CEREAL AND FUEL PRICE INTERACTIONS: ECONOMETRIC EVIDENCE FROM INDIA

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What's fuelling the food prices? While several reasons abound, the role of fuel prices in fuelling food prices cannot be negated. Evidence suggests that there is an increasing co-movement between world oil prices and agricultural commodity prices, with rising demand for bio-fuels also impacting the relationship. This has reinstated the interest in determining the price transmission from world crude oil prices to that of agricultural commodities. In this context, the present study analyzes the fuel-food price relationship in the Indian context. In addition to food and fuel prices, both domestic and international, two macro-economic variables, viz., inflation and real effective exchange rates have been analyzed. Using monthly time series data over the period April 1994 to December 2014, the long -and short term interactions between the variables have been estimated using Toda-Yamamoto causality and Johansen cointegration tests. Additionally, using VAR estimates, the impulse response functions have been generated and analyzed. A specific highlight of the present paper is the analysis based on forecast error variance decomposition.

Analysis based on impulse response functions indicates that international cereals price, and fuel prices-both domestic and international, in general, have a positive impact on domestic cereal prices. Based on variance decomposition of domestic cereal prices, the findings indicate that shocks to fuel prices- both domestic and international, have a negligible impact on domestic food prices over ten months period. In view of India's mandate on bio-fuel policy, as also the recent deregulation of fuel prices, the associated impact on food prices cannot be overlooked. The paper concludes with a broad policy perspective.

Keywords: *Agricultural Commodity Prices, Oil Prices, Time Series, Causality, Impulse Response Functions, Forecast Error Variance Decomposition, India*

JEL classification: *C320, E310, Q180, Q400*

1. Introduction

Global food commodities have exhibited exceptional price spikes and high volatility in recent years. The food price surges of 2007-08 and 2010-11 saw prices of nearly

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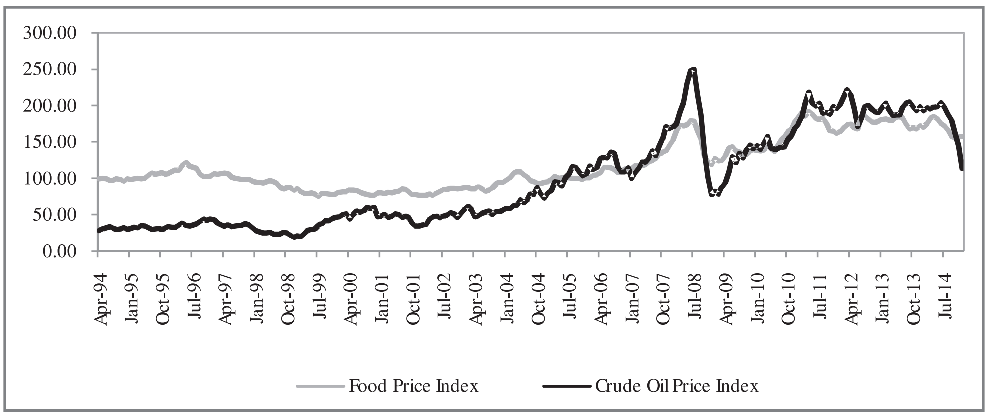
all food commodities soaring above their long term averages. This in turn has slowed down and to some extent even reversed the efforts to reduce poverty and hunger bringing the issue of food security higher up on the global agenda. The sudden and rapid increases in international food prices have had negative impacts on national economies not only in terms of the direct effect on poverty and nutrition but also due to the indirect impact caused by an inflationary wage-price spiral adversely impacting private investment and economic activity.

Food prices and their volatility are attributed to various demand and supply factors such as low harvests due to unfavourable weather conditions, increased demand from China and India, a weak dollar, high oil prices, low stock-to-use-ratios (SURs) and increased bio-fuel use (Abbott, 2009, 2011; Kaur and Kaur, 2014; Kaur and Kaur, 2015).

Figure 1: Plotting of Global Crude Oil and Food Price Indices[4] (April, 1994-December, 2014)



Source: International Monetary Fund, Primary Commodity Data Base

Evidence suggests a strong link between food and fuel prices (Imai, Gaiha and Thapa, 2008; Beak and Koo, 2010; Qui et al., 2012; Vacha et al, 2013). The intensification of the link between food and energy prices globally is apparent from Figure 1. The international crude oil price index (ICPI) reached a new peak in July, 2008 having started to rise from January, 2007. These movements were reflected in the food price index (FPI) as well which also started to rise from January, 2007 and continued to do so till June 2008. The two price indices are significantly correlated and have moved closely together[5].

[4] The base for both the indices is 2005. The Food Price Index includes Cereal, Vegetable Oils, Meat, Seafood, Sugar, Bananas and Oranges Price Indices and the Crude Oil Price Index is the average of three spot prices; Dated Brent, West Texas Intermediate and the Dubai Fateh.

[5] The coefficient of correlation for the period of our study for the two is 0.9165 (with a p value of zero).

The link between food and fuel prices is two way. First, rising fuel prices increase input costs and second, it increases the demand for agricultural crops, such as maize and sugarcane for alternative energy sources such as ethanol and biodiesel. With land diversion from production for consumption to production for fuel, food production is expected to fall, thereby putting pressure on food prices. Many countries such as the U.S., Brazil, and the European Union have adopted policies promoting alternate sources of fuel, further exacerbating food prices. Roughly around 40 per cent of U.S. corn is consumed for ethanol production, and this has been encouraged by government policies and incentives. Brazil is the second largest producer of ethanol (7,130.7 million gallons) which uses sugarcane for ethanol production. The European Union in 2007-08 used nearly 4.7 tonnes of rapeseed for biodiesel production i.e. 64 per cent of total output of rapeseed oil. This is indicative of the fact that though these countries have benefited by enhanced bio-fuel production, this has also put a significant upward pressure on global food prices.

Emerging economies like India are considered to be vulnerable to increasing food inflation, given that a large proportion of its population lives below or near the poverty line. As per the Wholesale Price Index (WPI), food inflation in India rose sharply to 18.18 per cent in August 2013[6], while general inflation increased to 6.1 per cent. According to the Union budget of 2013-14, there are around 355 million people living below the poverty line in India. Extreme poverty, coupled with rising food and fuel inflation can undoubtedly affect India's food security. Against this backdrop, there is an increased need to understand the relationship between food and fuel prices.

The remainder of this paper is laid out as under. The literature is reviewed in Section 2. Section 3 gives a background on food and fuel price trends in India. Data and econometric methodology is outlined in Section 4. Interpretation and discussion on empirical results is undertaken in Section 5. Finally, Section 6 summarizes the paper from a broad policy perspective.

2. Literature Review

Food and fuel sectors are linked together by two main channels. First, fuel is an essential input in agricultural production in terms of cost impact on oil-based fertilizers as well as transportation cost. Second, the recent increase in bio-fuels production (in response to higher fuel prices) has also established a stronger connection in terms of demand for food-feedstock for 'fuel production purposes'. The food and fuel debate has been extensively

[6] www.eaindustry.nic

analyzed in the literature with no common consensus emerging on the causal link.

Imai, Gaiha and Thapa (2008) study the food and oil price dynamics, at the global level as well as for India and China, using cointegration, Granger causality and vector autoregression (VAR) methods. They find that crude oil prices significantly impact (some) agricultural commodity prices at the global level and for India as well. However, for China they find that it is not crude oil prices but wheat prices that lead other agricultural commodity prices. Baek and Koo (2010) study the short- and long-run linkages between changes in U.S. food prices and changes in prices of energy and agricultural commodities and exchange rate. Employing the Johansen cointegration approach along with the Autoregressive Distributed Lag Model (ARDL) they show that agricultural commodity prices play a key role in determining the short and long-run movements of U.S. food prices. They also find that energy prices and exchange rate have been significant factors affecting U.S. food prices in both the short- and long run, implying the strong linkage between energy and agricultural markets. Qiu et al. (2012) use a Structural Vector Autoregression model (SVAR) to decompose how supply/demand structural shocks affect food and fuel prices within fuel and corn markets. Their findings support the hypothesis that corn prices increase as a response to those positive demand shocks in the short run, while in the long run, global competitive agricultural commodities markets as well as positive supply shocks respond to commodity price shocks, restoring prices to its long-run trends. Vacha et al. (2012) apply the wavelet coherence methodology on ethanol and biodiesel and a wide range of related commodities (gasoline, diesel, crude oil, corn, wheat, soyabeans, sugarcane and rapeseed oil). They find that ethanol is highly correlated with corn and biodiesel with German diesel – during a substantial part of the period analyzed (2003-2011). They also find that during crisis period, the bio-fuel prices react more rapidly to the changes in their producing factors. They broadly conclude that ethanol (biodiesel) is led by corn (German diesel).

