ABSTRACT

In India, prior to 1991, the tightly controlled interest rates caused impediments in the functioning of the interest rate channel of monetary policy transmission while after 1991, the RBI undertook various measures to strengthen the market-determination of interest rates. This paper has examined the evolution of the interest channel in India across the period 1985 to 2014 firstly by studying the interest rate pass-through using the Correlation matrix and the OLS technique and secondly, by studying the transmission of policy rates to the real economy using the reduced VAR model. The results show that the transmission of interest rates pass-through from policy rates to market interest rates (both - short-term as well as long-term) has strengthened while desired impact of long term market interest rates on industrial production and inflation appears to be weak.

Keywords: Correlation; Interest Rate Channel; Monetary Policy; OLS; Transmission Mechanism; Vector Auto Regression.

1.0 Introduction

The monetary policy is directed to regulate the money supply and the cost and the availability of bank credit in the economy. To implement the monetary policy, the central bank sets the short-term interest rates. They get transmitted to the short term money market rates, which, in turn, get transmitted to commercial interest rates, asset prices, exchange rate, and expectations and finally affect economic activity and inflation. This entire process through which monetary policy affects economic output and inflation is referred to as the transmission mechanism of monetary policy.

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The monetary policy is transmitted to the real economy through five channels: namely, the traditional interest rate channel, the asset price channel, the exchange rate channel, the credit channel and the ‘expectations’ channel (Cukierman, 2004). The interest rate channel has been termed as the traditional channel of the monetary policy. It exists if the monetary policy actions affect interest rates, causing individuals and businesses to alter their spending decisions that, in turn, bring about changes in output and prices (Mishkin, 1995). The development of the financial markets and financial system determines the ability of the monetary policy actions to influence the spectrum of market interest rates (Mohanty, 2012). This association between monetary policy and financial markets is a two-way relation. The financial market rates and prices reflect the expectations of market participants about future economic and monetary developments. These expectations, in turn, provide valuable information to the central banks in formulation of monetary policy to attain its objectives (Hildebrand, 2006).

Prior to the 1990s, India’s financial sector was tightly controlled. Banks remained captive subscribers to government securities under statutory arrangements; the secondary market of government securities was dormant (RBI, 2007). As these factors posed impediments in the working of the interest rate channel, prior to the financial liberalisation period, the credit channel was used to transmit policy changes. However after 1991, the interest rate channel was strengthened after the developments in the money market, exchange rate channel with the introduction if floating exchange rate, and asset price channel with the developments in capital and commodity markets to transmit policy decisions (Samantaraya, 2011). The RBI undertook measures to develop and integrate the financial markets and also remove of structural rigidities coming in the way of market determination of interest rates to ensure the success of monetary policy (Mohanty, 2011).

This paper makes an attempt to examine the existence and the effectiveness of the interest rate channel in India, across the period 1985 to 2014, starting from the operation of the ‘monetary targeting’ operating framework. The rest of the paper is organised into three parts: part two covers theoretical overview of the interest rate channel, literature review and an evaluation of monetary policy transmission mechanism in India; part three examines and analyses the existence and effectiveness of the interest rate channel; and conclusions and policy implications are given in part four.

2.0 The Interest Rate Channel of Monetary Policy Transmission: Theoretical Overview

Monetary policy actions may start with changes in monetary policy tools such as Bank Rate, Cash Reserve Ratio, Statutory Liquidity Ratio or Open Market Operations to
influence the interest rates by making changes in the monetary base (Ireland, 2006). Given the demand for money, an increase (decrease) in money supply leads to a fall (rise) in real interest rates, which, in turn, lowers (increases) cost of capital and increases (decreases) investment spending, leading to an increase (decrease) in aggregate demand and hence rise (fall) in output or real GDP.

It was the Keynes who first explained that in the short run prices are not flexible and hence they do not clear markets. Thus a fall in nominal interest rates, keeping prices constant leads to a decline in the real interest rates, i.e. nominal interest rate adjusted for inflation. A decline in real interest rate lowers the opportunity cost in consumption and investment. This causes domestic demand for private consumption and investment to increase.

In fact, it is the real long-term interest rate and not the short-term interest rate that has a major impact on spending. The crucial link between the policy rate and the long-term rate is the expectations hypothesis (EH). EH states that, at each point in time the long-term rate is equal to the average of the short term rate expected to prevail over the maturity of the long-term asset plus a constant risk premium. Lower real short-term interest rate leads to a fall in the real long-term interest rate (Mishkin, 1995). Thus policymakers affect long-term rates by changing current and expected future short-term rates (Thornton, 2005). Central banks influence money market conditions and interest rates therein. This has an impact on long-term interest rates as well as retail bank interest rates. This passing on of interest rates from the short term markets to the long term financial markets is termed as ‘interest rate pass through’ (Bondt, 2002).

In India, owing to the administered nature of interest rates, the interest rate pass-through was less than complete. It was 60 percent for lending rates and nearly 40 percent for deposit rates during period 1998-09 to 2004-03 (Mohan, 2006). There are signs of an increase in pass-through over time (RBI, 2004; Sastry, Singh and Bhattacharya, 2001; Prasad and Ghosh, 2005).

2.1 Literature review: Theory and evidence

Policymakers influence long-term rates by changing current and expected future short-term rates (Thornton, 2005) and this passing on of interest rates from the short term markets to the long term financial markets is termed as ‘interest rate pass through’ (Bondt, 2002). This pass-through of the interest rate channel depends upon a number of factors such as: the structure of the financial system (like the extent of the regulation of the financial system, ceilings on interest rates and the geographical and product-line restrictions); the degree of competition between intermediaries; the usage of variable-rate products (both deposits and loans) by the banking system; the response of portfolio
substitution to the policy rate; and, the transparency of the monetary policy operations (Sellon, 2002). A high pass-through suggests that a given change in the policy rate will have a larger effect on lending rate and a quicker pass-through implies that financial markets have become forward looking with decline in transmission lags (RBI, 2004).

In the U.S., both the credit channel and the interest rate channel were important in monetary policy transmission between 1960s and 1970s (Endut, Morley and Tien, 2013). Since the early 1980s, the interest channel has been stronger in transmitting monetary policy changes in the U.S. (Kuttner and Mosser, 2002) and is still a prominent channel in the transmission of monetary policy (Ramey, 1993; Taylor, 1995; Boivin, Kiley and Mishkin, 2010). The interest rate channel is more effective as far as its impact on investment spending, wealth, consumption and exchange rate is concerned. However where its impact on economic output and inflation is concerned, it is less effective compared to its effect prior to the 1980s (Boivin et al., 2010).

