Determination of Interest Rate in India: Empirical Evidence on Fiscal Deficit-Interest Links and Financial Crowding Out

Lekha Chakraborty

Working Paper No. 2012-110

December 2012

National Institute of Public Finance and Policy
New Delhi
http://www.nipfp.org.in

Determination of Interest Rate in India: Empirical Evidence on Fiscal Deficit-Interest Links and Financial Crowding Out

Lekha Chakraborty[1]
Email: lekhachakraborty@gmail.com

Abstract

Controlling for the capital flows, using the high frequency macrodata of financially deregulated regime, the paper examined whether there is any evidence of fiscal deficit determining interest rate in the context of India. The period of analysis is FY 2006-07[04] to FY 2011[04]. Quite contrary to the debates in the policy circles, the results found that increase in fiscal deficit does not cause the rise in interest rates. Using the asymmetric vector autoregressive model, it is established that the rate of interest is affected by the reserve money changes, expected inflation and volatility in the capital flows, but not the fiscal deficit. This result has significant policy implications for interest rate determination in India. The long term and short term interest rates are analysed to determine the occurrence of financial crowding out, but fiscal deficit does not appear to be causing both shorts and longs.

Key words: fiscal deficit, asymmetric vector autoregressive model, financial crowding out

JEL codes: E62, C32, H6

[1] The author is Associate Professor at the National Institute of Public Finance and Policy (NIPFP) and Research Associate at the Levy Economics of Bard College, New York. The views expressed in this paper are those of the author and do not necessarily reflect the position of the Institutes, where author is affiliated. The author is grateful to M Govinda Rao for the discussion on the interest rate determination. Thanks are also due to Luciano Greco, Pinaki Chakraborty, Sivaramakrishna Sarma and selected participants of 68th Congress of International Institute of Public Finance (IIPF) Conference, Dresden, August 16-19, 2012 for their useful comments. Thanks are also due to Amita Manhas for compiling the RBI high frequency data. The usual disclaimer applies.

Determination of Interest Rate in India: Empirical Evidence on Fiscal Deficit-Interest Links and Financial Crowding Out

Theoretically, an analysis of the link between fiscal deficit and interest rate assumes importance mainly for three reasons. Firstly, in the context of growing global integration of financial markets, the macroeconomic effects of an increase in the domestic interest rate due to the rise in the fiscal deficit can be spread globally. Secondly, if the increase in fiscal deficit leads to an increase in the rate of interest, it may lead to a crowding out of the interest-sensitive components of private spending, especially the private corporate investment. And thirdly, if such a relationship is verified, the fiscal and monetary policy linkage in the macro management of a country is established. For instance, a reduction of budget balances could moderate upward pressure on interest rates and could therefore provide monetary policy additional degrees of freedom in the interest rate management[2].

This is a rare gamut of empirical literature in India examining the link between the two. Chakraborty (2002) has made an attempt to address this empirical link and concludes that deficit does not induce rise in rate of interest in India, rather the causality is the other way round. Two years later, incorporating the monetary variables, the model by Chakraborty (2002) was reexamined by a study from RBI by Goyal (2004) and found the results in consistent with the former. Though Chakraborty (2007) revisited the question of crowding out in India, the aspects of the 'financial' crowding out channel via the interest rate mechanism was not analysed in the context of capital flows, rather the focus of the paper was on 'direct' crowding out. However, the study found that fiscal deficit is not a determinant of interest rate in India.

This paper takes the literature forward by incorporating the capital flows in the macro model of interest rate determination. Theoretical literature identifies two variants of crowding out in an economy – real and financial[3]. The *real* crowding out

[2]In a large number of industrial countries, actual fiscal imbalances prevent monetary policy from properly managing interest rates. Thus in order to stimulate economic activity, the setting of both monetary and fiscal policies needs to be reassessed within a comprehensive framework of sound and stable fiscal balances over the medium term (Correia, et al: 1995) .

[3] Blinder and Solow (1973) in his seminal paper "*Does fiscal policy matter?*" discuss three levels of crowding out at theoretical level. The first level of crowding out occurs when public investment displaces private investment broadly on a *dollar-for-dollar* basis. This level of crowding out occurs irrespective of the mode of financing the deficit. The second level of crowding out, as Blinder and Solow (1973) puts, is an integral part of Keynesian tradition. It is based on the notion that deficit spending *not accompanied by new issuances of money* carries with it the need for government to float debt issues which compete with the private debt instruments in financial markets. The resulting upward pressure on interest rates will reduce any private expenditure, which is interest rate sensitive. In other words, this financial side effect of crowding out occurs via rate of interest (that is, bond financing of deficit causes market rate of interest to rise and in turn crowds out private investment). As discussed by Blinder and Solow (1973), there is no theoretical controversy over this second level of crowding out; the only contested issues are empirical. The rationale for third level of crowding out is that any government deficit requires the issuance of some sort of debt instrument –outside money or interest bearing bonds – and this increase in private wealth will have further reverberations in the economy. In other words, debt financing of deficit simultaneously results in the creation of bonds, which is considered as net wealth in the private sector. It is a matter of debate whether bonds are considered as net wealth in the context of India, and this third level of crowding out may be beyond the scope of the study in the context of India. The second level of crowding out is the focus of this paper.

occurs when the increase in public investment displaces private capital formation, which is also termed as *direct* crowding out[4]. The phenomenon of partial loss of private capital formation in the economy, due to the increase in the interest rates emanating from the pre-emption of real and financial resources by the government through bond-financing of fiscal deficit is termed as *financial crowding out*. The *financial* crowding out occurs due to the upward pressures on rate of interest induced by the debt financing of fiscal deficit (interest rate effect). The phenomenon of financial crowding out is analysed in this paper in the context of deregulated financial regime in India.

The taxonomy of crowding out was discussed in detail by Buiter (1990). According to Buiter, *direct* crowding out (or crowding in) refers to substitution or complementary relationships between public and private spending that occur not through changes in prices, interest rates or required rate of return by changes in public sector activity, but through public sector consumption/investment being an argument in private utility functions and through the public sector capital stock being in argument in private sector production functions[5]. Buiter defined *indirect* crowding out as the consequences of public actions that affect private behaviour either by altering budget constraints or by influencing the prices faced by private agents, viz. rate of interest. In other words, the crowding out occurs via interest rate changes are referred to as *financial* crowding out[6].

