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Establishing Cointegrating Relationships Involving Interest Rates and Other Macroeconomic Variables in India

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Abstract

The objective of the study is to develop a relationship between interest rates and other macroeconomic variables using latest available data in Indian context so that a forecast of interest rate can be estimated. With the onset of economic reforms the interest rates India are deregulated and banks are allowed to determine market based interest rate. Market determined interest rates are likely to develop some relationship other economic variables and accordingly, cointegration among long term interest rate with other relevant variables are analyzed. While analyzing a number of variables the study found cointegrated relationship among interest rate, inflation and IIP growth rate and delineated an error correction model.

Keywords: Interest rates, Cointegration, Vector Error Correction Model

1. Introduction

The study discusses relationship amongst interest rates with other macroeconomic variables so that future interest rate can be estimated. Forecasting of interest rates helps to reduce the risk associated with large fluctuations in the interest rates and therefore crucial for savings, investing and policy making decisions. India has gradually slackened its position from tight regulation of interest rate regime to freeing interest rates. Further domestic sectors were allowed to be integrated with external sectors allowing cross border movement of funds across countries. Various measures to open up the economy have enabled interest rates to be determined by economic forces and Indian banks were given freedom to offer different interest rates based on maturity and size of deposits both for saving and lending instruments. In the study relationship of interest rate with other economic variables were examined and compared with a view to develop an appropriate model.

One of the oldest doctrines that tried to explain co-movement between interest rates and inflation is found in Fisher Hypothesis. It states that the nominal interest rate is the sum of real interest rate and expected inflation. The real interest rate in an economy usually remains unchanged but nominal interest rate undergoes point to point adjustment with the expected rate of inflation. Several studies have found strong empirical evidence in support of Fisher hypothesis in developed countries where interest rates are market determined.

The relationships of interest rates with other variables are widely studied and a large number of articles are available in literature. We give below findings of few recent studies carried out in Indian context. Bhanumurty and Agarwal (2003) observed that nominal interest rates adjust only to movements in the wholesale market prices but the relationship was not robust. They concluded that interest rate determination in India need not focus much on the domestic inflation rate, as there seems to be no strong co-movement between them. Bhatt and Virmani (2005) showed that short term interest rates in India are getting progressively integrated with those in the US even though the degree of integration is far from perfect. Singh and Sensharma (2006) found that Money Supply, Stock Index and Real Effective Exchange Rate are the three important variables which can be used to predict long term interest rates with a higher degree of accuracy. Bhattacharya, Bhanumurthy and Mallick (2008) noted that although interest rates depend on some domestic macroeconomic variables such as yield spread and expected exchange rates, they are primarily affected by the movement of international interest rates with some lag.

2. Interest Rates in India

Prior to economic reforms, interest rates in India were administered by monetary authority of the country, Reserve Bank of India (RBI). Measures were taken to deregulate interest rates from early 1990s when reforms were initiated for financial linearization of the country. Some of the measures initiated by government to free interest rates are as follows.

- Deposit rates and interest stipulations were simplified by reducing the number of slabs in interest rate structure (1991-92)
- Maturity-wise prescriptions of deposit rates were replaced by a single ceiling rate of 13 per cent on all deposits above 46 days (1992-92)
- Banks were allowed to determine their prime lending rate (PLR) for loans and advances exceeding Rs. 2 lakhs. The lending rates of cooperative banks were also freed (1994-95).
- On deposit front, banks were given freedom to fix their own interest rates on domestic and Non-Resident Indian (NRI) deposits with maturity of over two years (1995-96).
- Banks were given full freedom to determine interest rates on term deposits of 30 days and above. The structure of lending rates was deregulated and banks were given the freedom to 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. Minimum period of maturity of term deposits reduced to 15 days from 30 days. They were advised to determine their own penal rates of interest on premature withdrawal of domestic term deposits and NRE deposits (1998-99)
- Efforts were also made to lowering both the Cash Reserve Ratio (CRR) and Statutory Liquidity Ratio (SLR). The Statutory Liquidity Ratio was gradually brought down to 25% by 1997. Cash reserve ratio (CRR) also brought down from 15% in 1991 to as low as 4.5% in 2004. It was again increased to 9% in March 2008 but brought down to 5% in January 2009.

