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Yield Curve Dynamics of the Indian G-Sec Market: A Macro-Finance Approach

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ABSTRACT

We examine the interactions between monetary policy and the term structure of the g-sec market in India through a SVAR model comprising macroeconomic variables and latent factors of the yield curve. Among macroeconomic factors, while monetary policy has the dominant impact on level and curvature, the exchange rate largely determines slope of the yield curve. Moreover, the level is found to be an important input for monetary policy decisions. Despite the persistence of large fiscal deficits, the g-sec market is found to be strongly influenced by policy measures implying that the central bank has a distinct role in market development.

Keywords: Term Structure, Monetary Policy, Granger Causality, SVAR

JEL Classification: C32, E43, E52

1. INTRODUCTION

The impact of monetary policy on the term structure of interest rates is particularly important in the context of its influence on the long term interest rates of the economy. For the central bank, the key question is to what extent monetary policy actions at the short-end permeate to the longer end of the term structure which, in turn, determines the aggregate level of investment and spending through the monetary transmission mechanism. In this context, monetary policy influences the shape of the yield curve in terms of its level, slope and curvature. A policy shock that changes the level of interest rates of all maturities by almost identical amounts induces a parallel shift of the yield curve. In contrast, policies that increase short-term interest rates much more than long-term interest

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rates render the yield curve relatively flat. Finally, policy decisions that increase medium-term interest rates comparatively more than short and long-term rates alter the curvature of the yield curve by making it more “hump-shaped” than before (Wu, 2003).

The interpretation of such changes in the shape of the yield curve is largely attributed to the burgeoning macro-finance term structure models (Diebold *et al.*, 2005), which synthesizes emerging insights from the overlapping areas of macroeconomics and finance. For instance, the level factor is linked to the perceived medium-term central bank inflation target (Rudebusch and Wu, 2008), while policy tightening leads to a decline in the slope (Diebold *et al.*, 2006). Finally, curvature shifts might occur when market participants revise their expectations about the nature of the dynamics of interest rates, perhaps because of a shift in the policy stance (Giese, 2008).

While there is a large body of literature about the impact of monetary policy on the term structure pertaining to developed markets, the absence of similar work in the context of emerging and developing economies, notwithstanding few exceptions, is somewhat paradoxical. Given market imperfections, inadequacy of instruments and institutions and the predominance of the traditional banking channel in financial intermediation of many developing countries, a deeper understanding of the impact of monetary policy on the yield curve is imperative for assessing market expectations in these economies.

In the Indian case, an evaluation of the impact of monetary policy on the yield curve is particularly challenging on account of two factors. First, the central bank, *viz.*, the Reserve Bank of India (RBI), being both the monetary authority and the debt manager of the government, often have to balance conflicting objectives. As the debt manager, the RBI's objective is to oversee the successful completion of the government borrowing program at least cost *i.e.*, at low interest rates. Such low rates, however, may not be compatible with the objective of price stability, which the RBI has to ensure and safeguard as the monetary authority. Moreover, it can be argued that the actions of the RBI in its dual role may pose a signal extraction problem for market participants, particularly with the persistence of high government borrowing.

Second, in order to achieve multiple policy objectives, *viz.*, (a) supporting growth, (b) ensuring price stability, and (c) preserving financial stability, the RBI uses several instruments². Since the RBI has been using a mix of instruments at different points of time, it becomes difficult to identify any single instrument which could characterise the stance of policy at any point. Policy adjustments are made through direct rate instruments (repo and reverse repo) and indirect instruments (required reserve ratio), which works primarily through the quantity channel by altering the availability of funds. Moreover, the government debt market has illiquid segments within the yield curve where institutional

² The analysis in this paper pertains to the period prior to May 2011 when policy changes were made through several instruments. Since then, the RBI adopted the repo rate as the rate representing monetary policy stance.

and structural factors hinder active secondary market trading. In the light of these constraints, there is a paucity of meaningful work in the Indian context.

Addressing this shortcoming, this paper endeavours to assess the impact of monetary policy on the term structure of the government securities (g-sec) market, through a structural vector autoregression (SVAR) model, based on standard macroeconomic variables and the three unobservable common factors (level, slope and curvature) that characterise the yield curve in the literature (Knez *et al.*, 1994; Dai and Singleton, 2000). In this context, we use standard market proxies for level, slope and curvature as in Bekaert *et al.* (2010). Moreover, in view of the prevalence of multiple instruments, we make an important methodological contribution in terms of deriving a summative measure of policy stance - in terms of a monetary policy index akin to similar work in the context of the US (Boschen and Mills, 1991) - and use it to assess the impact of monetary policy on the g-sec yield curve. The results indicate that despite the persistence of chronic fiscal deficits³, the g-sec market continues to be significantly influenced by policy signals.

The structure of the paper is the following. Section II briefly discusses the contextual empirical literature. In Section III, we present some stylised facts on the market for government paper in India. The data and methodology of compilation of the monetary policy measure and the SVAR model is presented in Section IV. The empirical results and its implications are discussed in Section V. The concluding observations summarise the findings of the paper and suggest some further extensions of the results.

2. RELATED LITERATURE

Evans and Marshall (1998, 2007) demonstrate that macroeconomic shocks work through monetary policy to change the shape of the yield curve by shifting the level and flattening the slope. Ang and Piazzesi (2003) find that the observable factors (inflation and economic growth) explain most of the movement at the short end while the unobservable factors (level, slope and curvature) explain most of the movement at the long end of the yield curve. They interpret the coefficients of an estimated yield curve as the unobservable factors and show that these factors are very close to standard empirical and market proxies.

Diebold *et al.* (2006) find strong evidence of macroeconomic effects on the future yield curve and somewhat weaker evidence of yield curve effects on future macroeconomic developments. They observe that monetary policy shocks lead to a decline in the slope but a jump in the level of the yield curve, which is similar to earlier findings and report that the expectations hypothesis of the term structure only holds during certain periods

³ The average gross fiscal deficit of the Government (both Centre and States) was 7.8% of GDP during the period 2000-2010.

of the data. Rudebusch and Wu (2008) interpret the latent factors of the yield curve in terms of macroeconomic variables, with one of the factors identified as a perceived inflation target and the other as a cyclical monetary policy response to the economy. They also note that even after allowing for time-varying term premiums, there is no evidence of a slow partial adjustment of the policy interest rate and highlight the importance of expectations in the determination of output and inflation in the economy. Bekaert *et al.* (2010) present strong evidence of contemporaneous responses of the entire term structure to various macroeconomic shocks; their key finding being that the inflation target shock accounts for most of the variation in the level whereas the monetary policy shocks dominate the variation in slope and curvature.

In the context of an emerging economy (Brazil), Alves *et al.* (2011) conclude that (i) macro variables exhibit higher persistence (than the yield factors) and mostly exhibit insignificant responses to yield curve shocks; (ii) changes in perceptions about risk strongly influence the dynamics of the yield curve; (iii) the policy rate itself does not have a significant effect either on inflation or on economic activity; and (iv) there is relatively stronger impact of macroeconomic variables on the yield curve although the reverse causality is weak. In the Indian context, Kanjilal (2011) finds strong causality from financial factors to macroeconomic factors, however, the reverse causality is found to be weaker. The causality from yield factors to macro factors is primarily driven by the fact that the changes in the level of yield curve impact on inflation through changes in monetary policy.