Chakraborty (2007) though established nil evidence of *direct* crowding out of private corporate investment in India, the absence of direct crowding out does not necessarily imply the absence of *financial* crowding out. The *financial* crowding out may occur due to the upward pressures on the rate of interest induced by the debt financing of fiscal deficit. In other words, even if public sector investment does not crowd out private corporate investment, the private capital formation in the economy may suffer due to the increase in the interest rates arising due to the pre-emption of real and financial resources by the government to finance the increasing fiscal deficits. In this paper, we examine the plausibility of fiscal deficit affects interest rate. It is all the more important to examine such a link in the present context, as Chakraborty (2007) found that the rate of interest is a significant determinant of private corporate investment. If increase in fiscal deficit increases the rate of interest, it would imply financial crowding out.

It is well known that Indian financial system was characterised by administered interest rate structure till nineties. The process of financial deregulation since 1991 has been aimed at making the financial sector market-oriented to improve allocative efficiency[7]. The moot question is that, as rate of interest was administered

[4] Real crowding out is important to analyze in the context of developing countries like India because of the large share of public investment in gross capital formation and moreover, the nature of public investment (whether infrastructure or non-infrastructure) itself can affect private investment differently.

[5] Buiter, 1990, page 34.

[6] Kotlikoff (1984) also pointed out that 'financial crowding out' is advanced in literature through the testing of causal link between fiscal deficit and rate of interest. He further pointed out that much of the concern with 'financial crowding out' revolves round the transaction of selling bonds to finance fiscal deficit. As argument goes, a government's sale of bonds, regardless of its use of the proceeds, raises the total supply of bonds in the market. The greater supply of bonds, according to this view, means a lower bond price, that is, a higher interest rate, which reduces (crowds out) the private investment.

[7] The major highlights of financial liberalization are interest rate deregulation, a phased reduction of cash reserve requirement and statutory liquidity ratio, simplifying directed credit programmes, development of money markets etc. The administered interest rates were

until the financial deregulation, how a functional relationship could be justified between fiscal deficit and the administered interest rate. Even if it is assumed that administered rate of interest truly reflects the market signals; there is a need to establish such a relationship empirically. The task of establishing such a relationship is ambiguous, and might be the reason which thwarts the analysis of this link, prior to the deregulation of interest rates. However, contrary to the popular belief that administered rate of interest in developing countries is insensitive to market perceptions, the literature revealed that administered rate of interest does accommodate market signals, and in order to analyse that, literature suggested examining the intertemporal movement of rate of interest and its variability (Gupta, 1984). The analysis of intertemporal movements in the selected rates of interest adjusted for inflationary expectations also showed that the rates of interest in India, though administered, has shown variations over the years and real rates of interest remained positive in substantial number of years. Chakraborty (2007) using the annual data has established nil evidence for fiscal deficit causes interest rate determination. However, the model was not controlled for the capital flows. This paper takes the debate forward in the context of capital flows, focusing on the financially deregulated regime, using the recent high frequency data of fiscal deficit and rate of interest for the period April 2006-07 to April 2011-12.

This paper is organised into five different sections. *Section 1* discusses various theoretical paradigms on the relationship between fiscal deficit and interest rates and critically evaluates the empirical literature. *Section 2* discusses the theoretical model of rate of interest in an open-economy framework, while *Section 3* interprets data while *section 4* deals with econometric methodology adopted and reports the results obtained. *Section 5* concludes.

I. Theoretical Paradigms and Empirical Literature

At theoretical level, an extensive debate has developed to explain the link between deficit and interest rate. There are three different theoretical paradigms, *viz*., neo-classical, Keynesian and Ricardian, under which this relationship can be viewed and empirically tested. According to the neoclassical view, rise in deficit leads to an increase in the rate of interest and in turn crowds out private investment. Whereas the Keynesians visualize that though increase in the deficit leads to an increase in the rate of interest, such an increase stimulates savings and capital formation. In between the neoclassical and Keynesian view, there exists the central observation of Ricardian Equivalence Theorem which argued that deficits merely postpone taxes and therefore tax-financing and debt financing of deficit have equal impact on the economy and thus deficit does not have any impact on interest rate (Barro, 1974).

Many authors have empirically tested this relationship and found contradictory results. Evans (1985), Tanzi (1985), Dalamagas (1987), Ahamad (1994), Kulkarni and Lee (1996) found no positive link between rate of interest and

simplified since 1992-93. A small number of fixed rates for priority sector loans were retained, while large commercial borrowers faced a floor-lending rate. In 1993-94, the markets for commercial paper and certificate of deposit was deregulated, allowing companies to access credit at market terms that were considerably below the minimum lending rate. In October 1994, the minimum lending rate was eliminated. The deregulation of interest rates has been accompanied by the introduction of new instruments like 14-day and 182-day auction Treasury Bills in addition to the 91-days and 364-days auction Treasury Bills. It is to be noted that 182-day Treasury bill was reintroduced in mid-1999.

deficit. While Cebula (1990), Correia and Stemitsiotis (1995), Ostrosky (1979) did find evidence for the link between deficit and rate of interest.

Table 1: Selected Empirical Evidences on Link between Fiscal Deficit and Interest Rate

Study	Results
Paul Evans (1985)	Deficit does not have impact on rate of interest in the context of USA, for the period 1858-1950.
Mustaq Ahmed (1994)	No variable except inflation is significant. Monetary and fiscal policy variables do not have any impact in the context of Pakistan, for the period 1970-1991.
Tanzi, Vito (1985)	Sensitivity of rate of interest to fiscal deficit has come down in the recent years of study, in 1980-84 in the context of USA. The entire time period of the study was 1960-84.
Erol Balkan & Umit Erol (1985)	Significant and positive impact of government deficit on real rate of interest in the context of UK for the period 1960-84.
Cebula, Richard (1990) 1973-1993 US	Deficit Granger causes rate of interest.
Correia, Jose and Luakas Stemitsiotis (1995) 1970-1993 10 OECD (Organisation of Economic Co-operation and Development) countries	Deficit affects long run rate of interest.
Gupta, K L (1992) 1960-1985 10 Asian countries	RET is rejected for Sri Lanka, India, Indonesia, Philippines among 10 countries.
Kulkarni and Erick (1996) 1960-1988 India	Deficit does not affect rate of interest.
Elmendorf and Mankiw, (1998)	Fiscal deficits (ceteris paribus) reduce national savings and increase aggregate demand. This creates an excess supply of government debt, leading to higher real interest rates.
Gale and Orszag (2002) 60 countries	Of 60 countries, around one-half found a “predominantly positive significant” effect of fiscal deficits on interest rates and the other half a “mixed” or “predominantly insignificant” effect.

