Drivers and Impact of Food Inflation in India

Bhattacharya, Rudrani and Sen Gupta, Abhijit

National Institute of Public Finance and Policy, Asian Development Bank

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Drivers and Impact of Food Inflation in India[1]

Rudrani Bhattacharya[2] and Abhijit Sen Gupta[3]

Abstract

Average food inflation in India during 2006 to 2013 was one of the highest among emerging market economies, and nearly double the inflation witnessed in India during the previous decade. In this paper, we analyse the behaviour and determinants of food inflation over the recent past. Our main findings include that recent surge in food inflation in India is a result of various factors. On the cost side, agricultural wage inflation is found to be a universal driver of food commodities inflation, as well as the aggregate food inflation. The contribution of agricultural wages has increased significantly in the post MGNREGA era. Fuel inflation has a moderate impact on food inflation and the effects vary across commodities. Our analysis indicates limited role of fuel and international prices, except for in tradeables. Finally, results suggest significant pass-through effects from food to non-food and to the headline inflation.

JEL Classification: E31, E37, F62
Keywords: Food inflation, India, Agricultural wage growth, SVAR, SVECM

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[2] Assistant Professor, National Institute of Public Finance and Policy, New Delhi (Email:rudrani.bhattacharya@nipfp.org.in)
[3] Economist, Asian Development Bank, New Delhi (Email: asengupta@adb.org)

1. Introduction

Of the nearly 989.4 million people living below $1.90 a day (2011 PPP) globally in 2011, around 265.1 million are in India, and constitute 21.3% of India's population. This section spends an inordinately high amount of their income on food.[1] Thus, a sustained increase in food prices, as was witnessed in India during 2006 to 2013, adversely impact the welfare of this section, as they already spend a high share of income on food, and would be unable to divert additional resources towards food consumption to offset the effect of high prices.

In this paper, we focus on the factors that were responsible for sharp increase in food prices in India. While there exists a significant volume of literature highlighting the cost-push, demand-pull, global and policy related factors driving up food inflation, the literature lacks a rigorous empirical analysis of the role of these factors. This paper evaluates the role of these factors in a consolidated framework, and assess the transmission of food inflation to non-food and aggregate inflation. We focus on the impact of global food prices, fuel prices, agricultural wages and demand for food products. We analyse the impact of these on domestic food inflation (aggregate and main products) in a Structural Vector Autoregression (SVAR) framework, taking into account the dynamic inter-linkages among these indicators. It is important to gauge the transmission of food inflation to non-food inflation and aggregate inflation for the effective implementation of policies. Food inflation can impact non-food inflation via rise in cost of labour, substitution effects of higher relative food prices and the real income effect of producers in the food sector. We estimate a Structural Vector Error Correction Model (SVECM) among food, non-food and aggregate prices to gauge the structural relationship among these variables.

We find that high food inflation in India during 2006 to 2013 was driven by myriad of factors. Inflation in agricultural wages is a universal driver of inflation in specific commodities, as well as aggregate food inflation. The impact of agricultural wage inflation increased significantly in the post Mahatma Gandhi National Rural Employment Act (MGNREGA) period.[2] Fuel inflation has a moderate impact on food inflation, although the extent of the impact varies across commodities. Significant pass-through effects from global prices are found for tradeables. Finally, food inflation has a strong pass-through effect on non-food inflation, as well as headline inflation.

The remaining paper is structured as follows. In Section 2 we review the literature to identify the key factors driving food inflation globally, and in India. Section 3 highlights the trend and structure of food inflation in India while Section 4 uses an empirical framework to evaluate the contribution of various factors to food inflation taking into account the dynamic interlinkages. The extent of transmission of food inflation to non-food inflation, and to aggregate inflation is analysed in Section 5. Finally, Section 6 summarizes the main conclusions of the paper, highlighting the key policy implications.

2. Selective Review of the Literature

Rise in food prices during 2006 to 2013 was not confined to India only. Between November 2006 and August 2008, monthly global food inflation averaged 32.1%, while between October 2010 and August 2011, it averaged 30.7%.

[1] Food accounts for more than 60% of the monthly per capita expenditure (MPCE) of the households belonging to the bottom three expenditure deciles in rural areas, while the share is 56.5% in urban areas.

[2] The MGNREGA aims to enhance livelihood of the rural households by providing 100 days of guaranteed wage employment to adult member of the household. The scheme was introduced in 2006 and extended to all over India by 2008. In recent years the wages under MGNREGA have been indexed to CPI inflation.

Increased biofuel production, to offset fossil fuels, resulting in diversion of food commodities as biofuel feed stocks, is an important driver of food prices. Mitchell (2008) argues that biofuel production from grains and oilseeds account for two-third of the price increase in these commodities. FAO (2008) find grain prices to be 12% lower while wheat and vegetable prices to be 7% and 15% lower if biofuel production remained at 2007 level compared to if production doubled by 2018.

Excess liquidity, due to low interest regime in developed countries resulted in "new" money finding its way into commodity markets, thereby causing a speculative bubble. Gilbert (2010a) finds future positions of index providers strongly impacted price of soybean while Gilbert (2010b) finds that financial activity influenced food prices through the index futures investment channel.

Restrictive trade policies pursued by major exporters to enhance domestic food security have also impacted global prices. Timmer (2008) point out that the export control measures introduced by major rice exporters like Vietnam, impacted food prices globally. Similarly, Alexandratos (2008) notes that major exporters like China and India witnessed a drop in export balance from 22 million tons in 2002 to 5 million tons in 2007.

In India, high global prices led to a rising share of crops being diverted to export markets due to lucrative prices, causing domestic prices to rise (Chand 2010). Mishra and Roy (2012) find that the rise in demand for protein and vitamin rich food products, driven by rising income, unmatched by commensurate increase in supply due to low productivity, is the most important structural factor influencing food prices. Kumar et al. (2010) also argue that rise in demand for these food products, combined with their stagnant per capita availability, resulted in higher prices. Similarly, Gokarn (2011), Bandara (2013), Gulati and Saini (2013) also point out that a shift in consumption to protein and vitamin-rich products, caused an upward pressure on their prices. Bhattacharya and Sen Gupta (2017) estimate a demand supply gap for key food products, and find that excess demand played a vital role in driving up prices of the products. Goyal and Baikar (2015) find that though there was some improvement in productivity in the agricultural sector during this period, productivity growth in the non-traded rural sector was significantly higher than in agriculture.

Several cost escalation factors have also influenced food prices. The sharp increase in agricultural wages since 2008 has raised the cost of production (Gulati et al., 2013). Sonna et al. (2014) find that rural wages have a larger impact on food inflation compared to Minimum Support Prices (MSP) and an index of agricultural input.[3] Deregulation of administered fuel prices also transmitted rising fuel prices to fertilizer and transport costs (Bandara, 2013).

Several studies have identified the increases in MSP as a major driver of inflation. Mishra and Roy (2012) argue that for MSP to be effective in procurement, it needs to be set above the market-clearing price. Hence any increase in MSP can set up inflationary pressures. Gaiha and Kulkarni (2005), Sonna et al. (2014) and Bhalla et al. (2011) also corroborate the positive effect of MSP on food inflation.

Our paper adds to the existing literature in several ways. Firstly, we empirically investigate the role of previously unexplored factors like global prices and fuel prices in influencing

[3] The MSP is the floor price at which the government stands ready to buy whatever volume of crops the farmers are willing to sell.

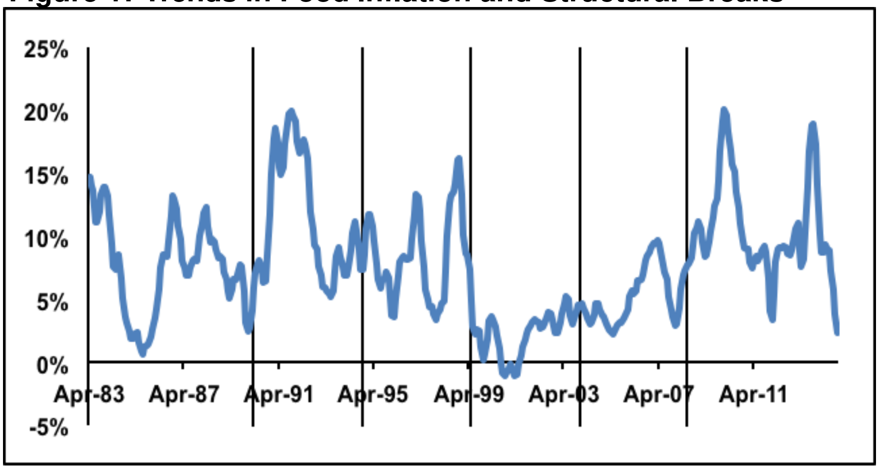
domestic food prices, in addition to analyzing other factors like demand from non-agricultural sector and agricultural wages. We also explore the dynamic inter-linkages among the key variables. Secondly, apart from evaluating aggregate food prices, we also analyze the driver of inflation at a disaggregate level. We find that the results vary considerably across the different food products. Finally, we examine the extent of transmission from a change in food prices to a change in non-food and aggregate prices, evaluating the dynamic inter-linkages between them.