The working of the interest rate channel in the Euro area has been supported by many scholars (Mojon, 2000; Mojon and Peersman, 2001; Smets and Wouters, 2003). Van Els et al. (2002) found that initially the exchange rate channel is effective and later, from the third year, the interest rate channel becomes dominant. In the Euro area, most of the times investment changes can be traced to interest rate changes and this shows the dominance of interest rate channel (Angeloni et al., 2002). Empirical studies conducted by Angeloni et al.(2003) show that change in policy rates impact consumption in the U.S. but impact investment more in the Euro area.

Empirical evidence on the interest rate channel in the developing economies is varied. Underdeveloped bond markets, low levels of competition, resource pre-emption and public sector ownership in the banking system and large informal financial sector impede the interest rate channel effectiveness (Moreno, 2008; Kumar, 2014). Traditional channels of monetary policy are ineffective in India (Bhattacharya et al., 2011) and in China (Yue and Zhou, 2007). But it is effective in Malaysia (Azali and Matthews, 1999) and in Indonesia (Wulandari, 2012).

The interest rate channel in India has strengthened post 1998 but the reaction among the firms varies with size, ownership, financial market access and leverage (Prasad and Ghosh, 2005). Its impact is the strongest in the money market and it varies across the segments of the financial market being more effective in deficit liquidity conditions (RBI, 2011). According to Mohanty (2011), the interest rate channel is gaining importance after the development in the financial markets. Interest rates have emerged as a significant factor for explaining the variation in real activity (Dhal, 2000). The monetary policy shocks impacted the prices more and faster than the output in India (Srimany and Samanta, 1998). Monetary policy changes impact output with a lag of two
quarters and inflation with a lag of three quarters and an overall impact on the economy of 8 to 10 quarters (Mohanty, 2011).

2.2 Evolution of monetary policy transmission mechanism in India

The focus of monetary policy has changed from only economic growth to the twin objectives of price stability and provision of adequate credit for economic growth (Mohan, 2007; Pacheco and Shiraly, 2014). Earlier, the monetary policy earlier was conducted largely through direct instruments including administered deposit and lending rates of commercial banks, selective credit control over sensitive commodities, open market operations (OMOs), statutory liquidity ratio (SLR) and the cash reserve ratio (CRR) and the Bank Rate. With the deepening of the financial markets, the RBI has moved towards market-based instruments such as the Liquidity Adjustment Facility and Marginal Standing Facility amongst others to use and to provide the necessary flexibility to monetary operations (Mohanty, 2010a).

Generally, during the administered era from 1964 to mid-1980s, due to a direct link between bank credit and economic output, the stance of monetary policy was conveyed through changes in bank credit (RBI, 2001-02). This period was characterised with very large increases in reserve money, high monetary aggregates and higher than desired rise in wholesale prices. Hence, the objective of the monetary policy was to control inflation and at the same time ensure credit to the productive sectors of the economy for fuller utilization of capacities.

Adverse macroeconomic conditions in the economy during the mid-eighties necessitated the review of monetary management and policy framework in India. The Committee to Review the Working of the Monetary System (Chairman: S. Chakravarty, 1985) recommended the adoption of ‘Monetary Targeting’ as the operating framework and the development of the Indian money market. Under the monetary targeting framework, central banks influence money supply which has a stable relationship with the final objectives of price and output, through the instruments under their direct control such as Cash Reserve Ratio (CRR) (Mohanty, 2011).

Structural reforms and financial liberalisation since 1985 led to market-determination of interest rates and exchange rate. This gave way to wider avenues of financing for the government and the commercial sectors which, in turn, allowed the Reserve Bank to successfully transmit policy signals through interest rates. In the credit market, multiple lending rates, which were borrower-specific, were rationalized and converted into a few slabs based only on size of loans; and lending rates were gradually deregulated over the entire decade. However, in the mid-1990s, increase in liquidity from capital inflows raised the ratio of net foreign assets to reserve money, in turn,
making monetary management difficult (Mohanty, 2012). Hence, the RBI shifted from ‘monetary targeting approach’ to the ‘multiple indicators approach’ as the operating framework in 1998. In the ‘multiple indicators approach’, as conceptualized by Dr. Bimal Jalan, broad money continued to remain an information variable for the conduct of monetary policy but in the formulation of the policy greater emphasis was placed on interest rate channels (Mohanty, 2011). The ‘multiple indicators approach’ included quantity variables and rate variables. The quantity variables comprise money, credit, output, trade, capital flows and fiscal position and the rate variables comprise rates of return in different markets, inflation rate and exchange rate. On the basis of the assessment of these indicators, future growth and inflation are projected. The Reserve Bank placed greater emphasis on the money market as the focal point for the conduct of monetary policy to develop its integration with other market segments (Mohanty, 2010).

In April 1998, based on the recommendations of the Narasimham Committee (1998) on Banking Sector Reforms, the RBI introduced the Liquidity Adjustment Facility (LAF) to meet short term liquidity requirements of banking system effectively. The repo rate and the reverse repo rate became the key instruments for signaling the monetary policy stance. This helped to develop interest rate as an important instrument of monetary transmission. The overnight management of systemic liquidity at desired interest rate emerged as the most active instrument of monetary policy replacing the much-used CRR and OMOs. The operating framework evolved further in 2011 with the introduction of the weighted average overnight call money rate as the operating target of monetary policy, the repo rate as the only one independently varying policy rate and a new Marginal Standing Facility (MSF) to provide a safety valve against unanticipated liquidity shocks.

3.0 The Interest Rate Channel: An analysis

The studies on interest channel of monetary policy transmission in India can be broadly segregated into three categories on the basis of their objectives: (i) The studies attempting to analyze the interest rate channel with respect to integration of financial markets (Dhal and Bhoi, 1998; Nag and Mitra, 1999; Jain and Bhanumurthy, 2005; RBI, 2007; Patnaik and Ramanathan, 2007), (ii) The studies analysing transmission of policy rates across financial markets and their impact on output and inflation (Ray, Joshi and Saggar, 1998; Dhal, 2000; Mohanty, 2012) and (iii) Studies analysing the impact of monetary policy stance and liquidity in the economy on the transmission of rates and the monetary policy (Ray and Prabhu, 2013).
The present paper is attempting to examine transmission of policy rates across financial markets and their impact on output and inflation. Section one examines the transmission of changes in policy rates to interest rates in the short-term and the long-term financial markets and to the lending rates in the credit market and section two examines the effectiveness of interest channel in terms of impact of changes in policy rates on the real economy, i.e. on economic output and prices in the economy.