The common analogy of latter set of studies is that, in a growth economy with accumulation, increasing budget deficits may create over the long term a shortage of funds available for investment. If this potential imbalance between the supply of funds and intended investment is not met, long-term rate of interest react as economic agents anticipate the shortage of funds. The former set of studies, which observed no link between interest rate and fiscal deficit emphasizes that in the context of global integration of financial markets, the supply of funds curve is infinitely elastic. Also, some studies under this category, tried to explain their findings under the paradigm of Ricardian Equivalence Theorem (hereafter RET).

It is to be noted that the empirical literature on fiscal deficit and interest rate link is largely confined to developed countries. To start with, in the context of US, Tanzi (1985) examined the relationship between fiscal deficit and interest rate. He observed that for the period between 1960 and 1984, the sensitivity of interest rate to fiscal deficit came down over the years. Tanzi pointed out that the plausible explanation beneath this phenomenon is the growing global integration of financial markets in recent years and correspondingly increasing flow of global capital to finance the domestic deficit. On the basis of the multivariate Loanable Funds Model (which incorporates the effect of term structure of rate of interest)[8], Cebula (1990) and Correia, et al (1995) showed that deficit, inflation, short run rate of interest, percentage change in GDP and capital flows Granger cause nominal long term rate of interest and hence crowd out private investment. In the study of Correia, et al (1995), which was, based on cross-country data of 10 OECD countries; there was evidence of crowding out as rate of interest was positively linked to the deficit. Further, Cebula (1997) examined the direction of causality between long term interest rates and structural budget deficits in the US for a period between 1973 and 1991 and found that there is bi-directional causality between rate of interest and the deficit. Gale and Orszag (2002) argued that rate of interest rate do not increase as a result of fiscal expansions because of foreign capital savings replacing domestic savings. However economic performance may still be negatively affected by persistent fiscal imbalances as capital stock accumulation declines either because of a decline in domestic or foreign net investment.

In the context of developing countries, studies are few on the link between budget deficit and interest rate. In the context of Pakistan, Ahmad (1994) found that there is no link between rate of interest and deficit. In India, paucity of data on market rate of interest might be the reason for no specific studies on the causal relationship between the deficit and interest rates. Sunderrajan and Takur (1990), Pradhan, et al (1990) and Parker (1995) addressed the issue of 'direct' crowding out between public and private investment in India, but these studies did not analyse the macroeconomic link of fiscal deficit and interest rate through which the crowding out phenomena should theoretically be operating.

II. Analytical Framework

The analytical framework for the study is derived from an extended version of Sargent's (1969) paper '*Commodity Price Expectations and the Interest Rate*'. The extended version of Sargent's model is flexible enough to incorporate the macroeconomic link that may operate in the determination of interest rates. Sargent (1969) expressed the nominal rate of interest as a combination of three components: the equilibrating rate of interest, the spread between market rate of interest and the equilibrating real rate of interest and the spread between nominal rate of interest and market rate of interest. It can be expressed as follows.

$$r_{n(t)} = r_{e(t)} + [r_{m(t)} - r_{e(t)}] + [r_{n(t)} - r_{m(t)}] \quad (1)$$

[8] The advantage of Loanable Funds model is that in addition of capturing the monetary and fiscal variables like real deficit, real money stock, government spending, expected inflation rate etc., it also captures the term structure of interest rates. In other words, loanable funds model framework allows the combination of the characteristics of the term-structure with the fiscal and monetary policy variables influencing the interest rate.

In equation (i), $r_{n(t)}$ is the nominal rate of interest, $r_{e(t)}$ is the real rate of interest which equilibrates desired savings and desired investment; $r_{m(t)}$ is the nominal rate of interest adjusted for the expected rate of inflation. Each of the three specific components is determined in turn by specific macroeconomic variables. The logical step that follows is to identify the determinants of each of the three terms in equation (1)[9]. One of the significant determinants of the first term, $r_{e(t)}$, which is the real rate of interest that equilibrates desired savings and desired investment, is the deficit of the government[10].

$$r_{e(t)} = \alpha + \beta_1(def_t) + \mu_t \qquad (2)$$

The determinant of the second term, [$r_{m\,(t)} - r_{e\,(t)}$], is determined by the rate of growth of high powered money[11]. In the open economy model, capital flows also determines the spread between the market rate and the equilibrium real rate of interest. The real exchange rate can also be inserted in the equation (3) to capture the effect on interest rate, in an open economy macro model. Assuming linearity, we thus have:

$$r_{m(t)} - r_{e(t)} = \lambda + \beta_2(\Delta M_3)_t + \beta_3(K_r)_t + \delta_t \qquad (3)$$

Where, $(\Delta M_3)_t$ = changes in high powered money,

$(K_r)_t$ = net capital flows

The last term of equation (1) is assumed to depend linearly and positively on the inflationary expectations.

$$r_{n(t)} - r_{m(t)} = \theta + \beta_4(\pi_t^e) + \upsilon_t \qquad (4)$$

Where, $\pi_t^e = Expected\ Rate\ of\ Inflation$

Now by substituting equation (ii), (iii) and (iv) in equation (i) we get equation (5)

$$r_{n(t)} = \varphi + \beta_1(def_t) + \beta_2(\Delta M_3)_t + \beta_3(K_r)_t + \beta_4(\pi_t^e) + \omega_t \qquad (5)$$

According to equation (5), rate of interest is a function of fiscal deficits, change in high powered money, capital flows and expected inflation. The capital flows

[9] The derivations of determinants of each term in the model are drawn from Gupta and Moazzami (1996). But as the objective of their study was to test the validity of alternative paradigms of link between deficit and rate of interest – Neoclassical, Keynesian and Ricardian Equivalence Theorem - across countries and to distinguish between the short term and long impact of deficits on rate of interest, we have not drawn heavily on the derivations of the determinants of the model; rather we improvise the specification according to our purpose to undertake the impact of fiscal deficit on rate of interest in the context of India, irrespective of the paradigm-specific details and dichotomy of transitory and permanent effects of deficits on rate of interest.