3 Food Inflation: Trend and Structure

Globally, consumer prices are primarily used to measure inflation. However, prior to 2011, India did not have a unified Consumer Price Index (CPI). Thus, there is a lack of historically comparable data. Driven by the limitation in data, much of the analysis on food inflation, including Mishra and Roy (2012), and Nair and Eapen (2012), has employed the wholesale price index (WPI). We also employ WPI data for food, as apart from its historical availability, WPI allows us to conduct the analysis at the disaggregated level.

Figure 1 show the long-term trend in food inflation, covering the last three decades. Using the methodology developed in Bai and Perron (1998), we identify 5 major structural breaks, implying 6 phases of food inflation. The most recent phase of high inflation started in June 2008, and continued till end 2014, although there was a perceptible decline in inflation since January 2014. Nevertheless, over this period inflation averaged 10.4%, only marginally less than Phase II when it breached 11%. However, the duration of the most recent phase at 76 months is significantly longer than Phase II, which lasted 54 months. Thus inflation in most recent period, apart from being high, has been persistent.

Figure 1: Trends in Food Inflation and Structural Breaks



Source: Database on the Indian Economy, RBI

To test the persistence, we estimate a simple autoregressive process on monthly year-on-year inflation rate. The sum of the auto-regressive coefficients provides the degree of persistence. Majority of the lag order selection tests select a model with 3 lags. We run the selected model for the entire sample as well as six phases. The sum of the coefficients and the results of the Wald Chi-square test of joint significance of the coefficients indicate that barring Phase II, the composite sum of coefficients is significant across all specifications (Table 1). The extent of persistence is highest in the most recent phase, implying that a positive shock will continue impact inflation over a longer time.

Table 1: Persistence of Food Inflation

	Apr-83 to Oct-14	Apr-83 to Mar-90	Apr-90 to Oct-94	Nov-94 to May-99	Jun-99 to Dec-03	Jan-04 to Jun-08	Jul-08 to Oct-14
1 Month Lag	1.715***	1.831***	2.223***	2.117***	1.914***	1.792***	1.464***
	(16.831)	(14.910)	(20.791)	(18.442)	(21.585)	(12.466)	(9.119)

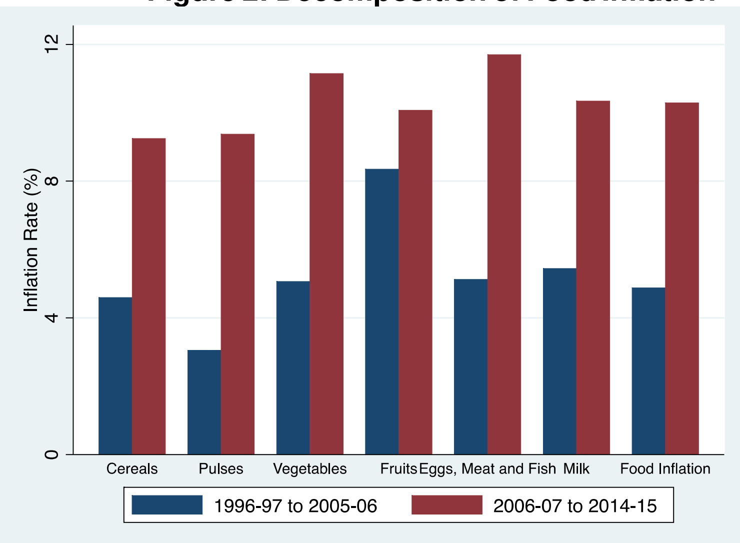
2 Month Lag	-0.966***	-1.187***	-1.844***	-1.667***	-1.407***	-0.949***	-0.594***
	(-6.083)	(-5.939)	(-9.321)	(-7.405)	(-9.595)	(-3.514)	(-2.644)
3 Month Lag	0.238***	0.341***	0.639***	0.537***	0.474***	0.144***	0.123***
	(3.155)	(3.606)	(5.725)	(4.344)	(6.027)	(2.865)	(2.953)
Sum of Coefficients	0.987***	0.985***	0.978	0.987***	0.981***	0.987**	0.992***
p values	(0.009)	(0.007)	(0.210)	(0.001)	(0.007)	(0.022)	(0.008)
Observations	377	81	55	55	55	54	77
R-squared	0.989	0.992	0.977	0.992	0.978	0.994	0.980

Robust t-statistics in parentheses.
The p values of the Wald Chi-square test are reported in parenthesis.
*** p<0.01, ** p<0.05, * p<0.1

Source: Database on the Indian Economy, RBI

Next, Figure 2 compares the average inflation rate of major food products during 2006-07 to 2014-15, with the previous corresponding period. Across all products, inflation rate was significantly higher in the second period. While pulses experienced a threefold increase in inflation, cereals, vegetables, milk and eggs, meat and fish experienced doubling of inflation. Product-wise, milk was the biggest contributor, accounting for 16% of the food inflation, followed by eggs, meat and fish (15%), cereals (13.3%), and fruits and vegetables (10% each).

Figure 2: Decomposition of Food Inflation



Source: Database on the Indian Economy, RBI

4. Drivers of Food Inflation in India

Here, we evaluate the major factors influencing food inflation, focusing on the impact of international prices, demand supply mismatch, and prices of key inputs.