3.1 Transmission of policy rates: Methodology

The objective of this analysis is to examine the interest rate pass-through, i.e. to see whether the changes in monetary policy get transmitted to other bank and market rates in the economy. To examine the presence of pass-through, the correlation matrix has been used (RBI, 2007) and to examine the strength of the pass-through, the Ordinary Least Squares (OLS) technique has been used.

The entire period from April 1993 to March 2014 is broadly divided into three distinct phases: Phase I from April 1993 to March 1998, the period following the financial sector reforms (RBI, 2007); Phase II from April 1998 to March 2008, the period when ‘monetary targeting’ was replaced by the ‘multiple indicators’ approach in 1998 and continued till the emergence of global financial crisis in 2008; Phase III from April 2008 to March 2014, the period starts with the global financial crisis of 2008 and witnessed volatility in financial markets. The monetary authority changes its policy either by changing the Bank rate or CRR or SLR or through open market operations or by changing all the variables. However, during the period under study the CRR was more actively used for policy making process compared to other variables (Note 1). The call money rate gained importance as the policy variable with the introduction of the ‘multiple indicators’ approach (Note 2).

To examine the transmission of the interest rate channel of monetary policy in India, the variables used are: Cash Reserve Ratio (CRR), Call money rate (CMR), yield on 91 days Treasury Bill (YTB91), yield on 364 days Treasury Bill (YTB364), interest rates on Commercial Papers (CP), interest rate on Certificate of Deposits (CD), yield on the 5 years (YGB5), yield on 10 years government bonds (YGB10) and SBI lending rate (LR). Out of these nine variables, the first two variables are proxy for monetary policy changes, next four variables used to capture changes in the money market and the last three variables are used to estimate changes in long-term financial markets.

3.2 Correlation results

To examine the presence of the interest rate channel of monetary policy transmission during the period from April 1993 to March 1998, correlation was
estimated among seven variables, namely CRR, CMR, YTB91, CP, CD, YTB364 and LR. Due to non-availability of data on YGB5 and YGB10, they were excluded from these estimates. The data on these two variables were made available from 1996 (RBI, 2007).

Tables 1-3 present the correlation results of Phase I, II and III. The results in Table 1 show that in Phase I, there was a stronger relation between CRR and yield of government securities of varying maturities and lending rates while whereas the relation between CMR and interest rates weakens as the maturity periods increase. In Phase II (Table 2), there was strong correlation between both CRR and CMR with other market interest rates. In Phase III (Table 3), the correlation results between CRR and other market rates show weak transmission and also are statistically not significant while correlation between CMR and other market rates was very strong and statistically significant implying that transmission has occurred mainly through the CMR to other market interest rates.

Table 1: Correlations Matrix (April 1993 - March 1998)

|       | CRR  | CMR  | YTB91 | YTB364 | CD   | CP   | LR   |
|-------|------|------|-------|--------|------|------|------|
| CRR   | 1    |      |       |        |      |      |      |
| CMR   | .318 | 1    |       |        |      |      |      |
| YTB91 | .638*| .604*| 1     |        |      |      |      |
| YTB364| .578*| .379*| .897* | 1      |      |      |      |
| CD    | .064 | .453*| .591* | .528*  | 1    |      |      |
| CP    | .354*| .493*| .785* | .759*  | .703*| 1    |      |
| LR    | .562*| .373*| .757* | .850*  | .632*| .747*| 1    |

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table 2: Correlations Matrix (April 1998 - March 2008)

|       | CRR  | CMR  | YTB91 | YTB364 | CD   | CP   | YGB5 | YGB10 | LR   |
|-------|------|------|-------|--------|------|------|------|-------|------|
| CRR   | 1    |      |       |        |      |      |      |       |      |
| CMR   | .658*| 1    |       |        |      |      |      |       |      |
| YTB91 | .879*| .840*| 1     |        |      |      |      |       |      |
| YTB364| .910*| .793*| .987* | 1      |      |      |      |       |      |
| CD    | .859*| .712*| .860* | .859*  | 1    |      |      |       |      |
| CP    | .871*| .776*| .918* | .908*  | .949*| 1    |      |       |      |
| YGB5  | .955**| .708**| .926**| .950**| .883**| .892**| 1    |       |      |
| YGB10 | .949**| .711**| .922* | .951*  | .873*| .880*| .990*| 1      |      |
| LR    | .819*| .532*| .752* | .753*  | .871*| .878*| .765*| .737*  | 1    |

** Correlation is significant at the 0.01 level (2-tailed).
The correlation results in the paper show that correlation coefficient of CMR and CRR strengthens in the period 1998-2008 as compared to 1993-1998. The strength of correlation weakened considerably in the last period of 2008-2014. This can be attributed to the fact that the RBI decided to use interest rate policy instruments, reducing dependence on direct instruments and also that the policy decision was to reduce the level of CRR which has remained at 4 per cent from February 2013 onwards.

### 3.3 Ordinary Least Squares (OLS)

The strength of the pass-through of policy rates to market rates of varying maturities is examined here using the Ordinary Least Squares (OLS) technique. The study is based on the work of Cook and Hahn (1989) and Patnaik and Ramnathan (2007) which is based on work done by Cook and Hahn (1989) with slight modifications. The Cook and Hahn (1989) model considered the Fed funds rate as monetary policy variable and yield on the following government securities as financial market interest rates viz. the 3 months Treasury Bill rate, 6 months Treasury Bill rate, 12 months Treasury Bill rate, 3 years Bond rate, 5 years Bond rate, 7 years Bond rate, 10 years Bond rate and 20 years Bond rate. The Patnaik and Ramnathan (2007) model examined pass through from repo rate and bank rate to select short-term rates short-term and long-term interest rates using the OLS technique with the aim to study the interest rate pass-through. The present study has compared the interest pass-through in the three periods under study, in the short-term market rates and long-term market rates using CRR and CMR as monetary policy variables using the OLS technique.

In the present analysis, yield on 91 day Treasury bill, yield on 364 days Treasury bill, Certificate of Deposits (CDs) rates and Commercial Papers (CPs) rates are the short term market interest rates used as dependent variables and CRR and CMR, used as independent variables reflecting monetary policy changes. On the other hand, the yield...
on 5 years Government Bonds (YGB5), the yield on 10 years Government Bonds (YGB10) and lending rates (LR) are long-term market interest rates used as dependent variables and the CRR and CMR used as the independent variables. The equations include the data series in first difference, which treats the problem of non-stationarity in time-series data (Annexure 2A & 2B). The regression equation used is as follows:

The regression equation is as follows:

\[
\Delta Y_t = a + \beta_1 \Delta X_{1t} + \beta_2 \Delta X_{2t} + u_t
\]

where,

\( \Delta Y_t \) represents the change in dependent variable (the financial market rates),
\( a \) is the intercept term,
\( \beta_1 \) is the coefficient of the explanatory variable (CRR)
\( \Delta X_{1t} \) represents the change in the independent variable (CRR)
\( \beta_2 \) is the coefficient of the explanatory variable (CMR)
\( \Delta X_{2t} \) represents the change in the independent variable (CMR) and
\( u_t \) is the error term.