High global food prices can get transmitted into higher domestic food prices especially in economies highly dependent on food imports. Exchange rates, trade policy, other policy measures and the speed of adjustment also influence the extent of transmission (Asian Development Bank, 2008). Lee and Park (2013) examine the transmission of food price inflation and volatilities for a panel of 72 countries from 2000 to 2011. Using Arellano-Bond Dynamic Ordinary Least Squares (DOLS) model, they find evidence in support of international transmission of food price inflation and volatility. Rapsomanikis (2011) investigates international price transmission and volatility spillover for six developing countries[7]. Evidence based on the Vector Error Correction – Baba Engle Kraft Kroner Model (VECM-BEKK) parameterization supports cointegration between domestic and international commodity prices. Cachia (2014) studies the transmission of price changes from international markets using a univariate error correction mechanism for separate regions. Substantial differences with respect to transmission of international food prices between regions[8] is found. The import dependency ratio of the region has a significant and positive impact on the transmission of international food prices. Gulati and Saini (2013) study the impact of domestic and global factors on Indian food price indices using a log-linear regression model. They find that the elasticity of domestic food price indices to domestic factors - the fiscal deficit and the farm wage index, is large. The global food price index is estimated to have a significant (though lower) impact on domestic food inflation.

Movements in countries' exchange rates can substantially change the prices of goods faced by producers and consumers and thereby affect incentives to produce, consume, and trade goods (Liefert and Persaud, 2009). Harri *et al.* (2009) find evidence linking commodity prices of corn, cotton and soyabean to oil prices. They also find that exchange rates play an important role in the linkage of prices. Kanyam (2014) examines the relationship between food prices and exchange rates in Ghana using monthly data (2008-2013). They find evidence of a unidirectional causality running from food prices to exchange rates. Yeboah, Shaik, and Quaicoe (2012) study the effects of exchange rate of the U.S. dollar along with other variables on the prices of feed grains, oilseed, and fruits for 13 low-income countries and seven middle-income countries using a modified SUR-VAR[9] model. They find that contemporaneous and one-year lagged exchange rates and income are factors affecting food prices.

A number of studies have been undertaken to examine the relationship between exchange rate and crude oil prices as well. Chen and Chen (2007) investigate the long-run relationship between real oil prices and real exchange rates for a panel of G7 countries using monthly data and find that real oil prices and real exchange rates are linked with real oil prices causing real exchange rate movements. Aziz (2009) studies the relationship between oil prices and real exchange rates and real interest rate differentials for a panel of eight countries (five oil importing and three oil exporting) using monthly data from 1980 to 2008.

[7] They study international price transmissions for different commodities in six countries- wheat for Peru, maize for Mexico, rice for India and Philippines, maize in Malawi and Sorghum in Niger.

[8] Transmission of global food prices takes longer in developed economies such as North America and Europe compared to developing regions where the impact is also larger.

[9] Seemingly Unrelated Regressions and Vector Autoregression Model

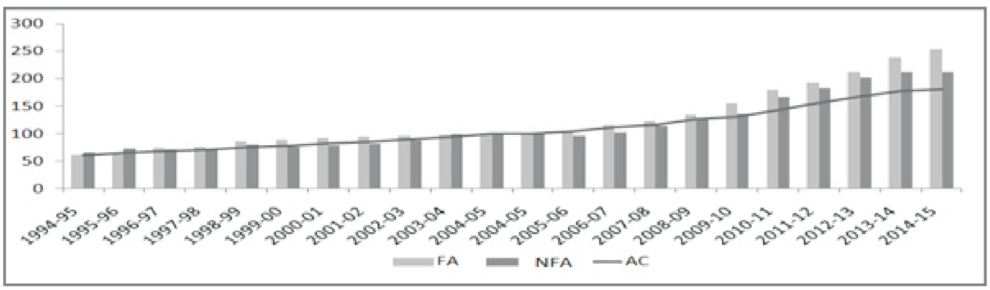
They find that the three series are cointegrated with causality running from real oil prices and real interest rate differentials to real exchange rates. However, for net oil exporting countries there does not appear to be a long run relationship between real oil price and real exchange rates. Amano and van Norden (1998) and Coudert, Mignon and Penot (2008) examine the link between oil price and the U.S. real effective exchange rate (for different time periods) and find the two to be cointegrated with a one way causality running from oil prices to exchange rates.

Food and Fuel Prices in India

Food Prices in India: Food inflation is detrimental in the context of overall inflation dynamics in an emerging economy like India. For one, the share of food expenditure in household expenditure is high, 53 per cent for rural India and 42.6 per cent for urban India (GOI, 2013)[10]. Secondly, people form expectations about future inflation levels based on current food inflation rates. Third, food inflation and the corresponding impact on consumer price inflation leads to a higher pressure on wages and thereby inflation (Anand, Ding and Tulin, 2014). Also poor people are particularly vulnerable to high food prices. According to Carrasco and Mukhopadhyay (2012), an increase in food prices by 10, 20 and 30 per cent respectively would increase rural poverty in India by 2.9, 5.8 and 8.8 per cent respectively. Urban poverty too would rise by 2.1, 4.3 and 6.4 per cent respectively.

The WPI (All Commodities, AC) and its sub components pertaining to food articles (FA) and non-food articles (NFA) are represented in Figure 2.

Figure 2: Plotting of WPI, WPI_{FA} and WPI_{NFA}[11] (1994-2014)



Source: Reserve Bank of India, Handbook of Statistics (various issues)

As is apparent, the WPI_{FA} has generally been higher than WPI_{NFA}, especially since 2005. Further, the gap between the two has also widened since then. The ratio of the former

[10] Based on modified mixed reference period (MMRP). NSSO 68th Round Government of India (2013).
[11] The base for all the three indices is 2004-05.

to the latter stood at about 1.2 in 2014-15. Thus, food articles have been a major contributor to the overall inflation in the Indian economy. The average annual inflation rates for food articles was 10.8 per cent during 2006-07 to 2013-14. Vegetables experienced the highest annual inflation at 13.3 per cent while the fruits sub-group experienced the lowest average inflation rate at 9 per cent during the same period. The food products category experienced an annual average inflation rate of 6.7 per cent. Oil cakes followed by sugar, khandasari and gur category contributed the most to this inflation (Table 1).

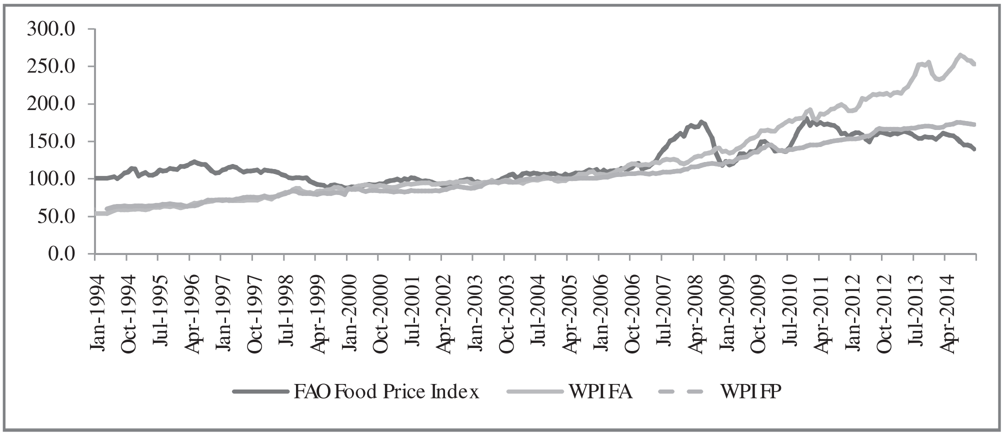
Table 1: Average Annual (WPI Based) Food Inflation Rate (2006-07 to 2013-14)