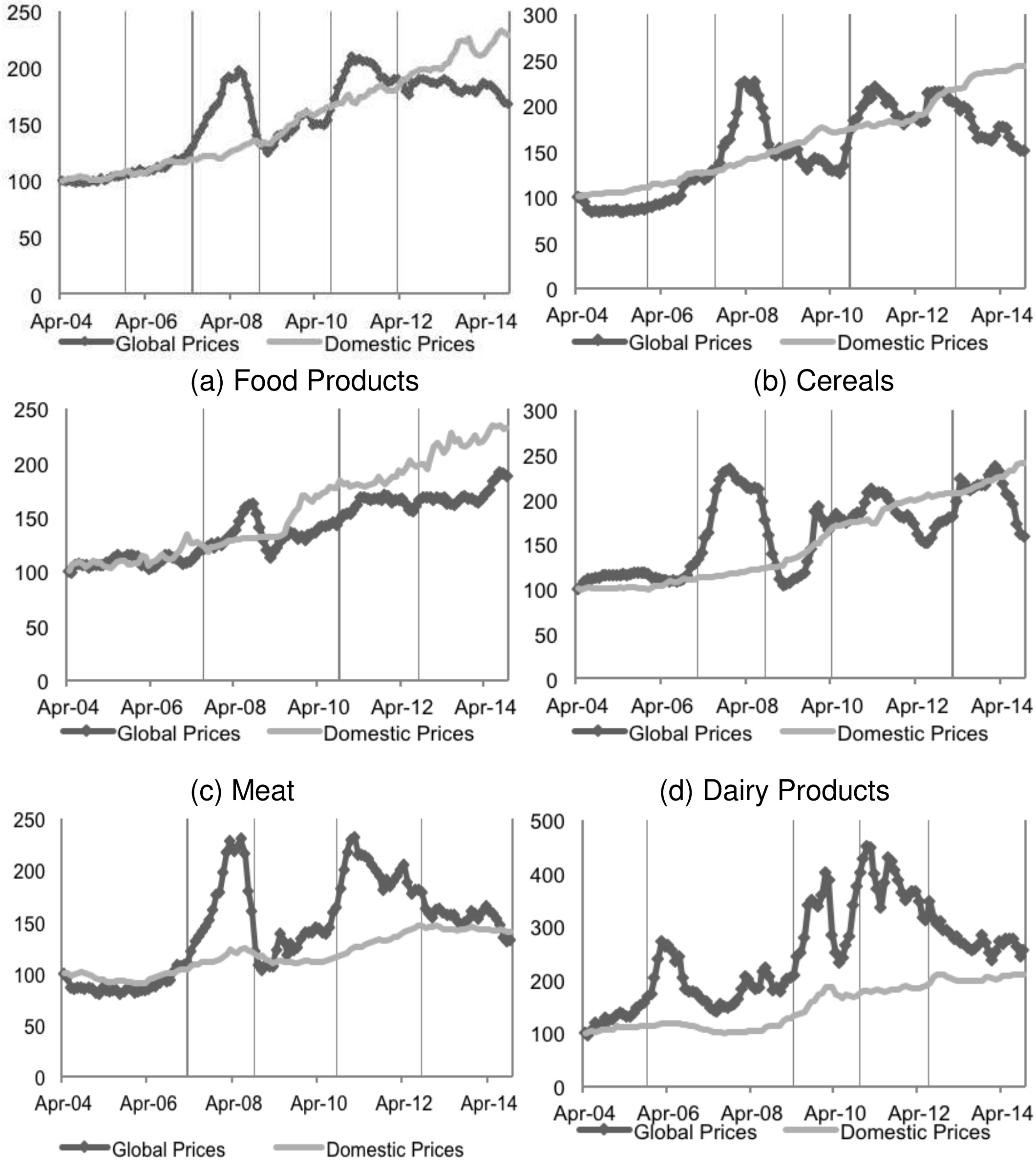
4.1 International Prices

International food prices impact domestic prices through international trade conditional on adjustment in trade policies. This channel gained importance with the surge in international food prices in 2008 and 2010. Furthermore, India's agriculture sector witnessed greater integration with global market, with the share of agriculture trade to agriculture GDP rising from 5.2% in 1990-91 to 19% in 2013-14.

Figure 3 traces out the movement in global and domestic food prices, along with five major products, highlighting the structural breaks in the global prices. Although at the aggregate level, both global and domestic food prices exhibit a rising trend between 2004 and 2014 at similar rates, there was substantial variation at the commoditywise inflation rates. For cereals and meat, the rate of increase in domestic prices was higher than that of global prices, while for edible oils and sugar, it was the other way round. More importantly, while moving in the same direction as global prices, the domestic prices avoided the sharp spikes and troughs that characterized the former. Barring meat products and sugar, global inflation was 4 to 6 times more volatile than domestic inflation.

The limited pass-through of spikes in global prices to domestic prices, even for tradeables was a result of trade policy adopted. During periods of adverse price movements, the government resorted to trade, tariff and administrative means to restrict trade.

Figure 3: Domestic vs. Global Prices (2002-2004 = 100)



(a) Food Products (b) Cereals

(c) Meat (d) Dairy Products

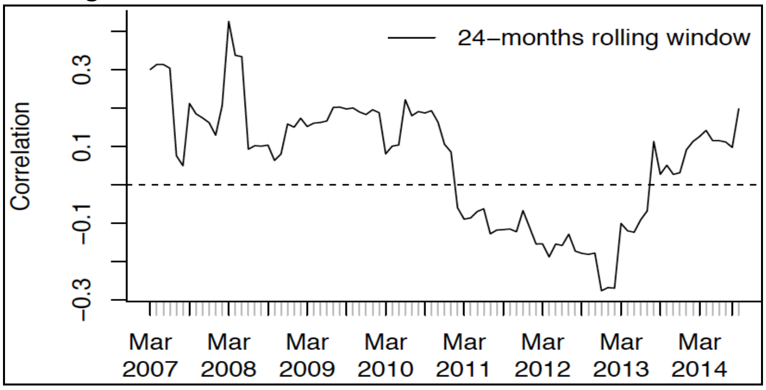
(e) Edible Oil (f) Sugar

Source: Database on the Indian Economy, RBI and FAOSTAT, Food and Agriculture Organisation

4.2 Fuel Inflation

Fuel prices influence food prices by impacting transport and fertilisers costs and input costs to power machines. Recent deregulation of petrol and diesel prices have resulted these prices being determined by market forces. Since 2005 there is moderate positive contemporaneous correlation between food and fuel inflation, except during November 2010 to July 2013 (Figure 4).[4]

Figure 4: Correlation of Fuel and Food Inflation

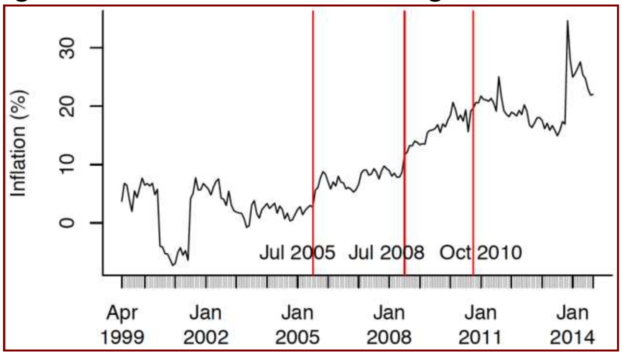


Source: Database on the Indian Economy, RBI

4.3 Agricultural Wages

Rural wages, which grew in line with aggregate inflation till 2007, increased at a faster pace in post 2007 period, although, the gap has narrowed down in the recent years. Within rural wages, agricultural wages witnessed higher acceleration than non-agricultural wages till mid-2011. Identification of structural breaks show that agricultural wage inflation rate entered double digits in mid-2008 and exceeded 20% during the last phase. (Figure 5 and Table 2).

Figure 5: Structural Breaks in Agricultural Wage Inflation



Source: Database on the Indian Economy, RBI

Table 2: Phases of Agriculture Wage Inflation

Phases	Average Inflation Rate
Phase I: Apr 1999 to Jun	2.26%
Phase II: Jul 2005 to May	7.44%
Phase III: Jul 2008 to Aug	15.87%
Phase IV: Sep 2010 onwards	20.35%

Source: Database on the Indian Economy, RBI

Several studies have linked the rise in agriculture wages to the introduction of the MGNREGA. Imbert and Papp (2012) find that MGNREGA raises casual wage income by 4.5%. Similarly, Berg et al. (2012) conclude that MGNREGA boosts the real daily agricultural wage rates by 5.3%, and it takes 6 to 11 months for an MGNREGA intensity shock to feed into higher wages. In contrast, Goyal and Baikar (2015) argue that while the spread of MGNREGA throughout India was not responsible for rise in wages, the sharp rise in MGNREGA wages in 2011 and its indexation to inflation did influence wages. Furthermore, Goyal and

[4] Food prices are seasonally adjusted using x-12 ARIMA of U.S. Census Bureau. Fuel prices are not adjusted for seasonality since the series is not a candidate for adjustment due to weak seasonal pattern in it.

Baikar (2015) find little evidence of wage-food-price spiral as while the link of the spiral from food prices to wages is strong, the link from wages to prices is weak.

4.4 Rising Demand for Food Products

Household consumer expenditure data indicate that between 1993-94 and 2011-12, the share of expenditure on food fell by 14.6 and 16.1 percentage points in rural and urban areas, respectively. However, there were significant shifts across the expenditure shares of major food products. There was a secular decline in the expenditure share on cereals and vegetables, while expenditure share on milk, eggs, meat and fish, vegetables and fruits increased, implying a rise in expenditure on protein and vitamin rich agriculture products as income increased.

Cross-sectional data from 2011-12 also highlights a faster rise in consumption of protein and vitamin rich products relative to staples with an increase in income (Table 3). The ratio of the MPCE on cereals, pulses and vegetables by the highest quintile to the lowest quintile ranged between 1.5 and 2.0 in rural areas, and between 1.7 and 2.2 in urban areas. In contrast, for eggs, meat and fish, the ratio exceeded 3.2 in urban areas and 4.2 in rural areas. For fruits, the ratio exceeded 9.0 in both urban and rural areas, while for milk, the ratio was almost 5.0 in urban areas and 7.5 in rural areas.