After these measures were taken to deregulate interest rates, banks became free to determine their own interest rates. Commercial banks started to determine their respective BPLRs (benchmark prime lending rates) taking into consideration of actual cost of funds, operating expenses and an acceptable minimum margin to cover regulatory requirements, expenses, capital cost and profit margin.

Removals of the restrictions have enabled interest rates to be market determined based on influences of various macroeconomic variables. The current trends of some of the interest rates time series is displayed in Figure 1.

It was observed that fluctuation of call money rates were very high and monthly averages varied from 28.7% to less than one percent. For example, average interest rates on call money changed from 8.21% in December 1997 to 28.7% in January 1998. Other three interest rate series plotted in the graph includes average yields on central government securities having remaining maturity of one year (YSGL1), 5 years (YSGL5) and 10 years (YSGL10). Formations of short term trends in interest rates are visible in almost all categories. The rates exhibited downtrend till the year 2003 but started taking reverse turn in 2004.

It is observed that all categories of interest rates are moving together indicating co-movement of these series. The correlation coefficients are tabulated in table 1.

In line with liquidity preference theory, it was also found that instruments having higher maturity usually yield higher interest rates.

3. Inflation in India

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. The WPI is a single national index compiled at the national level. The basis of inclusion of items in the basket for WPI is their importance in the national economy. The series covers in all 435 commodities. The sector- wise breakup of Commodities is

- Primary articles-98 (food articles-54, Non-food articles-25, minerals-19)
- Fuel, power, Light & lubricants-19
- Manufactured products-318.

WPI is estimated using Laspeyres base-weighted formula that uses arithmetic average of selected price ratios in comparison with corresponding base year prices.

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 as follows.

- 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 countries use the CPI as a measure of inflation, as this index measures the actual increase in price that a consumer will finally pay. CPI is the official indicator of inflation in countries such as the United States, the United Kingdom, Japan, France, Canada, Singapore, and China among others. India is the only large country that uses a wholesale index to compute inflation. Some of the many intricate problems hinder shifting from WPI based inflation to CPI based inflation measures in India are as follows.

- There are four CPI Index series namely, CPI for Industrial Workers, CPI for Urban Non-Manual Employees, CPI for Agricultural labourers and CPI for Rural labour. Which particular index is more appropriate is open to debate.
- Secondly, lag in reporting CPI numbers are high to the tune of two months and data is made available on monthly basis. Whereas WPI is published on a weekly basis and inflation in India is reported on weekly basis.

Owing to these reasons, changes in the wholesale price index still remain as the official measure of inflation in India and this change is measured on year-on-year (YOY) basis. However, the Consumer Price Index (CPI) is used in India in policy making for a wide variety of other purposes. CPI for Industrial Workers for example, is used mainly for determining Wage & Dearness allowance levels of government employees. CPI is also used as a deflator in national account estimates to obtain values at constant prices from values at current prices. Trends in inflation measured using year-on-year (YOY) index changes of both WPI and CPI –IW from 1996 to 2008 are plotted in Figure 2.

It is observed that the WPI and CPI based inflation estimates do not show apparent comovement. Inflation plots, particularly CPI based inflation estimates are highly volatile. During the period, CPI based inflation ranged from 0% to 20%. The average figure of inflation was below 6% and therefore the recent hike of inflation above 8% was considered an alarming situation.

4. Empirical Analysis

4.1 Data

The study considered monthly data of different interest rates, inflation estimates and other macroeconomic variables as available 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/). As on the date of writing, most of the time series data particularly yield in treasury bills and government dated securities for various maturities are available from April 1996 and updated till June 2008. In the study we collected monthly data for all other macroeconomic variables for the period of April 1996 to June 2008 covering a span of 12 years. Short term interest rates in USA are taken from the website of US Department of the Treasury (http://www.ustreas.gov/).

4.2 Relationship between Interest Rates and Inflation

The analysis was started with finding relationship between interest rates and expected inflation as per Fisher Hypothesis, which states that the nominal interest rate is the sum of real interest rate and expected inflation. The real interest rate in an economy by and large remains unchanged but nominal interest rates undergo point to point adjustment with the expected rate of inflation. Several studies have found strong empirical evidence in support of Fisher hypothesis in developed countries where interest rates are market determined. But in many developing countries interest rates are administered by their central banks and hence a natural relationship is willfully distorted.

