Do Interest Rates Matter for Stock Markets?

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This paper asks whether interest rates matter for stock markets in the Indian context. It uses the monthly averages of the SENSEX and NIFTY to measure stock prices in April 1996-June 2006. For the same period, the month-end yields on 10-year government security and treasury bills (15-91 days) are used to measure long-term and short-term interest rates, respectively. The paper finds that there is a long-run relationship between interest rates and stock prices. Both long-term and short-term interest rates affect stock prices. The long-term interest rates are found to affect stock prices negatively, whereas short-term interest rates affect stock prices positively. In addition, the SENSEX is found to be more responsive to changes in interest rates than the NIFTY.

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The stock market has become an important indicator of the performance of the Indian economy over the years. With this, the working of the stock market has become a vital and facilitating subject for academics, investment professionals, and monetary policymakers. The stock market works with the sentiments of participants, which depend on several factors, making it a very sensitive segment of the economy. Globalisation and financial sector reforms have added to the sensitivity by increasing determinants of the stock market movement manifold. Among the several other important determinants, one whose relationship with the stock market is of great concern and needs to be carefully studied is interest rates.

In theory, the relationship between interest rates and stock prices is negative. This is due to the cash flow discounting model according to which, present values of stocks are calculated by discounting the future cash flows at a discount rate. If the discount rate increases, then present values of stocks decline and vice versa. This discount rate is a risk adjusted required rate of return and equal to the level of interest rates in the economy. Therefore, an increase in interest rates lowers present values of stocks directly. Even a relatively small rise in interest rates can have a major effect on present values if it is spread out over several years. In addition, rising interest rates reduce cash flows by reducing the profitability of firms. Due to these two reasons, present values of stocks decline and so do current stock prices. The inverse holds true as well.

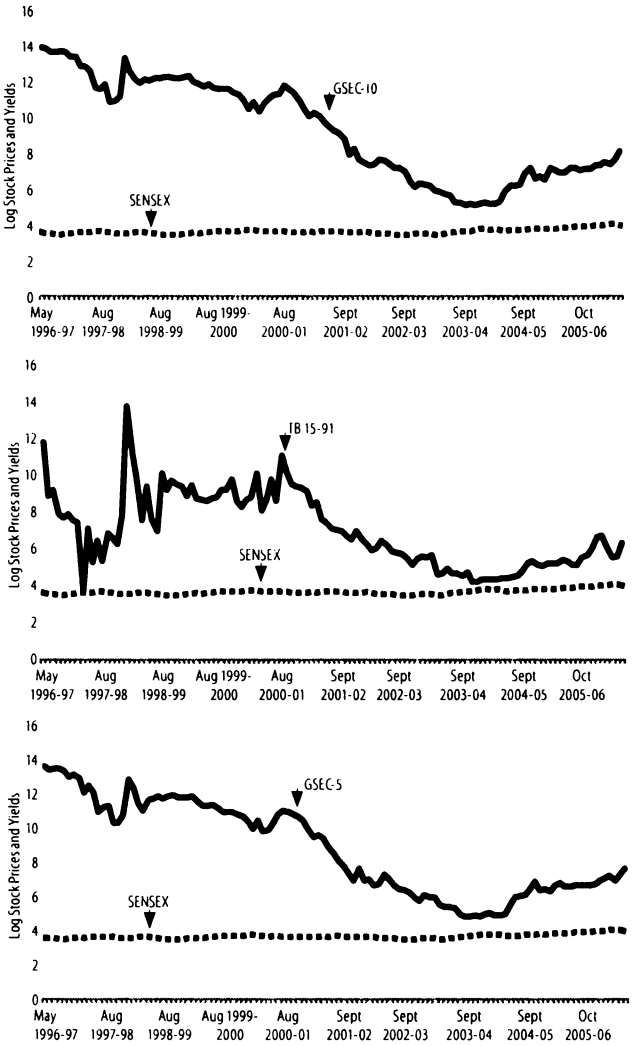
Apart from the above theoretical reason, there are other few reasons, which account for the negative relationship between interest rates and stock prices. First, interest rates are risk free returns on bonds and as interest rates on bonds rise, bonds become more attractive and stocks less attractive. Consequently, there is a change in the asset allocation in favour of bonds rather than stocks. This moves funds from the stock market to the bond market, which invariably increases the demand for bonds and reduces the demand for stocks. As a result, the prices of stocks fall. The opposite is true when interest rates fall and funds are shifted from the bond market to the stock market.

Second, corporate profitability is hit because of increase in interest rates in two ways: (i) companies earnings net of interest rates fall; and (ii) consumers' demand for the products decreases they pay more to borrow money. As the profitability decreases stock prices decline and vice versa. Third, if interest rates increase then investors' expectations about the economy and company earnings, which drive the stock market turn negative. This pushes stock prices down and the reverse is true as well.

The effects of interest rates changes on a stock's intrinsic value are more complex than outlined earlier because of the existence

of other economic variables that interact with interest rates in determining a stock's value. In addition, if the inflation rate is quite high and real interest rates do not exist, then the investors

Figure 1: Movements in Monthly BSE Sensex Stock Prices and Yields on 10-Year Government Security, 5-Year Government Security, and 15-91 Days Treasury Bill



Sources: Stock Exchange, Mumbai (BSE), Reserve Bank of India, *Handbook of Statistics on Indian Economy* and *RBI Bulletin* (various issues).

are unlikely to move their funds from the stock market to the bond market in response to an increase in interest rates. Hence, the negative relationship between interest rates and stock prices is not necessarily true.

The relationship can also be positive due to the following reasons. First, if interest rates increase in response to the economy growing too rapidly then corporate earnings should also be growing rapidly and so should stock prices. Second, higher interest rates suggest higher anticipated inflation. This leads to a likely increase in corporate pricing power because of which higher growth rates of earnings per share are witnessed by firms. Therefore, when the discount factor is increased in the stock valuation formula, the earnings per share are affected and increased. This implies that lower stock prices are not necessarily warranted [Durre and Giot 2005]. Third, a positive relationship can be explained in terms of a changing risk premium. For example, a drop in interest rates could be the result of increased risk or/and precautionary saving as investors move away from risky assets such as stocks towards less risky assets like bonds [Barsky 1989]. However, it is important to note that although the negative relationship between interest rates and stock prices is not automatic or perfect, in the long run, it is unavoidable.

The above discussion reveals that the relationship between interest rates and stock prices can either be positive or negative. This paper tries to examine the nature of relationship between interest rates and stock prices in the Indian context. This paper also tests the direction of causality between interest rates and stock prices i e, whether changes in interest rates affect stock prices or vice versa. The remainder of the paper is organised as follows. In Section 1, select previous studies on the relationship between interest rates and stock prices are surveyed. Some stylised facts about interest rates and the stock markets in India are presented in Section 2. Section 3 discusses the data and methodology followed by the analysis of empirical results in Section 4. Finally, Section 5 concludes the paper.