Commodity Description	Inflation Rate	Commodity Description	Inflation Rate
Food Articles	**10.8**	**Food Products**	**6.7**
Food Grains (Cereals and Pulses)	9.8	Dairy Products	7.8
Cereals	10	Canning, Preserving and Processing of Food	6.4
Rice	10.1	Grain Mill Products	6.1
Wheat	9.4	Bakery Products	4.1
Maize	10.6	Sugar, Khandsari and Gur	8.2
Pulses	9.8	Edible Oils	5.9
Fruits and Vegetables	10.9	Oil Cakes	11.1
Vegetables	13.3	Tea and Coffee Processing	8
Fruits	9	Manufacture of Salt	7.8
Milk	10.4	Other Food Products	6.8
Eggs,Meat and Fish	12.9		
Condiments and Spices	14		
Other Food Articles	10.6		
Tea	11.9		
Coffee	10.1		

Source: Authors' calculations based on data from Reserve Bank of India, Handbook of Statistics (various issues)

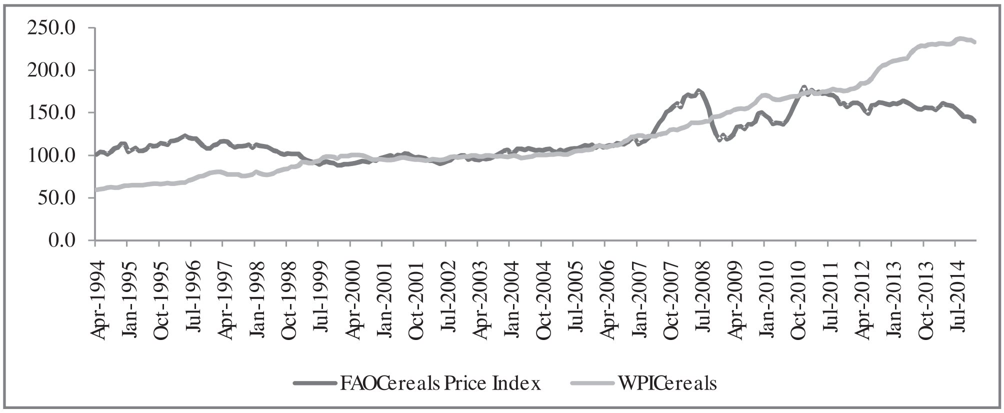
Figures 3 and 4 show the international and Indian price indices for food and cereals respectively. An interesting fact that emerges from the figures is that the rise in domestic price indices of WPI_{FA} overtook the international ones towards the end of 2008 and have remained higher than the FAO_{Food} ever since. However, for cereals the situation is somewhat different. The $WPI_{Cereals}$ has risen at a more rapid rate vis a vis the $FAO_{Cereals}$ and that too at a more steady rate with lower fluctuations. The $WPI_{Cereals}$ pulled ahead of the $FAO_{Cereals}$ towards the second half of 2008, when the latter index was actually falling. The Indian cereal price index continued to be higher than the international one till about October 2010 when the two were moving together for some time. After May 2011, there has been greater divergence between the two. $WPI_{Cereals}$ has continued to rise that too at a rapid rate compared to $FAO_{Cereals}$ which has actually exhibited a decline *albeit* with more fluctuations.

Figure 3: Plotting of FAO_{Food}, WPI_{FA} and WPI_{FP} (January, 1994-December, 2014)



Source: RBI, Handbook of Statistics (various issues) and FAO, Monthly Price Indices

Figure 4: Plotting of $FAO_{Cereals}$ and $WPI_{Cereals}$ (January, 1994-December, 2014)



Source: RBI, Handbook of Statistics (various issues) and FAO, Monthly Price Indices

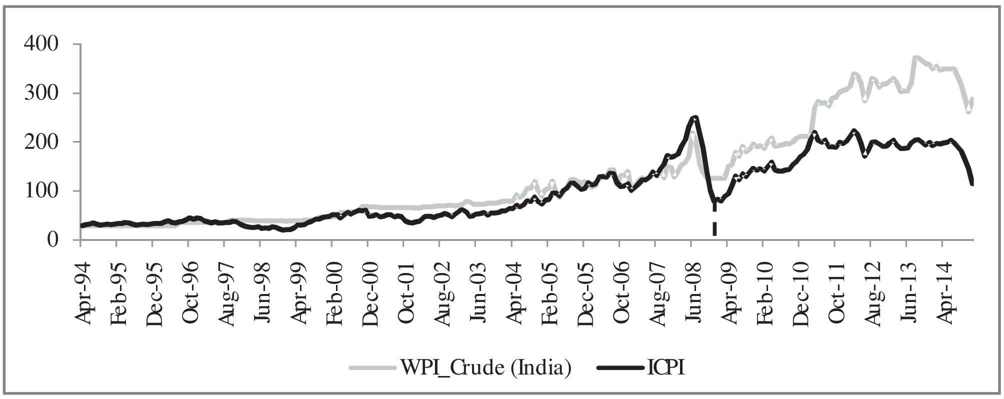
The increase in staple cereal prices is alarming as about 25 per cent of the total expenditure on food in rural areas is on cereals. Expenditure on cereals accounts for 19 per cent of the total food expenditure for urban India as well. Thus, understanding the factors contributing to the increase in cereal prices is essential.

Fuel Prices in India: The past decade has seen high fluctuations in the international crude oil prices. From early 2005, the per barrel price of crude oil started rising gradually from around USD 58 per barrel in January, 2004 to USD 80 per barrel in January, 2005. By July, 2008 crude oil prices peaked at USD 249.66 per barrel. Since India is majorly dependent on oil imports, a similar trend was reflected in the domestic crude oil prices.

Indian crude oil production has remained at around 38 MMT (0.02 per cent of imports) during the period 2013-14 as against import of 189,238 MMT (Publication Division, 2015). Oil import is the heaviest burden on India's Foreign Exchange, at USD 144 billion in 2012.

Domestic crude oil prices have in fact been rising more rapidly since 2008 and have been subject to more sharp turns as compared to the international ones (Sajeev, forthcoming). This is also evident from Figure 5. Further, the increase in domestic crude oil price index has been higher than the international crude oil price index since October, 2008. Rising oil prices have forced the Indian government to initiate several measures to augment production and use of bio-fuels. The 'National Policy on Bio-fuels' released in 2009 aims at mainstreaming bio-fuel by setting a target of 20 per cent with petrol and diesel in transport sector by 2017. However, the mandate is clear that only barren and currently unused soil is to be used for the production of bio-fuels.

Figure 5: Plotting of Indian and Global Crude Oil Price Indices (April, 1994-December, 2014)



Source: IMF, Primary Commodity Data Base for Crude Oil Price index and RBI, Handbook of Statistics (various issues) for WPI Crude Oil Price Index for India

Indian consumers have not really faced the blunt from the global crude oil prices, due to a regulated regime in domestic market till 2010. Crude oil prices in India were deregulated only in June, 2010. In 2015, it was reported that the deflationary trend of wholesale prices continued for sixth month in a row with inflation dropping to (-)2.65 per cent in April, mainly on account of decline in oil prices, even as food prices increased.

Fuel Blending Policy: Bio-fuel mandates have existed in India from around 2002-03. The Ministry of Petroleum and Natural Gas (MoPNG) made five percent ethanol blending in gasoline mandatory in 2003 (for 9 States and 5 Union Territories) and again imposed the same mandate in 2006 (for 20 States and four Union Territories). This was done through the 'Ethanol Blending Programme' (EBP). In 2008, the government increased the blending target to 10 per cent. The National Policy on Bio-fuels was approved in December, 2009. The policy set an indicative target of 20 per cent for the blending of both ethanol and bio-diesel by 2017. However, since ethanol in India is produced from sugarcane molasses, variations in sugarcane production and thereby, lower availability of sugarcane molasses often adversely affect ethanol supplies. The blending targets have yet to be accomplished successfully (TERI, 2015). The EBP is being implemented in thirteen States with the current blending level being only about 2.1 percent. The blending level is expected to increase to 2.5 percent by the end of 2015 (USDA, 2014).