What is noteworthy of the literature on macro-yields models is that the shape of the yield curve is estimated often through theoretical constructs on yield curve dynamics. In contrast, we adopt an alternative approach of estimating the impact directly from the data through standard market proxies of level, slope and curvature. In this context, we use secondary market g-sec yields of 1-year, 5-year and 10-year maturity which are the standard market benchmarks for short, medium and long-term, respectively, in India.

3. GOVERNMENT SECURITIES MARKET– SOME STYLISED FACTS

The g-sec market in India has evolved over the past two decades. Since the early 1990s, several measures have been initiated to develop a deep and liquid g-sec market for reducing the cost of government market borrowings, providing appropriate benchmarks for pricing of other financial instruments and conducting monetary policy in a flexible manner. The switch over to auction-based system of issuance of government securities was a major step towards development of the g-sec market. Over the years, the investor base has become more voluntary and diversified with the participation of non-banking entities. Taking into account market preferences, new instruments with innovative features have been introduced from time to time. Since the mid-1990s, there has been a consistent

increase in the size of the market in tandem with the growth in borrowings of both the Central and State Governments. For instance, the combined market borrowing of the Centre and States increased from Rupees 8,667 billion in 2000-01 to Rupees 50,924 billion in 2009-10, a staggering compound annual growth rate of 21.7% during the period⁴. Reflecting the effectiveness of various measures initiated to develop the market, average daily turnover in the secondary market for Central Government dated securities increased from Rupees 28 billion in 2000-01 to Rupees 139 billion in 2009-10. Moreover, the operation of a system of primary dealers (PDs), who act as market intermediaries, has facilitated the RBI's smooth withdrawal from subscribing to primary market auctions from April 1, 2006 under the Fiscal Responsibility and Budget Management (FRBM) Act¹.

Due to market uncertainty, investor preference has generally been for short-term paper although the need for elongation of maturity was realised in the mid-1990s. As inflation conditions stabilised from the latter half of the 1990s, a conscious strategy of elongating the maturity structure was adopted, keeping in view the preference of both the issuer and the investor. As a result, the weighted average maturity of debt of the Central Government almost doubled from 5.7 years in 1995-96 to 11.2 years by 2009-10. The yield curve, however, has generally remained flat at the longer end although the level has been substantially influenced by domestic and international factors. For instance, the global financial crisis rendered money markets illiquid resulting in sharp increase in levels in September 2008 from that of March 2005 (Chart 1). Although the tightness in liquidity conditions eased subsequently, domestic inflation pressures hardened yields across the term structure, although lower than the crisis level, in December 2010. There were also occasions when the yield curve inverted for some maturities.

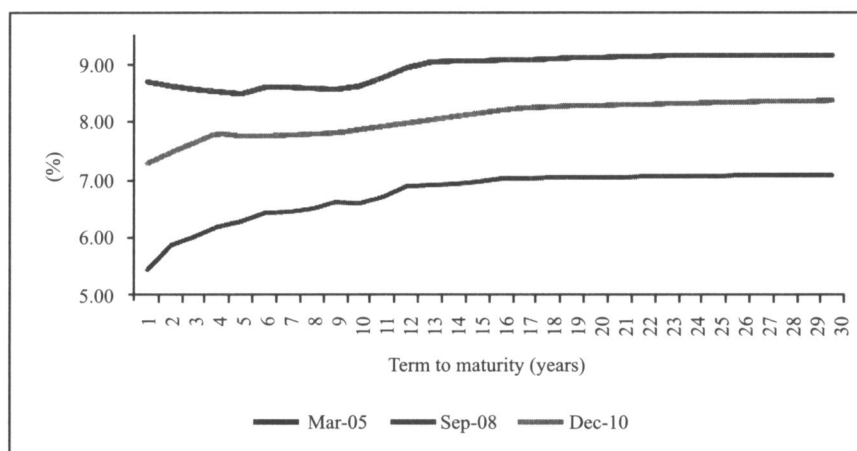


Chart 1: G-Sec Yield Curve

⁴ The Indian fiscal and financial year is April to March.

Reflecting the instability in the shape of the yield curve, the yield spread across various maturities showed volatile movements. The yield spread between the 1-year and 5-year benchmark securities declined sharply when uncertainty regarding the Iraq war dominated the market in early 2003 (RBI, 2007). The issuance of 30-year paper in 2002-03 extended the yield curve to the longer horizon although it is not liquid, being held mainly by long term investors such as insurance companies and pension funds. Yield spread across all benchmark securities remained low in the phase of declining interest rates up to May 2004. Thereafter, policy tightening resulted in an increase in yields although the response of short-term rates was quicker and more pronounced than long-term rates. At the height of the global financial crisis in 2008, the yield spread turned negative between the 1-year, 5-year and 10-year benchmark securities during June – October⁵. In such cases, the negative spread reflected the concentration of trading around the 10-year tenor as well as the impact of monetary policy actions at the short end. Thus, the formation of a smooth and robust yield curve is still at a formative stage in the wake of imperfect market microstructure with liquidity being confined only to a few maturity buckets, reflecting market segmentation.

4. DATA AND METHODOLOGY

4.1 Data

The study uses macroeconomic and yield data sourced from the Handbook of Statistics on the Indian Economy (RBI, 2010) and various issues of the monthly RBI Bulletin. We use monthly data from April 2001 to December 2010 (2001:M4 to 2010:M12), a period when interest rates have gained importance in policy signalling (Bhattacharyya and Sensarma, 2008).

For the empirical exercise, the data set includes index of industrial production (IIP), wholesale price index (WPI), the derived monetary policy index, the empirical proxies of level, slope and curvature, the index of 36-currency trade-weighted nominal effective exchange rate (NEER) and the effective Federal Funds Rate. In the absence of a monthly real GDP series, we use IIP as the proxy for output. Moreover, the unavailability of a harmonised consumer price index (CPI) precludes the use of CPI; therefore WPI is the inflation measure used for policy purposes. In view of the changes in base of IIP, WPI and NEER, each series has been standardised by splicing. Furthermore, we construct and use an index to represent monetary policy in contrast to the use of call money as the policy indicator in the Indian context, as in Kanjilal (2011). In this context, it is worthwhile to mention that the call money rate in India (unlike the Federal Funds rate in the US) is

5 The spread between 10-year and 1-year yields was (-)7 basis points at end-September 2008.

not an explicit target for policy⁶, although monetary operations are aimed at minimising the volatility of the call money rate and keeping it confined within the corridor of repo and reverse repo ratesⁱⁱ. The methodology of deriving the monetary policy index is discussed below separately.

The estimation of the shape of the yield curve requires yield data on a large number of bonds. As mentioned earlier, we use short-term (1-year), medium-term (5-year) and long-term (10-year) yields for government bondsⁱⁱⁱ. We use this information to construct what Bekaert *et al.* (2010) suggests as standard empirical proxies of the shape of the yield curve *viz.* (i) level (average of 1-year, 5-year and 10-year yields); (ii) slope (spread of 10-year over 1-year); and (iii) curvature (1-year *plus* 10-year *minus* twice of 5-year yield). Diebold *et al.* (2006) and Ang and Piazzesi (2003) show that the shape of the yield curve estimated using the Nelson-Siegel method closely correspond to these standard market proxies.

