Modeling an Extended Taylor Type Equation in Indian Environment

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Abstract

The objective of the paper is to examine applicability of Taylor type rule in current Indian economic environment. India has gradually slackened its control on several macroeconomic variables and allowed influence of market forces in many areas. In this scenario, we tried to examine an extended Taylor type equation involving interest rates, output gap, inflation gap, foreign exchanges rate, stock index and foreign investments in capital markets. We found a cointegrating relationship among these variables and delineated a vector error correction model following Johansen's method. It was also confirmed that inclusion of additional variables improved performance of the model.

Keywords: Inflation, Interest rate, Monetary policy, Taylor rule, Cointegration

1. Introduction

In conducting research on monetary policy rules, it is generally presupposed that central banks should have a goal, or target, for the rate of inflation. The target may be explicit as in Canada, New Zealand, Sweden, and the U.K. or implicit as in the United States or Germany; the target may be a range of inflation rates or an average inflation rate over a period of time (Taylor 1999). However, the preliminaries of the Reserve Bank of India (RBI) Act 1934 described mandated task of the central bank is to regulate the issue of Bank Notes and keeping of reserves with a view to securing monetary stability in India and generally to operate the currency and credit system of the country to its advantage.

In practice, RBI is responsible to achieve a number of simultaneous objectives namely, price stability, currency stability, financial stability, growth in employment and income, etc. (Reddy 2002).

One of the advantages of India is that the political system can not accept high inflation and this is the area where politicians have been ahead of the bureaucrats. Further absence of a clear relationship between inflation and GDP growth, parliament is right in demanding low inflation and high GDP growth. In comparison to other developing countries, India has been able to maintain a moderate level of inflation. Historically, inflation rates in India were well controlled to around 5% level and seldom allowed to increase to double digit. Whenever inflation exceeded, the single focus of the government became controlling inflation.

A common strategy is to identify the commodities that cause inflation, and the government start taking ad hoc measures like: banning exports, giving out import licenses, banning futures trading, sending the police to unearth hoarding, etc. This creates deep distortion in the economy. Milk exports were banned, and milk prices fell. But why should milk farmers pay for a macroeconomic problem of inflation? The cost of bringing down inflation needs to be dispersed all across the economy (Shah 2007).

Many economists have suggested that the Reserve Bank of India (RBI) should also adopt an inflation targeting arrangement. The Committee on Financial Sector Reforms has recommended that the RBI should formally have a single objective, to stay close to a low inflation number, or within a range. RBI should move steadily to a single instrument, the short term interest rate (repo and reverse repo) to achieve the target. However the report created a great deal of debate as RBI does not appear to have a clear monetary policy framework to control inflation (Cavoli and Rajan, 2008).

In the paper, we tried to formulate a relationship among inflation and other economic variables following a Taylor type rule, so that, effect on inflation resulting out of changes in other variables are better understood.

2. Taylor Rule and its Variations

Taylor (1993) formulated a simple equation for estimating the behavior of the Federal Reserve of US involving the current output gap and the current rate of inflation. The following equation was proposed:

$$r_t = 2\% + 0.5(y_t - y_t^*) + 0.5(p_t - 2\%) \qquad \text{Equation-I}$$

where, r_t is the targeted federal funds rate, $y_t - y_t^*$ is a measure of output gap and p_t is current rate of inflation.

The rule linearly maps inflation gap (the difference between current inflation and targeted inflation) and output gap (the difference between actual output and targeted output) with targeted interest rate. The Taylor's equation presents a simple relationship, yet it is found to be a very powerful rule in analyzing monetary policy. This rule is sometimes described as backward-looking Taylor-rule as both inflation and output gap measures are taken from past data. This situation is interpreted as a reactive stance of governments' decision making process to control the current level of inflation.

Effort of monetary authority is also directed to control future level of inflation and future growth rates in pursuance of its objectives. A forward-looking Taylor rule aims to achieve targeted inflation and targeted growth rates by adjusting policy instruments that affect market interest rates. Clarida, Gali and Gertler (1998), showed that a forward looking Taylor type rule that explains the monetary policy of a number of major economies very closely. The study suggested that the relatively greater economic stability in the US after 1979 era can broadly be attributed to the proactive stance taken by the Fed and the policy can be explained using a forward-type Taylor rule. In particular, Clarida, Gali and Gertler (1998) proposed the following equation for the forward looking Taylor type rule to explain short term interest rate target of the Fed.

$$r_t^* = r^* + \beta\left[E\left(\pi_{t+k} \middle| \Omega_t\right) - \pi^*\right] + \gamma\left[E\left(x_{t+k} \middle| \Omega_t\right)\right] \qquad \text{Equation-II}$$

where r_t^* = targeted short term interest rate, r^* = desired nominal interest rate when both inflation and output levels are at their respective target values, *E*(*) denote expectation operator, x_{t+k} is the average output gap between period *t* and *t+k*, p_{t+k} is the inflation between periods *t*, and *t+k*, W_t is the information up to time *t* and p^* is the target inflation rate.