In India, bio-diesel is produced mostly from non-edible oils extracted from seeds of plants like jatropha and pongamia. In 2003, the Planning Commission Report proposed a blending target of 5 per cent bio-diesel with high speed diesel from 2006–07. It was proposed to gradually raise the target to 20 per cent in 2011–12. India does not currently maintain a specific mandate for biodiesel usage and the current blending rate is about 0.08 per cent (USDA, 2014).

3. Data and Methodology

This paper investigates the relationship between international and domestic cereal prices, international and domestic crude oil prices, real effective exchange rates and domestic real interest rates for India over the period April, 1994 to December, 2014. We consider the Indian wholesale crude oil price index (WPI_{Crude}) and the international crude oil prices (ICPI) taken from the International Monetary Fund, IMF commodity price data set. We also consider the global cereal price index ($FAO_{Cereals}$) base (2002-04=100) provided by the Food and Agriculture Organization (FAO) to check to the extent to which Indian wholesale prices of cereals ($WPI_{Cereals}$) are correlated or determined by the global food prices. The monthly price indices for cereals and crude oil for the above mentioned period are collected from the website of the economic advisor, Government of India[12]. Along with these variables we consider the effect of the real effective exchange rates (REER) and real interest rates (I_R) on food and fuel prices. The data for these two variables is collected from International Financial Statistics, World Bank.

Stationarity of Variables: We adopt VAR to study the relationship between our variables. For the VAR estimation all the variables included in the model should be

[12] As per WPI manual, crude petroleum was included as an independent item in the 1981-82 series. However , in the 1993-94 series, it was dropped from mineral group as an independent item and its value was apportioned parametrically among the items in the mineral oil group.

stationary. A stationary time series is significant to a regression analysis since analyzing useful characteristics are difficult in a nonstationary time series. To check for stationarity of time series data, we employ the augmented dickey fuller (ADF) unit root tests.

Selection of Optimal Lag: An important aspect of VAR model is to select the optimal lag length. While too short a lag length may not capture the dynamic behavior of the variables (Chen and Patel, 1998), too long a lag length is likely to distort the data and lead to a decrease in the power of the model (DeJong et al., 1992). In this study, the following five criteria for choosing the optimal lag length have been adopted:

- LR: Sequential modified LR test statistics
- FPE: Final Prediction Error
- AIC: Akaike information criterion
- SC: Schwarz criterion, and
- HQ: Hannan-Quinn information criterion

The result of the lag length selection by different criteria is given in annexure Table A1. Of the five criteria, FPE and AIC propose an optimal lag length of 3 periods for the study.

Toda-Yamamoto (TY) Causality Test: Time series variables are often nonstationary and thus, we could counter the problem of spurious correlation while using traditional Granger Causality tests[13]. The TY Causality test helps overcome the problem of invalid asymptotic critical values for nonstationary or cointegrated series[14]. Causality testing in this case can be undertaken using VAR's formulated in levels for testing general restrictions on the parameter matrices even if the processes may be integrated or cointegrated of an arbitrary order applying a modified Wald criterion (Toda and Yamamoto, 1995).

The TY causality test estimates an augmented VAR of order ($p+ d_{max}$), where p is the optimal lag order of the VAR and d_{max} is the highest order of integration among the variables being considered. For instance to test for causality between two variables the following bivariate VAR is estimated:

[13]Granger's Causality test (1969) can be represented by the following equations:

$$Y_t = \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{j=1}^{p} \beta_j X_{t-j} + u_{1t} \text{---------(a)}$$
$$X_t = \sum_{i=1}^{p} \omega_i X_{t-i} + \sum_{j=1}^{p} \delta_j Y_{t-j} + u_{2t} \text{---------(b)}$$

More specifically, the null hypothesis that X_t does not Granger cause Y_t against the alternative hypothesis that X_t Granger causes Y_t is tested by checking if $\beta_j=0$ for all j=1 to p for equation (1) using a standard F test. Similarly we check the null that Y_t does not Granger cause X_t using equation (2).

[14]The Wald test statistic does not follow the asymptotic chi-square distribution if some series are nonstationary.

$$Y_t = \eta_1 + \sum_{i=1}^{p+d_{max}} \gamma_i Y_{t-i} + \sum_{j=1}^{p+d_{max}} \theta_j X_{t-j} + \lambda_{1t} \text{---------(1)}$$

$$X_t = \eta_2 + \sum_{i=1}^{p+d_{max}} \sigma_i X_{t-i} + \sum_{j=1}^{p+d_{max}} \pi_j Y_{t-j} + \lambda_{2t} \text{---------(2)}$$

More specifically, the null hypothesis that X_t does not Granger cause Y_t against the alternative hypothesis that X_t Granger causes Y_t is tested by checking if $\theta_j=0$ for all j=1 to p for equation (3) using the modified Wald procedure instead of a standard F test as in the conventional Granger Causality test.

Ordering of the Variables: In VAR estimation models, the ordering of variables remains critical. Proper ordering shows that current innovations in the variable that is placed first, affects the rest of the variables. At the same time, the current innovations in variables placed towards the end are not expected to affect the variables in the beginning of the order. The study selected the ordering of the variables by conducting pair-wise Granger and TY tests.

Cointegration: For checking cointegration or a long-run equilibrium relationship between nonstationary variables, the Johansen methodology is used. In case where the series are co-integrating, this is followed by a VECM to investigate the presence of equilibrium or disequilibrium in short run dynamics and long run equilibrium. To insure that the two variables move together in the long run also, the equations have been modified to include the *error-correction* terms to make sure that the two variables are cointegrated. If there is only one cointegration relation, we have:

$$\Delta y_t^1 = \alpha_0 + \alpha_1 \Delta y_{t-1}^2 + \alpha_2 \Delta y_{t-1}^1 - \alpha_3 (y_{t-1}^1 - \lambda y_{t-1}^2) + e_t^1 \text{---------(3)}$$

$$\Delta y_t^2 = \beta_0 + \beta_1 \Delta y_{t-1}^1 + \beta_2 \Delta y_{t-1}^2 - \beta_3 (y_{t-1}^2 - \lambda y_{t-2}^1) + e_t^2 \text{---------(4)}$$

This is a Vector Error Correction (VEC) model. The speed of adjustment depends on the strength of the two speed-of-adjustment coefficients (α_3 and β_3).

Impulse Response Functions (IRFs): IRFs are generated that show the effect of shocks on the adjustment path of the variables.

Forecast Error Variance Decomposition (FEVD): Another way to disentangle the effects of various shocks is to consider the contribution of each type of shock to the forecast error variance.

When variables contain stochastic trends, they must be differenced to become stationary. While it is possible to estimate a VAR in levels when the variables follow stochastic trend, it is preferable to estimate the VAR in first differences, such as:

$$\Delta y_t^1 = \alpha_0 + \alpha_1 \Delta y_{t-1}^2 + \alpha_2 \Delta y_{t-1}^1 + e_t^1 \text{---------(5)}$$

$$\Delta y_t^2 = \beta_0 + \beta_1 \Delta y_{t-1}^1 + \beta_2 \Delta y_{t-1}^2 + e_t^2 \text{---------(6)}$$

With knowledge of the initial values of y^1 and y^2, we can compute the levels by successively adding the changes to the initial values. Clearly, such a system contains interactions in the short run between the variables: the change in y depends on the change in x in the previous period and vice versa. As we found previously, this system implies that there is no long-run relation between y^1 and y^2. The reason is that the two variables will be subject to different permanent effects of the shocks. Even though both shocks affect both variables, by virtue of that they affect each other; the permanent effects need not be the same. If one variable changes permanently by 5 per cent in response to a given shock and the other variable by 2 per cent, they permanently move apart by 3 per cent (5-2). Over time, the permanent effects of additional shocks will be accumulated and the gap between the two variables will tend to increase.