4.2 Methodology of Construction of MPI

As discussed above, the monetary policy measure presents us with a difficulty. In the absence of a single policy objective and a single instrument, the RBI uses multiple instruments as discussed earlier. The use of multiple instruments precludes the use of any one instrument as the policy measure for our analysis. Previous studies have separately studied the impact of individual instruments on various financial market segments (Bhattacharyya and Sensarma, 2008). The results, however, only partially reflect the monetary policy actions as each exercise ignores the effect of the excluded instruments, which are often changed simultaneously. We overcome this weakness by developing a monetary policy index that incorporates all instruments used by the RBI. The index is based on the three instruments most actively used during the period *viz.*, the repo rate, the reverse repo rate and the cash reserve ratio (CRR) for signalling the monetary policy stance⁷.

In empirical research, the “narrative approach” propounded by Romer and Romer (1989) gained acceptance in the literature as a measure of shifts in policy stance. In this approach, federal open market committee (FOMC) directives and related records are utilised and interpreted to identify the stance of the US Federal Reserve on monetary policy over a period of time. A logical extension of the basic narrative approach was the construction of a monetary policy index by Brunner and Meltzer (1989). A monetary policy index depicts a numerical scale that indicates the stance as inferred from policy documents. It entails a mapping of the qualitative discussions in policy records to a quantitative scale by assigning a number indicating the degree of easing or tightening of

6 The weighted average overnight call money rate was adopted as the operating target for monetary policy from May, 2011.

7 The Bank Rate has been changed only three times in the period of study and has remained dormant since May 2003.

stance^{iv}. We generate such a measure in the Indian context for the period of our study⁸. The basic advantage of such an index is that it provides a time series of values summarising monetary policy stance. There have been a number of studies in generating such indices, particularly in the US, providing a unique set of data, which, with appropriate statistical techniques can be used to verify the potency of monetary policy actions (Boschen and Mills, 1991; 1995). There is, however, a distinct difference between the index used in these studies and that of ours. While these studies derive the measure by interpreting the intent of policy from FOMC statements, our measure is a quantification of the actual measures undertaken by the RBI.

The index has been prepared by mapping the policy measures to quantitative numbers during the period of study. First, all changes in the three policy instruments are listed on a monthly basis and represented as percentage changes from their previous existing level. Second, such changes in all three instruments are aggregated on a monthly basis. Next, the sum of all changes are categorised in terms of their magnitudes *viz.*, (i) less than or equal to 10 percent; (ii) less than or equal to 20 percent; and (iii) more than 20 percent and represented in the scale of 1, 2, and 3, respectively. While reductions in policy rates indicate expansionary monetary policy, rate hikes are contractionary. Therefore, the entire mapping of policy measures is categorised in a choice of seven, ranging from -3 to 3 with 0 being assigned to neutral policy which can occur due to policy inaction in any period^v.

4.3 VAR Methodology

We estimate a SVAR model to examine the dynamics of interaction between monetary policy and the shape of the yield curve. The main purpose of SVAR estimation is to obtain non-recursive orthogonalisation of the error terms for impulse response analysis. This is an alternative to the recursive Cholesky orthogonalisation which requires enough restrictions to identify the orthogonal (structural) components of the error terms. Moreover, the Cholesky orthogonalisation is sensitive to the ordering of variables.

Assuming y_t as a k -element vector of the endogenous variables, a SVAR with p lags is represented as

$$A_0 y_t = c_0 + B(L)y_t + \varepsilon_t \quad \dots(1)$$

where A_0 is a $k \times k$ matrix whose main diagonal terms (the coefficients of the i^{th} variable in the i^{th} equation) are scaled to 1, c_0 is a $k \times 1$ vector of constants, $B(L)$ is a $k \times k$ matrix (for every $i = 0, \dots, p$) and ε_t is a $k \times 1$ vector of error terms.

We estimate a five-variable SVAR model of monthly data. The variables included in the model are real output (y_t) as measured by index of industrial production, domestic

8 Such an index for the period 1973-1998 had been developed earlier by Bhattacharyya and Ray (2007).

price level (p_t) represented by wholesale price index, monetary policy index (m_t) as defined earlier, level, slope and curvature of yield curve (s_t) and nominal effective exchange rate (x_t). We put the following theoretical restrictions on the A_0 matrix to identify structural relationship:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ \alpha_{21} & 1 & 0 & 0 & 0 \\ 0 & \alpha_{32} & 1 & 0 & \alpha_{35} \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & 1 & 0 \\ \alpha_{51} & \alpha_{52} & \alpha_{53} & \alpha_{54} & 1 \end{bmatrix} \begin{bmatrix} y_t \\ p_t \\ m_t \\ s_t \\ x_t \end{bmatrix} = \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{pt} \\ \varepsilon_{mt} \\ \varepsilon_{st} \\ \varepsilon_{xt} \end{bmatrix} \quad \dots(2)$$

The formulation of the SVAR model relies on standard assumption that aggregate demand shocks represented by real income are not immediately affected by other macroeconomic aggregates in the model. Therefore, all other coefficients in the matrix appear as zero. An aggregate supply shock, captured by price behaviour, is contemporaneously related to aggregate demand shock only. The measure of monetary policy assumes contemporaneous reaction of the central bank to price changes and exchange rate movements. Output has been excluded from the monetary policy shock under the assumption that changes in real output do not immediately prompt the central bank to react. While concerns on price stability warrant immediate policy actions, excess volatility in the exchange rate prompts central bank intervention. This practice of management of excess volatility in foreign exchange market is typically an emerging market phenomenon, where large swings in capital flows are usually the primary driver of liquidity in these markets (Singh and Pattanaik, 2010). The behaviour of the yield curve is contemporaneously affected by price shocks, output shocks and monetary policy shocks in the model through the Fisher effect, the Taylor principle and the expectation channel, respectively. Following the standard practice in the VAR literature on monetary policy and exchange rate interaction, the exchange rate has been placed last in the ordering while it reacts simultaneously to all shocks.

We include nominal effective exchange rate as an endogenous variable on the following two grounds. First, changes in the effective exchange rate are viewed as an indicator of the monetary policy stance in open economies (Eichenbaum and Evans, 1995; Cushman and Zha, 1997; Kim and Roubini, 2000). Second, in a floating exchange rate regime, the exchange rate is expected to react contemporaneously to all macroeconomic shocks. These factors provide a strong rationale for the inclusion of exchange rate as the most endogenous variable in the VAR, *i.e.*, it responds contemporaneously to all other variables. In a managed float regime like India, ensuring orderliness in the foreign exchange market is a key objective. In view of this, the monetary authority has occasionally modulated volatility in the exchange rate through policy actions^{vi}.