1 Survey of Previous Studies

This section highlights the intricacy in the relationship between interest rates and stock prices by making a survey of select previous studies. Several studies find that interest rates and stock prices are negatively related. For example, Shiller and Beltratti (1992) examine whether the co-movements of stock prices and bond yields can be explained in terms of present value models by using annual data in the United States, 1871-1989, and the United Kingdom, 1918-89. Their results show that there is a negative correlation between the change in actual real log stock prices and the change in actual long-term interest rates. Thorbecke's (1997) results show a negative relationship between the change in federal funds rate and stock returns, pointing out that expansionary monetary policy leads to an increase in a firm's future cash flows and decreases the discount rate at which those cash flows are capitalised. Similarly, Fama and Schwert (1977), Campbell (1987) and Ferson (1989) find that nominal treasury bill yields are negatively correlated with future stock returns. Rigobon and Sack (2004) find that an increase in short-term interest rates leads to decreasing stock prices. According to their results, a 25 basis point increase in three-month interest rate results in a 1.70 per cent decline in the Standard and Poor's (S&P) 500 index and a 2.4 per cent decline in the NASDAQ index.

On the other hand, a good number of studies show a positive relationship between interest rates and stock prices. Apergis and Eleftheriou (2002) undertake an empirical effort to investigate the relationship between monthly stock prices, inflation and interest rates in Greece over the period 1988-99. The results demonstrate that although interest rates are positively correlated with stock prices, this relationship is found to be statistically insignificant.

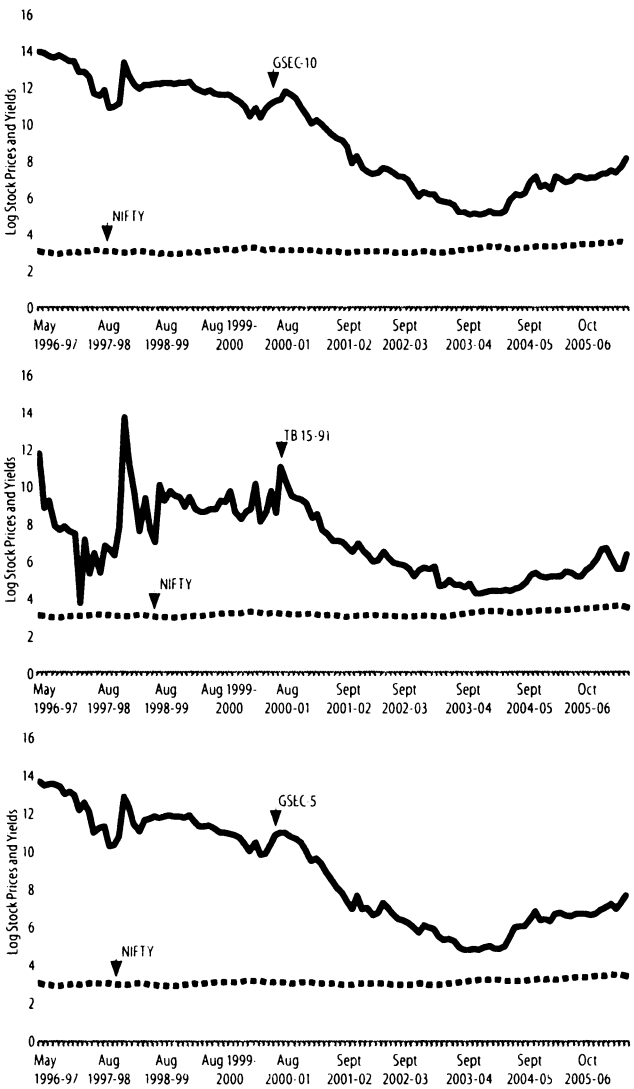
Table 1: Correlation Coefficients

Stock Prices and Yields			Turnovers (Rs crore)		
Stock Prices → / Yields ↓	SENSEX	NIFTY	Govt Security/Call Money Markets ↓ / Stock Markets →	BSE	NSE
GSEC-10	-0.4075	-0.4847	GOIDS	-0.2430	-0.0616
GSEC-5	-0.4115	-0.4773	TB-91	-0.1269	0.1442
TB 15-91	-0.3232	-0.3681	CALL	-0.0593	-0.4362

Bohl et al (2003) investigate the relationship between stock returns and short-term interest rates using the data from Germany over the period 1985-98. They find a positive but statistically insignificant relationship between German stock returns and short-term interest rates at both daily and monthly frequencies.

The direction of causality is another important issue in the interest rates and stock prices relationship. The causality may run from stock prices to interest rates. Rigobon and Sack (2003) attempt to decompose daily and weekly movements in interest rates and stock prices into the endogenous responses to different types of shocks over the period from March 1985 to December 1999. By relying on heteroscedasticity to identify the system of equations, they effectively measure the reaction of the short-term interest rate to the stock market, even when the stock market is endogenously reacting to the interest rate at the same time. They find that stock market movements have a significant impact on short-term interest rates, driving them in the same direction as the change in stock prices. Wong et al (2005) examine the long-run equilibrium relationships between the major stock indices of Singapore and the US and selected macroeconomic variables for the period January 1982 to December 2002. The results of various cointegration tests suggest that Singapore's stock prices generally display a long-run equilibrium relationship with interest rate and money supply but the same type of relationship does not hold for the US. From the Granger causality test, they find a consistent influence of the stock market on the interest rate of Singapore but no causal nexus between stock price and interest rate is found for the US.

Figure 2: Movements in Monthly NSE S&P CNX Nifty Stock Prices and Yields on 10-Year Government Security, 5-Year Government Security, and 15-91 Days Treasury Bill



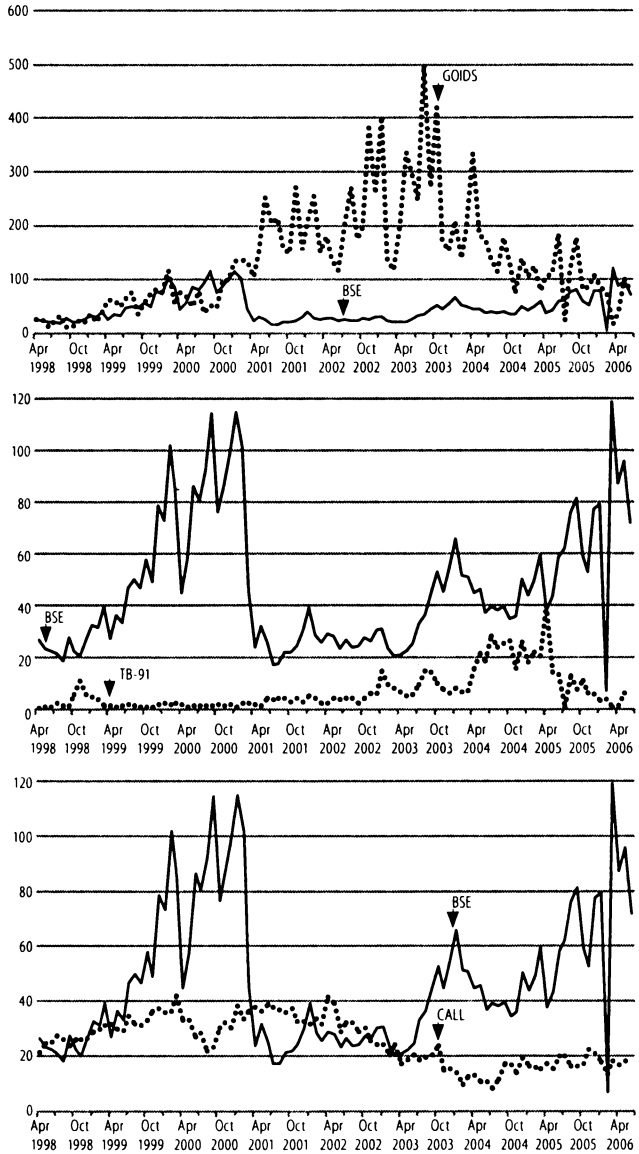
Sources: National Stock Exchange of India Limited, Mumbai (NSE) and *Handbook of Statistics on Indian Economy* and *RBI Bulletin*, Reserve Bank of India (various issues).