For the regression analysis, the time periods considered are the same as taken for the correlation analysis: Period One (April 1993 – March 1998); Period Two (April 1998 – March 2008); and Period Three (April 2008 – March 2014). The software package used for this analysis is the econometrics software, GRETL.

In this analysis, the interest rates have been used in the varying frequencies:
(i) Monthly data is used for transmission from policy rate to money market rates; and
(ii) Quarterly data is used for transmission from policy rate to long term rates. There are two but interconnected reasons behind using quarterly data for long term rates: First, long term market rates take longer time to get impacted by monetary policy changes and second, hence monthly data is unable to capture the impact of policy changes on the long term variables. If monthly data is used in this situation, then possibly they might not capture the change in long term interest rates and hence leading to zero observation value and this may cause problem to regression analysis.

3.4 Results of OLS

In the Phase I (Table 4), CRR was influential only with respect to yield on YTB91 amongst the short-term rates and there is no transmission from monetary policy rates to long-term lending rates. This could be attributed to the use of selective credit controls by the RBI (Mohanty and Mitra, 1999) during this period of monetary targeting while the interest rates were being gradually deregulated.
During Phase II (Table 5), CRR is more influential in impacting the yield on the government securities YTB91 and YTB364 as compared to CMR. However, CMR influences the short-term interest rates particularly the CP rates and CD rates.

### Table 4: Phase I OLS results

| Model: $\Delta MR_t = \alpha + \beta_1 \Delta CRR + \beta_2 \Delta CMR + \mu$ (monthly data) |
|---------------------------------------------------------------|
| Short term (money market) interest rates: 1993-1998            |
| $\alpha$ | $\beta_1$ | $\beta_2$ | R square | DW  | p-value (F) |
|----------|-----------|-----------|----------|-----|-------------|
| DYTB91   | 0.021     | 1.037     | 0.007    | 0.211 | 1.880 0.000 |
| DYTB364  | -0.031    | 0.300     | 0.002    | 0.104 | 2.040 0.185 |
| CP       | 0.013     | 0.553     | 0.0350   | 0.083 | 1.946 0.347 |
| CD       | 0.055     | 0.263     | -0.008   | -0.032 | 1.911 0.929 |

| Model: $\Delta MR_t = \alpha + \beta_1 \Delta CRR + \beta_2 \Delta CMR + \mu$ (quarterly data) |
|---------------------------------------------------------------|
| Long term market interest rates: 1993-1998                    |
| $\alpha$ | $\beta_1$ | $\beta_2$ | R square | DW  | p-value (F) |
|----------|-----------|-----------|----------|-----|-------------|
| LR       | -0.187    | -0.203    | 0.006    | 0.113 | 2.261 0.799 |

### Table 5: Phase II OLS results

| Model: $\Delta MR_t = \alpha + \beta_1 \Delta CRR + \beta_2 \Delta CMR + \mu$ (monthly data) |
|---------------------------------------------------------------|
| Short term (money market) interest rates: 1998-2008            |
| $\alpha$ | $\beta_1$ | $\beta_2$ | R square | DW  | p-value (F) |
|----------|-----------|-----------|----------|-----|-------------|
| DYTB91   | 0.006     | 0.313     | 0.121    | 0.215 | 2.044 0.000 |
| DYTB364  | 0.000     | 0.284     | 0.0426   | 0.123 | 1.965 0.001 |
| CP       | -0.021    | 0.233     | 0.185    | 0.210 | 1.906 0.000 |
| CD       | -0.060    | 0.051     | 0.116    | 0.053 | 1.564 0.025 |

| Model: $\Delta MR_t = \alpha + \beta_1 \Delta CRR + \beta_2 \Delta CMR + \mu$ (quarterly data) |
|---------------------------------------------------------------|
| Long term market interest rates: 1998-2008                    |
| $\alpha$ | $\beta_1$ | $\beta_2$ | R square | DW  | p-value (F) |
|----------|-----------|-----------|----------|-----|-------------|
| YGB5     | -0.094    | 0.192     | 0.078    | 0.260 | 2.001 0.048 |
| YGB10    | -0.105    | 0.286     | 0.065    | 0.307 | 1.861 0.013 |
| LR       | -0.101    | 0.321     | -0.059   | 0.141 | 2.179 0.007 |
Between the two monetary policy variables - CRR and CMR- CRR appears to have more impact on the long term rates viz. YBG10 and LR. It can be said that in Phase III (Table 6), the CMR has influenced the short-term market interest rates more strongly as compared to the impact of CRR. The CRR has significant impact on yield on long term government securities and CMR has impact on yield on medium term government bonds but neither had impact on lending rates. Activity in the CP market reflects the state of market liquidity as its issuances tends to rise amidst ample liquidity conditions when companies can raise funds through CPs at an effective rate of discount lower than the lending rate of banks. Banks book profits through arbitrage by borrowing in the call money market and investing in the CP market (Pathak B, 2008).

### Table 6: Phase III OLS results

| Model: $\Delta MR_t = \alpha + \beta_1 \Delta CRR + \beta_2 \Delta CMR + \mu$ (monthly data) |
|---------------------------------|-----|-----|------|-----|-----|
|                                 | $\alpha$ | $\beta_1$ | $\beta_2$ | R square | DW | p-value (F) |
| DYTB91                         | 0.023 | 0.098 (0.788) | 0.573 (7.50) | 0.461 | 1.909 | 0.000 |
| DYTB364                        | 0.028 | 0.240 (2.117) | 0.423 (6.046) | 0.400 | 2.128 | 0.000 |
| CP                              | -0.041 | -0.733 (-3.558) | 0.884 (7.327) | 0.430 | 2.056 | 0.000 |
| CD                              | -0.045 | -0.635 (-4.071) | 0.748 (8.189) | 0.462 | 2.045 | 0.000 |

| Model: $\Delta MR_t = \alpha + \beta_1 \Delta CRR + \beta_2 \Delta CMR + \mu$ (quarterly data) |
|---------------------------------|-----|-----|------|-----|-----|
|                                 | $\alpha$ | $\beta_1$ | $\beta_2$ | R square | DW | p-value (F) |
| YGB5                            | 0.082 | 0.304 (2.222) | 0.348 (4.436) | 0.723 | 1.946 | 0.000 |
| YGB10                           | 0.143 | 0.710 (4.887) | -0.03 (-0.474) | 0.630 | 2.035 | 0.000 |
| LR                              | 0.175 | 0.015 (0.080) | -0.159 (-1.468) | 0.106 | 1.938 | 0.225 |

All the models estimated have been tested for multi-collinearity and autocorrelation. All the tests prove the models to be efficient and robust yet low on predictive capability. Detected autocorrelation has been corrected by using the Cochrane – Orcutt procedure. The low R square values can be attributed to the non-incorporation
of other variables in the model that influence the interest rates in the short run and in the long run.