5. EMPIRICAL FINDINGS

5.1 MPI – Stylised Facts

Before approaching the SVAR estimation, we first discuss some attributes of the monetary policy index. Given that the index is constructed on the basis of subjective interpretations of policy actions, the series should be reflective of the stance of the central bank. The MPI is presented in Chart 2. It can be observed that the MPI takes positive (negative) value during periods of monetary tightening (easing), *i.e.*, when any or a combination of the three instruments increase (decrease)^{vii}. Thus, the MPI encapsulates the information contained in the individual policy instruments.

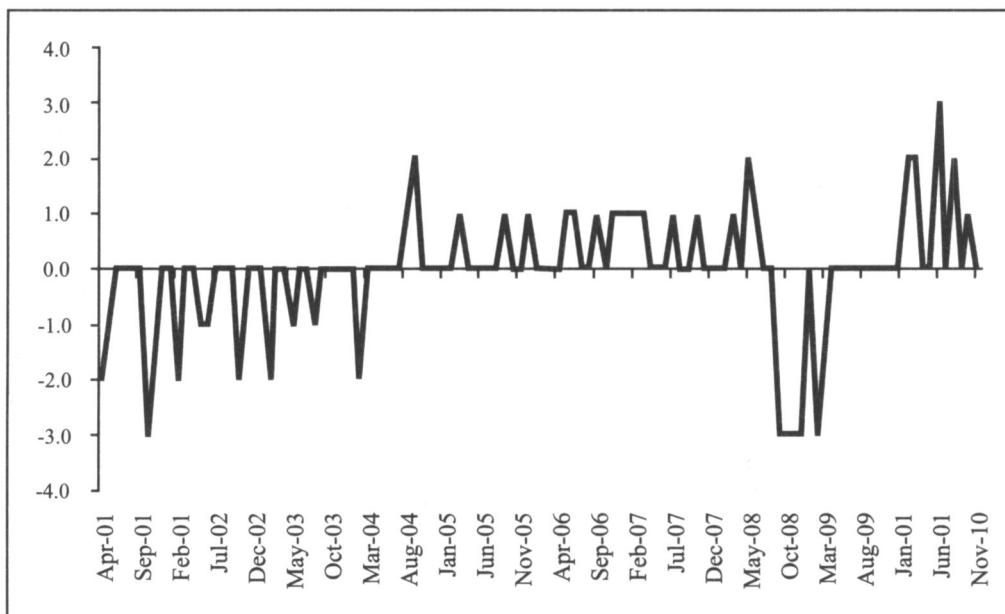


Chart 2: Monetary Policy Index

What does the constructed monetary policy measure look like? It is pertinent to note that it is a monthly incremental measure, which represents whether (corresponding to the previous month) there has been any change in monetary policy. Table 1 presents the basic descriptive statistics of the monetary measure, while the frequency distribution is given in Table 2. From Chart 2 and Table 1, the MPI is found to be mean reverting suggesting that there is no systematic bias in policy actions.

TABLE 1
DESCRIPTIVE STATISTICS OF MPI

MEASURE	VALUES
MEAN	0.05
MEDIAN	0.00
MAXIMUM	3.00
MINIMUM	-3.00
STD. DEV.	1.06
SKEWNESS	0.82
KURTOSIS	5.15
JARQUE-BERA	35.75
PROBABILITY	0.00
SUM	6.00
SUM SQ. DEV.	129.69
OBSERVATIONS	117

Of the period of study spanning 117 months, monetary policy has been contractionary on 23 occasions whereas it has been expansionary on 18 occasions as per our proposed measure. The expansionary phases are mainly concentrated in the period after the unravelling of the IT bubble in the US in the first 2 years of our period and during the peak of the global financial crisis. In contrast, the contractionary phases are more distributed reflecting measures to prevent the overheating of the economy during 2001-10 (in which the economy experienced sustained high growth). In particular, such measures were highly concentrated in 2010 when monetary policy aimed at curbing inflation pressures in the wake of supply constraints and rising global commodity prices.

TABLE 2
FREQUENCY DISTRIBUTION OF MPI

VALUE	OBSERVATIONS	PERCENT
3	1	0.9
2	5	4.3
1	17	14.5
0	76	65.0
-1	6	5.1
-2	6	5.1
-3	6	5.1

5.2 Causality Analysis

Before estimating the SVAR model, we examine the causal nexus between monetary policy, and level, slope and curvature of the yield curve by applying Granger (1969) causality test for the period 2001:04 to 2010:12 (Table 3).

TABLE 3
MONETARY POLICY AND YIELD CURVE - GRANGER CAUSALITY TEST

Null Hypothesis	F-Statistics	Probability
LEVEL does not Granger cause MPI	4.80	0.03
MPI does not Granger cause LEVEL	6.53	0.01
SLOPE DOES NOT GRANGER CAUSE MPI	0.02	1.00
MPI DOES NOT GRANGER CAUSE SLOPE	4.20	0.04
CURVATURE DOES NOT GRANGER CAUSE MPI	1.02	0.32
MPI DOES NOT GRANGER CAUSE CURVATURE	4.46	0.04

First, existence of bi-directional causality between MPI and level of the yield curve reveals that while changes in the monetary policy stance shifts the yield curve, the monetary authorities also extract information on the state of the economy from the existing levels and react through policy changes. This is similar to the findings of Diebold *et al.* (2006). Second, while monetary policy actions do alter the slope of the yield curve, the slope itself is not an indicator for changing policy. Finally, while policy changes bring about a change in expectations of returns across the term structure thus re-adjusting the curvature, changes in curvature solely do not prompt policy actions. Thus, while the level broadly acts as an input, the exact shape (slope and curvature) of the curve is not incorporated into the feedback mechanism for policy formulation. As the development of market-based monetary policy crucially hinges on evolving expectations of market participants, an approach of overall guidance is preferred rather than fine tuning market microstructure by reacting to slope and curvature changes. Such micromanagement can distort the signalling mechanism in the secondary market thereby impeding market development and the potency of policy signalling.

5.3 Structural VAR Analysis

We estimate a SVAR model using five variables, *viz.*, y_t , p_t , m_t , s_t and x_t as defined earlier. In this context, three separate SVAR models are set up in which s_t represents level, slope and curvature in the first, second and third models, respectively. Block exogeneity test in VAR framework satisfies the condition that all these five variables are endogenous, hence included in the model. We include 11 dummies as exogenous variables to adjust for monthly seasonality in the IIP and the WPI series. In addition, the Fed funds rate is included as an exogenous variable in the model as policy changes in the US is an indicator of global interest rates.

The above model is uniquely identified and the shocks are correlated as evident from the covariance among residuals (Annexure I). The SVAR model was estimated in levels disregarding the unit roots involved in some of the series^{viii}. The optimal lag length of the VAR model is found to be one month based on Schwarz and Hannan-Quinn information criteria. This is consistent given that financial market participants quickly incorporate and process all information within a short period of time.