Table 3: MPCE by Expenditure Quintiles

	Rural					Urban				
	P_0 to P_{20}	P_{20} to P_{40}	P_{40} to P_{60}	P_{60} to P_{80}	P_{80} to P_{100}	P_0 to P_{20}	P_{20} to P_{40}	P_{40} to P_{60}	P_{60} to P_{80}	P_{80} to P_{100}
Cereals	121.7	143.7	154.9	171.3	189.2	135.1	160.1	178.7	199.3	225.2
Pulses	26.6	34.3	38.6	44.8	54.4	34.8	44.2	51.9	57.5	69.4
Milk	32.5	65.9	99.6	143.3	239.3	70.1	124.1	171.1	225.0	342.0
Eggs Meat and Fish	19.9	32.7	40.4	52.2	82.8	33.0	52.7	64.4	78.2	106.5
Vegetables	44.4	54.5	59.4	68.6	82.5	51.7	67.0	80.1	93.9	114.3
Fruits	5.9	12.2	19.0	29.4	57.5	13.7	28.9	43.5	64.6	128.7

Source: Ministry of Statistics and Programme Implementation.

4.5 Contribution of Global and Domestic Factors to Food Inflation: A SVAR Analysis

We use monthly data from April 1998 to September 2014 to analyse the impact of the above-discussed factors on food inflation in a SVAR framework. We estimate models for aggregate food inflation as well as inflation in individual commodities, using fuel inflation, agricultural wage inflation and demand for food from industrial sector as common factors, along with the global prices for the respective food components.[5]

The unit root test results suggest that the variables are I(1). Hence, we estimate our SVAR models in the first difference of the variables in logs, i.e. on the period-on-period growth rates.[6] Given that 2008, the year of universal implementation of MGNREGA, corresponds to a structural break date in agricultural wage inflation, we re-estimate the SVAR model for the post-2008 period. We compare the impact of shock to wage inflation on food inflation for the entire sample period with the truncated period from 2008, to investigate any significant change in the pass-through of wage inflation to food inflation since 2008.

We estimate the following SVAR model:

$$A_{?}\ Y_t = A_1\ Y_{t\ 1} + A_2\ Y_{t\ 2} + A_3\ Y_{t\ 3} + B\ {}_t \quad (1)$$

[5] Gulati and Saini (2013) and Gulati et al (2013) point out hikes in MSP reflect developments in global prices and cost of production. By capturing these factors in our analysis, we implicitly cover the impact of MSP.

[6] For variables with significant seasonal variation, growth rates are calculated on their seasonally adjusted values.

where,

$$Y_t = \begin{bmatrix} \ln P_t^* \\ \ln P_t^{fuel} \\ \ln w_t \\ \ln y_t \\ \ln P_t \end{bmatrix}$$

Here Y_t is a vector consisting of domestic food prices and its determinants. The vector includes global food price index ($\ln P_t^*$); fuel price index ($\ln P_t^{fuel}$); seasonally adjusted agricultural wage ($\ln w_t$); seasonally adjusted IIP as a proxy for demand from industrial sector, ($\ln y_t$); and seasonally adjusted aggregate food price ($\ln P_t$).[7]

The SVAR model assumes the following relation between the structural and reduced form errors,

$$Au_t = B\varepsilon_t$$

where u_t and ε_t denote the vector of reduced form errors and structural errors, respectively. We assume the following restrictions on the structural parameters:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u_t^{P^*} \\ u_t^{fuel} \\ u_t^{w} \\ u_t^{y} \\ u_t^{P} \end{bmatrix} = \begin{bmatrix} b_{P^*}^{P^*} & 0 & 0 & 0 & 0 \\ 0 & b_{fuel}^{fuel} & 0 & 0 & 0 \\ 0 & 0 & b_w^w & 0 & 0 \\ 0 & b_y^{fuel} & 0 & b_y^y & 0 \\ b_P^{P^*} & b_P^{fuel} & b_P^w & b_P^y & b_P^P \end{bmatrix} \begin{bmatrix} \varepsilon_t^{P^*} \\ \varepsilon_t^{fuel} \\ \varepsilon_t^{w} \\ \varepsilon_t^{y} \\ \varepsilon_t^{P} \end{bmatrix} \qquad (2)$$

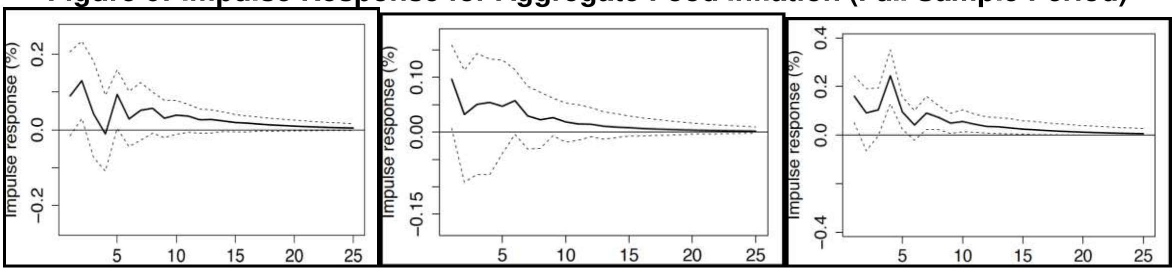
The restrictions assume that shocks to global food inflation, fuel inflation, agricultural wage inflation and industrial growth affect domestic food inflation instantaneously but a shock to domestic food inflation does not impact these variables instantaneously. A shock to fuel inflation affects industrial growth instantaneously, but not vice versa. The dynamics of global food inflation, fuel inflation and agricultural wage inflation are independent of instantaneous effects from shock to the other variables.

We conduct diagnostic tests of the underlying VAR process. The Portmanteau and the Breusch-Godfrey LM test are applied to test the presence of serial correlation in residuals from the VAR model. We cannot reject the null that the residuals do not contain serial correlation at 5% level of significance. To check for heteroscedasticity, we implement the multivariate ARCH-LM test. Again, the null of homoscedastic residuals cannot be rejected at 5% significance level. The roots of the polynomial of the underlying VAR(3) process are well

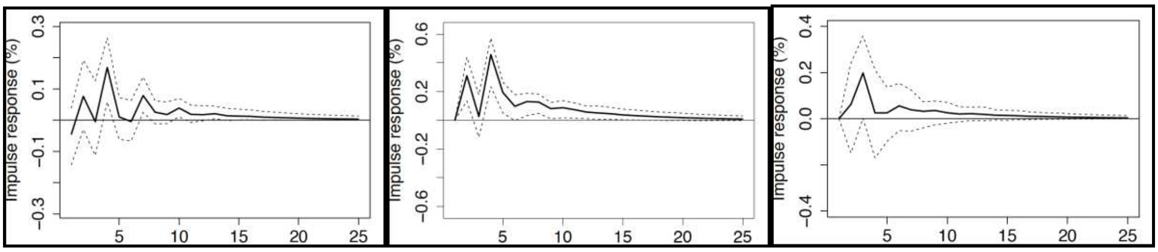
[7] The lag order of 3 for the VAR model is chosen following the AIC criteria.

below unity, indicating stability of the model. However, the Jarque-Bera statistics for normality test indicates that errors are not normally distributed.[8]

Figure 6: Impulse Response for Aggregate Food Inflation (Full Sample Period)



(a) Response of Food to Global Food Inflation (b) Response of Food to Fuel Inflation (c) Response of Food to Wage Inflation



(d) Response of Food to IIP Growth (e) Response of Wage to Food Inflation (f) Response of IIP Growth to Food Inflation

Source: Authors' Estimates

The dynamic effects of a shock to the determinants of food inflation on food inflation are captured in Figure 6. A 10% rise in the global food inflation has a transitory impact on domestic food inflation. It increases domestic food inflation by 1.3% after two months of the shock, but the impact does not remain significant after that. Similarly, a 10% rise in fuel inflation instantaneously increases food inflation by 1%, but the effect is transitory. Again, a 10% rise in wage inflation contemporaneously increases domestic food inflation by 1.6% and the effect increases to 2.4% after 4 months of the shock. The impact decline afterwards, but remains significant for long time. IIP growth has a small but significant impact on food inflation. We also find substantial second round effect from food to wage inflation.

The Forecast Error Variance Decomposition (FEVD) analysis in Table 4 shows that after 10 months, 10% of the variation in domestic food inflation is due to wage inflation, followed by demand pressure from industrial sector (3.5%), global food inflation (3.4%), and fuel inflation (1.8%) respectively. After 10 months of a shock, almost 14% of the variation in wage inflation is due to food inflation.