Fisher (1930) proposed that nominal interest rate i_t it at any period is composed of real interest rate r_t and expected inflation π_t^e as follows.

$$(1 + i_t) = (1 + r_t)(1 + \pi_t^e)$$ …Equation-1

The equation can be simplified as $i_t = r_t + \pi_t^e + r_t . \pi_t^e$ …Equation-2

Assuming that both interest rate and inflation rate are fairly small (on order of few percentage points, $r_t + \pi_t^e$ is much larger than $r_t . \pi_t^e$ and therefore the term $r_t . \pi_t^e$ can be dropped. Thus the Fisher equation can be approximated to $i_t = r_t + \pi_t^e$. Using the rational expectations model to estimate inflation expectations would mean that the difference between realized inflation π_t and expected inflation π_t^e is captured by an error term (ε_t) and thus $\pi_t^e = \pi_t + \varepsilon_t$ Where $E(\varepsilon_t) = 0$. The equation-1 can therefore be modified to $i_t = r_t + \pi_t + \varepsilon_t$ and a regression equation for testing the hypothesis can be formed as follows.

$$i_t = \alpha + \beta . \pi_t + \varepsilon_t$$ …Equation-3

If the value of β is 1 and found significant, it would mean one to one correspondence between nominal interest rate and inflation.

4.3 Stationarity of Data Series

A prerequisite to run OLS regression on equation-3 is to ensure that both nominal interest rate and inflation are stationary so that spurious results can be avoided. Figure-3 displays graph of 10-year interest rate and WPI based inflation rate and Figure-4 displays graph 10-year interest rate and CPI based inflation.

On visual examination of the graphs given in figure-3 and figure-4, neither stationarity nor comovement in time series can be established. In absence of any clear judgment from visual analysis, the stationarity of the series were tested using augmented Dicky and Fuller (ADF) (1979) and Phillips and Perron (PP) (1988) tests.

Dickey and Fuller (1979, 1981) developed formal tests procedures for checking non-stationarity by testing existence of unit root. The obvious test is to form a simple AR(1) model of the form:

$$y_t = \phi y_{t-1} + \varepsilon_t$$ …Equation-4

Where we need to test whether the value of $\phi = 1$. A more convenient way is to subtract y_{t-1} from both sides and test the form: $\Delta y_t = \gamma y_{t-1} + \varepsilon_t$ …Equation-5

in which $\gamma = 0$ since $(\phi - 1) = 0$. The test of the equation-5 will be valid only if the error term remains as a white noise and not auto correlated. If the error term is found to be auto correlated, the solution is to 'augment' the test using additional lag terms of the dependent variable to avoid effects of autocorrelation. The number of lag length can be determined using an information criteria like Akaike Information Criteria (AIC), Schwartz Bayesian Criterion (SBC) or similar others. In many software programs optimum lag length is automatically chosen using a user specified information criteria.

ADF test statistic in some cases may lead to erroneous conclusions in the event of a regime shift such as a market crash or an oil shock as the test often fails to reject the null hypothesis in the presence of structural breaks. It is found that structural breaks in stationary time series can generate apparent unit roots when using ADF based tests. Phillips and Perron (1988) avoided this problem by using a non-parametric adjustment. Other popular tests include The

Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) Test, Elliot, Rothenberg, and Stock Point Optimal (ERS) Test Ng and Perron (NP) Tests, etc.

In the study, both the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit-root tests on the null hypothesis of non-stationary (unit root) and alternative hypothesis (no unit root) of stationary are tested and results are given in Table 2.

It can be seen in table-2, that both the ADF and PP tests fail to reject the null hypothesis of the existence of a unit root in levels of the series at the 5% level and hence the series are non-stationary. However, in first-differenced form of the series, the null hypothesis of unit root is rejected. It indicates that, all the series are stationary in first-differenced form which means that all the series tested are integrated in order one, or I(1) and long run relationships can be established using cointegration analysis.