[10] The other determinants of term (i) in Gupta-Moazzami model constituted government consumption expenditure, national income, private consumption expenditure, private savings etc, which we omit in our specification due to multicollinearity problems and moreover, these explanatory variables are not required for our analysis as we have not gone into testing of validity of each of the alternative paradigms of fiscal deficit and rate of interest in the context of India; rather our prime concern was to assess the role of fiscal deficit on rate of interest to understand the transmission channel of crowding out phenomenon.

[11] For details, see Sargent (1969).

is an important variable for the model, especially when the period under study experiences volatility in the capital flows, and therefore controlling for this fluctuations in liquidity, whether fiscal deficit affects interest rate is an interesting aspect to examine. The above theoretical derivation is econometrically estimated.

Each of these determinants is linked to rate of interest through various macroeconomic channels; a few are attempted as follows. The unsettled relationship between money supply and rate of interest effect is reviewed extensively by Nachane, et al (1997). These are mainly unanticipated monetary announcement effect, Keynesian liquidity effect, financial effect, price expectations effect (Fisher effect) and income effect. Due to unanticipated monetary announcement effect, permanent higher money growth rate induces an increase in expected inflation and a resulting increase in interest rates to reflect an inflation premium. (Girton and Nattress, 1985). According to the Keynesian "liquidity effect," income and prices are slow to react as the money supply increases and thus the monetary system experiences excess liquidity at unchanging nominal income levels. Contemporaneous with the liquidity effect there runs the financial effect. As per the financial effect, as the growth of money increases, banks find themselves saddled with excess reserves and these excess reserves have to be temporarily parked in short term market securities. This temporary spurt in the demand for short-term marketable securities lowers short term interest rates. When money supply increases with the rise in income, demand for money rises. As a result the real balance of the economy decreases, finally pushing up the nominal rate of interest.

Price expectation effect (Fisher Effect) manifests that when money supply increases, the expected inflation increases and thereby the nominal rate of interest also increases. All five effects will be present in any given situation though their duration, strength and timing are largely an empirical matter and will vary from situation to situation. The relationship between monetary expansion and interest rate has been obscure in the empirical literature. While Mishkin (1982) found that the interest rate and money growth surprises have a significant positive correlation, Makin (1983) found that it is negative and significant. Makin explained these contradictory findings as a result of the different method used to measure interest rates. Makin implied that his *period-average* short term rate of interest is responding to the initial liquidity effect, while Mishkin's *end-of-period* short term rate of interest measure is sampled after the Fisher effect begins to dominate. Grier (1986) also showed that lagged money surprises have a significant positive impact on rates.

Fisherian theory predicts that the nominal rate of interest will tend to change at the same rate as changes in expected inflation. Thus it manifests one-to-one relationship between the expected inflation and the nominal rate of interest. According to Fisher equation, a one- percent increase in the expected rate of inflation in turn causes a one percent increase in the nominal rate of interest. Only a few studies in the context of US by Feldstein (1976), Gibson (1970) have found coefficients close to unity. But Sargent (1976), Shiller (1979) and Wood (1981) have observed that these findings of "coefficients close to unity" are limited to a particular period of US history, till early seventies. Furthermore, even a unit coefficient would contradict superneutrality hypothesis; that an increase in inflation will not affect real interest rates in the longrun.

Robert Lucas (1980) finds no empirical support for the hypothesis, which he calls one of the central implications of the quantity theory of money. Beginning with Irving Fisher (1930), most of the empirical investigations have found out that fully anticipated inflation has less than a unit effect on nominal rate of interest, and thus reduces the real rate of interest even in the longest of the runs. Fama (1975) concluded: … "*one ... cannot reject the hypothesis that all variation through time in one-to-six month nominal rates of interest mirrors variation in correctly assessed one-to-six month expected rates of purchasing*

power". Fama's conclusion rests on two assumptions: (a) there is a constant expected real rate of interest. (b). All relevant information about future inflation is fully incorporated in the expected-inflation component of the market rate of interest. Both assumptions are contradicted by evidence by Carlson (1977). Carlson pointed out that variations in short-term interest rates are not good predictors of variations in inflation rates. Further more, both of the key assumptions are of dubious validity. First, evidence has been presented that expected short-term real interest rates do have notable variation.

Under the scenario of large capital flows in a flexible exchange rate regime, the nominal exchange rate appreciation leads to the deterioration of international competitiveness. So to prevent the real appreciation of the exchange rate and to preserve external competitiveness, central bank intervenes in Forex market to sterilize the incremental liquidity thus generated, thereby keeping the monetary expansion under control. This process has however quasi- fiscal costs associated with it as it imposes the danger of rising the real interest rate, which can further induce the capital flows. Another explanation is that an increase in the exchange rate of the last year would make the domestic currency less valued in the international market, and therefore would attract the demand for domestic financial assets from abroad. This may lead to increase in interest rate. The capital flows has been incorporated in the macro model, however exchange rate is dropped in the econometric model for empirical reasons of non-stationary series as well as multicollinearity between capital flows and exchange rate.

III. Interpreting Data

Data is organised from the high frequency series of macro variables from the data bank of Reserve Bank of India. Selection of appropriate interest rate from the available spectrum of interest rates in India for an elaborate analysis of link between rate of interest and fiscal deficit is the crucial step in data mining. The major rates of interest are call money market rate, bank rate, Treasury bill rates (91 days, 364 days and 182 days), bank rate, prime lending rate of term lending institutions and interest rate on dated securities of Government of India. Among these rates of interest, call money market rate has exhibited large volatility and the bank rate appeared to be non-varying in nature, which intuitively can be opted out in analyzing the link between fiscal deficit and rate of interest. Long term rates of interest are also opted out as a reference rate. Prime Lending Rate is relevant as it is a significant determinant of private investment behaviour, but opted out as it is long term rate and also shown a broad stickiness in the rates. The redemption yield on dated securities of India is identified on the ground that shift from seigniorage financing to bond financing of fiscal deficit in India can have some pressure on rate of interest, especially the rate of interest on bonds or securities, but opted out as it is long term. Treasury bill rate is identified as the reference rate of interest. Theoretically, a reference rate is defined as the price of a short-term low risk instrument in a free liquid market. The weighted average of Treasury Bill rates of 91 days, 182 days and 364 days are used as the rate of interest variable in this paper. However, the determination of long term interest rates, in particular, the government securities rate, and the role of fiscal deficit in determine the longs is also analysed outside the purview of reference rate analysis, at the later stage, as interest rate on government security is also an important rate especially when government securities constitute a major chunk of bond financing of deficit in India.