Table 4: FEVD Analysis: Full Sample Analysis

	Horizon	Global food	Fuel	Wage	IIP	Food
	1	100	0	0	0	0
Global Food	5	95.049	1.164	0.294	2.312	1.182
	10	94.304	1.654	0.371	2.452	1.22
	1	0	100	0	0	0
Fuel	5	5.999	87.23	1.725	2.15	2.897
	10	8.053	84.528	2.079	2.42	2.92
	1	0	0	100	0	0
Wage	5	1.129	3.433	80.947	1.813	12.678
	10	1.662	3.74	78.348	2.378	13.872
	1	0	0.685	0	99.315	0
IIP	5	7.772	0.936	0.552	89.6	1.141

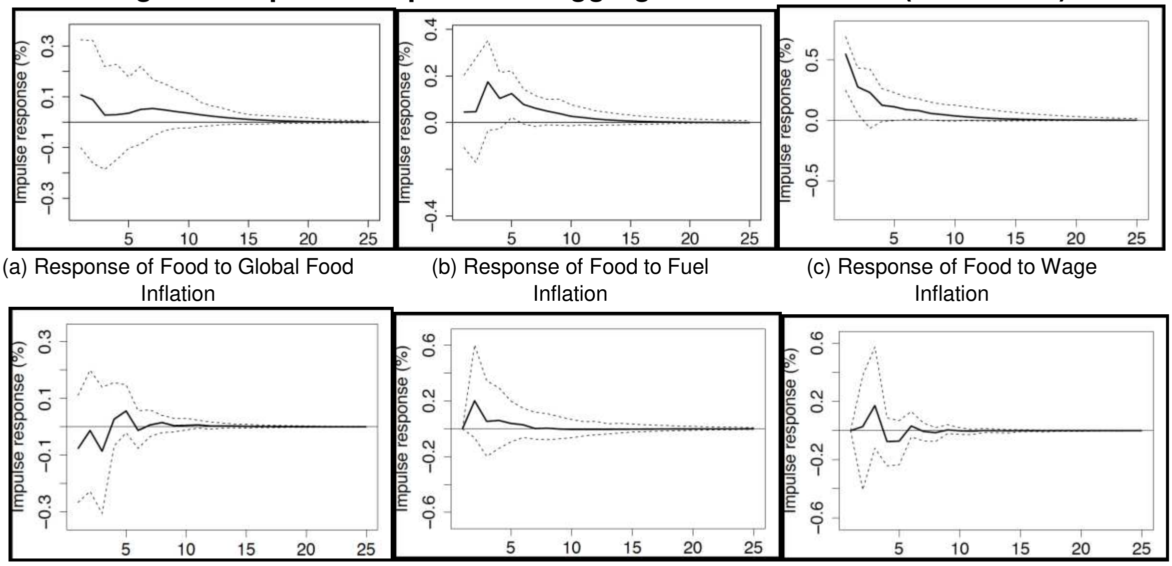
[8] Results of the diagnostic tests are available on demand.

	10	8.458	0.92	0.942	88.378	1.303
	1	0.856	1.001	2.756	0.215	95.171
Food	5	2.873	1.46	9.147	2.936	83.585
	10	3.436	1.823	10.274	3.452	81.015

Source: Authors' Estimates

We re-estimate the SVAR model for post-2008 period to identify the differential impact of MGNREGA. Figure 7 shows a sharp rise in the magnitude of the impact of wage inflation on domestic food inflation in the post-MGNREGA period. A 10% rise in wage inflation now increases food inflation by 5.5% and the effect is significant. Thus, post-MGNREGA, wage increase acts as both as a cost-push a demand-pull factor for food inflation. We do not find any transmission of global food inflation to domestic food inflation in the recent period, lending support to our preliminary observation that domestic inflation does not move with global inflation during the periods of global price spikes. Effect of fuel inflation shock does not change significantly in the recent period.

Figure 7: Impulse Response for Aggregate Food Inflation (Since 2008)



(a) Response of Food to Global Food Inflation

(b) Response of Food to Fuel Inflation

(c) Response of Food to Wage Inflation

(d) Response of Food to IIP Growth

(e) Response of Wage to Food Inflation

(f) Response of IIP Growth to Food Inflation

Source: Authors' Estimates

A comparison of the FEVD analysis for the post-2008 period (Table 5) with that for the full-sample shows that the sources of variation in food inflation have changed in the post-2008 period. The contribution of global food inflation to domestic food inflation halved after 2008. After 10 months, global food inflation explains only 1.5% variation in domestic food inflation after 2008, compared to more than 3% in the full-sample analysis, again conforming our observation that the global price spikes have not transmitted to domestic prices, due to the trade policies adopted by India. Moreover, after 10 months of a shock, more than 21% variation in the food inflation is due to wage inflation. Thus the contribution of wage inflation doubles in the post-2008 period. The contribution of fuel inflation increases to 3.4% from 1.8% in the full-sample scenario. In the post-2008 period, there are no significant second round effect on wage inflation from food inflation. Interestingly, we find that 10% of the variation in wage inflation, after 10 months of a shock, is caused by fuel inflation.

Figure A.1 depicts the results for individual commodities.[9] The drivers of inflation vary

[9] In each of these analysis, global food inflation is proxied by the corresponding global commodity price inflation.

considerably across commodities. While wage inflation is a common driver for all commodities, fuel inflation has transitory effects on cereal, dairy and sugar inflation. Sugar and edible oil inflation are highly responsive to their respective global counterparts with 1% rise in global sugar inflation leading to 0.5% rise in domestic inflation, while there being almost one on one impact of global edible oil inflation to domestic inflation.

Table 5: FEVD Analysis: Since 2008

	Horizon	Global Food	Fuel	Wage	IIP	Food
	1	100	0	0	0	0
Global Food	5	95.058	1.606	0.452	0.958	1.927
	10	94.148	2.173	0.75	0.993	1.935
	1	0	100	0	0	0
Fuel	5	13.242	80.139	5.802	0.684	0.133
	10	15.576	77.016	6.505	0.715	0.189
	1	0	0	100	0	0
Wage	5	2.193	9.101	86.101	1.564	1.041
	10	2.947	10.548	83.972	1.53	1.003
	1	0	2.976	0	97.024	0
IIP	5	2.04	3.397	1.246	92.576	0.74
	10	2.176	3.429	1.302	92.335	0.759
	1	0.647	0.115	16.897	0.324	82.017
Food	5	1.033	2.793	21.141	0.79	74.243
	10	1.501	3.383	21.652	0.794	72.669

Source: Authors' Estimates

The results of FEVD analysis are reported in Tables A.2 and A.3. Wage inflation is the common source of variation in inflation in cereals, dairy and sugar and meat. After 10 months of a shock, 4.8% to 8.0% of the variation in inflation in these commodities is due to wage inflation. Fuel inflation is a significant driver of inflation in cereals, dairy and sugar. A substantial proportion of variation in sugar and edible oil inflation are driven by their global counterparts. While 34% variation in the domestic edible oil inflation is caused by global inflation, global sugar inflation drives 10% variation in domestic inflation.

4.6 Robustness Analysis

We test the robustness of our analysis by estimating two alternative models. The first model incorporates MSP as a possible driver of food inflation along with other factors considered above, while the second model captures demand for food from industrial sector using industrial wages, instead of IIP.

4.6.1 Role of MSP

We include the average MSP prices along with global food prices, rural wages, fuel prices and IIP. The MSP index is constructed using weights of the WPI basket. Since MSP data are available annually, we interpolate the series for monthly frequency. Following the literature, in the SVAR analysis, we assume that MSP inflation responds to global inflation, fuel inflation and agricultural wage inflation contemporaneously. The FEVD results suggest, as in our main analysis, wage growth is the primary driver of food inflation (Table A.4). As depicted in Table A.4, after 5 months of the shock, 7.2% of variation in food inflation is due to agricultural wage growth, while 1.95% variation is due to MSP shock.

4.6.2 Role of Industrial Wage Growth

The SVAR structure in this specification assumes that the dynamics of industrial wage growth does not depend on shocks to other variables contemporaneously. The rest of the shock structure is similar to our main analysis.