4.4 Cointegration Testing

Engle and Granger (1987) established that a specific linear combination of two or more non-stationary series may perform like a stationary series. If such a stationary linear combination is found, the non-stationary time series are said to be cointegrated and the stationary linear combination is described as a cointegrating equation. This equation can be interpreted as a long-run equilibrium relationship among the variables. For the purpose of testing cointegrating relationship between interest rates and inflation, we adopted following VAR-based cointegration tests suggested by Johansen (1991, 1995).

Let us consider a VAR of order p:

$$y_t = A_1 y_{t-1} + \dots + A_p y_{t-p} + Bx_t + \varepsilon_t \qquad \text{.Equation-6}$$

where y_t is a vector of non-stationary I(1) variables, x_t is a vector of deterministic variables, and ε_t is a vector of innovations. The VAR described in equation-6 can be rewritten as

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + Bx_t + \varepsilon_t \qquad \text{Equation-7}$$

where:

$$\Pi = \sum_{i=1}^{p} A_i - I,\ \Gamma_i = -\sum_{j=i+1}^{p} A_j$$

Estimates of Γ_i contain information on the short-run adjustments, while estimates of Π matrix contain information on the long-run adjustments among the variables used in the equation. The number of linearly dependent cointegrating vectors that exist in the system is referred to as the cointegrating rank of the system. Johansen has developed method to identify the rank of Π matrix that uses the trace and maximum Eigenvalue tests (Johansen 1991,1995).

The rank of the matrix can be used to measure number of cointegrating vectors present in the system. (Johansen 1991, Harris1995, Kennedy 2003).

4.4.1 Parameter selection for Johansen's test

The Johansen procedure requires that the appropriate lag length for the VAR be estimated beforehand for use in the model. We used three different criteria namely: Akaike Information criterion (AIC), Schwartz Bayesian criterion (BIC) and Hannan-Quinn criterion (HQC) to select lag length. Though use of AIC suggested using 13 lags in all the series, but BIC and HQC criteria estimated optimum lags of all the series to be either 1 or 2. To keep the model simple we decided to keep uniform lag length to the order of one.

Further, as per Johansen (1995) procedure, one of the specified five deterministic trend assumptions is to be selected. However, there is very little research available in the context to ascertain which deterministic trend assumption is most appropriate. Wesso (2000) suggested that the final decision should be guided by both economic theory and statistical criteria.

We assumed that the level data will not have any deterministic trend as neither interest no inflation can increase (decrease) continuously without reversion. The past behavior of data suggests that these variables usually fluctuate within certain range. While estimating cointegrating relationship as per Johansen method, we had chosen the option that assumes no deterministic trends in the level data but the cointegrating equations can have intercepts. Cointegrating tests of various combinations of one year interest rate, 10 year interest rate, CPI based inflation and WPI based inflation are reported in Table 3.

It is interesting to note that none of the above four combinations of Interest rate and inflation series show signs of cointegrating relationships. In absence of any cointegrating relationship making a linear OLS model of interest rate and inflation will not be appropriate. The only option left is to derive relationship in the differences of the respective series as the series are of the order-1, but modeling with differenced series will fail to capture long term relationships in the level data.

4.5 Interest Rate modeling with other variables

Since none of the four combinations analyzed in previous section exhibited clear long term cointegrating relationship, we decided to add following of macroeconomic variables in the model.

Presences of cointegrating vectors with different combinations of economic variables were tested using Johansen's procedure and summarized results are reported in Table 5.

The detail result showing cointegrating relationships are presented in Table 6 and Table 7. It is found from table 6 that inclusion of iipgrowth improves rank of Π matrix enabling us to form cointegrating relationship among interest rate, cpiinflation and iipgrowth. Similarly from table-7, another cointegrating relationship involving interest rate, cpiinflation and Net Investment by FI can be developed.

These analysis indicate that both IIP growth rate and Net Investment by FII depicts individual cointegrating relationship with interest rate. Johansen test results involving all four variables (YSGL10, cpiinflation, iipgrowth and NetInvestmentFI) are given in Table-8. It is interesting to note that when cointegration tests were performed using these four variables the number of cointegrating relationships increased to two.