Having selected the relevant rates of interest for the analysis, the next task is to transform these rates of interest into ex ante real rate of interest. According to Fisher hypothesis, nominal rate of interest (γn) is given by

$$\gamma^n = \gamma^r + \pi^e \quad (6)$$

where γ^r is the real rate of interest and π^e is the expected rate of inflation. The real rate of interest in any period, thus, is postulated to evolve as a deviation between nominal rate of interest and the expected inflation. Correia, et al (1995) used the low frequency component of consumer price changes as generated by Hodrick-Prescott [HP] filter to model *expected* inflation. We use HP filter for computing expected inflation[12].

Using HP filter, how to capture expected inflation from the observed series[13]? Let us assume that observed inflation π contain both expected π^e and unexpected components π^u.

$$\pi = \pi^e + \pi^u. \quad (7)$$

The HP filter decomposes observed inflation into a stationary cyclical component and a smooth trend component (π and π^e denote the logarithms of observed and expected inflation respectively) by minimising the variance of cyclical component subject to a penalty for the variation in the second difference of the trend component. This results in the following constrained least square problem.

$$\text{Min} \quad \sum_{T=1}^{i} (\pi - \pi^e)^2 + \sum_{t=2}^{T} [(\pi^e_{t+1} - \pi^e_t) - (\pi^e_t - \pi^e_{t-1})]^2$$

The same procedure through the HP filter methodology is also used to derive at the unanticipated component in the reserve money as well as the money supply, by decomposing the series into cyclical and structural components.

IV. Econometric Estimation of Rate of Interest Model and Results

A significant debate exists in time series literature on performing the pretests of integration and co-integration (Todo and Yamamoto (1995). A stationary times series are integrated of order zero, xt ~ I(0). The time series econometrics encounters problems, how to involve a mixture of I(0) and non-stationary I(d) series, where the order of integration d can be different for different series and even fractional, and where the stationarity assumptions are difficult to verify. A few attempts to get rid of these problems of pretests for vector autoregressions (VAR) can be found in econometric literature, the prominent being the methodology by Todo and Yamamoto (1995) and Vinod (2006).

[12] Apart from HP filter method, various other econometric methods have also been employed to construct appropriate proxies for the market's expectations of future inflation. Tanzi [1985] used surveys of inflationary expectations such as Livingston index to generate series on expected inflation in the context of US. Autoregressive models have also been used to generate series of expected inflation.

[13] HP filter has good mathematical properties in order to extract the unobservable variable of expected inflation out of the observed series. The expected inflation series computed using HP filter contains both forward and backward looking information on inflation rates, which makes it relevant in rational expectations framework.. Past information is necessary to adjust prices from a disequilibrium position, while information regarding future trends is also required because rational economic agents look forward in time to form expectations about the future inflation rate (Correia, et al, 1995).

Getting to theoretical basics of economics, Samuelson's (1947) explained economic equilibrium as describing a given set of ''functional equations and initial conditions describing relationships between variables . . . for the purpose of determining the evolution of a set of economic variables through time" and therefore converting economic time series to stationarity via differencing transformation justified by unit root testing is problematic for evolutionary short series (Vinod, 2006). The entire debate on unit roots has roots in the work of Nelson and Plosser (1982), which suggested that most of the macroeconomic variables have a unit root time-series structure. For instance, there is a considerable amount of debate about the stationary properties of prices. While Perron (1989), Levin and Lin (1992), Culver and Papell (1997) suggested that inflation is a stationary series, other studies in the multivariate country contexts by Baille, Chung and Tieslau (1996), Baillie(1989), Ball and Cecchetti (1990) and Johanson (1992) found evidences in favour of unit roots in price series. This debate poses a serious revisit to the macroeconometrics, which assumes inflation as a unit root macroeconomic variable. This debate on the unit root properties can be extended to other macro variables, viz., deficits, interest rate, exchange rate, capital flows, money supply as well.

Against the backdrop of this debate, the methodology used in this paper is not an attempt to avoid the difficult inference problems associated with unit root testing, rather a judicious selection of macro variables to avoid the mixing of I(0) and I(d) variables; and care is taken to protect the time series properties of the macro variables by not succumbing a detrending or differencing process during the pretests. The unit roots are initially performed through the augmented Dickey Fuller methodology. However, as suggested by Perron (1989), ADF has a tendency not to reject the null hypothesis of unit root, when the series has a structural break. A test for structural breaks has been attempted by deciding apriori the units of break, and the growth rate analysis of both subsets of time periods were analysed and found no significant difference between the coefficients[14]. The *table 2* reports the unit roots performed on the macro series used in the study.

Table 2: ADF Inference on Unit Roots

Macro variables	**T-stat**	**lags**	**Decision**
gross fiscal deficit	-3.72621	0	I(0) with no c,t
real rate of interest (short)	-2.22177	2	I(0) with no c,t
expected real rate of interest(short)	-1.65794	2	I(0) with no c,t
Expected inflation	-3.48682	0	I(0) with no c,t
Unanticipated monetary supply	-3.95941	0	I(0) with no c,t
Capital flows	-6.42229	0	I(0) with no c,t
Portfolio-capital flows	-8.11423	0	I(0) with no c,t
high powered monetary	-2.82898	0	I(0) with no c,t
rate of interest (long)	-3.806301	2	I(0) with c, no t
real rate of interest (long)	-3.195627	3	I(0) with no c,t
expected real rate of interest (long)	-4.720559	2	I(0) with c,t

Source: (Basic data), Reserve Bank of India

[14] The potential existence and timing of structural breaks in the series could also be attempted through Zivot and Andrews (1992) test which identifies possible periods of structural break in the time series based upon a series of dummy variable constructs. If the dummy variables are statistically significant, the precise time of the structural break can be determined based on a max R^2 criteria.