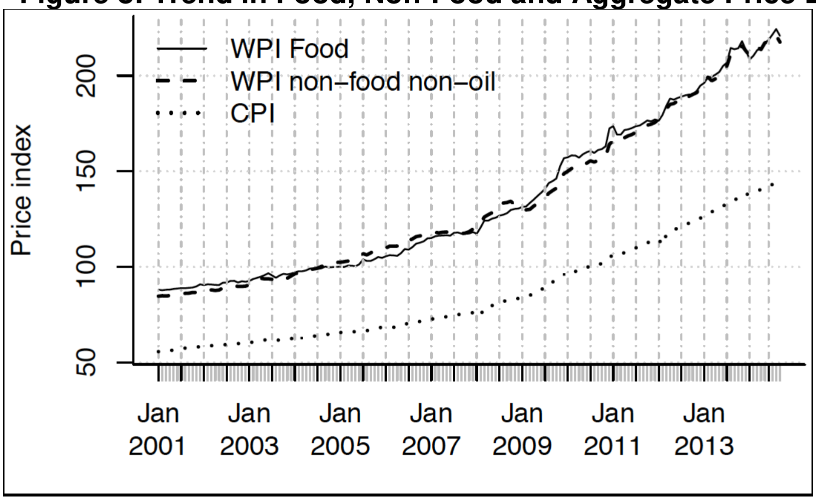
We again find that agricultural wage inflation is the main driver of food inflation (see the lower most panel in Table A.5). After 5 months of a shock, agricultural wage growth explains 7.2% of the variation, while 2.4% of variation is due to industrial wage growth. Global food inflation explains 3.5% of the variation in food inflation, while fuel inflation contributes to 1.5% variation.

5. Transmission from Food to Non-Food and Aggregate Inflation

Food inflation may impact on core inflation via rise in cost of labour, substitution effects of higher relative food, and the real income effect of food producers. Rise in food inflation induces labourers to demand higher wages, which raises the cost of production and hence prices of non-food items as well. Rise in food prices, relative to aggregate prices, would raise demand for non-food products via substitution effect (Aoki, 2001) and also via income effect of the food producers, as their real income increases. (Anand et al., 2010).

Food inflation can raise aggregate inflation substantially if food constitutes a significant share of the consumption basket. Aggregate inflation also increases through second round effect via the rise in non-food inflation caused by the rise in food inflation. However, in the long-run, high food inflation can have negative impact on non-food inflation. In an economy where food has a large share in the consumption basket, persistently high food inflation reduces real income in the long-run, causing proportionately greater decline in consumption of non-food items compared to food (Engel's law), and hence negative impact on non-food prices. Hence, it becomes pertinent to gauge the transmission of food inflation to non-food inflation and aggregate inflation.

Figure 8: Trend in Food, Non-Food and Aggregate Price Levels



Source: Database on the Indian Economy, RBI

Here the non-food and non-oil component of WPI is used as the proxy for non-food prices. We use the aggregate consumer price index to measure aggregate inflation. Figure 8 depicts the movements in food, non-food and aggregate prices over time, and highlights a clear co-moving pattern. We investigate time series properties of these prices, and possible co-integrating relation among them over the period January 2001 to September 2014.[10] The price series are found to be I(1). Both trace and eigenvalue test under Johansen co-integration test reveals one co-integrating relation among the price series at 5% and 10% level of significance.

[10] CPI, WPI food and WPI non-food prices are seasonally adjusted using x-12 ARIMA.

We estimate a SVECM among food, non-food and aggregate prices to gauge the structural relationship. The VECM specification captures both the long-run and the short-run relationships among the variables. The ordering of the variables follows from food prices to non-food prices and finally to the aggregate prices. The short-run shock structure assumes that food prices instantaneously affect non-food prices and aggregate prices but not vice versa. Similarly, non-food prices affects aggregate prices instantaneously but not vice versa. The SVECM model is as follows:

$$?y_t = \quad + \quad y_t + A_1 \; y_{t\;1} + ... + A_{p\;1} \; y_{p\;t+1} + u_t \qquad (3) $$

where,

$$ y_t = \begin{bmatrix} \ln(\text{food})_t \\ \ln(\text{non-food})_t \\ \ln(\text{cpi})_t \end{bmatrix} $$

and

$$ \begin{bmatrix} u_t^{food} \\ u_t^{non\ food} \\ u_t^{cpi} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ b_{non\ food}^{food} & 1 & 0 \\ b_{cpi}^{food} & b_{cpi}^{non\ food} & 1 \end{bmatrix} \begin{bmatrix} {}_t^{food} \\ {}_t^{non\ food} \\ {}_t^{cpi} \end{bmatrix} \qquad (4) $$

where u_t is the reduced form error, and $?_t$ denotes structural error.[11]

Table 6: Long Relationship in Food, Non-food and Aggregate Prices

Variables	Cointegration Coefficients	Adjustment Parameters
Log of CPI	-1	0.0955** (0.0075)
Log of WPI food	0.7604	-0.1350** (0.0034)
Log of WPI non-food	0.4506	-0.0992** (0.0086)
Trend	-0.0014	

Source: Authors' Estimates

The second column reports the long-run static relationship among the various prices. The cointegration coefficients are normalized with respect to the coefficient of log CPI. The third column reports the adjustments parameters of each series to the long-run relationship (p values are in parenthesis).

The estimated long-run cointegration relation in Table 6 suggests that 10% food inflation causes 7.6% aggregate inflation, whereas 10% non-food inflation causes 4.5% aggregate inflation. However, we find that in the long-run, food inflation exerts a negative impact on non-food inflation.[12]

The adjustment parameters show how different variables adjust to the long-run relation. Thus agrregate prices adjust by 9.6% in response to a 100% deviation from the long-run relation. Similarly, food and non-food prices adjust by 13.5% and 9.9% respectively, in

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[11] The parameters and represent the vector of long-run elasticities and adjustment parameters respectively. Since y_t is the vector of prices in log, $?y_t$ in equation 8 represents vector of inflation rates.

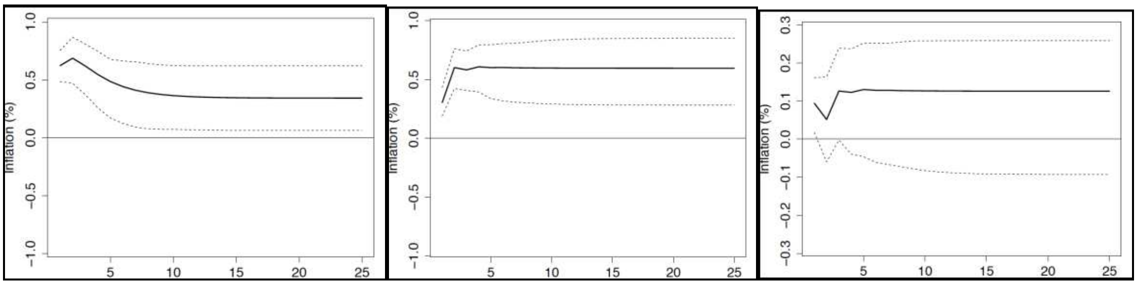
[12] 1% food inflation causes 0.59% deflation in non-food prices.

response to a 100% deviation from the long-run relationship. Thus, food prices respond to a deviation from the long-run relation faster than other variables.

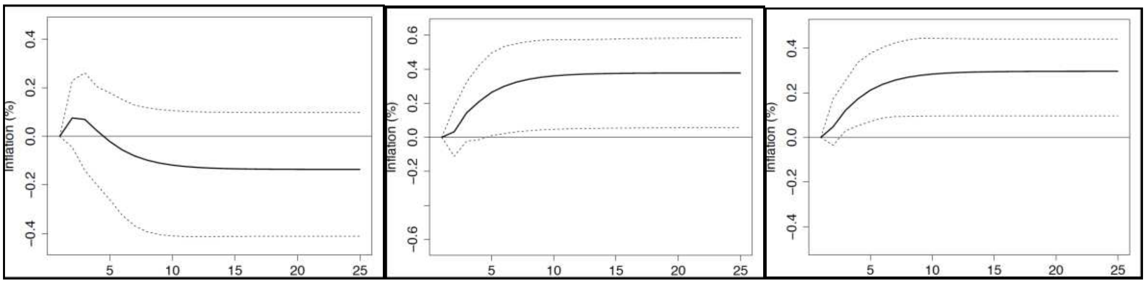
While the cointegration relation reveals the static relationship among the variables in the long-run, impulse responses from the estimated VEC specification capture the dynamic relationships.