On the contrary, the direction of causality from interest rates towards stock prices is documented in several literatures. For example, Darrat and Dickens (1999) examine the interrelationship among real, monetary, and financial variables in the US. The major finding of their study suggests that interest rates lead stock returns. Habibullah et al (2000) examine the lead lag relationship between stock prices and five macroeconomic variables, namely, interest rate, price level, national income, money supply, and real effective exchange rate in Malaysia. By employing the Toda-Yamamoto long-run Granger causality test, they find that interest rates lead stock prices. The causality from interest rates towards stock prices is also found by Wu (2001). He uses the monthly distributed-lag model to examine the impact of macroeconomic variables such as money supply, interest rates and the government fiscal stance on the straits times industrial index (STII). In the study, it is found that interest rate plays a significant role in determining the STII on the monthly investment horizon.

The long-term interest rates are more crucial than short-term interest rates in explaining changes in the stock markets which is found in a study by Zhou (1996). He uses term structure of interest rates to explain the variations of stock prices and stock returns by taking monthly data for the period 1952 to 1990. The results suggest that short-term interest rates contain very little information on the movements of the stock market. The long-term interest rates are found to play important roles in stock market fluctuations. Similarly, Durre and Giot (2005) examine the possible long-run relationship between earnings, stock prices and interest rates proxied by long-term government bond yields by using cointegration analysis for 13 countries and over a time span ranging from January 1973 to December 2003. Their empirical results show that the long-term government bond yield is not statistically significant in the long-run relationship. However, they find an important short-term impact of long-term government bond yield on the stock market.

The above survey of different studies conveys that the relationship and the causal direction between interest rates and stock prices are mixed and controversial. Nevertheless, two important issues, which emerge from the previous discussion are addressed in this paper in the Indian context. First, the nature of relationship i e, whether interest rates and stock prices are positively or negatively related. Second, the causal direction i e, whether interest rates affect stock prices or the later affects the former. The studies on these issues in the Indian context are either very limited or out of my attention. The objective of this paper is to try to fill in the gap by studying the relationship and the causality between interest rates and stock prices in India.

Figure 3: Movements in Monthly Turnovers of BSE, Government of India Dated Securities, Treasury Bill 91 Day, and Call Money
(Turnover in Rs '000 crore)

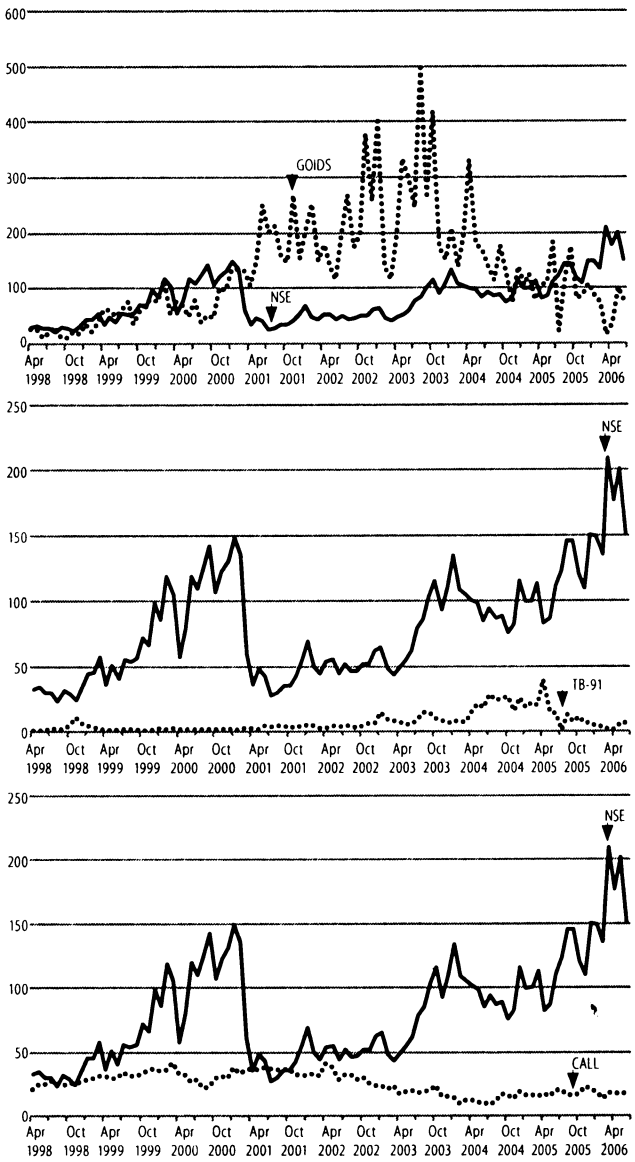


Sources: Stock Exchange, Mumbai (BSE), Reserve Bank of India, *Handbook of Statistics on Indian Economy* and *RBI Bulletin* (various issues).

2 Interest Rates and Stock Markets in India

In this section, a preliminary analysis of the relationship between interest rates and stock markets in India is made by using various facts and figures collected from the Bombay Stock Exchange (BSE), National Stock Exchange of India (NSE), and Reserve Bank of India (RBI). Figures 1 and 2 (pp 108, 109) show movements in stock prices and various interest rates during May 1996-June 2006. The comovements of the BSE sensitive index (SENSEX) with yields on 10-year government security (GSEC-10), 5-year government security (GSEC-5) and 15-91 days treasury bill (TB 15-91) are shown in Figure 1. In the figure, the SENSEX is showing a rising trend over the period. On the other hand, yields on GSEC-10, GSEC-5, and TB 15-91 are generally exhibiting falling trends for the same period barring the period April 2004-June 2006 when the yields firmed up. The declining trend of yields on government securities is primarily contributed to ample liquidity and expectations of interest rates cuts over the period. The firming up of yields from April 2004 is because of the upturn in the international interest rate cycle, rise in international crude oil prices, domestic monetary policy tightening and edging up of inflation. The SENSEX rose from a low level of 3,732 points in May 1996 to reach a peak level of 11,741 points in April 2006. On the other hand, yields on GSEC-10, GSEC-5 and TB 15-91 fell from higher levels of 13.93 per cent, 13.66 per cent, and 11.75 per cent, respectively to lower levels of 7.39 per cent, 6.96 per cent and 5.51 per cent, respectively for the corresponding period. From this it may be concluded that the comovement between SENSEX and yields on GSEC-10, GSEC-5, and TB 15-91 is negative. The negative comovement between SENSEX and yields on various government securities can be gauged from their negative correlation coefficients which are given in Table 1 (p 108). These correlation

Figure 4: Movements in Monthly Turnovers of NSE, Government of India Dated Securities, Treasury Bill 91 Day, and Call Money
(Turnover in Rs '000 crore)

