THE IMPACT OF EXTERNAL SHOCK AND MONETARY POLICY ON INFLATION IN INDIA

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1 Introduction

India has become the world's third largest crude oil importing country after the United States and China. It imports around 80 per cent of its crude oil requirements. At the same time, crude oil import constitutes around one third of India's total import bill, i.e., around $ 112 billion last. Every $ 1 fall in crude oil prices brings import bill down by around Rs. 6,500 crore, and the government subsidy burden is reduced by around Rs 2,900 crore. But at the same-time every Rs. 1 increase in the dollar exchange rate increases oil import bill by approx. Rs. 7,455 crore.

After the opening up of the economy, the world commodity prices and ex- change rate are playing an important role in domestic price determination. One of the examples is the global commodity price shock during 2009 to 2011, which caused severe inflation problem in India. Similarly, since 2012 depreciation in Indian Rupee has offset some of the benefit of decreasing commodity prices. Hence some of the questions arise like: what is the empirical relation- ship between the external sector shock and inflation in India? And if there is relationship then how much of the variation in inflation is explained by external sectors.

At the same time, the RBI with the help of its monetary policy instruments influences the demand side of the economy in the hope of influencing inflation. So, it becomes imperative to study the relative importance of external sector and monetary policy in influencing inflation in India.

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With decrease in the international crude oil price by more than 50 per cent since June,2014 questions are being raised by the observers that which has caused the negative growth rate in WPI inflation since August,2014, is it monetary policy effect or declining international crude oil price effect? So in this study, we endeavor to undertake the empirical study on 'the impact of external shock and monetary policy on inflation in India'

Our finding shows that the VAR model for April,1993 to June,2015 failed in diagnostic tests of autocorrelation and heteroscedasticity. But for the period April, 2002 to June, 2015 VAR diagnostic tests have been found to be statistically significant. The result shows that, external shock has more impact on inflation than money supply changes. At the same time around 25 per cent of the variation in inflation is explained by external shocks.

2 Literature review: Role of global factors and monetary policy in influencing inflation in India

Exchange rate in India till 1990 was nominally pegged to a basket of currencies, and only after the payment crisis of 1991 a two step downward adjustment in the exchange rate was undertaken. This was followed by a transitional 11 month period of dual exchange rates before a market determined exchange rate system was set in place in March, 1993. Since then, the exchange rate is primarily market determined.

India abolished Administrative Pricing Mechanism (APM) in April, 2002. Under the APM, the central government directly controlled the pricing of petroleum products, based on 'cost of operating capital plus' formula.

Under the new formula, the Oil Marketing Companies (OMCs) were free to price their products, based on 'import parity pricing' formula. But increasing price of crude oil since 2004 had made the government uncomfortable with rising petroleum prices, which would have fueled inflation, so again the Govt. of India(GoI) started sanctioning upward price

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revision of petroleum prices. The same arrangement is in place even now, as companies are free to decide their prices but are prone to government sanctions.

Given the importance of petroleum products in the economy, any increase in price has potential of fanning upward pressure on inflation, which in turn harms the overall economic progress of the nation. Popular perception in the Indian psyche is that whenever petroleum prices increase inflation increases. It is believed to be at the heart of soaring inflation during 2009 to 2011. But since Mid 2014 the crude oil price has fallen for more than 50 per cent and during the same period, the WPI growth has also been negative.

The RBI's monetary policy has been lauded by the economic commentator for breaking the rising inflationary expectation in India since mid 2014. But given the fact that, the period of cooling down in inflation has coincided with the cooling in international crude oil price, it has become imperative to study the relationship between inflation, monetary policy and crude oil price. Before undertaking this study by incorporating latest macroeconomic data, we have surveyed the literature on the subject, out of which some important studies have been discussed below:

Mohanty and John (2015) has noted that historically inflation in India had remained moderate with average annual headline WPI from 1950-51 to 2012-13 to be around 6.7 per cent.