The equation suggests that the level of the short term interest rate can be adjusted to achieve the future expectation of inflation and output gap.

While r_t^* is the target for nominal short term rate, central banks may like to introduce some king of smoothing in effecting interest rate changes to avoid sudden shocks and to minimize volatility in financial markets. The smoothing action was modeled by Chadha, Sarno and Valente (2004) assuming that the current short-term interest rate r_t adjusts to the target rate r_t^* according to a partial adjustment mechanism as follows.

$$r_t = [1 - r(1)]r_t^* + r(L)r_t - 1 + u_t \qquad \text{Equation-III}$$

where $r(L)$ is a lag polynomial, *L* is the lag operator, and u_t is a zero-mean exogenous interest rate shock.

Incorporation of above smoothing in Taylor type equation results in an interest rate rule where central banks change short-term interest rate in a gradual manner to reduce the gap between the current target rate and its past value. The following transformation of Taylor type takes into account the effect of interest rate smoothing.

$$r_t = a + l\,p_{t+k} + ux_{t+k} + r(L)r_{t-1} + e_t \qquad \text{Equation-IV}$$

Apart from equating inflation gap and output gap in interest rate modeling, it was felt necessary to include other economic variables that are likely influence interest rate. Ball (1999) found that adding the exchange rate to the benchmark policy rule could improve macroeconomic performance in a small open economy model. The exchange rate was included to the policy rule in two ways in Ball's analysis: First the central bank uses a monetary conditions index in place of the interest rate as its instrument. Second, the lagged exchange rate is added as a variable to the policy rule. The net effect of these two changes is to add the current and lagged exchange rate to the right hand side of the policy rule. Ball found that, for the same amount of inflation variability, output variability could be reduced by 17 percent by adding the exchange rate to the policy rule in this way.

Chadha, Sarno and Valente (2004) examined whether both asset prices and exchange rates may be admitted into a standard Taylor type rule, using data for the United States, the United Kingdom, and Japan since 1979. The asset prices and exchange rates were used as additional information variables to standard Taylor-type rule. Their analysis suggests that monetary policymakers may use asset prices and exchange rates not only as part of their information set for setting interest rates, but also to set interest rates to offset deviations of asset prices or exchange rates from their equilibrium levels. The baseline equation used by Chadha et al. is given below.

$$r_t = a + l\,p_{t+k} + ux_{t+k} + ce_{t-1} + ks_{t-1} + r(L)r_{t-1} + e_t \qquad \text{Equation-V}$$

where e_{t-1} and s_{t-1} denote lagged values of real exchange rate and stock price.

Virmani (2004) formulated a monetary policy reaction function for India by modeling backward and forward looking Taylor and McCallum rules after the balance of payment crisis period in India. They found that backward-looking McCallum rule tracks the evolution of monetary base over the sample period reasonably well, suggesting that RBI acts as if it is targeting nominal income when conducting monetary policy.

Cavoli and Rajan (2008), observed that there is some – albeit weak –evidence that the RBI may actually be following a monetary policy rule inadvertently but it is not being done in an intentional or strategic manner as interest rates do not seem to respond to simple measures of inflation forecasts. They estimated a Taylor type monetary rule for India by adding deviations of the nominal exchange rate from a long run value.

Inoue and Hamori (2009) also formed a Taylor type rule for India including exchange rate and concluded that short term interest rate has not been effective in controlling the inflation rate.

3. Applicability of Taylor Type Rules for India

Taylor commented in his paper that even though his rule was targeted for the US, the same can also be extended to other developed economies as well. Several studies found application of the rule in Japan and other European countries. It was observed that policy makers often work on some explicitly or implicitly defined inflation target and tries to achieve the same by adjusting interest rate. However, Taylor rule is not expected to work where interest rates are administered and accordingly the rule can only be tested after controls on interest rates were relaxed in India.

3.1 Recent Changes of Monetary Policy in India

Prior to reforms process, the Indian economy was practically a closed one and prices of a number of commodities were administered. The stability of prices was maintained by granting generous subsidies. Financing of these subsidies were responsible for chronic budget deficit, which were often met either issuing ad hoc treasury bills or borrowing from nationalized banks. Issue of credit to the government of India was the dominant reason for expansion of money supply necessitating RBI to increase the cash reserve ratio (CRR) from time to time. This process was facilitated by administering interest rates at an artificially low level. The entire structure of interest rates was complicated and tightly controlled by regulators leaving little scope to market to influence the rates. Similar to control in interest rates, foreign exchange rates were also regulated and movements of foreign exchange in and out of India were restricted (Bhattacharya 2006).