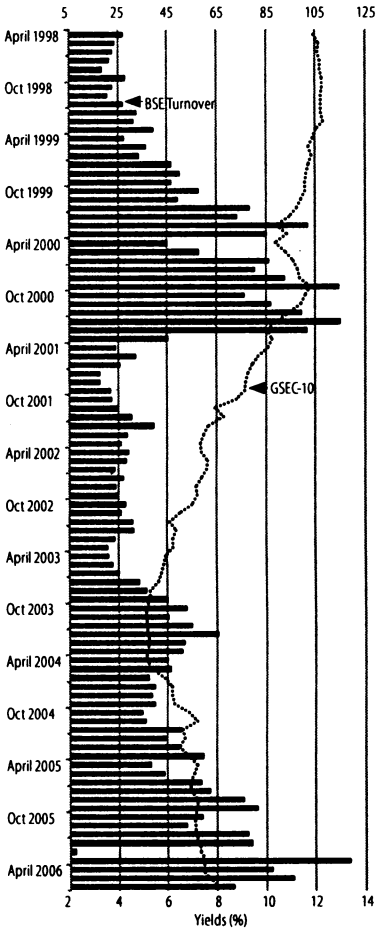


Sources: National Stock Exchange of India Limited, Mumbai (NSE) and *Handbook of Statistics on Indian Economy* and *RBI Bulletin*, Reserve Bank of India (various issues).

coefficients are calculated over the period May 1996-June 2006. The correlation coefficient between SENSEX and GSEC-10 is found to be -0.4075. Similarly, correlation coefficients of SENSEX with GSEC-5 and TB 15-91 are -0.4115 and -0.3232 respectively.

The comovements of NSE S&P CNX Nifty (NIFTY) with yields on GSEC-10, GSEC-5 and TB 15-91 are shown in Figure 2. We observe a negative comovement of NIFTY with yields on various government securities. The correlation coefficients of NIFTY with yields on GSEC-10, GSEC-5 and TB 15-91 are negative, which are equal to -0.4847, -0.4773 and -0.3681, respectively (Table 1). It is also observed in Table 1 that the NIFTY is more negatively correlated with yields on GSEC-10, GSEC-5 and TB 15-91 than the SENSEX.

Figure 5: Monthly Movements in BSE Turnover and Yield on 10-Year Government Security
(Turnover in Rs '000 crore)



Sources: Stock Exchange, Mumbai (BSE), Reserve Bank of India, *Handbook of Statistics on Indian Economy* and *RBI Bulletin* (various issues).

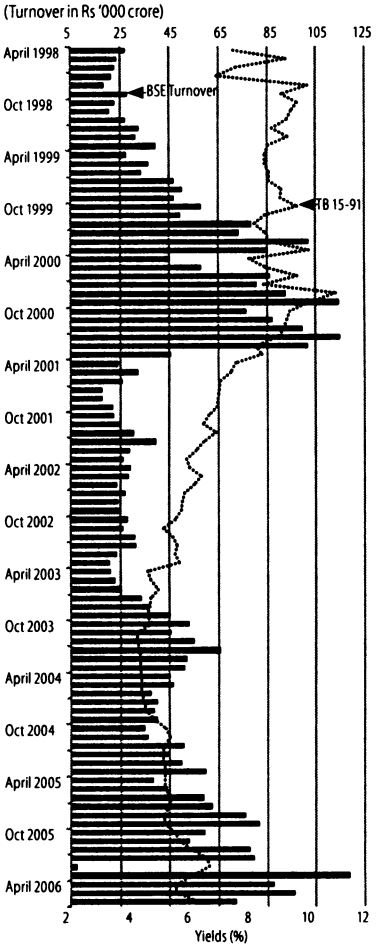
Figures 3 and 4 (p 110) show movements in monthly turnovers in stock markets, government securities and call money market. The comovements of turnover of the BSE with government of India dated securities (GOIDS), treasury bill 91 day (TB-91) and call money (CALL) for the period April 1998-June 2006 are shown in Figure 3. In the figure, the comovement between turnovers of BSE and GOIDS is seen to be negative. For example, turnover of GOIDS, amidst volatility, rose to a high level of Rs 4,98,818 crore in August 2003 from a low level of Rs 38,347 crore in August 2000. However, during the same period, turnover of BSE fell from a higher level of Rs 92,562 crore to reach Rs 36,334 crore. During the rest of the period, turnover of GOIDS showed a declining trend while BSE turnover exhibited a rising trend. However, turnover of BSE in February 2006 was reported to be the lowest in the whole period which was equal to Rs 7,070 crore.

Similarly, Figure 3 exhibits negative comovements between turnover of BSE and turnovers of TB-91 and CALL during April 1998-June 2006. The negative comovements of BSE turnover with turnovers of GOIDS, TB-91, and CALL can also be seen from their correlations given in Table 1. The correlation between turnover of BSE and turnover of GOIDS is found to be negative i e, -0.2430. Similarly, turnovers of TB-91 and CALL are found to be negatively correlated with turnover of BSE for which correlation coefficients are equal to -0.1269 and -0.0593, respectively.

Figure 4 displays comovements of NSE turnover with turnovers in GOIDS, TB-91 and CALL during April 1998-June 2006. The figure reveals that there is a negative comovement between the turnover of NSE and turnover in GOIDS. For example, turnover of NSE fell from Rs 1,25,347 crore to Rs 85,346 crore during August 2000-August 2003. For the same period, however, turnover in GOIDS increased from Rs 38,347 crore to Rs 4,98,818 crore. For the rest of the period, turnover of NSE exhibited a rising trend in contrast to a falling trend observed in turnover of GOIDS. Similarly, turnover in CALL showed a general declining trend opposed to a rising trend in turnover of NSE for the entire period. The negative comovements are further justified on the basis of their negative correlations given in Table 1. The only exception is the comovement between turnover in NSE and turnover in TB-91 which is found to be positive (Figure 4). The correlation coefficient between NSE turnover and turnover in TB-91 is positive, which is equal to 0.1442 (Table 1).

The comovements of the turnover of BSE with yields on GSEC-10 and TB 15-91 are respectively shown in Figures 5 and 6 for the period April 1998-June 2006. It is observed in both figures that the turnover of BSE varies positively with yields on GSEC-10 and TB 15-91. In other words, the BSE seems to be active and liquid when the rates are rising but turn lacklustre and illiquid when the rates fall. The estimated correlation coefficient between the turnover of BSE and yield on GSEC-10 is found to be 0.11, whereas it is 0.22 for the correlation between BSE turnover and yield on TB 15-91. On the other hand, the turnover of NSE is found to move inversely in general with yields on GSEC-10 and TB 15-91, which are shown in Figures 7 and 8 (p 112), respectively. The correlation coefficients of turnover of NSE with yields on GSEC-10 and TB 15-91 are found to be negative during April 1998-June 2006, which are equal to -0.29 and -0.19, respectively.