In the paper the researchers have used Structural Vector Auto regression (SVAR) to identify the determinants of inflation in India. Their finding shows that global factors impact on inflation is immediate and significant.

Saha and Zhang (2013) using the monthly data from January,1990 to March,2011 of China, India and Australia shows that the external factors account for a little variation in domestic prices of China and India. The authors conclude that decrease in international crude oil price has less impact on inflation in India and hence less effective in controlling inflation.

Bhanumurthy et al. (2012) analyses the impact of international oil price shocks and different configurations of pass through policy for oil on the major macroeconomic variables in India using structural macroeconomic model. The paper founds that in case of partial pass through of international crude oil shock a 10 per cent rise in international crude oil price results in rise of WPI by 0.3 per cent where as in case of complete pass through, the increase in WPI due to 10 per cent rise in international crude price is 0.6 per cent.

Mandal et al. (2012) using the data from April, 1994 to March, 2010 and VAR model have found that there is high pass-through impact of international prices on domestic inflation in India since 2002, when prices of some petroleum

Products began to adjust frequently in line with changes in international crude prices.

Kapur and Behera (2012) using the quarterly data from April-June,1996 to March,2011 have found that, international crude oil prices have no statistically significant impact on inflation. The exchange rate pass-through was found to be 0.06 in the short run and 0.12 in the long run.

Shaari et al. (2012) using the data from January,2005 to December,2011 have found that, in short run, crude oil price did affect inflation and it granger caused inflation, whereas the exchange rate did not granger caused inflation.

Galesi and Lombardi (2009) using the Global vector auto regression (GVAR) and data from 33 advanced and emerging economies have found that, oil and food price shocks have different inflationary effects. During the period 1999-2007, the inflationary effects of an oil price shock mostly affected developed regions while food price increases hit particularly to emerging economies. For the US and the euro area, there was no significant relationship between oil shocks and core inflation.

Bhattacharya and Batra (2009) using the data for the period April,1994 to December,2008 and using SVAR model have concluded that, when domestic prices are allowed to reflect

changes in international prices, its contribution in inflation is about 39 per cent by the sixth month.

Jongwanich and Park (2009) in the paper had sought to identify the underlying sources of developing Asia's inflation, in particular the relative importance of demand pull factors versus cost push factors. They collected the data for nine Asian economies including India. A VAR model had been used. Quarterly data from 2001 Q1-2009 Q1 was used for the purpose. The factors included were oil and food prices, output gap, exchange rate and domestic inflation. They found that the developing Asia's inflation was largely due to two factors, namely excess aggregate demand and inflationary expectations. according to the authors this finding was in sharp contrast to the prevailing misconception that the region's raising inflation was beyond the control of monetary policy because it was mostly the result of global food and oil price shocks they also found that, external food and oil price shocks explained less than 30 per cent of Asia's Consumer Price Index (CPI) inflation, except in Vietnam. In contrast, excess aggregate demand and inflationary expectations explained about 60 per cent of the CPI.

Bhattacharya et al. (2008) using the monthly data from September,1997 to October,2007 and using the VAR and Vector Error Correction Model(VECM) have concluded that, exchange rate pass through in India is moderate. The long run pass through elasticity for WPI is 28.6 per cent. The authors also find out that the immediate effect on WPI of 100 per cent exchange rate shock is around 12 per cent which falls to 1.3 per cent in the next year.

They have also found that, crude oil prices have moderate impact on inflation which they argue is due to the administered fuel prices in India.

Raj et al. (2008) using annual data for the period 1950-2007 and VECM model have found that, import prices, capital flows and exchange rate have statistically significant positive association with domestic inflation in the long run. The empirical findings of the paper suggested that, global factors (import prices, capital flows, movements of exchange rate) contributed 20 to 30 per cent in domestic inflation in India.

Khundrakpam (2007)investigates the exchange rate pass-through on inflation in India, since July 1991. He concludes that, there is no evidence of decline in the pass-through of exchange rate on domestic prices. He also observes that, there is asymmetry in pass-through between appreciation and depreciation of exchange rate changes.