Figure 9 shows that one unit shock to food prices, which causes 1% food inflation, raises non-food inflation by 0.62% immediately, with the effect increasing to 0.68% in the next period followed by a reduction to 0.34%, that persists till 25 months. Similarly, one unit shock to food prices raises aggregate CPI by 0.60% after two months of the shock, and the effect persists for two years.

Figure 9: Impulse Response Analysis



(a) Response of Non-Food to Food (b) Response of CPI to Food (c) Response of CPI to Non-Food



(d) Response of Food to Non-Food (e) Response of Food to CPI (f) Response of Non-Food to CPI

Source: Authors' Estimates

Non-food inflation exerts upward pressure on aggregate inflation, but the effects are not statistically significant. We do not find any evidence of the second round impact on food inflation due to non-food inflation via rise in nominal income in non-food sector. Finally, we find moderate but significant rise in food and non-food prices due to a positive shock to aggregate inflation.

Table 8 reports the FEVD results, which shows that 10 month out, 60% of variation in aggregate inflation is due to variation in food inflation, whereas food inflation contributes 40% variation in aggregate inflation after 10 month of the shock.

Table 7: FEVD Analysis

	Horizon	Food	Non-food	CPI
	1	100	0	0
Food	5	96.717	0.256	3.026
	10	89.517	0.788	9.695
	1	60.556	39.444	0
Non-food	5	47.85	49.676	2.474
	10	40.542	52.422	7.036
	1	16.193	1.56	82.247
CPI	5	56.382	2.205	41.413
	10	60.838	2.583	36.578

Source: Authors' Estimates

6. Conclusion

Exisiting literature enumerates various cost-push, demand-pull and global factors as drivers of inflation in food commodities in India. In this study, we evaluate the role of these factors in a consolidated framework, and assesses the diverse pattern of sources in inflation across food commodities.

We find limited role of international prices, although significant pass-through effects are found for tradeables such as sugar and edible oil. Rise in prices of key inputs have also impacted the prices of various commodities. The rapid increase in fuel prices in recent years exerts a moderate influence in food prices. Agricultural wage inflation is a universal driver of aggregate food inflation, as well as individual commodities' inflation, with the contribution of agricultural wages increasing significantly in the post-MGNREGA era.

Finally, we find significant evidence of transmission of food inflation to non-food inflation and aggregate inflation. A rise in food inflation impacts non-food and aggregate inflation, with the effects being quite persistent.

Given that high food inflation in India is a result of rising demand pressure, high input costs and supply side impediments, there are several policy implications. On the demand side, monetary policy can stabilize food inflation, by moderating consumption demand (Anand et al., 2010 and Catao and Chang, 2010). Similarly, investments in long-run agricultural productivity growth, infrastructural investments, institutional reforms, and liberal trade policies can enhance supply responses. To boost agricultural productivity, the government has introduced several reforms including widening the area under irrigation, issuing soil health cards to optimize fertilizer use and raise yield, and allowing FDI in agriculture related sector, to improve productivity through technology transfer. These reforms have ambitious goals and implementation on the ground will have to be significantly accelerated. Agriculture also needs to adapt new technology on several fronts. Apart from using genetically modified seeds in a prudent manner, there is a need to enhance the adaption of new technologies like precision farming, rice intensification, raised bed planting, precision seeders, self-propelled sprayers, and multi-crop harvesters and threshers (NITI Aayog 2017).

The agriculture market is highly fragmented and suffers from numerous distortions. The wholesale activities are conducted in *mandis* sanctioned by the Agricultural Product Marketing Committee (APMC) of the states. Under the APMC Act, farmers are required to sell their produce in a local *mandi* where the intermediaries manipulate the price. In a move to empower farmers to sell their produce to whomsoever they wish, thereby fostering competition and ensuring lucrative prices for the farmers, the government has initiated unifying market for agricultural commodities, i.e., creating a 'National Agricultural Market (NAM)' by connecting mandis across states via an electronic platform.

Agricultural wage growth is a major factor behind food inflation. Consequently, it must be ensured that a rise in agricultural wages is matched by productivity growth, as failure to do so will lead to higher prices. This would entail alleviating the major supply side constraints in agricultural sector (Bhattacharya et. al., 2014).

Restrictive trade policies have limited the transmission of surge in global food prices to their domestic counterparts. However, the system of *ad hoc* trade policies needs replacement with a planned approach to reduce uncertainty. The opportunity to capture better prices in the global market would incentivize producers to upgrade productivity. A consistent trade policy would help importers to plan their activities, prohibiting spikes in prices during domestic scarcity.

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Appendix A

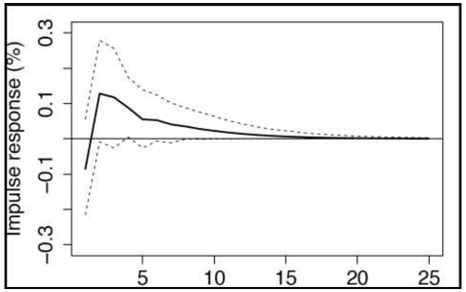
Table A.1: Weights Associated to sub-components of WPI

Components	1993-94 base	2004-05 base
Food	26.94	24.31
Food articles	15.40	14.34
Food products	11.54	9.97
Cereals	4.41	3.37
Dairy	5.05	3.81
Meat	1.09	0.93
Sugar	1.94	5.36
Edible oil	2.76	3.04
Fuel and Power	14.23	14.91

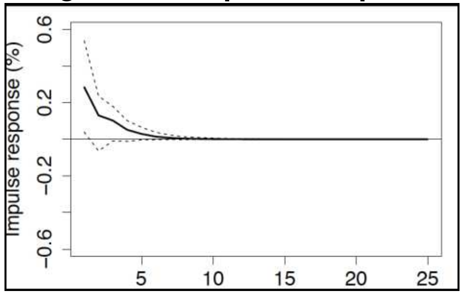
Data on food, various food components and fuel indexes are sourced from the Office of Economic Advisor while data on agricultural wages are sourced from Labour Bureau. Dta on index of industrial production and minimum support prices are sourced from Central Statistics Office while data from global prices are sourced from Food and Agricultural Organisation. All the domestic variables, except for fuel, and global sugar prices are seasonally adjusted using x-12 ARIMA of U.S. Census Bureau. The unit root tests using ADF and KPSS tests are performed on the seasonally adjusted values of the series which are candidates for seasonal adjustments.[13]

[13] The unit root test results are available on demand.

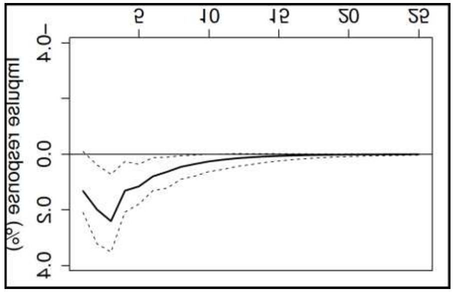
Figure A.1: Impulse Response for Commodities



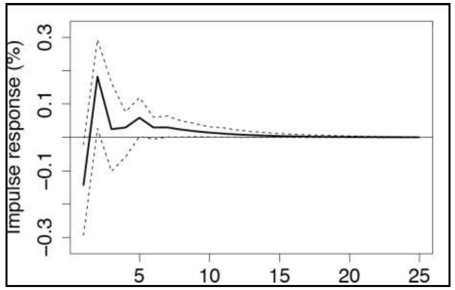
(a) Response of Cereal to Global Cereal Inflation



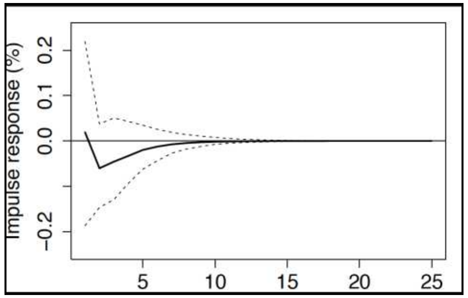
(b) Response of Cereal to Fuel Inflation



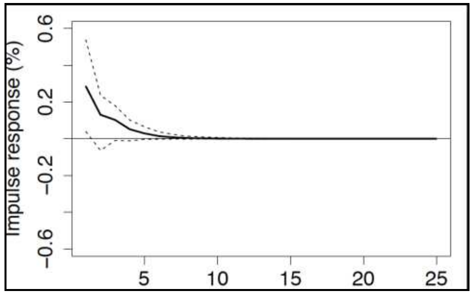
(c) Response of Cereal to Wage Inflation



