</sub></b> = 0.0051729	2.98	0.004
<b>a<sub>4</sub></b> = 0.78350	28.13	0.000
<b>b<sub>1</sub></b> = -0.021736	-4.244	0.000
<b>b<sub>2</sub></b> = -0.0088241	-1.710	0.092
<b>b<sub>3</sub></b> = -0.0030840	-0.7155	0.477
<b>b<sub>10</sub></b> = 0.010702	0.8575	0.394
<b>b<sub>11</sub></b> = 0.016532	2.341	0.022
<b>b<sub>12</sub></b> = -0.0084545	-1.463	0.148

**Table 7 REGRESSION RESULTS USING CHANGE IN THEORETICAL PRICES,  
RATING CHANGES AND INDIVIDUAL BOND EFFECTS**

<p><b>Panel A</b></p> $5. \frac{dP}{P} = a_3 + a_4 \frac{dT}{T} + b_1 D1 + \sum_{i=13}^{19} b_i D_i + \varepsilon$ <p>BUSE [1973] R-SQUARE = 0.9964, BUSE RAW MOMENT R-SQUARE = 0.9964  DURBIN-WATSON = 1.9101  AKAIKE (1973) INFORMATION CRITERION - LOG AIC = 0.22729  SCHWARZ (1978) CRITERION - LOG SC = 0.54349</p>		
<b>Variables</b>	<b>T ratio</b>	<b>P value</b>
<b>a<sub>3</sub></b> = 0.0036248	2.772	0.007
<b>a<sub>4</sub></b> = 0.78780	112.4	0.000
<b>b<sub>1</sub></b> = -0.038850	-1.055	0.295
<b>b<sub>13</sub></b> = 0.023371	1.082	0.283
<b>b<sub>14</sub></b> = -0.0012702	-0.03798	0.970
<b>b<sub>15</sub></b> = 0.018595	0.3582	0.721
<b>b<sub>16</sub></b> = 0.012267	0.4444	0.658
<b>b<sub>17</sub></b> = 0.019992	1.027	0.309
<b>b<sub>18</sub></b> = -0.037093	-1.03	0.307
<b>b<sub>19</sub></b> = 0.029884	0.9681	0.337
<p><b>Panel B</b></p> $6. \frac{dP}{P} = a_3 + a_4 \frac{dT}{T} + b_2 D2 + \sum_{i=20}^{26} b_i D_i + \varepsilon$ <p>BUSE [1973] R-SQUARE = 0.9972, BUSE RAW MOMENT R-SQUARE = 0.9972  DURBIN-WATSON = 1.7502  AKAIKE (1973) INFORMATION CRITERION - LOG AIC = 0.26501  SCHWARZ (1978) CRITERION - LOG SC = 0.58121</p>		
<b>Variables</b>	<b>T ratio</b>	<b>P value</b>
<b>a<sub>3</sub></b> = -0.0014354	-2.260	0.027
<b>a<sub>4</sub></b> = 0.71615	110.1	0.000
<b>b<sub>2</sub></b> = -0.0027812	-0.07375	0.941
<b>b<sub>20</sub></b> = 0.022421	0.9832	0.329
<b>b<sub>21</sub></b> = -0.033193	-1.104	0.274
<b>b<sub>22</sub></b> = -0.030767	-0.5834	0.562
<b>b<sub>23</sub></b> = 0.019249	0.7392	0.463
<b>b<sub>24</sub></b> = -0.0013943	-0.07317	0.942

$b_{25} = 0.058545$	1.615	0.111
$b_{26} = -0.020150$	-0.6208	0.537
<p><b>Panel C</b></p> $7. dP/P = a_3 + a_4 dT/T + b_3 D3 + \sum_{i=27}^{33} b_i Di + \varepsilon$ <p>BUSE [1973] R-SQUARE = 0.9917, BUSE RAW MOMENT R-SQUARE = 0.9917  DURBIN-WATSON = 1.9225  AKAIKE (1973) INFORMATION CRITERION - LOG AIC = 0.16670  SCHWARZ (1978) CRITERION - LOG SC = 0.48290</p>		
<b>Variables</b>	<b>T ratio</b>	<b>P value</b>
$a_3 = 0.0040730$	2.801	0.007
$a_4 = 0.73377$	84.92	0.000
$b_3 = -0.027916$	-0.7884	0.433
$b_{27} = -0.024031$	-1.128	0.264
$b_{28} = 0.024668$	0.8238	0.413
$b_{29} = 0.0021432$	0.04189	0.967
$b_{30} = 0.015128$	0.5949	0.554
$b_{31} = 0.017888$	1.022	0.311
$b_{32} = 0.018303$	0.4724	0.638
$b_{33} = 0.034585$	1.1777	0.244

**Table 8 IMPACT OF COST OF MIGRATION ON YIELDS TO MATURITY**

Bond	Date	Maturity	price	after downgrade	yld before	yld after	diff in yld
IDBI,10%,\$, 6/89	Sept 30-1990	06/06/96	100.125	96.9967	0.0995	0.1071	0.0076
ONGC, 9.75%,\$, 12/88	Sept 30-1990	16/11/93	100.25	97.1178	0.0963	0.1086	0.0123
ONGC, 10%,\$, 3/90	Sept 30-1990	16/03/97	99.875	96.7545	0.1000	0.1069	0.0069
SBI, 5.25%, Y, 6/88	Sept 30-1990	21/06/93	91.125	88.2779	0.0904	0.1038	0.0133
IDBI, 6.375%, DM, 3/87	Sept 30-1990	21/12/94	88.625	85.8560	0.0977	0.1069	0.0092
IDBI, 6.625%, DM, 9/88	Sept 30-1990	01/09/95	88.75	85.9771	0.0959	0.1040	0.0081
IDBI, 7%, DM, 2/86	Sept 30-1990	01/02/93	94	91.0631	0.0996	0.1153	0.0156
ONGC,6.375%, DM, 2/87	Sept 30-1990	25/02/94	91	88.1568	0.0981	0.1100	0.0119
IDBI,10%,\$, 6/89	Mar 31-1991	06/06/96	102	100.8972	0.0948	0.0975	0.0028
ONGC, 9.75%,\$, 12/88	Mar 31-1991	16/11/93	97.875	96.8168	0.1067	0.1116	0.0049
ONGC, 10%,\$, 3/90	Mar 31-1991	16/03/97	99	97.9296	0.1023	0.1048	0.0025
SBI, 5.25%, Y, 6/88	Mar 31-1991	21/06/93	93.75	92.7364	0.0842	0.0897	0.0055
IDBI, 6.375%, DM, 3/87	Mar 31-1991	21/12/94	89.125	88.1614	0.0999	0.1034	0.0035
IDBI, 6.625%, DM, 9/88	Mar 31-1991	01/09/95	87.75	86.8012	0.1018	0.1048	0.0030
IDBI, 7%, DM, 2/86	Mar 31-1991	01/02/93	93.125	92.1181	0.1131	0.1199	0.0068
ONGC,6.375%, DM, 2/87	Mar 31-1991	25/02/94	90	89.0269	0.1053	0.1097	0.0044