One of the first important financial reforms initiated in India after the balance of payments crisis in 1990-91 was to change to a market-determined exchange rate system and to introduce current account convertibility in a phased manner. After stabilization of the balance of payments crisis, the liberalization of interest rates in India gathered momentum. Measures were adapted to effect changes in the short-term official interest rates so that it percolates towards the longer term structure, facilitating their emergence as effective policy instruments.

Except for a few specified deposits, interest rate restrictions of other securities have been withdrawn and banks have been given full operational freedom to determine both deposit and lending rates. Some of the measures taken to liberate interest rates under economic reforms initiative are given below.

- By reducing the number of slabs in interest rate structure, deposit rates and interest stipulations were simplified (1991-92)
- Maturity-wise deposit rates were changed by a single ceiling rate of 13 per cent on all deposits above 46 days (1992-92)
- Banks were permitted to decide their prime lending rate (PLR) for loans and advances of more than Rs. 2 lakhs (1994-95).
- Banks were allowed to fix their own interest rates for domestic and Non-Resident Indian (NRI) deposits with maturity of over two years (1995-96).
- Banks were allowed to determine interest rates on term deposits of 30 days and above. The structure of lending rates was deregulated and banks could offer fixed or floating PLR on loans of all maturities. (1995-96)
- Banks were given freedom to offer differential rate of interest based on size of deposits (1998-99)

The Cash reserve Ratio (CRR), which was the primary instrument of monetary policy, has been brought down from 15.0 per cent in March 1991 to only 5% now. Statutory Liquidity Ratio (SLR) has also been brought down from 38.5 per cent to its statutory minimum of 25.0 per cent by October 1997 (Reddy 2002).

3.2 Interest rate after Reforms

After introduction of these changes the current monetary policy framework of India became remarkably similar to the frameworks of US and other developed economies. Though the relative emphasis between price stability and growth kept on changing depends on prevailing economic conditions, the price stability started getting increased importance. Despite the fact that RBI modulates only short term interest rates through repo and reverse repo auctions, the signals started to change long term interest rates. It is found that long term interest rates tend to follow the direction of short term rate changes with some time lag. The trends of some of the interest rates time series (monthly average of call money rates, yields on treasury bills of 15 to 91 days maturity, yields on treasury bills of 92 to 182 days maturity, yields on government securities having 1, 5 and 10 years of remaining maturity) are depicted in Figure-1. Though interest rates on short term securities are volatile, yield on the government securities of higher maturities tend to move together.

Insert Figure 1 here

4. Empirical Analysis

In the study we tried to further expand Taylor type rule in lines with Chadha, Sarno and Valente (2004). One additional variable likely to influence interest rate and asset prices in India is foreign investments in financial markets. Stock prices in India are highly sensitive to foreign investments as can be seen from figure-2 below.

Insert Figure 2 here

In our expanded version of Taylor rule, interest rate were compared with inflation gap, output gap, exchange rate, asset prices and foreign investment in capital market, using both current and lagged values of the variables.

4.1 Data

The data used in the study were mainly drawn from Handbook of Statistics on Indian Economy published by Reserve Bank of India. This handbook is available from website of Reserve Bank of India (http://www.rbi.org.in/). We obtained data in respect of interest rates, wholesale price index and consumer price indexes, stock index, exchange rates and flow of foreign investments from the Handbook. As data was updated till June 2008 and few data series related to interest rates are available from April 1996, the study used monthly data from April 1996 to June 2008.

4.1.1 Interest rate

While yields of various interest rate instruments are different, the rates tend to move together as shown in figure-1. In view of that, we selected secondary market yields of government security having one year remaining maturity as representative interest rate for the model. Yields of very short term interest rates were avoided as those series exhibit high volatility.

4.1.2 Inflation

Measurement of inflation in India can broadly be classified into two categories: inflation relating to bulk transactions and inflation in respect of small transactions. Inflation relating to bulk transactions includes wholesale prices, farm harvest prices, export and import prices, etc. and is measured by Wholesale Price Index (WPI). WPI is measured by the Office of the Economic Adviser (OEA), Ministry of Industry for all-India, on weekly basis on base year 1993-94 with a time lag of two weeks.

Inflation related to price changes of goods and services at retail level is measured by Consumer Price Index (CPI). There are four different CPIs reported in India on monthly basis are: CPI for Industrial Workers (CPI-IW), CPI for Urban Non-Manual Employees (CPI-UNME), CPI for Agricultural Laborers (CPI-AL) and CPI for Rural Laborers (CPI-RL). The CPI(UNME) is published by Central Statistical Organization (CSO), whereas the other three CPIs are published by the Labor Bureau.