4.6 Choosing an appropriate model

From various combinations of interest rate and other variables, three sets of cointegration relationships are found and therefore three different Vector Error Correction Models can be formed.

Sl #	Variables in the Model	No. of Cointegrating Vectors
Model-1	YSGL10, cpiinflation, iipgrowth	1
Model-2	YSGL10, cpiinflation, NetInvestmentFII	1
Model-3	YSGL10, cpiinflation, iipgrowth, NetInvestmentFII	2

Out of the above three models which model is likely to be more appropriate may be chosen using an acceptable information criteria. We have analyzed Akaike Information criterion (AIC), Schwartz Bayesian criterion (BIC) and Hannan-Quinn criterion (HQC) values of the respective VECM model to select final model. The information criteria values are presented in Table 9. It can be found that Model-1 give lowest value in all the three information criteria and hence a VECM equation is delineated for the model. The complete VECM equation of model-1 is given in Table 10.

From Table-10, VECM equation of interest rate is reproduced in following linear form.

dYSGL10) = 0.0034070122465(ysgl10(-1) + 3.09472376496*cpiinflation(-1) + 8.36402455042*iipgrowth(-1) - 85.7941020055) - 0.0556916660629*d(YSGL10(-1)) + 0.0225547185272*d(cpiinflation(-1)) - 0.0179157676812*d(iipgrowth(-1))*

5. Conclusion

In the study we tried to model long term relationship of interest rates with other macroeconomic variables in India. We selected yield on 10 year government security as proxy for interest rate as this interest rate showed co-movement with other medium to long term interest rates. Call money rates and yield on short term treasury bills were highly volatile and hence avoided. Though Fisher hypothesis postulates stable long term relations between interest rates and Inflation, we could not found a stable relationship between the variables on visual plots. The lack of long term relationship was also confirmed using methodology suggested by Johansen.

In the next step, we included other macroeconomic variables one by one and found that inclusion of growth rate on index of industrial production and Net Investment by Foreign Institutional Investors help to establish cointegrating relationship with interest rate. In India, Index of Industrial Production (IIP) represents the status of production in the industrial segment of India and this estimate gives a single representative figure to measure the general level of industrial activity in the country. This indicator is very important and used by the Government for policy planning purposes and is also used by Industrial Associations, Research Institutes and Academicians. The IIP growth figures can also be considered as a proxy for the overall output of the economy as GDP data is not available on monthly frequency. Cointegrating relation of IIP growth reconfirms that interest rates in the country are strongly influenced by demand of fund for industrial growth. Inclusion of Net investment by foreign investors also found to influence interest rate and as expected it has a negative coefficient. That is, more investment by foreign investors tends to reduce domestic interest rate. Finally we tried to develop a model combining all four variables, Interest rate, CPI Inflation, IIP Growth and Net Investment by FII and found two cointegrating equations.

Out of the three models, final model is chosen based on lowest AIC, BIC and HQC scores and a VECM equation is delineated encompassing interest rate, CPI based inflation and growth rate of industrial production

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Table 1. Correlation coefficient between selected interest rate series

	CALL_MONEY_AVG	YSGL1	YSGL5	YSGL10
CALL_MONEY_AVG	1.000000	0.591832	0.465101	0.461746
YSGL1	0.591832	1.000000	0.966109	0.959159
YSGL5	0.465101	0.966109	1.000000	0.994457
YSGL10	0.461746	0.959159	0.994457	1.000000

Table 2. Unit root test results, p-value of ADF and PP tests

	Fisher ADF Test		PP Test	
Variables	Levels	First Difference	Levels	First Difference
wpiinflation	0.3362	0.0013	0.1620	0.0000
cpiinflation	0.3194	0.0000	0.0838	0.0000
YSGL1	0.4199	0.0000	0.2561	0.0000
YSGL10	0.4616	0.0000	0.4619	0.0000