4. Empirical Findings

4.1 Tests for Stationarity

Table 2 gives the test statistics for ADF tests. The test statistic suggest the presence of a unit root in the level data, while first differencing the series yields the apparent lack of a unit root in any of the series.

Table 2: Augmented Dickey-Fuller Unit Root Test Statistics

	ADF	
Maxlag = 14	**At level**	**1st Difference**
WPI_{Crude}	-2.457563	-14.59012***
ICPI	-3.409809	-9.236442***
$WPI_{Cereals}$	-0.573542	-9.564298***
I_R	-2.246724	-16.05226***
REER	-3.150913	-13.68436***
$FAO_{Cereals}$	-3.204355	7.89802***

Note ***, ** and * denote significance at a 1%, 5% and 10% respectively. Results Generated by EViews 8.

4.2 Toda-Yamamoto (TY) Granger Causality Tests

Table 3 reports the significant results of bivariate TY Granger Causality Tests[15].

[15]Using the generalized impulse response method, the IRFs have almost similar movements with less pronounced peaks and dips.

There is a one way causality running respectively from WPI_{Crude}, ICPI, $FAO_{Cereals}$ and REER to $WPI_{Cereals}$ respectively. Further, there is a bivariate causality between $WPI_{Cereals}$ and I_R.

Table 3: Toda-Yamamoto (TY) Granger Causality Test Results

H_O	Chi-sq
WPI_{Crude} does not Granger Cause $WPI_{Cereals}$	14.24321***
ICPI does not Granger Cause WPI_{Crude}	13.85809***
ICPI does not Granger Cause $WPI_{Cereals}$	13.34818***
$FAO_{Cereals}$ does not Granger Cause ICPI	13.18626***
WPI_{Crude} does not Granger Cause $FAO_{Cereals}$	9.209494**
$FAO_{Cereals}$ does not Granger Cause $WPI_{Cereals}$	8.833442**
I_R does not Granger Cause $WPI_{Cereals}$	8.754712**
REER does not Granger Cause $WPI_{Cereals}$	6.752526**
$WPI_{Cereals}$ does not Granger Cause I_R	5.592895*
WPI_{Crude} does not Granger Cause REER	4.967795*

Note ***, ** and * denote significance at a 1%, 5% and 10% respectively. Results Generated by EViews 8.

4.3 Cointegration and VECM Results

The possibility of cointegrating relationship between the variables is tested using the Johansen methodology. Different models are employed for multivariate equations and results show that there is one error correction term (Annexure Table A3). If the variables are indeed cointegrated, a vector error correction model can be estimated.

To check the nature of causality whether it is short run or long run, the VECM is estimated. The error correction terms (Table 4) help determine long run causality.

Table 4: Cointegration Long-Term Coefficients[16]

	$WPI_{Cereals}$	I_R	$FAO_{Cereals}$	ICPI
Error correction terms	-0.010620 (0.00253) [-4.20143]	-0.033890 (0.01135) [-2.98607]	-0.008068 (0.00217) [-3.71505]	-0.052749 (0.01735) [-3.04016]

Results complied by the authors using EViews 8. (Standard error in parentheses) [t-statistic in square brackets]

The error correction (EC) term reported in the above table explains that there is a long-run causality running amongst the set of endogenous variables. As per the results, there is long-run causality running from ICPI, WPI_{Crude}, $FAO_{Cereals}$, I_R and REER to $WPI_{Cereals}$. There is

[16]Only the coeffecients significant at 5 per cent have been reported in the table.

no long-run causality running from ICPI, $WPI_{Cereals}$, $FAO_{Cereals}$, I_R and REER to WPI_{Crude}, since the EC is not significant.

To determine short-run causality a test on the joint significance of the lagged variables, a Wald test is undertaken. The results of the same are reported in Table 5. Even though the co-efficient for long-term causality is not significant in case of WPI_{Crude} and REER there are significant short-run causalities.

Table 5: Short-Run Causality

H_0	Chi-Square value
$I_R \rightarrow WPI_{Cereals}$	10.92**
$ICPI \rightarrow WPI_{Crude}$	16.07642***
$WPI_{Cereals} \rightarrow I_R$	11.66875***
$FAO_{Cereals} \rightarrow REER$	7.945646**
$WPI_{Crude} \rightarrow FAO_{Cereals}$	10.8770**
$REER \rightarrow FAO_{Cereals}$	19.95645***

Source: Authors' calculations using EViews 8.

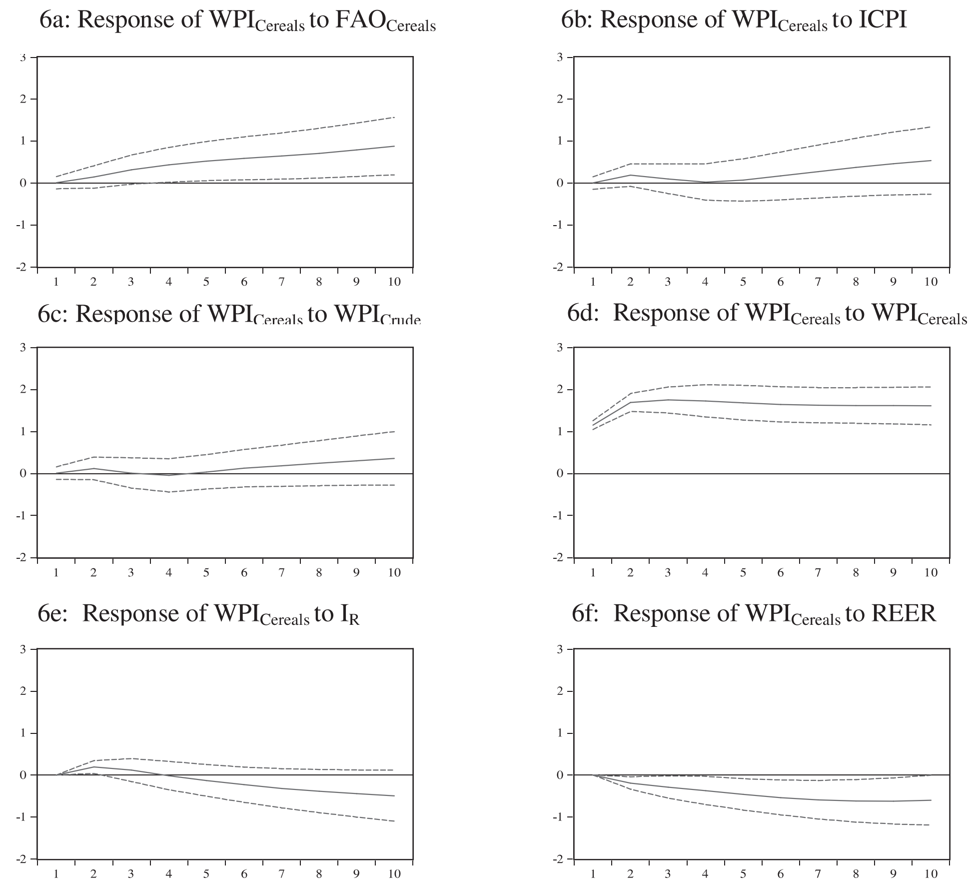
4.4 Impulse Response Analysis

The IRF traces the effect of a one standard deviation shock to the dependent variable on current and future values of all endogenous variables. Here we are reporting impulse responses using the Cholesky impulse response method[17].

The impulse responses estimated in our study show the response to one standard deviation shock in the error terms of other variables. The X axis represents the time period, while the Y axis represents the shock in the movement trend. In Figure 6, select IRFs have been represented. Each is analyzed thereafter.

[17]Using the generalized impulse response method, the IRFs have almost similar movements with less pronounced peaks and dips.

Figure 6: Impulse Response Functions of $WPI_{Cereals}$
Response to Cholesky One S.D. Innovations ± 2 S.E.