Figure 6: Monthly Movements in BSE Turnover and Yield on 15-91 Days Treasury Bill
(Turnover in Rs '000 crore)

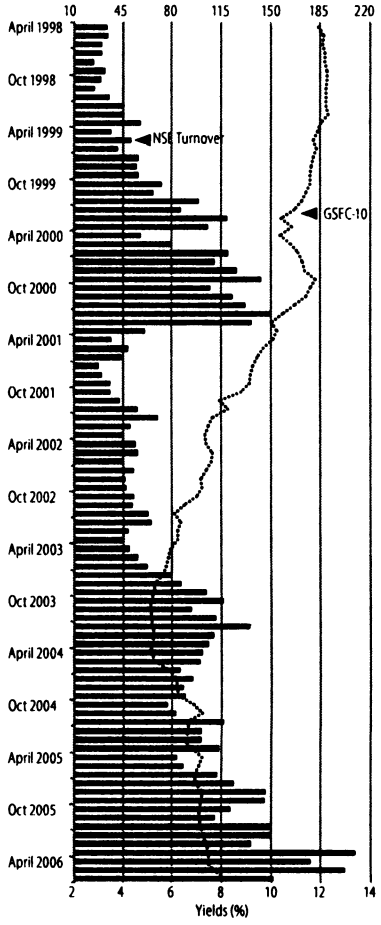


Sources: Stock Exchange, Mumbai (BSE), Reserve Bank of India, *Handbook of Statistics on Indian Economy* and *RBI Bulletin* (various issues).

The monthly movements in interest rates and stock markets price-earning (P/E) ratios are shown in Figures 9 to 12 (p 113). Figure 9 displays the negative comovement between the P/E ratio for the 30 scrips included in the BSE SENSEX and yield on GSEC-10 during May 1996-June 2006. Whenever yield on GSEC-10 has decreased, the BSE SENSEX has a higher P/E ratio. This is reflected in the negative, although low, correlation coefficient between the two which is equal to -0.01. However, on the other hand, yield on TB 15-91 shows a positive correlation with the BSE SENSEX P/E ratio during the same period, which is shown in Figure 10. The correlation coefficient between these two is positive and equal to 0.20. Figure 11 shows the positive comovement between NIFTY P/E ratio and yield on GSEC-10 during January 1999-April 2006. The correlation coefficient between these two is found to be 0.53. Similarly, in Figure 12, we see a positive comovement between P/E ratio of NIFTY and yield on TB 15-91 during January 1999-April 2006. A positive correlation coefficient, which is equal to 0.59, is observed between NIFTY P/E ratio and TB 15-91 yield.

Figure 7: Monthly Movements in NSE Turnover and Yield on 10-Year Government Security

(Turnover in Rs '000 crore)



Sources: National Stock Exchange of India Limited, Mumbai (NSE) and *Handbook of Statistics on Indian Economy* and *RBI Bulletin*, Reserve Bank of India (various issues).

3 Data and Methodology

Monthly data series for the period from April 1996 to June 2006 are used in this study. The total number of observations, which is equal to 121, is believed to constitute a large data set for any kind of time series analysis. We use the monthly averages of the BSE SENSEX and NIFTY to measure stock prices. The choice is made with the obvious belief that these two indices are the pulse of the Indian stock markets. The month-end yields on GSEC-10 is used to measure long-term interest rates while the month-end yields on TB 15-91 is taken to represent short-term interest rates. Stock prices i e, the SENSEX and NIFTY are expressed in logarithmic forms for the analysis. The same is not done for long-term and short-term interest rates. This approach is standard as transformation of interest rates which are expressed in percentages into logarithms may add complications to the interpretation. Data on stock prices are obtained from the BSE and NSE. The data of 10-year government securities and TB-15-91 are obtained from various issues of *Handbook of Statistics on the Indian Economy* and *RBI Bulletin* published by the RBI.

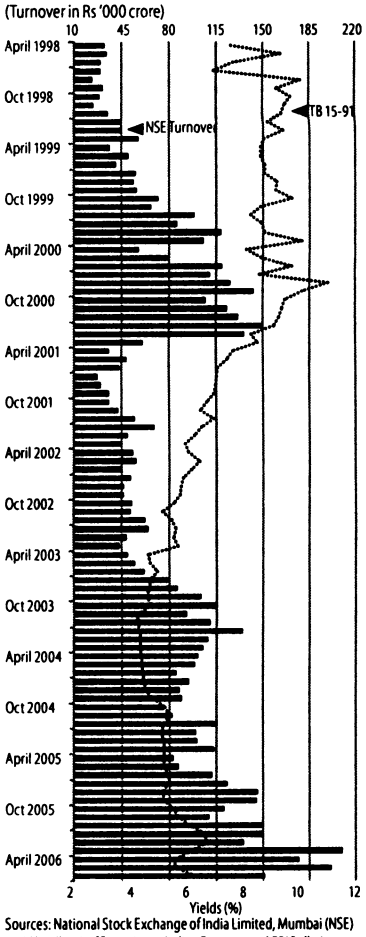
The cointegration methodology is employed to investigate the long-run relationship among stock prices, short-term interest rates and long-term interest rates. Before employing the cointegration technique, it is required to pretest the variables for their order of integration. This is because in the cointegration all the variables are required to be integrated of the same order. The augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are used in this paper to infer the order of integration in each of the variables. If all variables are stationary i e, integration of order 0, it is not necessary to employ the cointegration methodology since standard time-series methods apply to stationary variables. If the variables are found to be integrated of different orders then it can possibly be concluded that they are not cointegrated.

In the case all variables are found to be integrated of the same order, say integrated of order 1, we proceed with cointegration test in the Johansen (1988) and Johansen and Juselius (1990) framework.[1] This framework allows for the testing of more than one cointegrating vector in the data by calculating the maximum likelihood estimates on these vectors. Two test statistics such as λ_{trace} and λ_{max} are used in order to determine the number of cointegrating vectors. Johansen and Juselius (1990) provide the critical values of the λ_{trace} and λ_{max} statistics. If the test statistic is greater than the critical value at a significance level then the null hypothesis of r cointegrating vectors is rejected in favour of the alternative hypothesis.

If the variables are found to be cointegrated i e, the long-run relationship exists among variables, the vector error correction model (VECM) can be employed to establish the Granger causal direction. VECM allows the modelling of both the short-run and long-run dynamics for the variables involved in the model. Engle and Granger (1987) show that cointegration is

Figure 8: Monthly Movements in NSE Turnover and Yield on 15-91 Days Treasury Bill

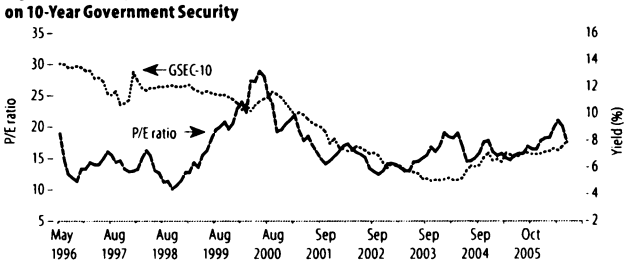
(Turnover in Rs '000 crore)



Sources: National Stock Exchange of India Limited, Mumbai (NSE) and *Handbook of Statistics on Indian Economy* and *RBI Bulletin*, Reserve Bank of India (various issues).