The R square values, although appreciably higher in the later period (2008-14) as compared to the earliest period (1993-98), are not very high. This also could be attributed to the presence of other variables that impact the money market rates which have not been included in the model. On comparison of regression output for Phase I (1993-98), Phase II (1998-08) and Phase III (2008-14), we find that the values of R square have improved in the third period although they are not very high for the short term interest rates but high for the long term interest rates equations. This might be indicating that though the transmission mechanism has improved over the years.

A few noteworthy features of the analysis in Section I are: (i) the government securities responded to changes in CRR till 2008 and in the latest period have responded to CMR, (ii) there is a strong pass-through from CMR to other money market rates like Commercial Paper and Certificates of Deposit and (iii) the monetary policy variable in the recent period is more responsible for changes in the market interest rates. The CMR has become the monetary policy variable (rising R²).

3.5 Vector Auto regressions (VAR)

Vector Auto regression (VAR) is a macroeconometric framework developed by Sims (1980) which captures dynamics in multiple time series in a systematic way (Stock and Watson, 2001). VAR is an n-equation, n-variable linear model in which each variable is explained by its own lagged values, plus past values of the remaining variables. When one needs to explain the dynamic relations and co-movements among a group of time series variables - the Multivariate time series – the VAR model is used for analysis. VAR in the ‘reduced form’ expresses each variable as a linear function of its own past values, the past values of all other variables being considered, and a serially uncorrelated error term. Each equation is estimated by ordinary least squares (OLS) regression. In the VAR in the reduced form, there is a chance that error terms are correlated across equations when the different variables are correlated with each other (Stock and Watson, 2001).

In the example including interest rates (R), money growth (M) and income (Y) as three variables in the VAR model, we could be interested in examining the impact of changes in money growth (M) and in income (Y) on interest rates (R) which represents equilibrium in the money market. In this case, the three autoregressive equations will be as follows:

\[
R_t = \alpha_1 + \beta_1 R_{t-1} + \beta_2 M_{t-1} + \beta_3 Y_{t-1} + \epsilon_1
\]

\[
M_t = \alpha_2 + \beta_4 R_{t-1} + \beta_5 M_{t-1} + \beta_6 Y_{t-1} + \epsilon_2
\]
\[ Y_t = \alpha_3 + \beta_7 R_{t-1} + \beta_8 M_{t-1} + \beta_9 Y_{t-1} + \epsilon_3 \]

Here VAR in the reduced form is used in which each variable is assumed to be a linear function of its own past values and the past values of all the other variables under consideration. As the macroeconomic variables included for the purpose of analysis are non-stationary hence VAR at level is being used (Annexure 1 & 2C). The period under study is from April 1985 to March 2014, divided into two broad phases: (i) April 1985 to March 1998 constitute the first phase when the ‘monetary targeting’ operating procedure was in place and (ii) April 1998 to March 2014 constitute the second phase when the ‘multiple indicators’ approach was in place.

### 3.6 Interpretation of VAR output

From the VAR analysis, the results to be analysed include results from (i) Impulse responses, and (ii) Forecast error variance decompositions. **Impulse responses** trace out the response of current values and future values of each of the variables to a one unit increase in the current value of one of the VAR errors, assuming that this error returns to zero in subsequent periods and that all other errors are equal to zero (Sims, 2001). The **forecast error decomposition** is the percentage of the variance of the error made in forecasting a variable. The forecast error decomposition can be compared to a partial \( R^2 \) for the forecast error, by a particular forecast period.

VAR results are sensitive to the selection of lag length, or the order of the VAR. Lag length selection has been made based on the basis of Akaike Information Criteria (AIC). Monthly dummies have been included in the models in order to tackle the problem of seasonality. To study the interest rate channel, here, the lag length has been selected using the Aikaike’s Information Criterion (AIC) for both the periods under study - 1985 to 1998 and 1998 to 2014. For our analysis, the lag length selected for the period 1985 to 1998 is 2 (lag two) and for the period 1998 to 2014 is 4 (lag four) (Annexure 3).

### 3.7 Specification of the model

The variables selected for the model are based on selection of variables to study the interest rate channel by Dhal (2000) and Mohanty (2012a). However the present study is a slightly modified version of the study by Dhal (2000) and Mohanty (2012a). The entire period has been divided into two sub-periods based on the operating procedure in place to implement monetary policy. In this model output is proxied by Index of Industrial Production (IIP), price level is proxied by Wholesale Price Index (WPI), interest rate is proxied by Call Money rate (CMR) and money supply is proxied...
by Broad Money (M3). Except for CMR, for modelling purpose, all variables are taken in logarithms denoted by prefix L, so that \( Lx = \log(x) \).

Therefore the model used here is: \( X_t = \{LIIP, LWPI, CMR, LMONY\} \)

where, \( X_t \) is the dependent variable and, in VAR, every independent variable once becomes the dependent variable.

In VAR, after running the model, it is very important to ensure that the lag length selected on the basis of AIC is the correct lag length where the issue of autocorrelation has been addressed and the model is indeed a good model. This can be verified by running the Lagrange multiplier (LM) tests. The null hypothesis of the LM test is that there is no serial correlation up to lag order \( p \). Once the model has been ascertained as a good model, the interpretation of results in the form of Impulse Response Function and Forecast Error Variance Decomposition can be undertaken.

### 3.8 Results of VAR

The results of impulse response function and variance decomposition derived from VAR estimations are presented in Annexure 4 and Annexure 5. The objective is to examine the interest rate and monetary impacts on industrial production and on inflation.

#### 3.8.1 Impact of policy change on industrial production

In the ‘monetary targeting’ period, the changes in call money rate had negative impact on industrial production and it was short-lived; as against in the ‘multiple indicators’ period, it was more persistent. However, industrial production takes almost four months to respond to changes in money supply in the ‘multiple indicators’ period as against responding in two months in the ‘monetary targeting’ period.