5.4 Impulse Response Analysis

The impulse response of monetary policy tightening to the level, slope and curvature of the yield curve is presented in Chart 3⁹. As can be seen from the chart, contractionary monetary policy leads to an increase in the level till the third month but decreases thereafter. Policy tightening is perceived to reflect higher inflation concerns in the short-term, therefore it shifts the yield curve upwards temporarily. Once the impact of policy results in lower inflation in the long-term, the yield curve shifts down. Similarly, policy tightening leads to a decline in the slope till the third month, which is similar to the findings of Diebold *et al.* (2006), but increases thereafter. In the first three months, the short term yields increase more than the long term thereby flattening the yield curve which is consistent from the expectation hypothesis of the term structure. However, the increase in slope beyond this period basically reflects that in the long run, investors need to be compensated with higher returns for holding longer maturities. Thus, in this phase, the expectation hypothesis is dominated by the term-premia considerations of investors implying heightened risk aversion. Moreover, the beneficial impact of reigning inflation leads to a favourable future economic outlook thereby increasing yields. Finally, hardening of policy stance through rate hikes leads to a decline in curvature. In other words, short and long term yields increase relatively less than medium term yields. Thus,

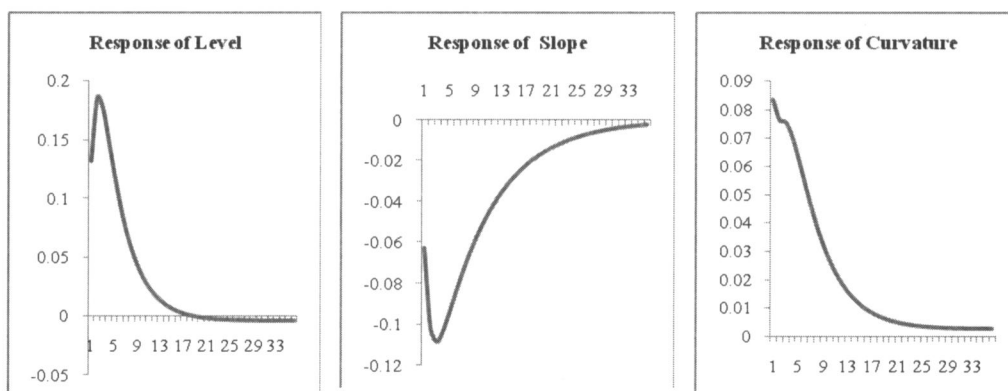


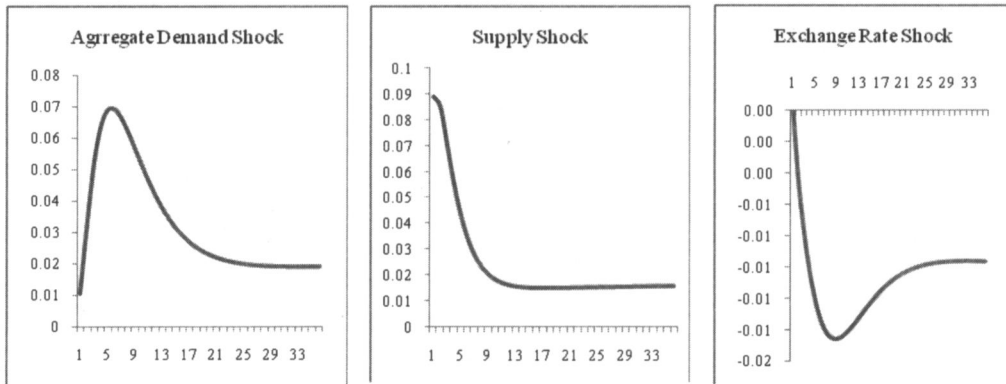
Chart 3: Monetary Policy Shock – Structural Impulse Response

⁹ The charts on impulse response of all shocks on level, slope and curvature are provided in Annexure II, Annexure III and Annexure IV, respectively.

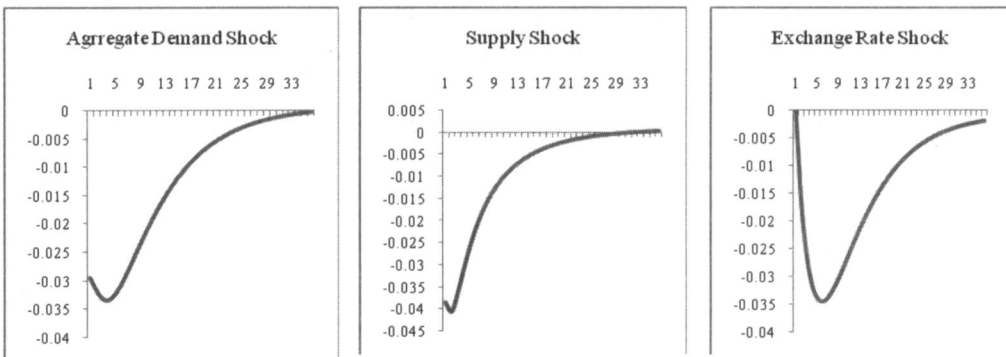
on an average, investors tend to have a bias on returns from the medium term as indicated in the “preferred habitat” theory of the term structure^x. As suggested by Giese (2008), the change in curvature also reflects shifting market perceptions about yield curve dynamics where expectations on yields of the medium term dominate those of the short and long term.

Having discussed the response of the yield curve to shocks in monetary policy, it is interesting to examine the impulse response of the shape of the yield curve to standard macroeconomic shocks (Chart 4). While policy induced changes in the term structure reflect the potency of the signalling mechanism, the impact on yields resulting from the announcement of macroeconomic data captures the news impact.

Response of Level



Response of Slope



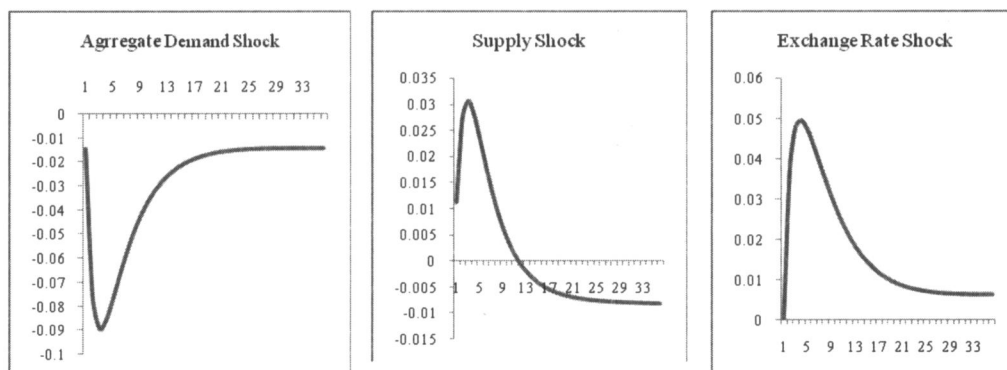
Response of Curvature

Chart 4: Shocks in Aggregate Demand, Supply and Exchange Rate – Impulse Response

An aggregate demand shock increases the level of yields till the sixth month but declines thereafter and stabilises by the end of two years. Simultaneously, it leads to a decline in slope for about four months and in curvature for three months, increasing thereafter. The immediate impact of an increase in output results in a hardening of inflation expectations through concerns of overheating resulting in an increase in levels. However, once the beneficial impact of the output increase results in positive sentiments about the economy, the levels come down and stabilise at lower yields as noted by Rudebusch and Wu (2008). This expectation driven phenomenon of market reaction is also evident from the decline in slope and curvature in the short-term. In this period, short term yields increase more than long-term due to hardening inflation expectations. However, once the positive sentiments are factored in, market expectations are buoyant about the future which reflects in a steepening of the yield curve^x.