Table 3: Phillips Perron Inference on Unit Roots

	(PP) T-stat	lags	Decision
gross fiscal deficit	-3.72621	0	I(0) with no c,t
Real rate of interest (short)	-1.816985	2	I(0) with no c,t
Expected rate of interest (short)	-2.06752	4	I(0) with no c,t
Expected inflation	-3.48682	0	I(0) with no c,t
Unanticipated monetary supply	-3.95941	0	I(0) with no c,t
Capital flows	-6.42229	0	I(0) with no c,t
Portfolio flows	-8.11423	0	I(0) with no c,t
high powered money	-2.82898	0	I(0) with no c,t
Rate of interest (long)	-2.862993	3	I(0) with c, no t
Real rate of interest (long)	-2.106247	5	I(0) with no c,t
expected real rate of interest (long)	-3.282140	3	I(0) with c,t

Source: (Basic data): Reserve Bank of India

The ADF and PP tests of unit roots revealed that the macro variables for the study are stationary at levels with no drift and trend. Therefore the logical next step that follows to analyse the causality. Toda and Yamamoto (1995) developed an alternative causality testing procedure based upon the test equations of Granger, but augmented with extra lags depending on the potential order of integration of the series of interest. If the series are assumed I (1), one extra lag is added to each variable in the test equation. If both variables are assumed I (0), no extra lag is added in the equation, and the Toda Yamamoto test is equivalent to the Granger Causality test. A Wald Test is carried out to determine the relationship between the two variables. However, Hsiao (1981) is used in this paper as it simultaneously identifies the optimal parametrisation of the model and the causality directions. The optimal parametrisation is attempted in Hsiao (1981) through Final Prediction Error (FPE).

Vector Auto Regression models can be written in general form as

$y_t = \square + \square(L)\, y_t + \square_t$ ---------- (i)

where y_t is vector of model variables

$\square$ is vector of constants

$\square_t$ is vector of white noise error terms

$\square$ (L) is vector of polynomials in the lag operator, L

where $\varphi_{ij} = \sum_{t=1}^{k} \varphi_{i\,j\,i} L^i$ where L is the lag operator

$\square_t$ and $\square_t$ are white noise error terms.

To choose the order of lags in $\square_{ii}$ (L) and $\square_{ij}$ (L) by the minimum FPE is equivalent to applying an approximate F test with varying significance levels [for details, see Hsiao [1981].

Akaikes' definition of Final Prediction Error criteria is expressed as

$$FPE_y(m,n) = \frac{T+m+n+1}{T-m-n-1} * \frac{\sigma^2 y(m,n)}{T}$$ where T is the number of observations, m and n are the order of lags of the variables under the concern , private corporate investment [y] and determinants[x_s] respectively and

$$\sigma^2 y(m,n) = \sum_{t=1}^{T} (y_t - \hat{\psi}^{m}_{ii}(L) y_t - \hat{\psi}^{n}_{ij}(L) x_{s_t} - \hat{a})^2$$

where superscripts m and n denote the order of lags in $\psi_{11}(L)$ and $\psi_{12}(L)$. And $\psi^{m}_{11}(L)$, $\psi^{n}_{12}(L)$ $x_{s\,t}$ and $\hat{a}$ are the least square estimates. The causality can be detected as follows: If FPE y (m, n) < FPE y (m, 0) then $x_{(s)t}$ Granger causes y_t, denoted by $x_{(s)t} \rightarrow y_t$.

In the multivariate autoregressive modeling, the sequence in which variables enter the equation matters. We used Specific Gravity Criteria suggested by Caines, Keng and Sethi (1981) for sequencing the variables. Caines, et al (1981) suggested the following procedure for multivariate autoregressive modeling for stationary processes:

(i). For a pair of stationary processes (X, Y) construct bivariate AR models of different orders, then compare the multivariate final prediction errors of these models, and choose the model of order k possessing minimum FPE to be the optimal model for the pair of processes (X, Y).

(ii). Construct bivariate AR (k) models (both causal models and non-causal (independent) models] for (X, Y) and apply the stage wise causality detection procedure to determine the endogeneity, exogeneity or independent relations between X and Y.

(iii). If a process, say X, has n multiple causal variables, $y^1, y^2, \ldots, y^n$, we rank these multiple causal variables according to the decreasing order of their specific gravities.

(iv). For each caused (endogenous) process, X, we first construct the optimal univariate AR model using FPE criterion, then we include X's multiple causal variables, one at a time, according to their causal ranks and use FPE criterion to determine the optimal orders of the model at each step.

(v). Pool all the optimal univariate AR models constructed in (iv) and estimate the system.

The final prediction error (FPE) of fitting one dimensional autoregressive process for fiscal deficit (DEF) and rate of interest (TB) are computed with upper bound of lag length (L^*) assumed equal to 15. Firstly, we have considered real rate of interest as controlled variable, holding the order of its autoregressive operator to one, we sequentially added the lags of the manipulated variables upto the L^* of 15. In this treatment of real rate of interest as the manipulated variable we found that FPE_{DEF} (m*,n*) > FPE_{DEF} (m*,0) which implies fiscal deficit doesnot Granger-causes rate of interest. However, the changes in money supply, capital flows and inflationary expectations determines rate of interest.