Over 36 months, call money rates explained only about 3 per cent variation in industrial production in the ‘monetary targeting’ period, as against 6 per cent in the ‘multiple indicators’ period. Over 36 months, money supply explained nearly 25 per cent of the variation in industrial production in the ‘monetary targeting’ period, as against 3.5 per cent in the ‘multiple indicators’ period. In the in the ‘multiple indicators’ period, money supply explained about 4 per cent variation in industrial production after 18 months, which declined thereafter.

#### 3.8.2 Impact of policy change on inflation

The response of inflation to changes in call money rate in both the ‘monetary targeting’ period and in the ‘multiple indicators’ period appears to be positive which weakens over the period. Inflation takes longer to respond to changes in money supply in the ‘monetary targeting’ period as compared to the time taken to respond in the ‘multiple
indicators’ period. Over 36 months, call money rates explained about 13 per cent variation in inflation in the ‘monetary targeting’ period as against 8.24 per cent in the ‘multiple indicators’ period. Over 36 months, money supply explained nearly 9 per cent of the variation in inflation in the both, the ‘monetary targeting’ period and the ‘multiple indicators’ period. It is also seen that the policy variables - call money rate and money supply - together explain relatively less amount of variation in the target variables, viz. industrial production and inflation, in the ‘multiple indicators’ period as against in the ‘monetary targeting’ period.

Although industrial production has ‘a priori’ negative relation to CMR, inflation appears to rise before responding to changes in CMR. This alludes to the presence of the ‘price puzzle’\(^2\). An unanticipated monetary policy tightening is followed immediately by a sustained increase in the inflation rate is known as the price puzzle (Dueker, 2006). One of the reasons could be that policy rates hiked to control higher future inflation are not enough to fully offset the subsequent inflation (Balke and Emery, 1994).

*The Reserve Bank raised its policy repo rate 13 times between March 2010 and October 2011 by a cumulative 375 basis points. The policy repo rate increased from a low of 4.75 per cent to 8.5 per cent. Still it did not help contain inflation. The critics of the Reserve Bank argue that monetary tightening rather than lowering inflation has slowed growth. Interest rate is a blunt instrument. It first slows growth and then inflation (Mohanty, 2013).*

### 4.0 Conclusion and Policy Implications

From the results of the analysis it appears that after the deregulation of interest rates, the transmission of interest rates pass-through from policy rates to market interest rates (both - short-term as well as long-term) - has strengthened across the period from 1993 to 2014. More importantly, the call money rate has had a stronger impact on all market rates.

Based on the analysis of the impulse response function and variance decomposition, it appears that call money rates have had gradual impact on industrial output in the two periods; whereas the impact of call money rates on inflation is delayed. A change in money supply seems to be having a consistent impact on inflation in the two periods; but its impact on industrial output has considerably reduced in the ‘multiple indicators’ period. The impact of interest rates on industrial production has weakened in the recent period and prices rise in response to an interest rate shock possibly due to the factoring in of policy rate shocks.
4.1 Policy Implications

The financial sector reforms have resulted in stronger transmission of policy rates from the short term markets to long term markets. However, the desired impact of long term market interest rates on industrial production and inflation appears to be weak. Therefore, the RBI should take measures to make transmission of long term market interest rates to target variables more effective. Our analysis of the interest rate channel shows that changes in interest rates have a delayed impact on inflation and negative impact on industrial production. The ability of the monetary policy tools in managing inflation appear to be blunt. It can be understood that inflation is being caused by factors, of which many are not under the control of the RBI.

Endnotes

1. Monetary policy decisions of the RBI prior to 2014 had given greater weightage to the Wholesale Price Index (WPI) as compared to the Consumer Price Index (CPI) in taking policy decisions. Based on the recommendations of the Urjit Patel Committee Report, the CPI was adopted as the key measure of inflation in April 2014. This study examines the effectiveness of monetary policy decisions from 1985 to 2014, a period during which the RBI based policy decisions to a greater extent based on the WPI.

2. The paper has put forth that inflation rises and then begins to taper in response to a shock in policy rates. Inflation tapers with a smaller lag in the period 1998-2014 and compared to 1985-1998.

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**Annexure 1: VAR at Level**

According to Ray (2008), the VAR can be run under three different conditions: (i) level VARs (without checking for stationarity), (ii) difference VARs (checking for stationarity but not cointegration and (iii) VECM (checking for both stationarity and cointegration). The justification of the first category came from Sims, Stock and Watson (1990) who, while developing Fuller (1976) results, put forth that the coefficients were consistently estimated irrespective of the order of integration. A VAR model in levels in the presence of cointegration is over-parameterization leading to inefficient but consistent estimates of parameters of interest. Further, according to Ray and Prabhu (2013), when variables are found to be non-stationary, differencing the data series is suggested. However the authors have highlighted another view that states that a VAR in differences leads to loss in information on the co-movement among the variables which, in fact, is most important to find out (Brooks, 2002). It has been established that while VARs with non-stationary variables incur some loss in the estimator’s efficiency, the consistency properties of the estimators remain intact (Sims, Stock and Watson, 1990). Even in case of loss in efficiency of
estimates, differencing the variables has not been recommended since the goal of VAR analysis is
to study inter-relationships among variables and not to determine efficient estimates (Sims, 1980).

This view is further strengthened in Canova (2007), who said, when doubts about the
unit root test exists, one can indirectly check the reasonableness of the stationarity assumption by
studying estimated residuals. Practical experience suggests that VAR residuals show break and
outliers but they rarely display unit root behavior. Hence, a level VAR could be appropriate even
when \( y_t \) is nonstationary. It is also important to remember that the properties of \( y_t \) are important
in testing hypothesis about the coefficients since classical distribution theory is different when
unit roots are present. However, they are irrelevant for estimation. Consistent estimates of VAR
coefficients, in fact, obtain with classical methods, even when unit roots are present ... (Canova,
2007; p. 115). Available at http://www.international-economy.com/TIE_F09.Asset.PriceSymppdf