In conventional reasoning, a supply shock in terms of rising inflation is expected to increase the level of the term structure. However, in the Indian context, the evidence is found to be contrary to expected lines where the liquidity effect dominates the news impact of rising inflation. Higher inflation results in higher nominal interest rates which widens the interest rate differential thereby attracting more capital inflows. In a managed float regime, such inflows have to be often accommodated leading to monetary and liquidity expansion. The increase in liquidity results in greater appetite for government paper thereby reducing yields. The impact of rising inflation on slope and curvature is on expected lines where the expectation hypothesis prevails in the short-term but is dominated by term-premia considerations of risk-averse investors in the long-term. Overall, while the impact of inflation on level is protracted, that on slope and curvature is more instantaneous.

The impact of an exchange rate shock on the shape of the yield curve works through the pass-through effect and the liquidity effect. First, an appreciation of the nominal

exchange rate reduces inflation pressure through the pass-through impact of imported items (Sahoo *et al.*, 1994). The lower inflation, in turn, eases yields through the Fisher effect. Second, appreciation of the exchange rate induces central bank intervention which augments liquidity thereby softening yields across the term structure. The impact of exchange rate appreciation on slope and curvature works through the expectations hypothesis in the short-term and is governed by term-premia considerations in the long term.

5.6 Decomposition of shocks

The variance decomposition of shocks provides some useful insights (Table 4). First, monetary policy is dominant among the various shocks in influencing the level of the yield curve. Although the predominance of policy shock persists over a long horizon, the immediate impact is felt over six months. While an inflation shock has a more instantaneous impact on yield levels, the output shock gains ascendancy over time. The exchange rate shock, however, is found to be negligible. Second, the exchange rate shock appears to be important for the slope of the yield curve in general while the monetary policy shock gains importance gradually. Finally, as in the case of the level, monetary policy, besides output, remains important for the curvature of the yield curve. These results are, however, in contrast to Bekaert *et al.* (2010) who find inflation and monetary policy to be the dominant factor, respectively, in explaining the level and slope of the yield curve in the US. We postulate that this difference is attributed to (i) the imperfect and less mature expectation of financial market participants; and (ii) a managed float exchange rate regime in an emerging economy like India *vis-a-vis* the US where market expectations are more informed and stable in a flexible exchange rate system^{xi}.

TABLE 4
VARIANCE DECOMPOSITION OF VARIOUS SHOCKS (PER CENT)

MONTH	SHOCKS				
	DEMAND	SUPPLY	MONETARY POLICY	LEVEL/SLOPE/ CURVATURE	EXCHANGE RATE
LEVEL					
1	0.11	7.91	17.41	74.57	0.00
6	4.35	6.60	32.41	56.51	0.13
12	7.83	6.43	31.44	53.92	0.38
24	9.45	6.84	30.58	52.43	0.70
36	10.20	7.32	30.00	51.56	0.92

TABLE 4 Continued...

MONTH	SHOCKS				
	DEMAND	SUPPLY	MONETARY POLICY	LEVEL/SLOPE/ CURVATURE	EXCHANGE RATE
SLOPE					
1	1.01	1.67	0.21	81.12	15.99
6	1.75	1.77	2.71	65.18	28.59
12	2.10	1.60	3.96	62.65	29.69
24	2.18	1.54	4.40	62.03	29.85
36	2.18	1.54	4.43	62.00	29.85
CURVATURE					
1	0.27	0.16	8.85	90.72	0.00
6	14.80	1.63	14.16	64.66	4.75
12	17.35	1.56	14.87	59.91	6.31
24	18.36	1.66	14.68	58.57	6.73
36	18.97	1.92	14.45	57.84	6.82

5.7 Implications

The empirical results provide several important policy insights in the Indian context. First, monetary policy is largely neutral and does not have any systematic bias given the multiple objectives. Second, while monetary policy significantly influences the shape of the yield curve, it also incorporates the feedback from market developments in framing policy responses, which implies a more market-oriented policy framework. In this regard, the monetary authority has adopted a consultative approach with all stakeholders. Third, Indian bond market seems to be explained by the standard macroeconomic factors and theories of the term structure which, however, holds in specific market segments. While the short end is governed by the expectation hypothesis of the term structure, the medium and long term yields are more in tune with the preferred habitat theory and the liquidity premium hypothesis which reflects preferred maturity segments and higher risk-aversion of investors for longer maturities. Fourth, while aggregate demand shocks have a significant impact on future expectations, supply shocks have a long term *albeit* subdued impact on

yield levels. Also, the exchange rate has a significant influence on the domestic bond market which, although indicative of greater financial market integration, entails a proactive role for the central bank in maintaining systemic stability. Finally, the predominance of monetary policy among macroeconomic factors in explaining the shape of the yield curve suggests that despite the persistence of large market borrowing programme over the decade, the Indian g-sec market remains substantially responsive to policy signals. Therefore, the RBI has an important role in furthering market development, both at an institution level and through the introduction of new instruments. This would also facilitate the development of a pricing mechanism for other segments of the financial market in India.

6. CONCLUDING REMARKS

While there is a large volume of exclusively macroeconomic or finance-theoretic explanations of the term structure in the Indian context, there is a paucity of research on macro-finance interface which has received wider attention in the literature in recent years. This paper sets out to bridge this gap by considering a wide range of macroeconomic shocks, including monetary policy, along with the latent factors of the term structure. However, instead of estimating the latent factors from the data, the paper uses the available market proxies of level, slope and curvature and explores the dynamic interaction of the macroeconomic and latent factors for understanding the shape of the yield curve. Moreover, the policy index developed in the paper can be used as a better indicator of policy stance rather than rely on any single indicator or instrument.

The empirical results suggest the potency of monetary policy in the short-term although a subdued impact persists in the long run. The impact is found to be more pronounced at the short end of the term structure. Among the other macro factors, while output has a more long-term impact, inflation and exchange rate movements have a more instantaneous effect. In determining the shape of the yield curve, monetary policy is found to have a stronger impact on level rather than on slope and curvature. In turn, the levels act as an important input for any change in policy. Finally, while the expectation theory of the term structure is found to be important in the short run, term premia and market segmentation considerations determine long run yields. In this context, the liquidity effect emanating from various macroeconomic shocks is found to have a distinct impact on yields although expectations about future economic prospects also play an important role.

Summing up, it is worthwhile to mention that the Indian g-sec market is different from advanced economies on account of two factors. First, the persistence of high and chronic fiscal deficits entails that the government has to raise progressively higher resources from the domestic market. In this context, the gross fiscal deficit becomes a key indicator for the yield curve and the term structure, which can be used as an additional

macroeconomic variable in macro-finance models. Second, the central bank, as the monetary authority and the debt manager, has to do a balancing act between price stability and raising resources at low cost. Despite these constraints, the empirical results of the paper are a pointer to the fact that the market is significantly influenced by policy signals. As a result, the central bank has a key role in guiding expectations about the yield curve and furthering market development.