Many developed countries such as the United States, the United Kingdom, Japan, France, Canada, Singapore, and China among others use the CPI as the official measure of inflation, as CPI measures increase in prices actually paid by consumers. In India however, WPI changes are used to report official level of inflation, due few operational difficulties to measure CPI quickly. The time lag of reporting CPI estimates are of two months and data is made available on monthly basis, whereas WPI estimates are made available on weekly basis with about two weeks time lag.

However, both WPI and CPI estimates are used for policy making purposes, for example, CPI for Industrial Workers, is used to determine Wage & Dearness allowance levels of government employees. In line with official measure of inflation in India, we used year-on-year changes of WPI as measure of inflation. Average figure of WPI based inflation for the period April 1996 to June 2008 was 5.003272 (rounded off to 5.00) and therefore the targeted inflation is taken as 5%.

4.1.3 Output Gap

In India, Index of Industrial Production (IIP) signifies the status of production in the industrial segment of the country and this measure gives a single representative figure to ascertain the level of industrial activity in the country. This indicator is used by the Government for various policy planning purposes and is also used by academic researchers. The IIP estimate are often used as a proxy for the overall output of the economy, as GDP figures in India are not made available on monthly basis.

One imminent problem of using IIP is that the index exhibits too much seasonal fluctuation as can be seen from figure-3. To alleviate the problems of seasonal fluctuation we used X-12 ARIMA to remove seasonality. X-12-ARIMA is the seasonal adjustment software developed and used for all official seasonal adjustments at the U. S. Census Bureau. To measure the output gap, we fitted a 12 month simple moving average curve on seasonally adjusted data and the difference between them is used as a measure of output gap.

Insert Figure 3 here

4.1.4 Foreign Exchange Rate

We have used the exchange ratio of Indian Rupee per US$ as measure of foreign exchange rate as US$ dominates volume of transaction in foreign exchange market in India.

4.1.5 Asset Prices

The Bombay Stock Exchange Sensitive Index (sensex) comprising 30 selected high market-cap stocks are used as proxy for asset values. This index is the oldest and most popular stock index in India.

4.1.6 Foreign Investment in Capital Market

After foreign investors were allowed to invest in Indian capital markets, the quantum of investment has shown exponential growth in recent years and deeply influenced stock prices as can be seen from figure-2. The relationship became more established from the year 2002 onwards. The cumulative foreign investments in capital market from April 1996 onwards are used for the study.

The variables used in the study and their symbols are produced below

Sl #	Variable	Symbol
1	Interest rate of government security having one year remaining maturity	ei_rate
2	Cumulative foreign investment in Indian capital market since April 1996	fii_cum
3	Output gap: difference between seasonally adjusted index of industrial production with its 12 month moving average	iip_gap
4	Inflation gap: difference between WPI inflation with its average	infl_gap
5	Exchange Rate : Rupee - US$ exchange rate, monthly average	rs_dollar
6	BSE Sensitive Index monthly closing value	sensex

4.2 Stationarity of Data

Majority of financial and economic time series display some kind of trending behavior and are non-stationary. For example, Index of Industrial Production plots given in figure-3 clearly show that the series are trending upwards, even after seasonal adjustments. The major problem of using non-stationary data is that of spurious regression. The regression results may show high R2 and t-values even in absence of significant economic relationships. Dicky and Fuller (1979, 1981) developed procedures to test non stationarity of time series by testing presence of unit root. The tests were further extended by including extra lagged terms of the dependent variable to remove autocorrelation. The lag lengths can be automatically selected by using a specified information criterion. Several econometric packages (including GRETL and Eviews) provide menu driven options to perform the tests to determine presence of unit root. We used two asymptotically equivalent tests: augmented Dicky-Fuller (ADF) test and Phillips-Perron (PP) test and results are given in table-1 below.

Insert Table 1 here

Except for the iip_gap, the results of Fisher-ADF and PP tests reported in the table are not fundamentally different. The results from the test on levels of the variables point out presence of unit roots in all the variables. However results of first differenced series reject the null hypothesis of presence of a unit root and hence it is ascertained that the series are integrated of the order one I(1).