### Annexure 2A: Unit Root Test: Interest Rate Channel: OLS

| Variable | Unit Root Tests 1983-98 | Unit Root Tests 1998-08 | Unit Root Tests 2008-14 |
|----------|-------------------------|-------------------------|-------------------------|
|          | ADF                     | ADF                     | ADF                     |
|          | Level                   | First Difference        | Level                   | First Difference        | Level                   | First Difference        |
|          | Constant                | Constant and Trend      | Constant                | Constant and Trend      | Constant                | Constant and Trend      |
|          |                         |                         |                         |                         |                         |                         |
|          | 1                       | 2                       | 3                       | 1                       | 2                       | 3                       |
| CRR      | 0.03                    | -1.21                   | -6.10*                  | 0.26                    | -9.85*                  | -1.69                   | -2.07                   | -7.29*                  |
| CMR      | -4.23*                  | -4.22*                  | -7.30*                  | -4.38*                  | -4.86*                  | -14.81*                 | -1.98                   | -2.63                   | -5.54*                  |
| YTB91    | -0.91                   | -1.04                   | -7.03*                  | -1.43                   | -1.49                   | -11.23*                 | -1.14                   | -1.93                   | -6.27*                  |
| YTB364   | 0.55                    | -0.53                   | -5.64*                  | -0.95                   | -9.22*                  | -1.63                   | -2.39                   | -5.81*                  |
| CD       | -2.13                   | -2.27                   | -6.35*                  | -3.19                   | -0.51                   | -9.30*                  | -1.83                   | -2.06                   | -8.93*                  |
| CP       | -2                      | -1.96                   | -9.81                   | -2.45                   | -1.29                   | -14.89*                 | -1.98                   | -2.28                   | -10.44*                 |
| Test     |                         |                         |                         |                         |                         |                         |                         |                         |
| critical values: |               |                         |                         |                         |                         |                         |                         |                         |
| 1% level | -3.55                   | -4.12                   | 1% level                | -3.49                   | -4.04                   | 1% level                | -3.52                   | -4.09                   |
| 5% level | -2.91                   | -3.49                   | 5% level                | -2.89                   | -3.45                   | 5% level                | -2.9                    | -3.47                   |
| 10% level| -2.59                   | -3.17                   | 10% level               | -2.58                   | -3.15                   | 10% level               | -2.59                   | -3.16                   |

**Notes:** * - Significance at the 1% level; ** - Significance at the 5% level.
### Annexure 2B: Unit Root Test: Interest Rate Channel: OLS

| Variable | Unit Root Tests 1993-98 | Unit Root Tests 1998-08 | Unit Root Tests 2008-14 |
|----------|-------------------------|-------------------------|-------------------------|
|          | ADF                     |                         |                         |
|          | Level                   | First Difference        | Level                   | First Difference |
|          | Constant                | Constant and Trend      | Constant                | Constant and Trend |
|          | Level                   | First Difference        | Level                   | First Difference |
|          | Constant                | Constant and Trend      | Constant                | Constant and Trend |
| CRR      | -2.04                   | -3.85                   | -2.09                   | -1.89             | 0.39             | -3.46             | -1.71             | -2.17             | -4.59             |
| YGB5     |                         | -3.00                   | -1.15                   | -3.75             | -1.92             | -2.56             | -5.12             |
| LR       | -1.96                   | -3.10                   | -3.18                   | -2.46             | -1.06             | -6.09             | -0.77             | -1.47             | -3.67             |
|          | 5% level                | -3.03                   | -3.67                   | 5% level           | -2.94             | 5% level           | -2.99             |
|          | 10% level               | -2.66                   | -3.28                   | 10% level          | -2.61             | 10% level          | -2.64             |

Notes: * - Significance at the 1% level; ** - Significance at the 5% level.

### Annexure 2C: Unit Root Test VAR variables

| Variable | Unit Root Tests 1985-98 | Unit Root Tests 1998-14 |
|----------|-------------------------|-------------------------|
|          | ADF                     |                         |
|          | Level                   | First Difference        | Level                   | First Difference |
|          | Constant                | Constant and Trend      | Constant                | Constant and Trend |
|          | Level                   | First Difference        | Level                   | First Difference |
|          | Constant                | Constant and Trend      | Constant                | Constant and Trend |
| LIIP     | -0.456                  | -1.968                  | -3.907                  | -1.007             | -1.502             | -2.517             |
| LWPI     | -0.683                  | -1.224                  | -8.869                  | 0.573              | -1.999             | -10.322             |
| LINVS    | -1.262                  | -2.431                  | -20.348                 | -1.537             | -1.988             | -14.628             |
| LNFCR    | -0.236                  | -3.612                  | -2.224                  | 0.116              | -1.842             | -2.273             |
| LSMONY   | -0.096                  | -5.203                  | -10.025                 | -0.589             | -1.846             | -2.505             |
| CMR      | -5.923                  | -5.910                  | -11.955                 | -4.375             | -4.348             | -17.355             |
| CRR      | -1.296                  | -0.441                  | -11.532                 | -1.927             | -1.839             | -12.207             |

Test critical values:

|          | Constant                | Constant and Trend      | Constant                | Constant and Trend |
|          |                         |                         |                         |                   |
| 1% level | -3.472534               | -4.017956               | -3.464460               | -4.006566         |
| 5% level | -2.879966               | -3.438886               | -2.876435               | -3.433401         |

Notes: * - Significance at the 1% level; ** - Significance at the 5% level.
### VAR Lag Order Selection Criteria

**Exogenous variables:** DUM  
**Endogenous variables:** CMR LIIP LWPI LSMONY  
**Sample:** 1985M04 1998M03  
**Included observations:** 156

| Lag | LogL  | LR    | FPE    | AIC    | SC    | HQ    |
|-----|-------|-------|--------|--------|-------|-------|
| 0   | -10.2 | NA    | 2.48E-05 | 0.747  | 1.685 | 1.128 |
| 1   | 1028  | 1863  | 5.09E-11 | -12.4  | -11.10176* | -11.84479* |
| 2   | 1051  | 41.29155* | 4.62e-11* | -12.45147* | -10.9  | -11.8 |
| 3   | 1064  | 21.09 | 4.86E-11 | -12.4  | -10.5  | -11.6 |
| 4   | 1079  | 25.03 | 4.93E-11 | -12.4  | -10.2  | -11.5 |
| 5   | 1094  | 23.65 | 5.05E-11 | -12.4  | -9.88  | -11.4 |

**Sample:** 1998M04 2014M03  
**Included observations:** 192

| Lag | LogL  | LR    | FPE    | AIC    | SC    | HQ    |
|-----|-------|-------|--------|--------|-------|-------|
| 0   | 145.1 | NA    | 4.28E-06 | -1.01  | -0.2  | -0.68 |
| 1   | 1580  | 2631  | 1.63E-12 | -15.8  | -14.7  | -15.4 |
| 2   | 1623  | 76.9  | 1.23E-12 | -16.1  | -14.71453* | -15.52210* |
| 3   | 1637  | 23.99 | 1.27E-12 | -16    | -14.4  | -15.4 |
| 4   | 1658  | 37.03026* | 1.20e-12* | -16.10708* | -14.2  | -15.3 |
| 5   | 1674  | 25.59 | 1.21E-12 | -16.1  | -13.9  | -15.2 |

* * indicates lag order selected by the criterion  
LR: sequential modified LR test statistic (each test at 5% level)  
PFE: Final prediction error  
AIC: Akaike information criterion  
SC: Schwarz information criterion  
HQ: Hannan-Quinn information criterion
Annexure 4A: Impulse Response Function 1985-1998

Response to Cholesky One S.D. Innovations ± 2 S.E.