Table 3. Number of cointegrating vectors

	Null Hypothesis	1-Yr interest rate & CPI Inflation	1-Yr interest rate & WPI Inflation	10-Yr interest rate & CPI Inflation	10-Yr interest rate & WPI Inflation	Critical value at 5%
Lags		2	2	2	2	
Trace Test	r = 0	14.372	10.755	14.035	11.669	15.495
	r <= 1	3.989	3.483	3.298	3.125	3.842
L test	r = 0	10.383	7.713	10.737	8.544	14.265
	r <= 1	3.989	3.483	3.299	3.125	3.842
No of Cointegrating Vectors	Trace Test	0	0	0	0	
	L Test	0	0	0	0	

Table 4. Variables used in the study

Sl #	Variable Name	Particulars
1	YSGL10	Redemption yield on central government securities of 10 years maturity
2	cpiinflation	Inflation measured using year-on-year changes of CPI-Industrial Workers
3	gold10gm	Monthly average price of 10 gram gold in domestic market
4	silverKg	Monthly average price of one kilogram silver in domestic market
5	iipgrowth	Year on year growth in index numbers of industrial production
6	M3growth	Year on year growth of money supply (M3)
7	sensexgrowth	Changes on BSE Sensitive Index measured by year on year changes
8	USDRs	Exchange rate of Indian Rupee per US Dollar
9	PoundRs	Exchange rate of Indian Rupee per UF Pound
10	USinterestrate	Short Term Interest rate (3-month TB) in US
11	NetInvestmentFII	Net Investments by FII in the Indian Capital Market

Table 5. Number of Cointegrating Relationships

			Number of Cointegrating Relationships*	
Sl #	Variables in cointegrating relationships	Lag Order	Trace Test	L Test
1	YSGL10, cpiinlation, gold10gm	1	0	0
2	YSGL10, cpiinflation, silverkg	1	0	0
3	YSGL10, cpiinflation, iipgrowth	1	1	1
4	YSGL10, cpiinlation, M3growth	1	0	0
5	YSGL10, cpiinflation, sensexgrowth	1	0	0
6	YSGL10, cpiinflation, USDRs	1	0	0**
7	YSGL10, cpiinlation, PoundRs	1	0	0
8	YSGL10, cpiinlation, USinterestrate	1	0	0
9	YSGL10, cpiinflation, NetInvestmentFII	1	1	1

* measured at 5% level,

** showed 1 cointegrating relationship at 10% level

Table 6. Johansen test: Using YSGL10, cpiinflation, iipgrowth

Rank	Eigenvalue	Trace test p-value	Lmax test p-value
0	0.25595	56.472* [0.0000]	43.165* [0.0000]
1	0.062017	13.307 [0.3476]	9.3474 [0.4097]
2	0.026755	3.9594 [0.4302]	3.9594 [0.4293]

* Both Trace test and Lmax test indicate presence of 1 cointegrating equation.

Table 7. Johansen test: Using YSGL10, cpiinflation, NetInvestmentFII

Rank	Eigenvalue	Trace test p-value	Lmax test p-value
0	0.45418	101.38* [0.0000]	88.398* [0.0000]
1	0.062253	12.982 [0.3734]	9.3841 [0.4059]
2	0.024343	3.5981 [0.4867]	3.5981 [0.4857]

* Both Trace test and Lmax test indicate presence of 1 cointegrating equation.

Table 8. Johansen test: Using YSGL10, cpiinflation, NetInvestmentFII, iipgrowth

Rank	Eigenvalue	Trace test p-value	Lmax test p-value
0	0.49083	152.43* [0.0000]	98.547* [0.0000]
1	0.24285	53.883* [0.0001]	40.616* [0.0000]
2	0.061853	13.267 [0.3507]	9.3219 [0.4123]
3	0.026658	3.9449 [0.4324]	3.9449 [0.4315]

* Both Trace test and Lmax test indicate presence of 2 cointegrating equations.