4.3 Cointegrating Relationship

Though ADF and PP tests determined that each variables are of order one I(1), there may exist a special case wherein a linear combination of the variables are integrated to order zero I(0). Engle and Granger (1987) found that when such combination is detected then the variables are said to be cointegrated. The cointegrated variables can be used to from regression equation without worrying for spurious relationship. The stationary linear combination is described as forms cointegrating equation, which gives long term equilibrium relationship among the variables. As per Eviews 6 User's Guide (2007), a VAR of order *p* can be written as follows:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + Bx_t + e_t \qquad \text{Equation-VI}$$

where y_t is a vector of non-stationary I(1) variable, x_t is a vector of deterministic variables, and e_t is a vector of innovations. The VAR described in equation-VI can be rewritten as

$$\Delta y_t = \pi y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + Bx_t + \varepsilon_t \qquad \text{Equation-VII}$$

where: $\pi = \sum_{i=1}^{p} A_i - I, \quad \Gamma_i = -\sum_{j=i+1}^{p} A_j$

Estimates of G_i contain information on the short-run adjustments, while estimates of p matrix contain information on the long-run adjustments among the variables. Testing for cointegration is ascertained by detecting the number of linearly independent columns in the p matrix. Johansen (1988, 1995) developed a methodology that can be used to test the rank of p matrix and to determine value of other coefficients using a procedure known as reduced rank regression. Though the procedure if quite involved, the routine for the calculations are available in many econometric packages including GRETL and Eviews. We estimated a model involving expected interest rate, cumulative foreign investment in capital markets, iip gap, inflation gap, rupee-dollar exchange ratio and BSE sensex value using Johansen's procedure.

Prior to the test using Johansen procedure, certain related inputs are to be determined. One of them is to ascertain the appropriate lag length for the VAR. We used three different information criteria namely: Akaike Information criterion (AIC), Schwartz Bayesian criterion (BIC) and Hannan-Quinn criterion (HQC) to select optimum lag length. But results were not consistent; optimum lag lengths using AIC, BIC and HQC were 13, 1 and 2 respectively. To keep the model simple we decided to set a uniform lag length of order two. Further, as per Johansen (1995) procedure, one of the specified five deterministic trend assumptions is to be selected. We assumed that the level data will not have any deterministic trend as neither interest nor inflation can trend in one single direction continuously without reversion. In the Eviews menu, we selected the option that assumes no deterministic trends in the level data but the cointegrating equations can have intercepts. The number of cointegrating equations is determined by Trace test and Maximum Eigen-value test. The results are presented in table-2.

Insert Table 2 here

4.4 Vector Error Correction Model

After the cointegrating relationship between the selected variables is established, a Vector Error Correction Model (VECM) can be conceived using these variables. The VECM output obtained using Eviews are given in table-3 and an error correction equation depicting relationship of interest rate with other variables is produced below in equation-VIII.

d(ei_rate) = - 0.116111709872(ei_rate(-1) + 7.15434108104e-05*fii_cum(-1) -*
*0.339108834967*iip_gap(-1) - 0.476501339501*infl_gap(-1) - 0.0259136820481*rs_dollar(-1) -*
*0.00126071672065*sensex(-1) - 2.28420821422) - 0.194697749126*d(ei_rate(-1)) -*
*0.251587694523*d(ei_rate(-2)) + 2.96172904695e-06*d(fii_cum(-1)) +*
*1.38869675563e-05*d(fii_cum(-2)) - 0.0346395882267*d(iip_gap(-1)) -*
*0.0261734024365*d(iip_gap(-2)) - 0.173396615526*d(infl_gap(-1)) -*
*0.00501662644798*d(infl_gap(-2)) + 0.318284747971*d(rs_dollar(-1)) +*
*0.446835028856*d(rs_dollar(-2)) - 5.57120108787e-06*d(sensex(-1)) +*
*3.76721594571e-05*d(sensex(-2)) - 0.0850130357388* Equation-VIII

4.5 Significance of Additional parameters

In the analysis, we added three additional economic parameters, namely fii_cum, rs_dollar and sensex in a Taylor-type equation. To test the hypothesis that these new terms are not significant in the cointegration equation, certain restrictions can be specified in the model. The restrictions can be put by forcing coefficients of the cointegrating variables to specified values. In this case, we liked to test whether coefficients of fii_cum, rs_dollar and sensex can be set to zero. As explained in Eviews 6 User's Guide (2007) and Brooks (2008), this can be achieved in Eviews system by inserting B(1,2)=0, B(1,5)=0, B(1,6)=0 in the VEC coefficient Restriction box. A partial output of restricted test is reproduced in table-4.

Insert Table 4 here

In this case, three restrictions were imposed and therefore, test statistic follows a c^2 distribution with 3 degrees of freedom. The p-value of the test is only 0.015095 (< 0.05) and hence restrictions are not supported. It is therefore ascertained that addition of these new variables helped us to obtain better relationship as modeled in previous section (4.4).