Source: Generated by Authors using Eviews 8

The X-axis shows the response of $WPI_{Cereals}$ over a period of 10 month horizon to one standard deviation shock in other variables. A positive shock to $FAO_{Cereals}$ (Figure 6a) causes a positive movement in $WPI_{Cereals}$ throughout the 10 month period, though after the 4th month the pace of increase, decreases. Nevertheless, the magnitude of the impact continues to diverge from the initial position. A positive shock to ICPI (Figure 6b) has a favorable effect on $WPI_{Cereals}$ until the 2nd month. Thereafter, its response becomes adverse until the end of the 4th month. However, around the middle of the 5th month, the direction of response changes in the upward direction and continues until the end of the 10th month. As represented in Figure 6c, a similar trend is seen in $WPI_{Cereals}$ in response to one standard deviation shock to WPI_{Crude}.

Here, there is a favourable effect till the end of the 2nd month, followed by no corresponding change until the beginning of the 4th month. Thereafter, around the middle of the 4th month, the response changes in the upward direction and continues until the end of the 10th month. As represented in Figure 6d, a one standard deviation shock to itself causes $WPI_{Cereals}$ to have a positive movement till the second month, thereafter it stabilizes at a new higher level. A positive shock to I_R has a favorable effect on $WPI_{Cereals}$ (Figure 6e) until the end of the 1st month; thereafter its response becomes adverse. After the end of the 4th month the effect becomes negative. This continues until the end of the 10th month. Finally, a positive shock to REER, as represented in Figure 6f has an adverse impact on $WPI_{Cereals}$ throughout the 10 month period. Also, the negative effect is smaller in the initial months and keeps widening until the end of the 7th month. Thereafter, it stabilizes at the new lower level.

4.5 Forecast Error Variance Decomposition

Forecast Error Variance Decomposition (FEVD) separates the variation in an endogenous variable into the component shocks to the VAR. It simply apportions the variance of forecast errors in a given variable to its own shocks and those of the other variables in the VAR. From among the various ordering of variables for the VAR model based on the Granger Causality (TY) tests and also logical relationships based on literature, the following ordering has been selected:

$$FAO_{Cereals},\ ICPI, WPI_{Crude}, WPI_{Cereals}, I_R, REER$$

The results are reported in Table 6.

$FAO_{Cereals}$: The international food price index ($FAO_{Cereals}$) variance decomposition analysis reveals that the largest shock to $FAO_{Cereals}$ is significantly explained from its own variance, which accounts for 100 per cent in the 1st month and gradually reduces to around 95.92 per cent in the 6th month. While it further reduces to 92.78 per cent in the 10th month, its influence nevertheless remains high. Apart from its own shock in the short period, WPI_{Crude} accounts for about 2.2 per cent in the 6th month and the influence gradually reduces to 2.13 per cent by the 10th month. Also, by the 10th month around 2.83 per cent of the variation is explained by REER. $WPI_{Cereals}$ and ICPI explain less than 1 per cent of the variation in $FAO_{Cereals}$ throughout the 10 month period.

ICPI: Analysis of variance decomposition of ICPI indicates that apart from its own shock contribution of 94.84 per cent in the 1st month, $FAO_{Cereals}$ account for the remaining 5.16 per cent in the period. Innovation of $FAO_{Cereals}$ on ICPI gradually increases to 25.18 per cent by 6th month and further to 32.27 per cent by the end of the 10th month. By the 10th month, 5.14 per cent of the contribution is from REER and 2.94 per cent from $WPI_{Cereals}$. The variation in ICPI as explained by WPI_{Crude} and I_R remains negligible at less than 1 per cent throughout the 10 month period.

WPI_{Crude}: Apart from own shock in variance decomposition of WPI_{Crude} which is around 68 per cent in the 1st month and 42 per cent in the 10th month, shocks to ICPI contributes substantially to changes in WPI_{Crude} prices. It begins by explaining 28.67 per cent of the variation in WPI_{Crude} and peaks to about 42 per cent in the 4th month. Gradually it reduces to 32 per cent by the 10th month. The impact of I_R shocks to variations in WPI_{Crude} remains meager at less than 1 per cent throughout the 10 month period. Thus by the 10th month, 41.72 per cent of the variations in WPI_{Crude} are caused by itself, followed by 32.58 per cent by ICPI and 17.69 per cent by $FAO_{Cereals}$.

$WPI_{Cereals}$: In case of variance decomposition analyses of $WPI_{Cereals}$, own shock is impacting around 99.99 per cent in the 1st month. By the 10th month 78.08 per cent of its variation in price is explained by its own shock. Shocks to $FAO_{Cereals}$ and REER also explain variance in $WPI_{Cereals.}$ By the 10th month they contribute around 9.59 per cent and 6.55 per cent of the variance respectively. Shocks to I_R and WPI_{Crude} have negligible impact on the $WPI_{Cereals}$ throughout the period.

Table 6: Forecast Error Variance Decomposition (%)

Variables Explained	Period	$FAO_{Cereals}$	ICPI	WPI_{Crude}	$WPI_{Cereals}$	I_R	REER
$FAO_{Cereals}$	1	100.0000	0	0	0	0	0
	2	97.92904	0.140501	1.707104	0.098023	0.053955	0.071374
	3	97.14455	0.397954	2.118104	0.161937	0.137323	0.040132
	4	96.83688	0.509022	2.144013	0.194422	0.259762	0.055906
	5	96.39534	0.555657	2.198075	0.218918	0.460770	0.171244
	6	95.92736	0.535260	2.209324	0.240919	0.665702	0.421434
	7	95.38936	0.479310	2.185602	0.257093	0.866732	0.821902
	8	94.70058	0.438094	2.160397	0.272065	1.057046	1.371812
	9	93.83231	0.452072	2.141539	0.290336	1.231475	2.052264
	10	92.78083	0.546457	2.130095	0.314612	1.388144	2.839859
ICPI	1	5.157556	94.84244	0	0	0	0
	2	9.675436	89.83135	0.393258	0.055223	0.011296	0.033434
	3	13.60774	85.28964	0.600607	0.410992	0.070801	0.020212
	4	17.74975	80.48467	0.677982	0.914846	0.113010	0.059742
	5	21.65208	75.70226	0.795878	1.460572	0.111480	0.277728
	6	25.18018	71.13340	0.884361	1.949364	0.096837	0.755856
	7	28.11932	67.02686	0.923882	2.323666	0.084638	1.521628
	8	30.35220	63.48014	0.936975	2.592721	0.086714	2.551256
	9	31.87565	60.50668	0.936548	2.788686	0.109414	3.783028
	10	32.77314	58.06036	0.929928	2.940148	0.153622	5.142802
WPI_{Crude}	1	3.237709	28.67170	68.09059	0	0	0
	2	3.733273	37.92527	58.27036	0.068301	0.002800	8.74E-07
	3	4.864246	41.94173	52.52401	0.659027	0.002413	0.008580
	4	6.668619	42.62547	49.12464	1.564393	0.001940	0.014939
	5	8.850683	41.69444	46.91638	2.387729	0.012261	0.138504
	6	11.11899	39.99668	45.32889	3.098951	0.050938	0.405547
	7	13.24018	37.99071	44.16908	3.686165	0.124068	0.789789
	8	15.06471	35.99860	43.25271	4.166908	0.241705	1.275362
	9	16.54261	34.18184	42.45563	4.583288	0.405196	1.831435
	10	17.69318	32.58788	41.72336	4.965547	0.607477	2.422555
$WPI_{Cereals}$	1	0.002573	2.83E-05	0.007660	99.98974	0	0
	2	0.471142	0.804368	0.340548	96.70298	0.852190	0.828776
	3	1.584770	0.584098	0.196382	95.42785	0.674774	1.532125
	4	2.820834	0.411902	0.155089	93.84077	0.471710	2.299691
	5	4.068778	0.347827	0.130080	91.74449	0.473838	3.234985
	6	5.212521	0.437072	0.192986	89.26303	0.677062	4.217330
	7	6.257850	0.707534	0.319880	86.57084	1.026190	5.117705
	8	7.291749	1.151618	0.511185	83.75948	1.452160	5.833811
	9	8.390551	1.718756	0.760510	80.90566	1.911589	6.312935
	10	9.595459	2.333961	1.049564	78.08449	2.380180	6.556350
I_R	1	0.765130	0.157668	0.000729	0.860909	98.21556	0
	2	0.712706	0.102158	0.125382	3.361137	95.68888	0.009738
	3	0.495877	0.384383	0.397237	3.702362	94.99012	0.030024
	4	0.399041	1.276257	0.464944	3.606212	94.16528	0.088262
	5	0.376629	2.275196	0.503138	3.441843	93.02876	0.374435
	6	0.359222	3.084987	0.577724	3.262748	91.90517	0.810147
	7	0.340217	3.665105	0.626509	3.099346	90.95151	1.317318
	8	0.318971	4.046859	0.638270	2.975261	90.18714	1.833499
	9	0.301306	4.259230	0.629397	2.892549	89.58575	2.331763
	10	0.294024	4.348820	0.609907	2.845104	89.09886	2.803280
REER	1	1.531080	0.583501	0.765836	0.909236	1.288921	94.92143
	2	1.911857	1.299062	1.338908	0.749838	0.879418	93.82092
	3	3.527107	2.545371	1.014093	0.554099	0.713977	91.64535
	4	4.231606	3.945317	1.187737	0.553469	0.591941	89.48993
	5	4.355264	5.314570	1.886801	0.480117	0.505074	87.45817
	6	4.188066	6.830679	2.589287	0.439581	0.446611	85.50578
	7	3.904694	8.257263	3.323315	0.456112	0.406449	83.65217
	8	3.606243	9.430938	4.132910	0.519494	0.380761	81.92965