Table 9. Information Criterion Values

	Model-1	Model-2	Model-3
AIC	8.0958	23.0309	27.7355
BIC	8.2797	23.2148	28.0624
HQC	8.1705	23.1056	27.8683

Table 10. Vector Error Correction Estimates

Sample (adjusted): 1996M06 2008M06

Included observations: 145 after adjustments

Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	**CointEq1**		
YSGL10(-1)	1.000000		
cpiinflation(-1)	3.094724		
	(1.46019)		
	[2.11940]		
iipgrowth(-1)	8.364025		
	(1.77500)		
	[4.71211]		
c	-85.7941		
	(16.6505)		
	[-5.15264]		
error correction:	**d(YSGL10)**	**d(cpiinflation)**	**d(iipgrowth)**
cointeq1	0.003407	-0.001282	-0.026524
	(0.00125)	(0.00376)	(0.00744)
	[2.73016]	[-0.34055]	[-3.56664]
d(YSGL10(-1))	-0.055692	-0.199597	0.409847
	(0.08706)	(0.26261)	(0.51880)
	[-0.63970]	[-0.76004]	[0.78998]
d(cpiinflation(-1))	0.022555	0.413773	-0.049543
	(0.02637)	(0.07956)	(0.15717)
	[0.85516]	[5.20086]	[-0.31521]
d(iipgrowth(-1))	-0.017916	0.041413	-0.504423
	(0.01192)	(0.03596)	(0.07105)
	[-1.50266]	[1.15151]	[-7.09958]