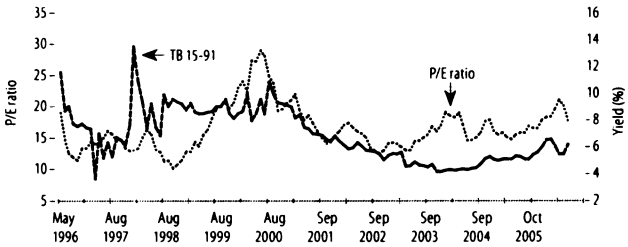
implied by the existence of a corresponding error correction representation which implies that changes in the dependent variable are a function of the level of the disequilibrium in

Figure 9: Monthly Movements in BSE Sensex Price-Earning Ratio and Yield on 10-Year Government Security



Sources: Stock Exchange, Mumbai (BSE), Reserve Bank of India, *Handbook of Statistics on Indian Economy* and *RBI Bulletin* (various issues).

Figure 10: Monthly Movements in BSE Sensex Price-Earning Ratio and Yield on 15-91 Days Treasury Bill



Sources: Stock Exchange, Mumbai (BSE), Reserve Bank of India, *Handbook of Statistics on Indian Economy* and *RBI Bulletin* (various issues)

the cointegrating relationships (captured by error correction term) and changes in other independent variables. According to Granger representation theorem, if variables are cointegrated then their relationships can be expressed as ECM. Provided that variables in our case are cointegrated of order r, the VECM can be written as:

$$\Delta LSENSEX_t = \alpha_1 + \alpha_{LSENSEX}\hat{e}_{t-1} + \sum_{i=1} \alpha_{11}(i)\,\Delta LSENSEX_{t-i} + \sum_{i=1} \alpha_{12}(i)\,\Delta LNIFTY_{t-i} + \sum_{i=1} \alpha_{13}(i)\,\Delta GSEC\text{-}10_{t-i} + \sum_{i=1} \alpha_{14}(i)\,\Delta TB15\text{-}91_{t-i} + e_{1t} \quad ...(1)$$

$$\Delta LNIFTY_t = \alpha_2 + \alpha_{LNIFTY}\hat{e}_{t-1} + \sum_{i=1} \alpha_{21}(i)\,\Delta LSENSEX_{t-i} + \sum_{i=1} \alpha_{22}(i)\,\Delta LNIFTY_{t-i} + \sum_{i=1} \alpha_{23}(i)\,\Delta GSEC\text{-}10_{t-i} + \sum_{i=1} \alpha_{24}(i)\,\Delta TB15\text{-}91_{t-i} + e_{2t} \quad ...(2)$$

$$\Delta GSEC\text{-}10_t = \alpha_3 + \alpha_{GSEC\text{-}10}\hat{e}_{t-1} + \sum_{i=1} \alpha_{31}(i)\,\Delta LSENSEX_{t-i} + \sum_{i=1} \alpha_{32}(i)\,\Delta LNIFTY_{t-i} + \sum_{i=1} \alpha_{33}(i)\,\Delta GSEC\text{-}10_{t-i} + \sum_{i=1} \alpha_{34}(i)\,\Delta TB15\text{-}91_{t-i} + e_{3t} \quad ...(3)$$

$$\Delta TB15\text{-}91_t = \alpha_4 + \alpha_{TB15\text{-}91}\hat{e}_{t-1} + \sum_{i=1} \alpha_{41}(i)\,\Delta LSENSEX_{t-i} + \sum_{i=1} \alpha_{42}(i)\,\Delta LNIFTY_{t-i} + \sum_{i=1} \alpha_{43}(i)\,\Delta GSEC\text{-}10_{t-i} + \sum_{i=1} \alpha_{44}(i)\,\Delta TB15\text{-}91_{t-i} + e_{4t} \quad ...(4)$$

where the error correction term $\hat{e}_{t-1}$ represents the previous period's deviation from long-run equilibrium. $\alpha_{LSENSEX}$, α_{LNIFTY}, $\alpha_{GSEC\text{-}10}$ and $\alpha_{TB\,15\text{-}91}$ coefficients are called the speed of adjustment. These coefficients represent the proportion by which the long-run disequilibrium in the dependent variables is corrected in each short period. e_{1t}, e_{2t}, e_{3t} and e_{4t} are white noise disturbances. The lag length i is determined by using the likelihood ratio (LR) test.

4 Empirical Results and Discussion

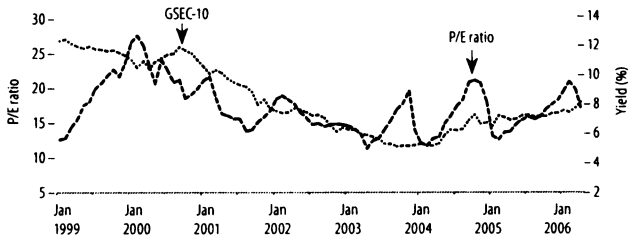
As a first step, unit root tests are conducted in order to establish the order of integration for stock prices and interest rates. The ADF and PP unit root tests are used for this purpose. Table 2 shows the results of unit root tests for four variables such as SENSEX, NIFTY, GSEC-10 and TB 15-91 in levels and first differences. All variables are found to be non-stationary (i e, presence of unit root) in levels according to the ADF test. However, they are stationary (ie, rejection of presence of unit root) on their first differences. So far as the PP test is concerned, all variables except TB 15-91 are found to contain a unit root in levels. Dua et al (2003) apply three unit root tests such as ADF, PP and Kwiatkowski, Phillips, Schmidt and Suin (KPSS) to test the presence of a unit root in TB 15-91. Except the PP, the other two tests provide the evidence of a unit root in levels of TB 15-91. On the basis of two out of three tests supporting for the

Table 2: Unit Root Test Results

Variables	Lags	ADF		PP	
		Levels	First Differences	Levels	First Differences
LSENSEX	1	-1.2903	-5.8657**	-1.3176	-10.0259**
	4	-1.2599	-4.3257**	-1.4977	-10.0798**
	8	-1.4438	-3.8790*	-1.5616	-10.0807**
LNIFTY	1	-1.7892	-6.0172**	-1.504	-8.1202**
	4	-1.476	-4.2233**	-1.6561	-8.0865**
	8	-1.5595	-3.8298*	-1.6674	-7.9987**
GSEC-10	1	-0.5017	-7.6474**	-0.5442	-10.9535**
	4	-0.7656	-3.8587*	-0.5392	-10.9555**
	8	-0.624	-3.0509	-0.6242	-10.9524**
TB 15-91	1	-2.8736	-9.5174**	-4.0486**	-15.4599**
	4	-2.3038	-5.6309**	-4.2829**	-16.5638**
	8	-2.8114	-4.3044**	-4.7139**	-17.5015**

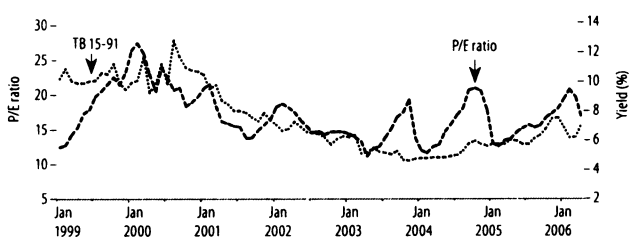
** and * indicate the rejection of hypothesis of a unit root at 1 per cent and 5 per cent levels respectively.
The MacKinnon critical values for rejection of the hypothesis of a unit root for ADF at 1 per cent and 5 per cent levels are -4.0429 and -3.4504, respectively; and for PP at 1 per cent and 5 per cent levels are -4.0400 and -3.4491, respectively. The test regressions for ADF and PP include a constant and linear trend. L indicates the logarithmic form of the variable.