Jha and Mundle (1987) using the data from 1970-71 to 1984-85 and applying input-output system have found that, if administered price of petroleum rose

by 7 per cent it resulted in WPI increase of 1 per cent.3   Data and methodology

Since our endeavor is to find out the impact of external shock(international crude oil price and exchange rate) and monetary policy shock on inflation after the liberalization, our sample period is, from April, 1991 to May, 2015. Accordingly, we have collected the series of India's Wholesale Price Index(WPI),M3, and nominal exchange rate from the RBI's data base 'database on Indian Economy (dbie). We have collected data on international crude oil price from the World bank database of 'GEM Commodities'. We have taken WPI as inflation measure since the RBI communicated indicative level of inflation in terms of WPI itself till february,2015. We have also multiplied average international crude oil price in terms of dollar with average nominal exchange rate to find out crude oil prices in domestic currency. This, crude oil price in domestic currency has been taken as the global factor influencing WPI. We have taken M3 as a measure of monetary policy since the supply of money is controlled by the RBI and changes in it represents the monetary policy stance of the RBI.

WPI series has been converted to the base year of 1981-82 using linking factor of 2.478 for 1993-94 base year. 2004-05 base years have been first converted to the base year 1993-94 by multiplying 1.875 and again it has been converted to 1981-82 by multiplying by 2.478. These multipliers have been suggested by the office of the Economic Adviser,the Govt.of India, Ministry of Commerce and Industry, Department of Industrial Policy and Promotion(DIPP). Finally we have taken natural logarithm of all the time-series data.

To find out the impact of changes in international crude oil price and money supply on inflation we have employed Vector Auto regression(VAR). The test in described below:

Vector Auto regression (VAR)

Since the criticism of Sims (1980) of the paradigm of simultaneous equation models laid out by Cowles Foundation in the 1940s and 1950s, VAR has become a standard instrument for analysis of multivariate time-series analysis.

In basic form, a VAR consists of a set of K endogenous variables $y_t = (y_1 t, ..., y_k t, ..., y_K t)$

for K=1,....K. The VAR(p)-process is then defined as

$$Y_t = A_1 Y(t-1) + ... + A_p Y(t-p) + CD_t + u_t \qquad (3.1)$$

Where A_i are (K x K) coefficient matrices for $i = 1, ..., p$ and u_t is a K-dimensional white noise process. The matrix C is the coefficient matrix of potentially deterministic repressors with dimensions (K x M), and D_t is an (M x I) column vector holding the appropriate deterministic repressors, like constant, trend and dummy variables.

4 Empirical Analysis

We have taken two different time period for our analysis, one from April,1993 to June,2015; the time when the exchange rate in India became market deter- mined and other from April, 2002 to June,2015; when some of the petroleum products prices was deregulated. Diagnostics of the VAR model for the time period April,1993 to June,2015 could not reject the null hypothesis of autocorrelation and heteroscedasticity.

Stationary of the macro economic variables have been tested in level and first difference form and have been reported in Table 1. The result shows that, all the variables are non stationary in level form but stationary in first difference, i.e., they are integrated to level one, I(1).

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For the time period April,2002 to June,2015, the lag length of the estimated VAR has been chosen to be 3 as per the Schwarz Bayesian Information

Table 1: Stationary and integration of time series data:ADF and

KPSS(April,2002 to June,2015)

|	In level form		Stationary	first difference		Stationary
	ADF	KPSS	result	ADF	KPSS	result
lnW P I	-1.92	4.05	non stationary	-5.79	0.46	stationary
			non stationary			stationary
lnM3	-1.11	4.08	non stationary	-7.97	0.06	stationary

Criterion (BIC). The diagnostics of the VAR has been done and the hypothesis of autocorrelation and heteroscedasticity has been rejected. The impulse response function(IRF) and forecast error variance decomposition(FEVD) have been used to draw conclusions about the impact of money supply and external factors on inflation. The IRFs of one per cent shock of money supply and crude oil prices(in Indian Rupee) on inflation in reported in Fig.1 and Fig.2 respectively. The 3-month,6-month,9-month and 12-month ahead FEVD has been reported in Table 2.