Fig. 5.1a

Response of CMR to LSMONY

Fig. 5.1b

Response of LIIP to CMR

Fig. 5.1c

Response of LIIP to LSMONY

Fig. 5.1d

Response of LWPI to CMR

Fig. 5.1e

Response of LWPI to LSMONY

Fig. 5.1f

Response of LSMONY to CMR
Annexure 4B: Impulse Response Function 1998 – 2014

Response to Cholesky One S.D. Innovations ± 2 S.E.

Response of CMR to LSMONY

Response of LIIP to CMR

Response of LIIP to LSMONY

Response of LWPI to CMR

Response of LWPI to LSMONY

Response of LSMONY to CMR

Response of LSMONY to CMR

Response of LSMONY to LWPI

Response of LSMONY to LWPI
Annexure 5A: Variance Decomposition Output: 1985-1998

### Variance Decomposition: Period 1985-98

| Period | LIIP  | LWPI  | CMR   | LSMONY | Period | LIIP  | LWPI  | CMR   | LSMONY |
|--------|-------|-------|-------|--------|--------|-------|-------|-------|--------|
| 1      | 98.94 | 0.00  | 1.06  | 0.00   | 1      | 0.10  | 99.30 | 0.60  | 0.00   |
| 6      | 90.60 | 0.29  | 2.34  | 6.78   | 6      | 14.39 | 76.13 | 9.21  | 0.27   |
| 12     | 84.17 | 1.00  | 2.49  | 12.34  | 12     | 19.99 | 66.33 | 12.78 | 0.91   |
| 18     | 78.99 | 1.58  | 2.66  | 16.78  | 18     | 21.27 | 62.94 | 13.58 | 2.22   |
| 24     | 75.16 | 1.86  | 2.72  | 20.25  | 24     | 21.55 | 60.68 | 13.69 | 4.09   |
| 30     | 72.27 | 1.95  | 2.72  | 23.06  | 30     | 21.41 | 58.68 | 13.51 | 6.40   |
| 36     | 69.98 | 1.94  | 2.69  | 25.38  | 36     | 21.06 | 56.74 | 13.18 | 9.02   |

### Variance Decomposition: Period 1985-98

| Period | LIIP  | LWPI  | CMR   | LSMONY | Period | LIIP  | LWPI  | CMR   | LSMONY |
|--------|-------|-------|-------|--------|--------|-------|-------|-------|--------|
| 1      | 0     | 100   | 0     | 0      | 1      | 8.04  | 0.49  | 0.53  | 90.94  |
| 6      | 15.00 | 1.56  | 78.41 | 5.03   | 6      | 2.47  | 0.25  | 0.36  | 96.91  |
| 12     | 19.38 | 2.44  | 73.22 | 4.95   | 12     | 1.47  | 0.55  | 0.19  | 97.79  |
| 18     | 19.59 | 2.55  | 72.89 | 4.98   | 18     | 1.24  | 0.91  | 0.15  | 97.71  |
| 24     | 19.59 | 2.57  | 72.85 | 4.99   | 24     | 1.21  | 1.29  | 0.14  | 97.35  |
| 30     | 19.58 | 2.58  | 72.84 | 5.00   | 30     | 1.27  | 1.68  | 0.17  | 96.88  |
| 36     | 19.58 | 2.58  | 72.84 | 5.00   | 36     | 1.36  | 2.06  | 0.20  | 96.38  |
## Annexure 5B: Variance Decomposition Output: 1998 – 2014

### Variance Decomposition: Period 1998-2014

| Period | LIIP | LWPI | CMR | LSMONY | Period | LIIP | LWPI | CMR | LSMONY |
|--------|------|------|-----|--------|--------|------|------|-----|--------|
|        |      |      |     |        |        |      |      |     |        |
| 1      | 99.73 | 0.00 | 0.27 | 0.00   | 1      | 0.00 | 99.63 | 0.37 | 0.00   |
| 6      | 95.62 | 0.87 | 0.62 | 2.89   | 6      | 0.38 | 94.46 | 3.54 | 1.62   |
| 12     | 92.10 | 3.05 | 1.02 | 3.82   | 12     | 0.23 | 90.04 | 6.60 | 3.14   |
| 18     | 82.46 | 11.11| 2.31 | 4.12   | 18     | 0.19 | 87.32 | 7.99 | 4.50   |
| 24     | 72.62 | 19.61| 3.75 | 4.01   | 24     | 0.36 | 85.27 | 8.44 | 5.94   |
| 30     | 64.88 | 26.37| 4.95 | 3.79   | 30     | 1.01 | 83.05 | 8.45 | 7.48   |
| 36     | 59.12 | 31.44| 5.87 | 3.57   | 36     | 2.41 | 80.28 | 8.24 | 9.07   |

### Variance Decomposition: Period 1998-2014

| Period | LIIP | LWPI | CMR | LSMONY | Period | LIIP | LWPI | CMR | LSMONY |
|--------|------|------|-----|--------|--------|------|------|-----|--------|
|        |      |      |     |        |        |      |      |     |        |
| 1      | 0    | 0    | 100 | 0      | 1      | 0.73 | 0.09 | 0.38 | 98.80  |
| 6      | 0.74 | 14.25| 83.82| 1.19   | 6      | 2.19 | 3.96 | 0.81 | 93.04  |
| 12     | 2.54 | 33.45| 63.12| 0.90   | 12     | 12.99| 3.44 | 0.59 | 82.98  |
| 18     | 2.74 | 38.26| 58.19| 0.81   | 18     | 26.95| 3.35 | 0.63 | 69.07  |
| 24     | 2.73 | 39.42| 57.06| 0.79   | 24     | 37.88| 5.06 | 0.98 | 56.08  |
| 30     | 2.72 | 39.75| 56.75| 0.78   | 30     | 44.77| 8.47 | 1.62 | 45.14  |
| 36     | 2.72 | 39.86| 56.64| 0.78   | 36     | 48.37| 12.82| 2.42 | 36.39  |