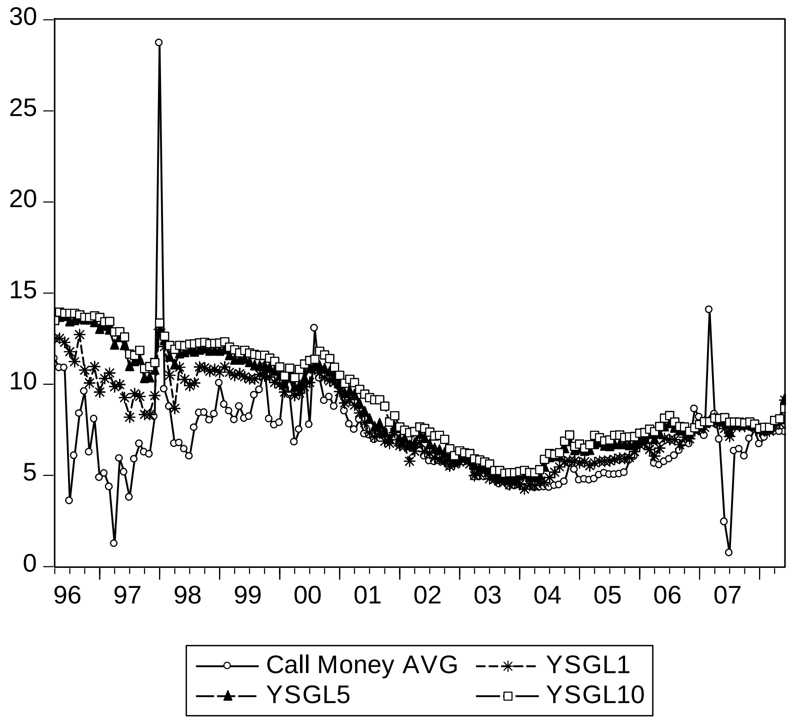

Figure 1. Interest Rate Graphs

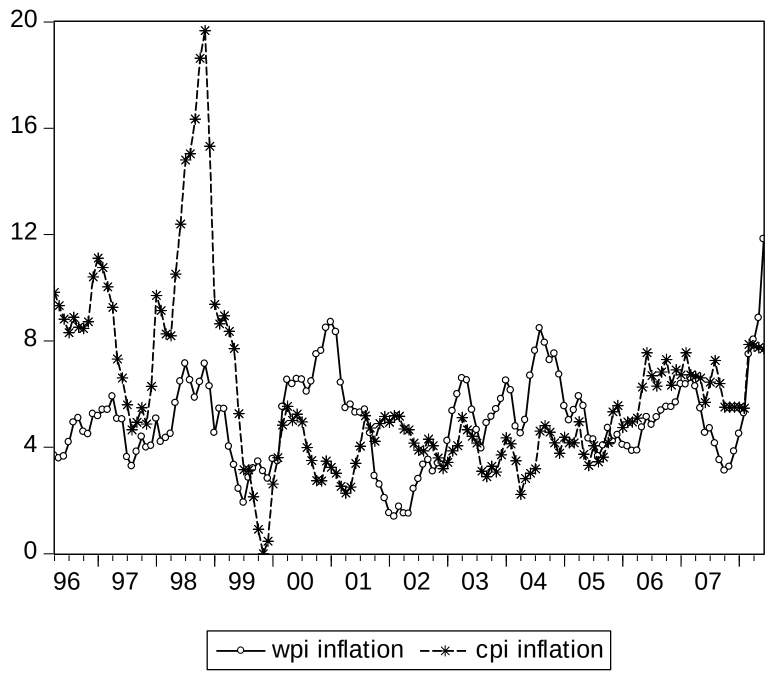

Figure 2. Inflation Trends

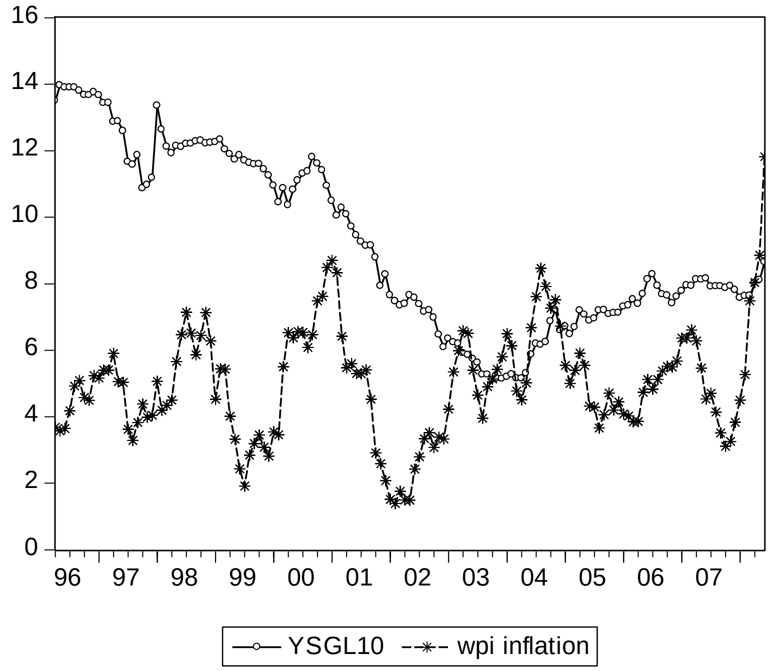

Figure 3. 10 year interest rate and WPI Inflation

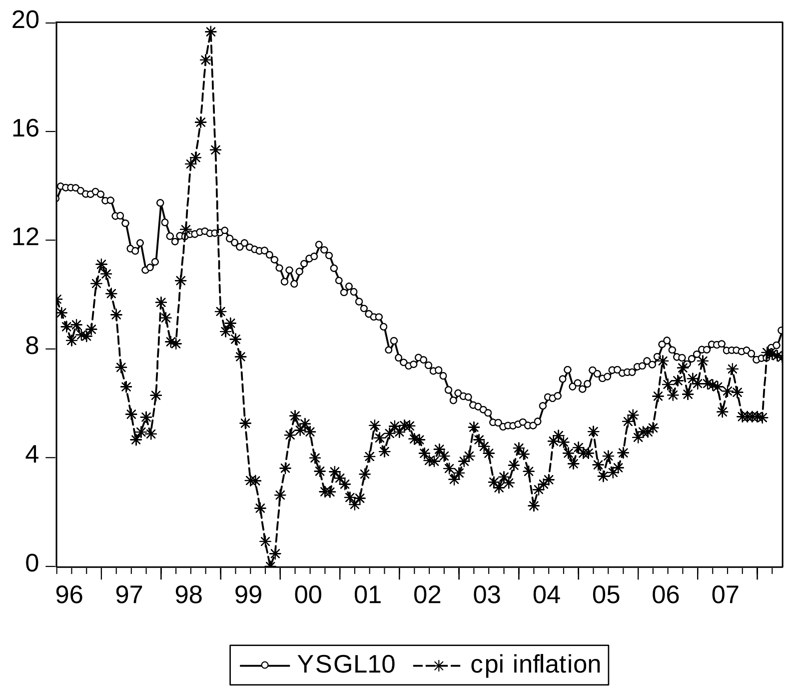

Figure 4. 10 year interest rate and CPI Inflation