Table 4: Shorts: Optimal Parametrisation and Causality Detection

Controlled Variable	Manipulated Variables				Optimum lags of Manipulated Variable	Final Prediction Error	Causality Inference
$(i_r - \pi^e_t)$ [1]	-	-	-	-	1	0.37445	
$(i_r - \pi^e_t)$ [1]	$(expinf)_t$	-	-	-	4	0.29759	$(expinf)t \Rightarrow (i_r - \pi^e_t)$
$(i_r - \pi^e_t)$ [1]	$(expinf)_t$	Δhpm_t	-	-	3	0.29998	$\Delta hpm \Rightarrow (i_r - \pi^e_t)$
$(i_r - \pi^e_t)$ [1]	$(expinf)_t$	Δhpm_t	$(Kr)_t$	-	1	0.31025	$(Kr)_t \Rightarrow (i_r - \pi^e_t)$
$(i_r - \pi^e_t)$ [1]	$(expinf)_t$	Δhpm_t	$(Kr)_t$	def_t	1	0.38971	$def_t \neq (i_r - \pi^e_t)$

Note: Figures in the parentheses denotes the lag length of controlled variable.
Source: (Basic Data), Reserve Bank of India

Table 5: Longs: Optimal Parametrisation and Causality Detection

Controlled Variable	Manipulated Variables				Optimum lags of Manipulated Variable	Final Prediction Error	Causality Inference
$l(i_r - \pi^e_t)$ [1]	-	-	-	-	3	0.10907	
$l(i_r - \pi^e_t)$ [1]	$(expinf)_t$	-	-	-	4	0.099105	$(expinf)t \Rightarrow l(i_r - \pi^e_t)$
$l(i_r - \pi^e_t)$ [1]	$(expinf)_t$	$(Kr)_t$	-	-	2	0.102801	$Kr \Rightarrow l(i_r - \pi^e_t)$
$l(i_r - \pi^e_t)$ [1]	$(expinf)_t$	$(Kr)_t$	Δhpm_t	-	1	0.11289	$\Delta hpm_t \neq l(i_r - \pi^e_t)$
$l(i_r - \pi^e_t)$ [1]	$(expinf)_t$	$(Kr)_t$	Δhpm_t	def_t	2	0.111701	$def_t \neq (i_r - \pi^e_t)$

***Note*:** Figures in the parentheses denotes the lag length of controlled variable.
Source: (Basic Data), Reserve Bank of India

Table 4 and *5* present the results of Hsiao autoregressive modeling of causality detection, for the shorts and longs. The results showed that in the context of financial liberalisation and deregulation of interest rates, deficit does not induce rise in rate of interest. It is also found that in the deregulated financial regime, rate of interest is primarily determined by the inflationary expectations and capital flows (plausibly the exchange rate effects) in the economy. The result is true for the interest rate determination of shorts and longs.

V. Conclusion

The paper examined whether there is any evidence of financial crowding out in the recent years of financially deregulated interest rate regime. Using the high frequency macrodata, we found quite contrary to the popular belief that increase in fiscal deficit induces a rise in the rate of interest, that no significant relationship between the two. The conclusion drawn from the multivariate vector autoregressive analysis for the period from FY 2006[4] to FY 2011[4] revealed that rate of interest is affected by the unanticipated components of high powered money, expected inflation and fluctuations in capital flows.

As the causality is not established from fiscal deficits to rates of interest, the plausible evidence for nil financial crowding out is reinforced in Indian context.

The econometric results revealed that neither long term nor short term interest rate is determined by fiscal deficit in India. This result has significant policy implications for interest rate determination in India, as the central bank has kept the policy rates unchanged in all recent policy announcements, citing one of the prime reasons as the high fiscal deficits. Keeping the interest rates high or unchanged has negative implications for the economic growth.

References

Ahamad, Mustaq. (1994):"The Effects of Government Budget Deficits on Interest rates: A case Study of a Small Open Economy", Economia Internationale, Vol XLVII.

Baillie, R.T., 1989. Tests of rational expectations and market efficiency. Econometric Reviews 8, 151–186.

Baillie, Richard T., Ching-Fan Chung, and Margie A. Tieslau, "Analyzing Inflation by the Fractionally Integrated ARFIMA-GARCH Model", *Journal of Applied Econometrics*, Vol. 11, No. 1, 1996, pp. 23-40.

Balkan, E. and Balkan, U. (1995): 'Country Risk and International Portfolio Diversification', *Economia Internazionale*, 48(1): 1-12.

Ball, Laurence, and Stephen G. Cecchetti. (1990), Inflation and Uncertainty at Long and Short Horizons." *Brookings Papers on Economic Activity* 1:1990, 215-245.

Barro R J (1974), 'Are government bonds net wealth?' Journal of Political Economy, 82.

Blinder and Solow (1973): Does Fiscal Policy Matter?," Journal of Public Economics, November 1973, pp. 319-337.

Buiter, William (1990), 'Principles of Budgetary and Financial Policy, Harvester Wheatsheafhm, New York.

Caines P E, Keng C W and Sethi S P (1981), 'Causality Analysis and Multivariate Autoregressive Modeling with an application to supermarket sales analysis', Journal of Economic Dynamics and Control, 3.

Carlson, A Johns. (1977): "Short-term rates as predictors of inflation: Comment", American Economic Review, Volume 67, No.3.

Cebula, (1990):"Federal Government Borrowing and Interest rates in United States: An Empirical Analysis Using IS-LM Framework", Economia Internationale, Vol.43, No.2.

Cebula, Richard J. (1997): The Impact of Federal Budget Deficits on Long-Term Nominal Interest Rates in the U.S.: New Evidence and an Updating Using Cointegration and Granger-Causality Tests, 1973.2-1993.3, Economia Internazionale; 50(1), February.

Chakraborty , L (2002): Fiscal Deficit and Rate of Interest Link in India: An Econometric Analysis of Deregulated Financial Regime, in Economic and Political Weekly, May 11-17, 2002, Volume XXXVII No. 19.

Chakraborty, L 2007, "Fiscal Deficit, Capital Formation, and Crowding Out in India: Evidence from an Asymmetric VAR Model," Economics Working Paper Archive wp_518, Levy Economics Institute, The.

Correia Nunes, Jose and Stemitsiotis, Loukas (1995): Budget Deficit and Interest Rates: Is There a Link? International Evidence' Oxford Bulletin of Economics and Statistics; 57(4), November 1995.

Correia-Nunes, Jose and Stemitsiotis, Loukas (1995): Budget Deficit and Interest Rates: Is There a Link? International Evidence' Oxford Bulletin of Economics and Statistics; 57(4), November 1995.

Culver and Papell (1997) Culver, S. E., and D. H. Papell (1997). Is there a unit root in the inflation rate? Evidence from sequential break and panel data models. Journal of Applied Econometrics 12, 436-44.

Dalamagas, Basil A. (1987): Government Deficits, Crowding Out, and Inflation: Some International Evidence; Public Finance; 42(1).