ENDNOTES:

- i. The Fiscal Responsibility and Budget Management Act, 2003 (FRBMA) was enacted to institutionalise financial discipline, reduce fiscal deficit, improve macroeconomic management and the overall management of the public funds by moving towards a balanced budget. The main purpose was to eliminate revenue deficit and bring down the fiscal deficit to a manageable 3% of the GDP by March 2008. However, due to the 2007 global financial crisis, the deadlines for the implementation of the targets in the Act was initially postponed and subsequently suspended in 2009.
- ii. The Liquidity Adjustment Facility (LAF), introduced in June 2000, emerged as the principal operating instrument for modulating short-term liquidity. Consequently, the repo rate (the rate at which banks borrow funds from the RBI against collateral) and the reverse repo rate (the rate at which banks place their funds with the RBI and receive collateral) emerged as the key instruments for signaling the monetary policy stance. In this context, it may be noted that the RBI is not allowed to lend or borrow clean under the RBI Act, 1934. Under the operating framework in effect from November 2004, all liquidity injections were made at the fixed repo rate and liquidity absorption at the fixed reverse repo rate, with the two rates acting as the upper and lower bound of the corridor, respectively during the period of our study.
- iii. These yields are available as weighted averages of yields on all bonds of the corresponding maturity being traded in the corresponding month with the volumes as weights and yields computed on a zero coupon basis.
- iv. The quantitative interpretations of policy statements in terms of indices are subjective and, thus, debatable. It is, however, largely unbiased, as the same criteria has been applied uniformly over the sample period. As Romer and Romer (1989) point out, "The fact that the selection of disturbances is judgmental and retrospective introduces the possibility [of] an unconscious bias".
- v. A value of 3 is indicative of a strong contractionary policy, 2 is contractionary and 1 is mild contractionary, while a value of -1 represents mild expansionary, -2 reflects expansionary and -3 represents strong expansionary policy, respectively.
- vi. However, presence of nominal rigidities and quantitative controls can hinder complete pass-through of exchange rate shocks to macroeconomic variables.
- vii. A positive monetary policy shock is contractionary in our study in contrast to other studies (Boschen and Mills, 1995), where such shocks are interpreted as expansionary policy.

- viii. One possible solution could have been estimating the VAR model by converting the series as stationary by differencing. However, Sims *et al.* (1990) argue that the objective of estimating a VAR model in levels is to examine the underlying relationship among variables. Furthermore, the option of differencing of series produces no gain in asymptotic efficiency and throws away information since, in a VAR framework, estimation and interpretation of individual coefficients is of little relevance. However, multivariate cointegration test based on Johansen-Juselius method reveals the presence of at least one cointegrating vector among the endogeneous variables.
- ix. The Preferred Habitat Theory states that in addition to interest rate expectations, investors have distinct investment horizons and require a meaningful premium to buy bonds with maturities outside their “preferred” maturity, or habitat. Proponents of this theory believe that short-term investors are more prevalent in the fixed-income market, and therefore long-term rates tend to be higher than short-term rates, for the most part, but short-term rates can be higher occasionally. This theory is consistent with both the persistence of the normal yield curve shape and the tendency of the yield curve to shift up and down while retaining its shape. The Preferred Habitat Theory is another form of the Market Segmentation theory.
- x. The reverse causality also holds as the yield spread is found to be a leading indicator of economic activity explaining about 40 percent of the variation in future growth of industrial output in India (Kanagasabapathy and Goyal, 2002).
- xi. While inflation in India is largely due to supply shocks arising from structural bottlenecks, it is more demand driven in the US reflecting the pace of economic activity.

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ANNEXURE I

TABLE 1
RESIDUAL CORRELATION MATRIX
SVAR MODEL (IIP, WPI, MPI, LEVEL, NEER)

	LIIIP	LWPI	MPI	LEVL	LNEER
LIIIP	1.00				
LWPI	0.14	1.00			
MPI	0.24	0.18	1.00		
LEVL	0.13	0.28	0.46	1.00	
LNEER	-0.07	-0.15	0.07	0.07	1.00

SVAR Model (IIP, WPI, MPI, SLOPE, NEER)

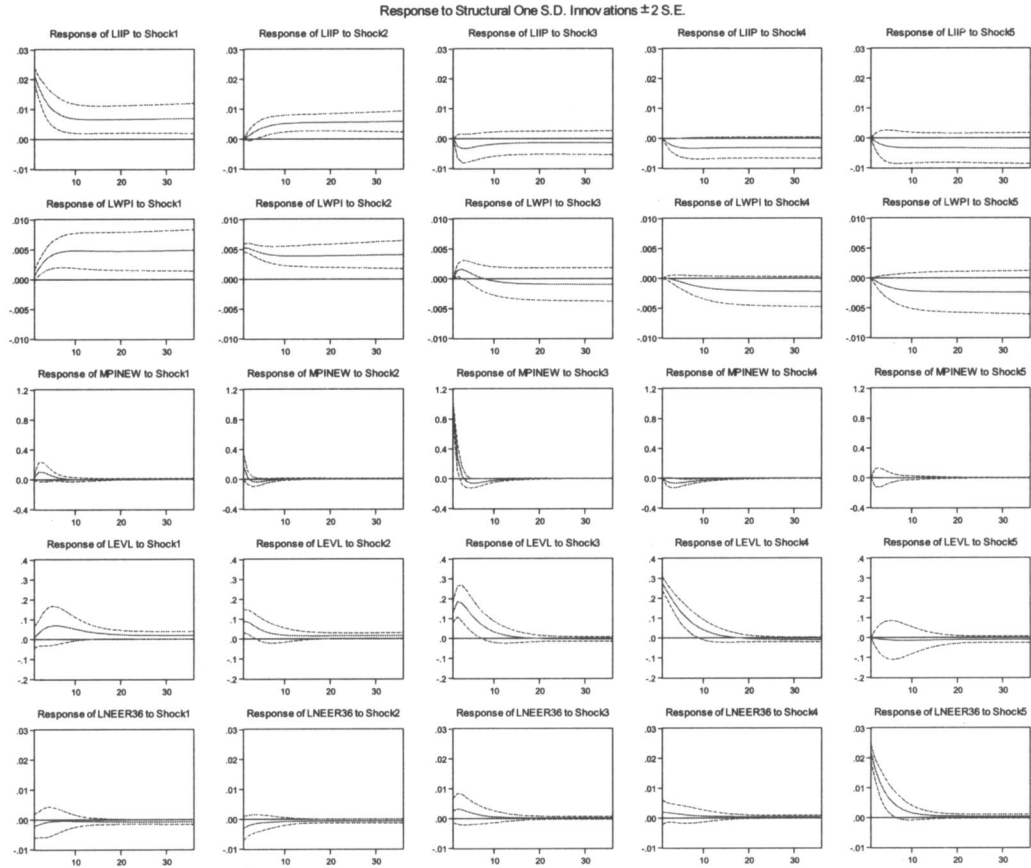
	LIIIP	LWPI	MPI	SLOP	LNEER
LIIIP	1.00				
LWPI	0.17	1.00			
MPI	0.25	0.19	1.00		
SLOP	-0.09	-0.14	-0.25	1.00	
LNEER	-0.05	-0.16	0.07	-0.02	1.00