The impact of import on inflation is represented by international price of crude oil in Indian Rupee. Increase in the price of crude oil(in Rupee) by one per cent leads to increase in domestic inflation by 4 basis points in the next month with 6 month accumulated impact being 10 basis points. Similarly, the impact of one per cent increase in money supply leads to 3.4 basis point increases in inflation in the next month with 6 month accumulated impact being 5 basis points.

From the Table 2 it is clear that more than 70 per cent variation in inflation is explained by its own shocks. While approximately, 25 per cent of the variation in inflation is explained by

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global factors, i.e., crude oil price and exchange rate. On the other hand, only about 1.8 per cent variation in the WPI is explained by shock in M3

• Impulse Response from M3d
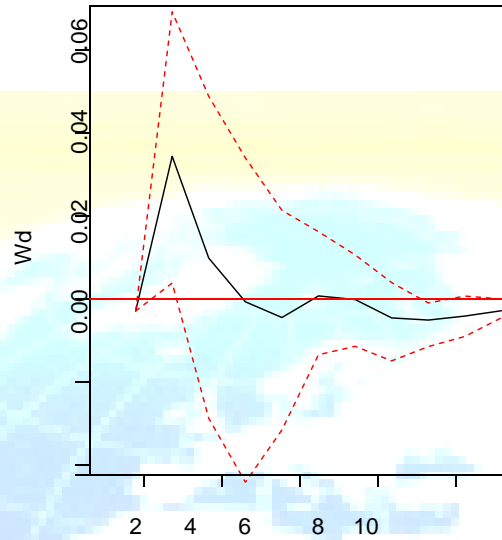
F				
Variable	Variance in inflation explained-3 months ahead(%)	Variance in inflation explained-6 months ahead(%)	Variance in inflation explained-9 months ahead(%)	Variance in inflation explained-12 months ahead(%)
Inflation	77.80	71.25	71.22	71.19
Crude Oil	20.31	27.05	27.06	27.10
M$_3$	1.86	1.69	1.70	1.70

95 % Bootstrap CI, 100 runs

Figure 1: Money Supply(April,2002 to June,2015)

Table 2: Forecast error variance decomposition-WPI inflation (April, 2002 to une, 2015)