Elmendorf Douglas W. and Gregory Mankiw, 1998. "Government Debt," NBER Working Papers 6470, National Bureau of Economic Research, Inc.

Evans, Paul. (1985): "Do large deficits produce high interest rates?" American Economic Review, Volume 75, No. 1.

Fama, Eugene. (1975): "Short-term rates as predictors of inflation", American Economic Review, Volume 65.

Feldstein (1976): " Inflation, income taxes and interest rates: A theoretical analysis", American Economic Review, Volume 66.

Fisher, Irving (1930): The Theory of Interest, New York

.

Gale, William G. and Peter R. Orszag. 2002. "The Economic Effects of Long-Term Fiscal Discipline." Urban-Brookings Tax Policy Center Discussion Paper. December 17.

Gibson, William E. (1970): " Price Expectations Effects on Interest rates"' Journal of Finance, Vol.25.

Girton, L and Nattress, D (1985), 'Monetary Innovations and Interest Rates', Journal-of-Money, Credit, and Banking; 17(3).

Goyal 2004, Does Higher *Fiscal Deficit* Lead to Rise in *Interest* Rates? Vol - XXXIX No. 21, May 22, *2004.*

Grier, Kevin B (1986), 'A Note on Unanticipated Money Growth and Interest Rate Surprises: Mishkin and Makin Revisited', Journal-of-Finance; 41(4).

Gupta, K. L. (1992): *Budget Deficits and Economic Activity in Asia*, Routledge, London.

Gupta, K. L. and Moazzami, B. (1996): *Interest Rate and Budget Deficit: A Study of the Advanced Economies,* Routledge Studies in Modern World Economies.

Harris, R. I. D. (1995) *Using Cointegration Analysis in Econometric Modelling*, New York, Prentice Hall.

Hsiao, Cheng, 1981. "Autoregressive modeling and money-income causality detection," Journal of Monetary Economics, Elsevier, vol. 7(1), pages 85-106.

Johansen, S, 1991, “Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models,” *Econometrica*, Vol. 59, No. 6, pp. 1551–1580.

Johansen, S, 1995, *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models* (New York: Oxford University Press).

Johansen, S. and Juselius, K. (1992): Testing Structural Hypotheses in a Multivariate Cointegration Analysis of the PPP and the UIP for the UK, *Journal of Econometrics,* 53(1-3): 211-44.

Johansen, S., 1988, “Statistical Analysis of Cointegration Vectors,” *Journal of Economic Dynamics and Control*, Vol. 12, No. 2–3, pp. 231–254.

Johansen, S., 1992. Determination of co-integration rank in the presence of a linear trend. Oxford Bulletin of Economics and Statistics 54, 383–397.

John, C (1977): ‘Short-term Rates as Predictors of Inflation: Comment’, *The American Economic Review*, 67(3). 469-75.

Kotlikoff, LJ (1984): Taxation and saving: A neoclassical perspective. Journal of Economic Literature, 22(4), 1576-1629.

Kulkarni, G Kishore and Erickson, lee Erick (1996): ‘Is Crowding out hypothesis evident in LDCs?: A case of India’, *Indian Economic Journal*, 43(1): 116-26.

Levin, A. and C-F. Lin (1992). Unit root tests in panel data: asymptotic and finite-sample properties. Discussion Paper 92-23, University of California, San Diego.

Makin, J. (1983): " Real Interest, Money Surprises, Anticipated Inflation and Fiscal Deficits", Review of Economics and Statistics, Vol. 65, No. 3.

Mishkin (1982), ‘Does anticipated monetary policy matter? An econometric investigation’, Journal of Political Economy, Vol. 90.

Nachane , D, Karnik, A. and N. Hatekar , 1997: Interest Rate Imbroglio”, Economic and Political Weekly, May 31.

Nelson and Plosser (1982), Trends and random walks in macroeconmic time series: Some evidence and implications, Journal of Monetary Economics, Volume 10, Issue 2, 1982, Pages 139–162

Ostrosky, Anthony. (1979): "An Empirical Analysis of the Crowding out effect of fiscal policy in the United States and Canada: Comments and Extensions", Kyklos, Volume 32.

Parker, Karen,(1995): " The Behaviour of Private Investment", IMF Occasional Paper No. 134, International Monetary Fund, Washington D C.

Perron, Pierre, *1989*. "The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis," *Econometrica*, Econometric Society, vol. 57(6), pages 1361-1401.

Pradhan, B K., Ratha, D K. and Sarma, Atul (1990): " Complementarity between Public and Private Investment in India", Journal of Development Economics, Vol 33., North Holland.

Reserve Bank of India (2001), 'Handbook of Statistics 2001', Reserve Bank of India, Mumbai.

Sargent, T. J. (1969): 'Commodity Price Expectations and The Interest rate', *Quarterly Journal of Economics*, 127-140.

Sargent, Thomas. (1976): "Commodity Price Expectations and The Interest Rate", Quarterly Journal of Economics.

Shiller, Robert J.(1979): " The Volatility of Long term Interest rates and Expectations Models of the Term Structure", Journal of Political Economy, Vol.87.

Sundararajan V and Takur, S. (1980), 'Public Investment, Crowding Out and Growth: A Dynamic Model applied to India and Korea', *IMF Staff Papers*, 27(4): 814-855.

Tanzi, V (1985): " Fiscal Deficits and Interest rates in the United States: An Empirical Analysis, IMF Staff Papers, Vol.32, No.4.

Toda, H.Y. and P.C.B. Phillips (1994) : "Vector Autoregressions and Causality: A Theoretical Overview and Simulation Study", *Econometric Reviews* 13, 259-285

Toda, H.Y. and Yamamoto (1995) Statistical inference in Vector Autoregressions with possibly integrated processes. *Journal of Econometrics*, 66, 225-250.

Vinod, Hrishikesh (2006), Maximum entropy ensembles for time series inference in economics, Journal of Asian Economics, 17 (2006) 955–978.

Wood, John H. (1981): "Interest rates and Inflation", Economic Perspectives, Vol.5.

Zivot, Eric & Andrews, Donald W K, 1992. "Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis," Journal of Business & Economic Statistics, American Statistical Association, vol. 10(3), pages 251-70, July.