Figure 11: Monthly Movements in NSE S&P CNX Nifty Price-Earning Ratio and Yield on 10-Year Government Security



Sources: National Stock Exchange of India Limited, Mumbai (NSE) and *Handbook of Statistics on Indian Economy* and *RBI Bulletin*, Reserve Bank of India (various issues).

Figure 12: Monthly Movements in NSE S&P CNX Nifty Price-Earning Ratio and Yield on 15-91 Days Treasury Bill



Sources: National Stock Exchange of India Limited, Mumbai (NSE) and *Handbook of Statistics on Indian Economy* and *RBI Bulletin*, Reserve Bank of India (various issues).

non-stationarity of TB 15-91, they conclude that TB 15-91 is non-stationary in levels. Following this finding, we consider TB 15-91 to be non-stationary in levels. Meanwhile, the null hypothesis of a unit root is strongly rejected for all variables on first differences according to the PP test. To summarise the results of the ADF and PP tests, it can be said that all variables are found to be integrated of order one ie, I(1).

Next, the Johansen cointegration test is applied to check the cointegration between stock prices and interest rates. The number of lags in the model is optimally chosen as seven by the LR test. The results of Johansen's cointegration test are presented in Table 3. The results indicate that there exists at lest one cointegrating relationship between SENSEX, NIFTY, GSEC-10 and TB 15-91. This is because the calculated values of λ_{trace} and λ_{max} test statistics exceed the 5 per cent critical values for testing the null hypothesis of a zero cointegrating vector. Therefore, the null hypothesis is rejected in favour of the alternative hypothesis of at least one cointegrating vector.

Table 3: Johansen Tests for Cointegrating Relationships

Null	Alternative	Test Statistics	5% Critical Values	1% Critical Values
		λ_{trace} Test		
r = 0	r > 0	69.97*	62.99	70.05
r ≤ 1	r > 1	36.77	42.44	48.45
r ≤ 2	r > 2	18.70	25.32	30.45
r ≤ 3	r > 3	6.78	12.25	16.26
		λ_{max} Test		
r = 0	r = 1	33.19*	31.46	36.65
r = 1	r = 2	18.07	25.54	30.34
r = 2	r = 3	11.92	18.96	23.65
r = 3	r = 4	6.78	12.25	16.26

r indicates the number of cointegrating relationships. * indicates rejection of the null hypothesis of no cointegration at the 5 per cent critical level.

The presence of at least one cointegrating vector indicates that there exists a long-run relationship between SENSEX, NIFTY, GSEC-10 and TB 15-91. Hence, the vector error correction model can be established. The results of the vector error correction model are shown in Table 4. The results show that the error correction term is significant in equations 1 and 2. In other words, the lagged error correction is statistically significant in the SENSEX and NIFTY equation. However, the error correction term is insignificant in the GSEC-10 and TB 15-91 equation. These results imply that the SENSEX and NIFTY change in response to stochastic shocks (represented by e_{1t} and e_{2t} in equations 1 and 2, respectively) and to the previous period's deviation from long-run equilibrium. The sizes of error correction coefficients of the SENSEX and NIFTY are equal to -0.6032 and -0.2964, respectively. This finding suggests that the SENSEX and NIFTY fall to correct the long-run disequilibrium. The SENSEX corrects 60.32 per cent and NIFTY corrects 29.64 per cent every month so as to attain the long-run equilibrium.

The significant error correction term in the case of the SENSEX and NIFTY and insignificant error correction term in the case of the GSEC-10 and TB 15-91 have another important implication. This result conveys that interest rates such as GSEC-10 and TB 15-91 do exert independent influences on stock prices ie, the SENSEX and NIFTY. In other words, this implies a unidirectional long-run causality from interest rates towards stock prices. In addition to the long-run causality, the short-run causality is also observed from interest rates to stock prices. This is because the five-period lagged difference of GSEC-10 is significant in explaining changes in the SENSEX and NIFTY. The significant negative coefficients of the five-period lagged difference of GSEC-10 with respect to the SENSEX and NIFTY, which are equal to -0.0360 and -0.0277, respectively imply that long-term interest rates affect stock prices negatively in the short-run. However, the change in GSEC-10 is shown in the table to be affected by the six-period lagged difference of the NIFTY. From this, it may be concluded that there is short-run bidirectional causality between GSEC-10 and NIFTY.

As far as the short run causality between short-term interest rates and stock prices is concerned, Table 4 shows a unidirectional causality from TB 15-91 towards the SENSEX and NIFTY. For example, the three-period, four-period and five-period lagged differences of TB 15-91 are found to be significant in explaining changes in the SENSEX. The significant coefficients of TB 15-91 are positive, which, in turn, implies that short-term interest rates affect the SENSEX positively. Similarly, the three-period lagged difference of TB 15-91 is significant and affects the NIFTY positively. From this, it may be surmised that short-term interest rates affect stock prices positively in the short-run.

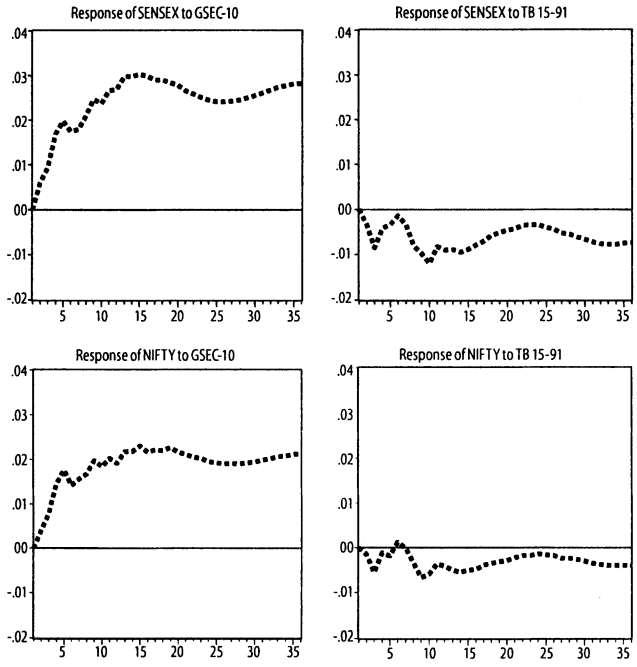
The above findings suggest that both long-term and short-term interest rates affect stock prices. The long-term interest rates affect stock prices negatively whereas short-term interest rates are found to affect them positively. Intuitively a negative effect of interest rates is expected due to the direct effect of on the discount rate. The long-term interest rates directly reflect the discount rate and hence should have a negative