SVAR Model (IIP, WPI, MPI, CURVATURE, NEER)

	LIIIP	LWPI	MPI	CURV	LNEER
LIIIP	1.00				
LWPI	0.16	1.00			
MPI	0.20	0.20	1.00		
CURV	0.00	0.03	0.29	1.00	
LNEER	-0.07	-0.15	0.07	0.19	1.00

ANNEXURE II

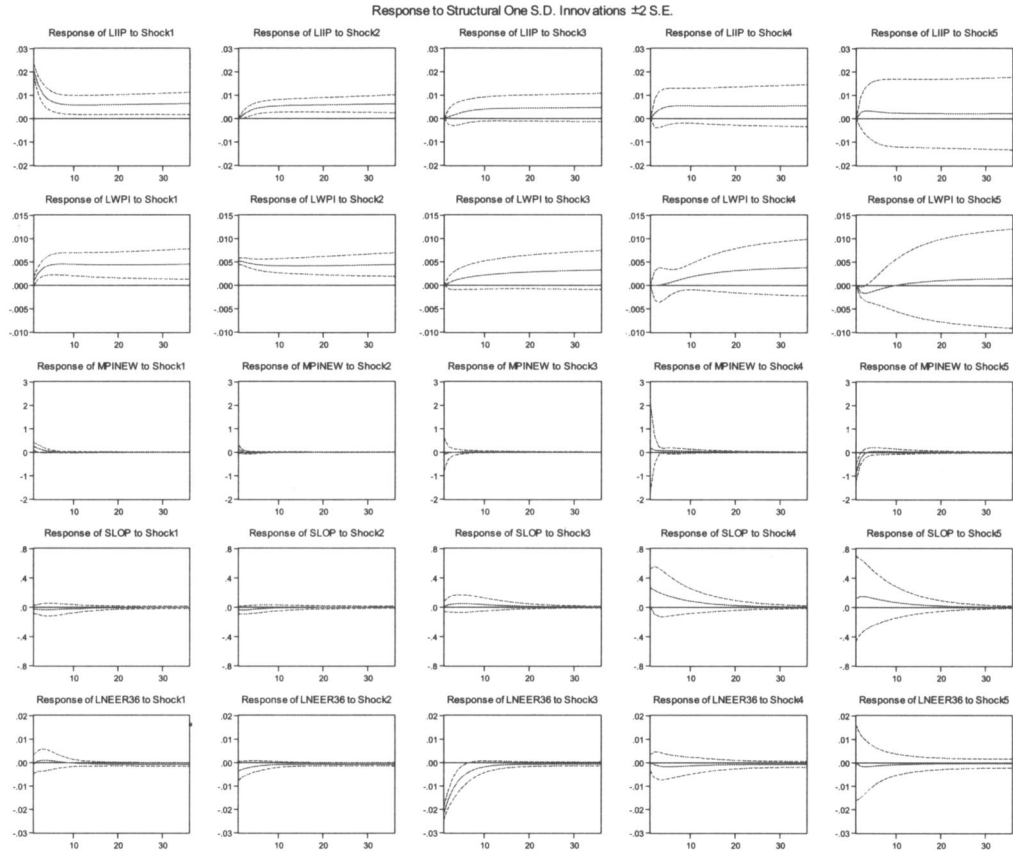
SVAR Model (IIP, WPI, MPI, LEVEL, NEER)



Note: Shock I: Aggregate demand shock
 Shock II: Supply shock
 Shock III: Monetary policy shock
 Shock IV: Own shock (level/slope/curvature)
 Shock V: Exchange rate shock

ANNEXURE III

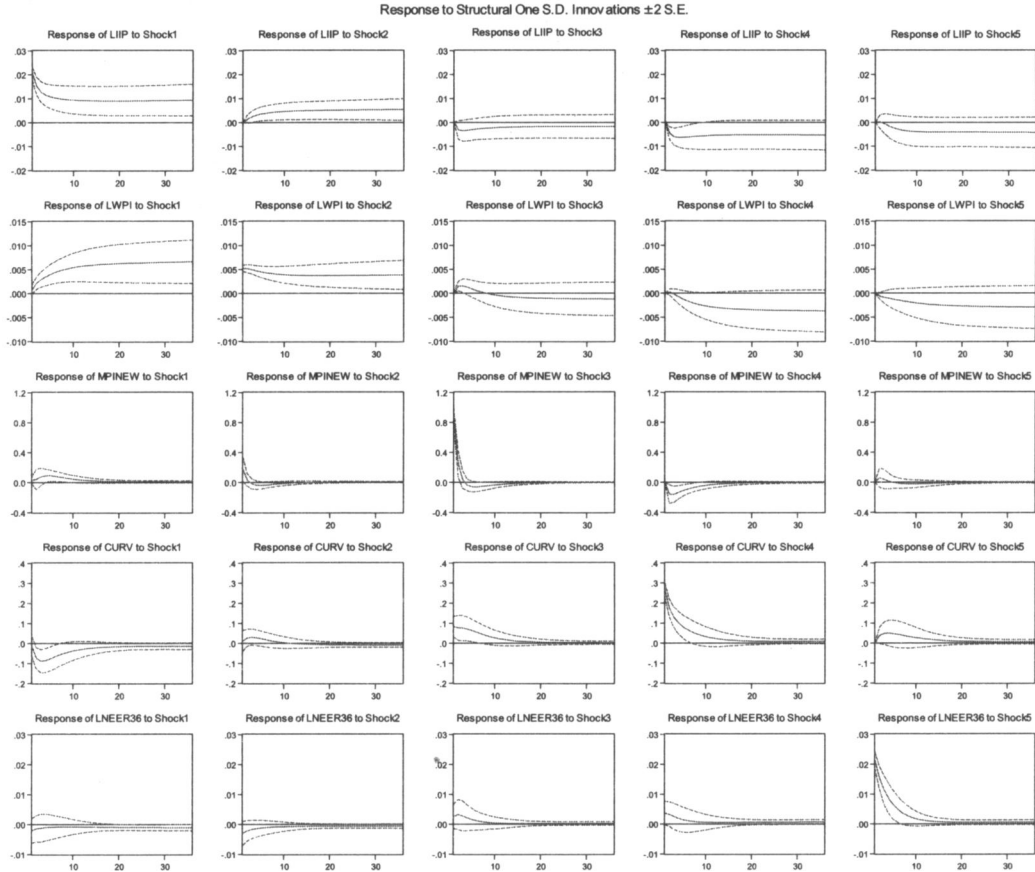
SVAR Model (IIP, WPI, MPI, SLOPE, NEER)



Note: Shock I: Aggregate demand shock
 Shock II: Supply shock
 Shock III: Monetary policy shock
 Shock IV: Own shock (level/slope/curvature)
 Shock V: Exchange rate shock

ANNEXURE IV

SVAR Model (IIP, WPI, MPI, CURVATURE, NEER)



Note: Shock I: Aggregate demand shock
 Shock II: Supply shock
 Shock III: Monetary policy shock
 Shock IV: Own shock (level/slope/curvature)
 Shock V: Exchange rate shock