Source: Authors' calculations using EViews 8.

I_R: The variance decomposition of I_R is significantly explained by itself, 98.21 per cent in 1^{st} month and 91.90 per cent in the 6^{th} month and 89.6 in the 10^{th} month. The impact of innovations to ICPI gradually increases from 1^{st} month to 10^{th} month, rising from 0.15 per cent to 4.34 per cent. FAO_{Cereal} and WPI_{Crude} have negligible effect throughout the 10 months and the impact of innovations in both remains at less than 1 per cent.

REER: For REER variance decomposition apart from its shock which amounts to 94.92 per cent in the 1^{st} month and 78.86 per cent in the 10^{th} month, shocks to ICPI and $FAO_{Cereals}$ seems to be significant. The impact of ICPI increases from 0.5 per cent in the 1^{st} month to around 11.12 per cent by end of 10^{th} month. Shocks to $FAO_{Cereals}$ peaks around the 5^{th} month (4.35 per cent) and then reduces gradually to 3.2 per cent in the 10^{th} month. Shocks to WPI_{Crude} also gradually increase whereas that to $WPI_{Cereals}$ and I_R stays meagre throughout.

5. Conclusion and Policy Implications

What's fuelling the food prices? While reasons abound, the role of fuel prices in fuelling food prices cannot be negated. An obvious reason is that fuel acts as an input, first as a cost for transporting food, and second for producing fertilizers that enhance agricultural productivity of foodgrains. However, an equally important, though less obvious reason is the increase in production of bio-fuels made from maize and sugar, on account of rising fuel prices. Enhanced production of bio-fuels diverts land from producing food for consumption to producing grains for fuel production. The loss of arable land for food production is often argued to have led to food price hike. The ongoing debate of 'fuel' fuelling the 'food prices' is the major motivation behind this research study. Specifically, the paper investigates the relationship between international and domestic cereal prices, and international and domestic crude oil prices for India. Additionally, the impact of macro-economic parameters such as the real effective exchange rates and domestic real interest rates have also been analyzed. Several time series tests, such as Granger causality, VAR, VECM and FEVD have been conducted on monthly data pertaining to time period April, 1994 to December, 2014.

Some of our important results are:

Causality Results:

There is a long-term causality running from all the five variables i.e. $WPI_{Crude,}$ ICPI, REER, I_R and $FAO_{Cereals}$ to $WPI_{Cereals.}$

In the short-run, there is a bi-causal relationship between $WPI_{Cereals}$ and I_R. Further, as expected ICPI causes WPI_{Crude} and also there is uni-directional causality running from WPI_{Crude} and REER to $FAO_{Cereals}$.

Impulse Response Functions:

A positive shock to ICPI as also to WPI_{Crude} has a favorable effect on $WPI_{Cereals}$ initially, followed by an adverse effect that soon reverses by the 4^{th} month. The positive trend continues until the end of the 10^{th} month.

Forecast Error Variance Decomposition:

FEVD of $WPI_{Cereals}$ shows that 99.98 per cent of the variance in $WPI_{Cereals}$ can be explained by its own shock in the 1^{st} month, though by the 10^{th} month it reduces to about 78 per cent. Shocks to WPI_{Crude} have negligible impact on $WPI_{Cereals}$ throughout the 10 month period.

Apart from own shock in the variance decomposition of WPI_{Crude}, which is around 68 per cent in the 1^{st} month, and 42 per cent in the 10^{th} month, shocks to ICPI also substantially explain the changes in WPI_{Crude}. Shocks to ICPI explain about 32 per cent of the variations in WPI_{Crude} by the 10^{th} month. This is followed by $FAO_{Cereals}$ that contributes close to 18 per cent in 10^{th} month. Impact of shocks to $WPI_{Cereals}$ though small, increases gradually from less than 1 per cent in the 2^{nd} month to about 5 per cent by the 10^{th} month.

Policy Implications: Rising oil prices have forced the Indian government to initiate several measures to augment production and use of bio-fuels. The 'National Policy on Bio-fuels' released in 2009 aims at mainstreaming bio-fuels by setting a target of 20 per cent with petrol and diesel in transport sector by 2017. While the mandate is clear that only barren and currently unused soil is to be used for the production of bio-fuels, the reality might be different. Further, the results indicate that the bio-fuel channel which indirectly influences food prices does not appear as important for India, unlike in countries such as the United States or Brazil, since Indian bio-fuel production contributes just 1 per cent of global production. The analysis also indicates that agricultural prices do not significantly react to crude oil prices in India. Thus, the deregulation of pricing in the oil sector is likely to have a small impact on cereals and food price inflation in the country.

Since 'fuel prices' in India, do not *fuel* 'food prices', promoting bio-fuels may not necessarily lead to food inflation. However, this does not negate the importance of promoting agricultural production *per se*. Need for improving agricultural productivity by adopting high yielding variety seeds, increasing public investment in agriculture to better agricultural infrastructure and facilitating a second green revolution in the east for pulses need to be emphasized. Additionally, to address the supply side constraints, designing distribution channels and mechanisms that minimise losses along the agricultural value chain also need to be promoted. Also, given the huge proportions of vulnerable groups in the country, the importance of appropriately designed targeted social protection programmes, safety nets and maintenance of adequate buffer stocks cannot be undermined in the wake of food price volatility.

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Annexure

Table A1: Descriptive Statistics

At Level	$FAO_{Cereals}$	ICPI	WPI_{Crude}	$WPI_{Cereals}$	I_R	REER
Mean	121.7139	97.83566	129.7622	123.5313	4.681126	92.12984
Median	106.1374	73.02000	91.90000	101.0000	5.522851	91.83000
Maximum	208.5340	249.6600	371.4000	237.0000	8.815193	103.4400
Minimum	80.70884	19.54000	29.38000	61.20033	-3.992297	80.94000
Std. Dev	33.90526	65.18714	102.3077	48.70570	3.184015	4.494980
Skewness	0.846856	0.539720	0.981072	0.888445	-0.699376	0.561869
Kurtosis	2.479688	1.828178	2.671104	2.691988	2.393533	3.042266
Jarque-Bera	32.57114	26.33546	41.06613	33.74167	24.11472	13.11996
Probability	0.000000	0.000002	0.000000	0.000000	0.000006	0.001416
Sum	30306.76	24361.08	32310.79	30759.30	1165.600	22940.33
Sum Sq. Dev.	285092.6	1053842.	2595781.	588316.9	2514.212	5010.801
Observations	249	249	249	249	249	249
At 1st Difference	$\Delta FAO_{Cereals}$	ΔICPI	ΔWPI_{Crude}	$\Delta WPI_{Cereals}$	ΔI_R	ΔREER
Mean	0.156637	0.344758	1.039355	0.693950	-0.006839	-0.017621
Median	-0.267003	1.125000	0.000000	0.506718	0.000000	-0.045000
Maximum	28.09865	26.28000	58.20000	6.200000	8.561020	4.850000
Minimum	-26.47432	- 50.72000	-44.70000	-2.700000	-7.066587	-4.670000
Std. Dev	5.973371	8.798811	11.07513	1.435283	0.915504	1.465289
Skewness	0.606718	- 1.587131	0.631188	0.907996	1.343548	-0.157617
Kurtosis	7.763981	9.809682	10.60713	4.744815	49.76690	3.996207
Jarque-Bera	249.7354	583.2930	614.4413	65.53615	22675.09	11.28194
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.003549
Sum	38.84596	85.50000	257.7600	172.0997	-1.696196	-4.370000
Sum Sq. Dev.	8813.247	19122.51	30296.66	508.8293	207.0224	530.3265
Observations	248	248	248	248	248	248