Table 4: Parameter Estimates of Vector Error Correction Model

Independent Variable	Dependent Variable			
	ΔLSENSEX	ΔLNIFTY	ΔGSEC-10	ΔTB 15-91
Constant	-0.0023 [-0.6607]	0.0005 [0.1611]	-0.0376 [-0.8448]	-0.0777 [-0.6444]
$\hat{e}_{t-1}$	-0.6032** [-4.4459]	-0.2964** [-2.9281]	1.4186 [0.8187]	-2.8025 [-0.5968]
ΔLSENSEX(-1)	0.0794 [0.4672]	0.2185 [1.3694]	-1.8245 [-0.8400]	-0.8305 [-0.1411]
ΔLSENSEX(-2)	0.2792 [1.6630]	0.0491 [0.3120]	-1.3976 [-0.6518]	-0.6749 [-0.1161]
ΔLSENSEX(-3)	0.2638 [1.5378]	0.1277 [0.7932]	-1.2341 [-0.5632]	-2.5071 [-0.4222]
ΔLSENSEX(-4)	0.3550* [2.0592]	-0.0007 [-0.0479]	-0.4866 [-0.2209]	1.5020 [0.2516]
ΔLSENSEX(-5)	0.4342** [2.4562]	0.3360* [2.0258]	-0.9397 [-0.4162]	1.8215 [0.2977]
ΔLSENSEX(-6)	0.4896** [2.7097]	0.4977** [2.9356]	-3.4863 [-1.5106]	2.6972 [0.4312]
ΔLSENSEX(-7)	0.3110 [1.7642]	0.1751 [1.0587]	2.2621 [1.0046]	7.3674 [1.2073]
ΔLNIFTY(-1)	0.1379 [0.7003]	0.1187 [0.6426]	0.1072 [0.0426]	-1.6534 [-0.2425]
ΔLNIFTY(-2)	0.1044 [0.5615]	0.1172 [0.6717]	0.3358 [0.1413]	3.0635 [0.4759]
ΔLNIFTY(-3)	-0.2266 [-1.2327]	-0.1577 [-0.9143]	2.2856 [0.9735]	-3.4846 [-0.5476]
ΔLNIFTY(-4)	-0.3920* [-2.1079]	-0.0135 [-0.0777]	-0.1960 [-0.0825]	-4.6127 [-0.7167]
ΔLNIFTY(-5)	-0.4208* [-2.1751]	-0.2946 [-1.6231]	1.2228 [0.4949]	2.1918 [0.3273]
ΔLNIFTY(-6)	-0.2739 [-1.3844]	-0.2665 [-1.4356]	5.8095* [2.2993]	3.7726 [0.5509]
ΔLNIFTY(-7)	-0.2160 [-1.1465]	-0.3235 [-1.8296]	-0.8278 [-0.3440]	-1.5066 [-0.2310]
ΔGSEC-10(-1)	0.0026 [0.2260]	0.0041 [0.3840]	0.0696 [0.4701]	0.4240 [1.0558]
ΔGSEC-10(-2)	0.0061 [0.5558]	0.0068 [0.6581]	0.0885 [0.6294]	0.1710 [0.4485]
ΔGSEC-10(-3)	-0.0060 [-0.5528]	-0.0028 [-0.2769]	-0.1596 [-1.1339]	-1.0195**[-2.6728]
ΔGSEC-10(-4)	-0.0131 [-1.1840]	-0.0012 [-0.1228]	0.2389 [1.6800]	0.0217 [0.0564]
ΔGSEC-10(-5)	-0.0360** [-3.2235]	-0.0277** [-2.6443]	0.2175 [1.5233]	0.2534 [0.6548]
ΔGSEC-10(-6)	-0.0068 [-0.5831]	0.0056 [0.5135]	-0.1641 [-1.0889]	-0.6826 [-1.6708]
ΔGSEC-10(-7)	0.0092 [0.8302]	-0.0015 [-0.1533]	-0.0242 [-0.1705]	0.0877 [0.2281]
ΔTB 15-91(-1)	0.0048 [1.1091]	0.0025 [0.6247]	-0.0295 [-0.5333]	-0.5184** [-3.4486]
ΔTB 15-91(-2)	-0.0014 [-0.3020]	-0.0016 [-0.3698]	-0.0452 [-0.7550]	-0.2091 [-1.2886]
ΔTB 15-91(-3)	0.0092** [2.7107]	0.0085* [1.9772]	0.0331 [0.5636]	-0.0244 [-0.1531]
ΔTB 15-91(-4)	0.0093** [2.8295]	0.0032 [0.7556]	0.0334[0.5706]	0.0900 [0.5674]
ΔTB 15-91(-5)	0.0083* [2.1484]	0.0050 [1.2513]	-0.0638 [-1.1728]	-0.1507 [-1.0216]
ΔTB 15-91(-6)	0.0048 [1.1612]	0.0024 [0.6186]	0.0688 [1.2791]	0.0325 [0.2227]
ΔTB 15-91(-7)	-0.0041 [-1.1211]	-0.0024 [-0.7162]	0.0318 [0.6789]	0.1976 [1.5561]

The numbers in parentheses denote lags of variables and the numbers in [ ] are t-ratios.
** and * imply significance at 1 per cent and 5 per cent levels, respectively.
L denotes the logarithmic of the variable and Δ indicates the first difference of the variable.

Figure 13: Responses of SENSEX and NIFTY to Cholesky One SD Innovations in GSEC-10 and TB 15-91



coefficient. On the other hand, short-term interest rates are used by central banks as a growth stimulus. Thus, falling short-term interest rates could be the result of a central bank's response to an economic downturn and rising short-term interest rates might be in response to an economic upturn. Therefore, the positive effects of short-term interest rates on stock prices can be explained by counter-cyclical central bank responses to economic fluctuations.

In addition to these findings, the SENSEX shows a considerably larger reaction than the NIFTY to changes in GSEC-10 and TB 15-91. This is evidently clear from impulse responses of the SENSEX and the NIFTY to Cholesky one standard deviations innovations in GSEC-10 and TB 15-91, which are shown in Figure 13. In the figure, the responses of the SENSEX are larger than the NIFTY to shocks in GSEC-10 and TB 15-91. This is perhaps because the SENSEX may include those securities whose cash flows are farther in the future making the share price more sensitive to the discount factor while the NIFTY may include companies that have current rather than back-loaded cash streams.

5 Conclusions

This paper addresses an important question of whether interest rates matter for stock markets by studying the nature of relationship and the direction of causality between interest rates and stock prices in India for the period from April 1996 to June 2006. The monthly averages of the BSE SENSEX and NIFTY are used to measure stock prices. The month-end yields on 10-year government security and TB-15-91 are used to proxy for long-term and short-term interest rates, respectively. By using the Johansen cointegration technique and the vector error correction model, the study has following major findings. There is a long-run relationship between interest rates and stock prices. A unidirectional long-run causality is found from interest rates towards stock prices. The short-run causality is found from long-term interest rates to stock prices. However, the short-run causality between long-term interest rates and NSE NIFTY is found to be bidirectional. So far as the short-run causality between short-term interest rates and stock prices is concerned, we find a unidirectional causality running from the former to the latter. In the short-run, long-term interest rates negatively affect stock prices whereas short-term interest rates are found to affect stock prices positively. In addition, the BSE SENSEX is found to be more responsive to changes in interest rates than the NSE NIFTY.

The findings in this paper correspond to a certain period, methodology employed and variables chosen. The findings may change if these change. Therefore, the generalisation of the findings in this paper can be done with certain caveats. Nevertheless, it is believed that these findings may help the monetary policymakers to change interest rates as a part of monetary policy by understanding their effects on stock prices. The investors or traders might take these findings of interest rates effects on stock prices into consideration while investing in the stock market. Finally, the findings in this paper may be intriguing for academicians and provoke further researches in this area.

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