5. Concluding Remarks

Taylor opinioned that his rule is not only applicable in US, but also can be extended in other developed economies. A number of subsequent studies have validated his viewpoint. In India, prices of many products used to be administered and interest rates were also regulated. With the initiation of economic reforms, monetary policy framework of India is made comparable with those of other developed economies, paving way to study applicability of Taylor rule in post reforms era. Few studies have included exchange rates and asset prices in extended version of Taylor type model. We observed that foreign investment in capital markets heavily influence stock (asset) prices in India and decided to include this variable in the study. Finally, a vector error correction model is delineated combining present and past two period lagged values of these variables.

Though controlling inflation is not an explicit objective of the central bank, the country has been able to maintain moderate level of inflation averaging around 5% per year. Actual inflation however, fluctuates and even touches double digit figures at times, forcing government to take immediate measures to reduce price of certain commodities. It is found that inflation rates form a stable cointegrated relationship with other macroeconomic variables, and therefore, control on inflation can be better achieved by attending gaps in these variables rather than taking ad hoc measures to administer prices of the commodities.

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Table 1. Unit root test results, p-value of ADF and PP tests

	Fisher ADF Test		PP Test	
Variables	Levels	First Difference	Levels	First Difference
ei_rate	0.339	0.000	0.256	0.000
fii_cum	1.000	0.000	1.000	0.000
iip_gap	0.842	0.000	0.003	0.000
infl_gap	0.101	0.000	0.162	0.000
rs_dollar	0.236	0.000	0.150	0.000
sensex	0.932	0.000	0.979	0.000

Table 2. Number of cointegrating equations in the Relationship

Hypothesized No. of CE(s)	Trace Statistic	5% Critical Value	p-value	Max-Eigen Statistic	5% Critical Value	p-value
None	103.53	95.75	0.011*	48.42	40.08	0.005*
At most 1	55.12	69.82	0.414	25.17	33.88	0.374
At most 2	29.94	47.86	0.722	16.47	27.58	0.626
At most 3	13.47	29.80	0.869	8.42	21.13	0.876
At most 4	5.05	15.49	0.804	4.64	14.26	0.786
At most 5	0.41	3.84	0.524	0.41	3.84	0.524

*Both Trace test and Max-Eigenvalue test indicate 1 cointegrating equation at the 0.05 level

Table 3. Vector error correction estimates, standard errors in ( ) and t-statistic in [ ]

Cointegrating Equation:	**CointEq1**					
ei_rate(-1)	1					
fii_cum(-1)	7.15E-05 (0.0000) [4.61028]					
iip_gap(-1)	-0.339109 (0.1242) [-2.72993]					
infl_gap(-1)	-0.476501 (0.1795) [-2.65471]					
rs_dollar(-1)	-0.025914 (0.0847) [-0.30608]					
sensex(-1)	-0.001261 (0.0003) [-4.95566]					
c	-2.284208					
Error Correction:	d(ei_rate)	d(fii_cum)	d(iip_gap)	d(infl_gap)	d(rs_dollar)	d(sensex)
CointEq1	-0.116112	-316.6707	0.069679	-0.062288	0.034363	57.67121