Table A2: VAR Lag Order Selection Criteria

Endogenous variables: $FAO_{Cereals}$ ICPI WPI_{Crude} $WPI_{Cereals}$ I_R REER

Exogenous variables: C
Date: 04/28/15 Time: 00:08
Sample: 1994M04 2014M12
Included observations: 241

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-5750.720	NA	2.25e+13	47.77361	47.86037	47.80856
1	-3638.267	4102.192	740045.5	30.54163	31.14894*	30.78630
2	-3551.470	164.2293	485749.7	30.12008	31.24794	30.57448*
3	-3509.956	76.48162	464645.8*	30.07433*	31.72274	30.73844
4	-3474.190	64.11226	466725.5	30.07626	32.24523	30.95010
5	-3454.684	33.99381	537390.9	30.21314	32.90266	31.29670
6	-3427.619	45.81980	582284.1	30.28729	33.49736	31.58057
7	-3393.786	55.59202*	597902.2	30.30528	34.03589	31.80828
8	-3371.168	36.03913	675729.9	30.41633	34.66749	32.12905

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table A3: Granger Causility Results (First Differences)

Null Hypothesis:	F-Statistic
D_WPI_{Crude} does not Granger Cause D_ $WPI_{Cereals}$	6.96593***
D_ICPI does not Granger Cause D_ WPI_{Crude}	6.63556***
D_ WPI_{Crude} does not Granger Cause D_$FAO_{Cereals}$	6.1581***
D_ICPI does not Granger Cause D_WPI_C	5.67205***
D_ $FAO_{Cereals}$ does not Granger Cause D_ICPI	5.51784***
D_INTEREST does not Granger Cause D_ $WPI_{Cereals}$	4.84904***
D_REER does not Granger Cause D_$WPI_{Cereals}$	3.30567**
D_I_R does not Granger Cause D_REER	2.82463*
D_$WPI_{Cereals}$ does not Granger Cause D_I_R	2.47422*
D_WPI_{Crude} does not Granger Cause D_REER	1.98898
D_ICPI does not Granger Cause D_I_R	1.93083
D_ $FAO_{Cereals}$ does not Granger Cause D_$WPI_{Cereals}$	1.68064
D_ICPI does not Granger Cause D_ $FAO_{Cereals}$	1.45971
D_ $WPI_{Cereals}$ does not Granger Cause D_REER	1.38245
D_ WPI_{Crude} does not Granger Cause D_ICPI	1.32969
D_ $FAO_{Cereals}$ does not Granger Cause D_REER	1.19284
D_ $FAO_{Cereals}$ does not Granger Cause D_WPI_{Crude}	1.18694
D_ICPI does not Granger Cause D_REER	1.03609
D_ $WPI_{Cereals}$ does not Granger Cause D_CRUDE_OIL	0.86392
D_REER does not Granger Cause D_ $FAO_{Cereals}$	0.68283
D_REER does not Granger Cause D_ I_R	0.56076
D_ $FAO_{Cereals}$ does not Granger Cause D_I_R	0.54153
D_ $WPI_{Cereals}$ does not Granger Cause D_ $FAO_{Cereals}$	0.4402
D_REER does not Granger Cause D_ICPI	0.38349
D_I_R does not Granger Cause D_ $FAO_{Cereals}$	0.32921
D_$WPI_{Cereals}$ does not Granger Cause D_ICPI	0.30606
D_ WPI_{Crude} does not Granger Cause D_ I_R	0.19696
D_ I_R does not Granger Cause D_ WPI_{Crude}	0.08278
D_REER does not Granger Cause D_ WPI_{Crude}	0.06826
D_I_R does not Granger Cause D_ICPI	0.04341

Note ***, ** and * denote significance at a 1%, 5% and 10% respectively. Results Generated by EViews 8

Table A4: Toda-Yamamoto (TY) Granger Causality Test Results

H_O	Chi-sq
WPI_{Crude} does not Granger Cause $WPI_{Cereals}$	14.24321***
ICPI does not Granger Cause WPI_{Crude}	13.85809***
ICPI does not Granger Cause $WPI_{Cereals}$	13.34818***
$FAO_{Cereals}$ does not Granger Cause ICPI	13.18626***
WPI_{Crude} does not Granger Cause $FAO_{Cereals}$	9.209494**
$FAO_{Cereals}$ does not Granger Cause $WPI_{Cereals}$	8.833442**
I_R does not Granger Cause $WPI_{Cereals}$	8.754712**
REER does not Granger Cause $WPI_{Cereals}$	6.752526**
$WPI_{Cereals}$ does not Granger Cause I_R	5.592895*
WPI_{Crude} does not Granger Cause REER	4.967795*
I_R does not Granger Cause REER	4.544235
$WPI_{Cereals}$ does not Granger Cause REER	3.822987
$FAO_{Cereals}$ does not Granger Cause REER	3.65696
ICPI does not Granger Cause REER	3.46722
FAOCereals does not Granger Cause WPI_{Crude}	3.281272
$WPI_{Cereals}$ does not Granger Cause WPI_{Crude}	2.764514
ICPI does not Granger Cause I_R	2.541626
$WPI_{Cereals}$ does not Granger Cause ICPI	2.186769
WPI_{Crude} does not Granger Cause ICPI	1.884567
REER does not Granger Cause $FAO_{Cereals}$	1.593953
I_R does not Granger Cause $FAO_{Cereals}$	1.33528
ICPI does not Granger Cause $FAO_{Cereals}$	1.115093
REER does not Granger Cause ICPI	0.724791
I_R does not Granger Cause WPI_{Crude}	0.692547
$FAO_{Cereals}$ does not Granger Cause I_R	0.654694
REER does not Granger Cause I_R	0.63422
I_R does not Granger Cause ICPI	0.408284
$WPI_{Cereals}$ does not Granger Cause $FAO_{Cereals}$	0.351006
REER does not Granger Cause WPI_{Crude}	0.180339
WPI_{Crude} does not Granger Cause I_R	0.099702

Note ***, ** and * denote significance at a 1%, 5% and 10% respectively. Results Generated by EViews 8.

Table A5: Significant Long-Run Relationships

$WPI_{Cereals}$	WPI_{Crude}	I_R	REER	$FAO_{Cereals}$	ICPI
	0.045720	5.788772	8.910489	-0.186537	-1.037507
	(0.14788)	(1.99552)	(1.45156)	(0.27544)	(0.28784)
I_R	$WPI_{Cereals}$	WPI_{Crude}	REER	$FAO_{Cereals}$	ICPI
	0.172748	0.007898	1.539271	-0.032224	-0.179228
	(0.06743)	(0.03813)	(0.24306)	(0.04551)	(0.04664)
$FAO_{Cereals}$	WPI_{Crude}	REER	$WPI_{Cereals}$	ICPI	I_R
	-0.245099	-47.76801	-5.360875	5.561946	-31.03288
	(1.17617)	(7.79223)	(2.11950)	(1.25153)	(10.3637)
ICPI	$FAO_{Cereals}$	REER	WPI_{Crude}	$WPI_{Cereals}$	I_R
	0.179793	-8.588364	-0.044067	-0.963849	-5.579501
	(0.21526)	(1.11386)	(0.18199)	(0.38098)	(1.82703)

Results generated by EViews 8. Normalized Cointegrating co-efficients (standard error in parentheses).

Table A6: Impulse Response Functions

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