Impulse Response from cind
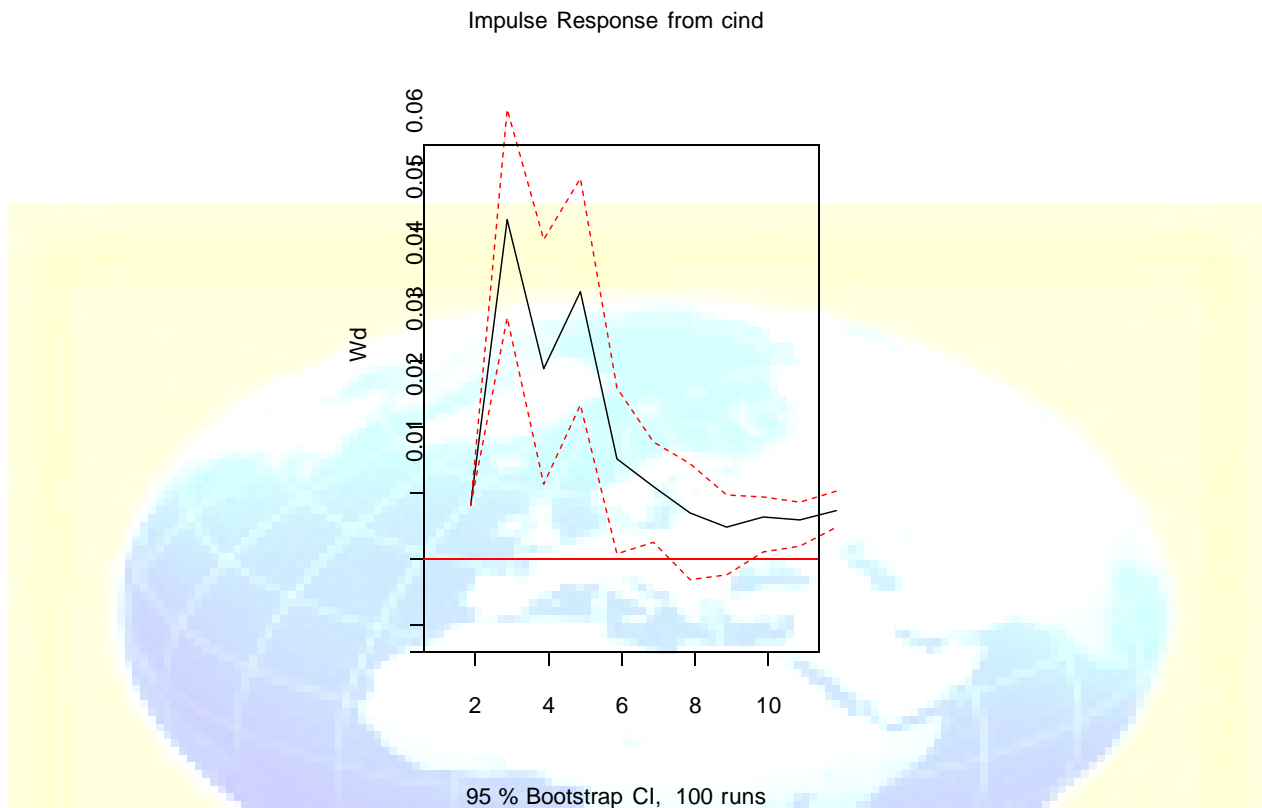

95 % Bootstrap CI, 100 runs

Figure 2: nominal Rs. crude oil price(April,2002 to June,2015)

5   Conclusion

The paper tries to empirically assess the relative importance of external sec- tor and monetary policy in influencing inflation in India after liberalization. International crude oil price in Indian Rupee has been taken as the proxy for external sector, given the crude oil importance in the total import of India.

The result shows that since April,2002(when some of the petroleum product prices started to be market determined) crude oil has more influence on inflation in India than money supply. Similarly the crude oil price variation explains significant variation in inflation in India.

The paper raises some questions:(i) Why the VAR model for April,1993 to June,2015 failed the diagnostic test of no autocorrelation and homoscedastic ity? Is it due to the fact that

all of the petroleum prices in India were regulated by the government till March,2002?(ii)What would have been the impact of changes in crude oil prices on domestic inflation if the domestic petroleum prices would have been completely deregulated ? and (iii) What improvement in these results could have been achieved if we would have used the Time-varying Structural Vector Auto regression(SVAR) model to capture the dynamics of macroeconomic data? All these issues are left for future researches.

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A Cumulative IRF,Impulse-International crude, oil price, response-WPI(April,2002 to May,2015)

Impulse response coefficients $cind Wd

[1,]   0.00000000

[2,]   0.04327429

[3,]   0.06396134

[4,]   0.09632679

[5,]   0.10336193

[6,]   0.10620226

[7,]   0.10505441

[8,]   0.10175678

[9,]   0.09999945

[10,]   0.09778501

[11,]   0.09699722

Figure 3: Cumulative IRF,impulse=International Crude oil priceB

Cumulative IRF,Impulse-Money Supply ,response- WPI(April,2002 to May,2015)

Impulse response coefficients $M3d Wd

[1,]   0.00000000

[2,]   0.03435690

[3,]   0.04609485

[4,]   0.04812144

[5,]   0.04666368

[6,]   0.05001662

[7,]   0.05255430

[8,]   0.05099490

[9,]   0.04897745

[10,]   0.04784271

[11,]   0.04790118

Figure 4: Cumulative IRF,impulse=Money Supply