	(0.0258)	(177.2170)	(0.1517)	(0.0312)	(0.0214)	(21.6855)
	[-4.49415]	[-1.78691]	[0.45945]	[-1.99403]	[1.60972]	[2.65943]
d(ei_rate(-1))	-0.194698	775.0865	-0.199479	-0.02783	-0.082173	59.70512
	(0.0781)	(535.8830)	(0.4586)	(0.0945)	(0.0646)	(65.5745)
	[-2.49211]	[1.44637]	[-0.43498]	[-0.29463]	[-1.27300]	[0.91049]
d(ei_rate(-2))	-0.251588	465.5714	-0.137619	0.051633	-0.124455	60.72039
	(0.0768)	(526.4490)	(0.4505)	(0.0928)	(0.0634)	(64.4201)
	[-3.27800]	[0.88436]	[-0.30547]	[0.55643]	[-1.96257]	[0.94257]
d(fii_cum(-1))	2.96E-06	0.06854	0.000165	-2.13E-06	-1.96E-05	0.042431
	(0.0000)	(0.1011)	(0.0001)	(0.0000)	(0.0000)	(0.0124)
	[0.20089]	[0.67778]	[1.90557]	[-0.11967]	[-1.60885]	[3.42897]
d(fii_cum(-2))	1.39E-05	0.128589	0.000332	-2.44E-05	-7.43E-06	0.030821
	(0.0000)	(0.1005)	(0.0001)	(0.0000)	(0.0000)	(0.0123)
	[0.94745]	[1.27902]	[3.86315]	[-1.37526]	[-0.61330]	[2.50526]
d(iip_gap(-1))	-0.03464	-291.3697	-0.595483	0.010333	0.05122	26.93873
	(0.0170)	(116.5580)	(0.0998)	(0.0206)	(0.0140)	(14.2629)
	[-2.03848]	[-2.49978]	[-5.96992]	[0.50295]	[3.64810]	[1.88873]
d(iip_gap(-2))	-0.026173	-247.6145	-0.049796	0.011262	0.021429	13.21356
	(0.0177)	(121.6540)	(0.1041)	(0.0214)	(0.0147)	(14.8865)
	[-1.47574]	[-2.03540]	[-0.47831]	[0.52519]	[1.46232]	[0.88762]
d(infl_gap(-1))	-0.173397	-1360.366	1.271191	0.324028	0.048859	-96.86442
	(0.0753)	(516.4780)	(0.4420)	(0.0910)	(0.0622)	(63.1999)
	[-2.30285]	[-2.63393]	[2.87608]	[3.55930]	[0.78535]	[-1.53267]
d(infl_gap(-2))	-0.005017	156.7567	-0.068774	-0.174135	0.0495	43.24797
	(0.0785)	(538.1040)	(0.4605)	(0.0949)	(0.0648)	(65.8462)
	[-0.06395]	[0.29131]	[-0.14935]	[-1.83592]	[0.76367]	[0.65680]
d(rs_dollar(-1))	0.318285	-1109.261	-0.009625	0.535263	0.342688	-33.28298
	(0.1117)	(766.3240)	(0.6558)	(0.1351)	(0.0923)	(93.7729)
	[2.84892]	[-1.44751]	[-0.01468]	[3.96267]	[3.71241]	[-0.35493]
d(rs_dollar(-2))	0.446835	-345.3535	0.396455	-0.170762	-0.071694	-70.15583
	(0.1265)	(867.5500)	(0.7424)	(0.1529)	(0.1045)	(106.1600)
	[3.53288]	[-0.39808]	[0.53400]	[-1.11668]	[-0.68605]	[-0.66085]
d(sensex(-1))	-5.57E-06	-2.061456	-0.002288	0.000151	0.000218	0.121411
	(0.0001)	(0.8534)	(0.0007)	(0.0002)	(0.0001)	(0.1044)
	[-0.04478]	[-2.41546]	[-3.13222]	[1.00292]	[2.12483]	[1.16257]
d(sensex(-2))	3.77E-05	0.523593	-0.001369	2.09E-05	-4.33E-05	-0.142044
	(0.0001)	(0.8458)	(0.0007)	(0.0002)	(0.0001)	(0.1035)
	[0.30553]	[0.61909]	[-1.89183]	[0.13986]	[-0.42514]	[-1.37251]
c	-0.085013	1768.388	-0.357794	0.059527	0.049286	-51.30095
	(0.0621)	(425.7790)	(0.3644)	(0.0751)	(0.0513)	(52.1014)
	[-1.36955]	[4.15330]	[-0.98195]	[0.79317]	[0.96098]	[-0.98464]

Table 4. Results of the restricted test

Cointegration Restrictions:	
B(1,2)=0, B(1,5)=0, B(1,6)=0	
LR test for binding restrictions (rank = 1):	
Chi-square(3)	10.45135
Probability	0.015095
Cointegrating Eq:	**CointEq1**
ei_rate(-1)	-0.232133
fii_cum(-1)	0.000000
iip_gap(-1)	0.201016
infl_gap(-1)	0.226997
rs_dollar(-1)	0.000000
sensex(-1)	0.000000
c	0.586431

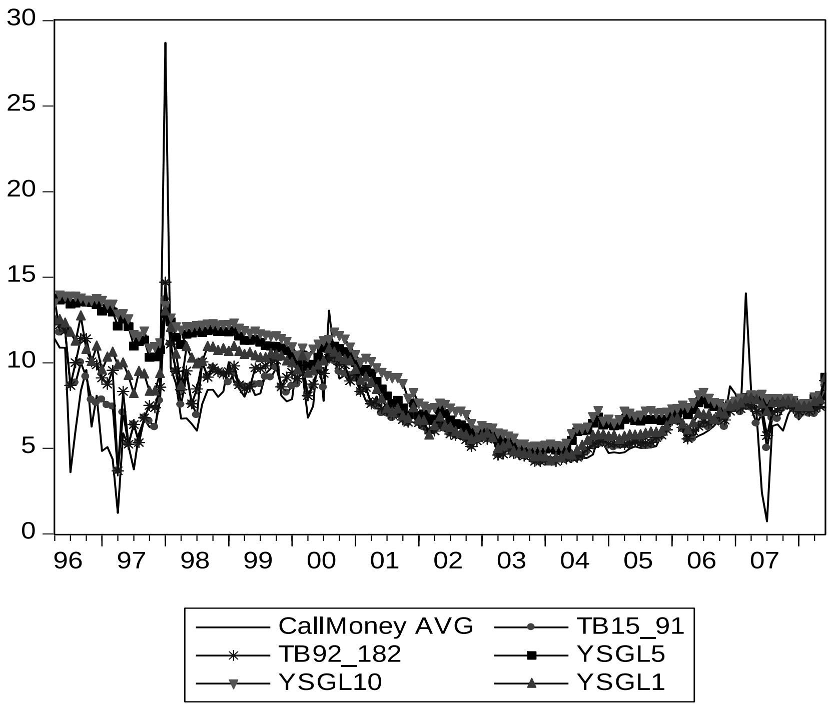

Figure 1. Yields on government securities

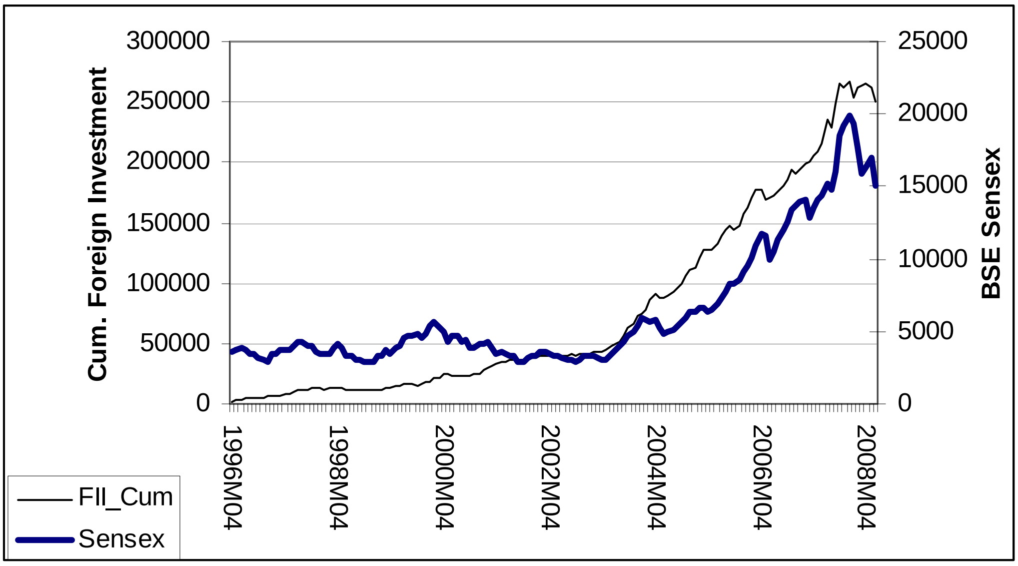

Figure 2. BSE sensitive index vs. cumulative foreign investment in capital markets

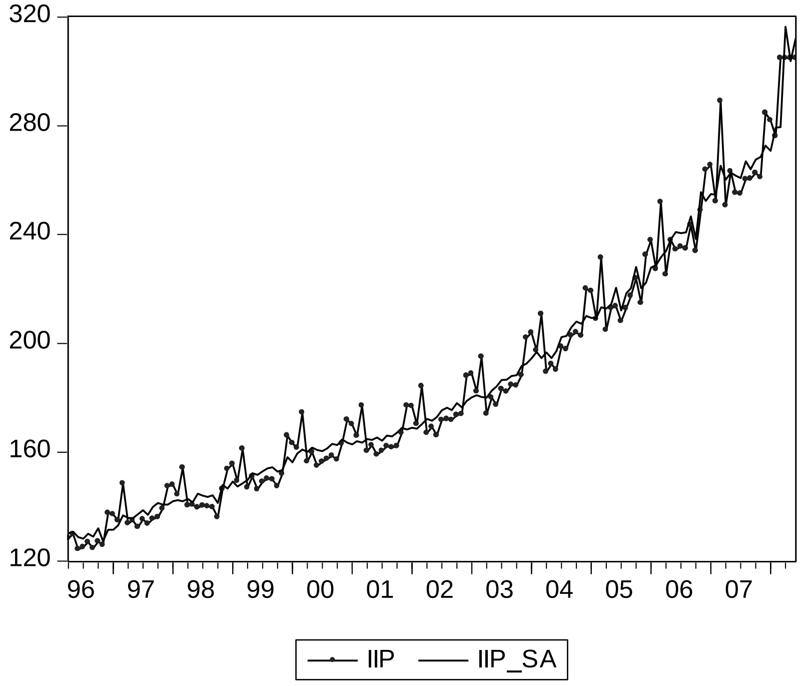

Figure 3. Index of industrial production (actual and seasonally adjusted series)