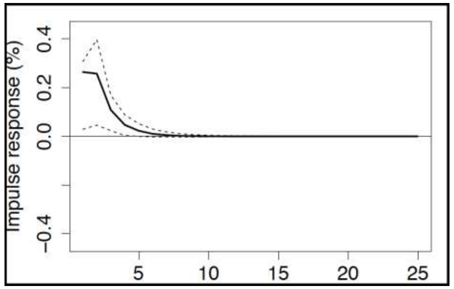
(d) Response of Cereal Inflation to IIP Growth



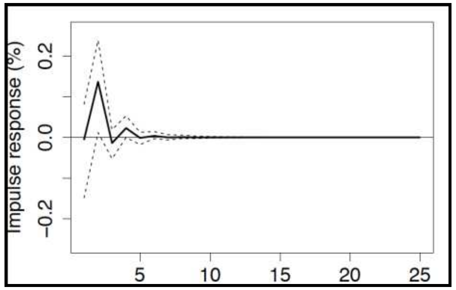
(e) Response of Dairy to Global Dairy Inflation



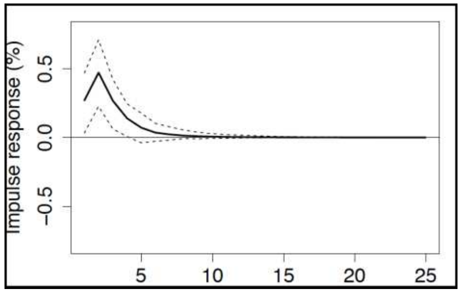
(f) Response of Dairy to Fuel Inflation



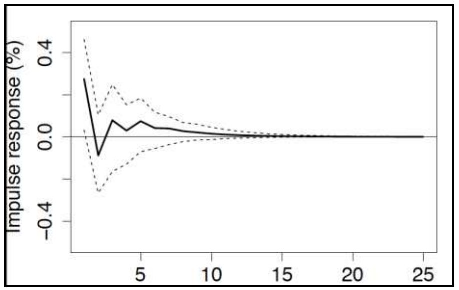
(g) Response of Dairy to Wage Inflation



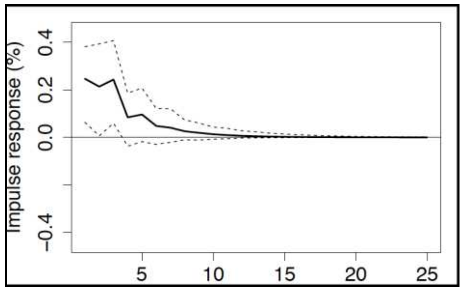
(h) Response of Dairy Inflation to IIP Growth



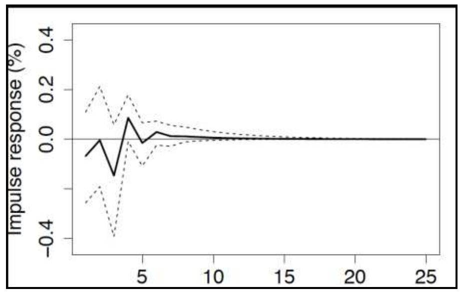
(i) Response of Sugar to Global Sugar Inflation



(j) Response of Sugar to Fuel Inflation

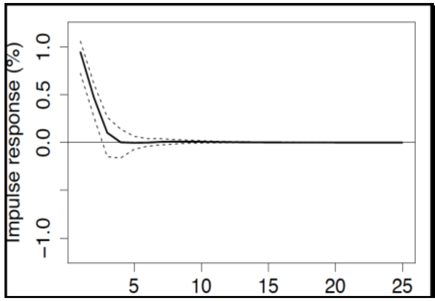


(k) Response of Sugar to Wage Inflation

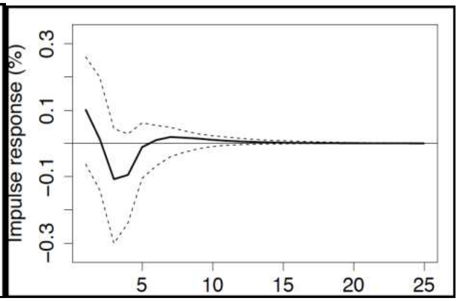


(l) Response of Sugar Inflation to IIP Growth

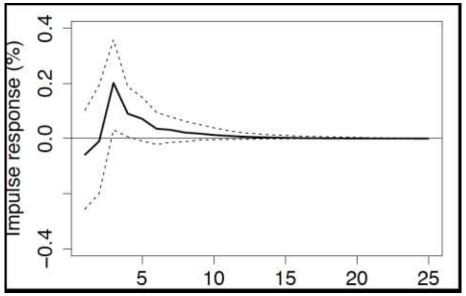
Figure A.1: Impulse Response for Commodities (continued)



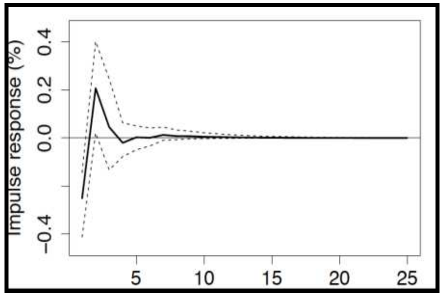
(m) Response of Oil to Global Oil Inflation



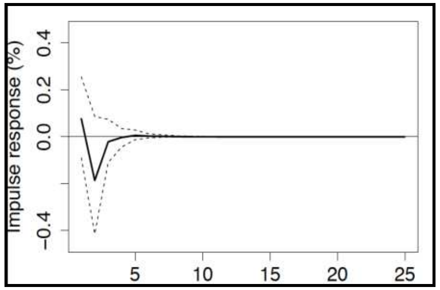
(n) Response of Oil to Fuel Inflation



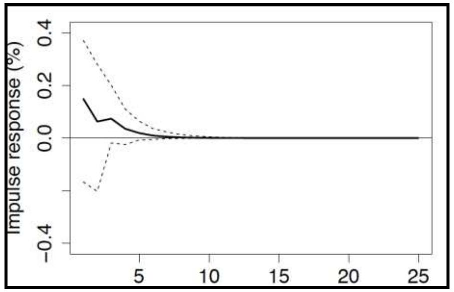
(o) Response of Oil to Wage Inflation



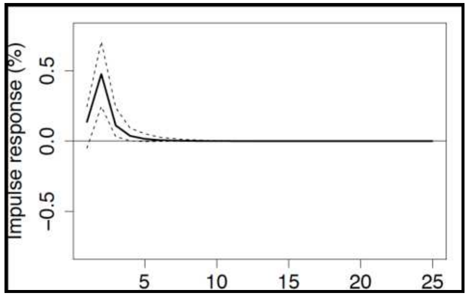
(p) Response of Oil Inflation to IIP Growth



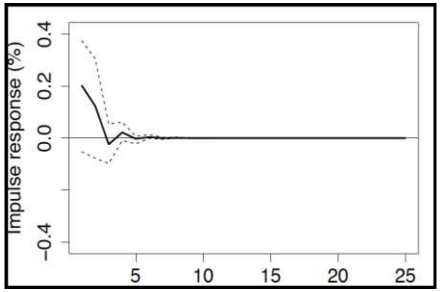
(q) Response of Meat to Global Meat Inflation



(r) Response of Meat to Fuel Inflation



(s) Response of Meat to Wage Inflation



(t) Response of Oil Inflation to IIP Growth

Table A.2: FEVD Analysis: Cereal, Dairy and Sugar

		Horizon	Global Cereal	Fuel	Wage	IIP	Cereal
Cereal	Global Cereal	1	100	0	0	0	0
		5	97.565	0.072	0.553	1.683	0.127
		10	97.523	0.089	0.571	1.688	0.13
	Fuel	1	0	100	0	0	0
		5	2.919	90.891	2.116	3.823	0.251
		10	3.405	90.097	2.22	3.908	0.37
	Wage	1	0	0	100	0	0
		5	2.245	4.772	88.153	1.168	3.663
		10	2.628	5.348	86.616	1.343	4.065
	IIP	1	0	0.752	0	99.248	0
		5	2.064	2.252	0.873	93.196	1.615
		10	2.179	2.311	0.949	92.878	1.683
	Cereal	1	0.472	1.932	1.118	1.312	95.166
		5	2.551	2.42	7.682	3.091	84.256
		10	2.851	2.818	8.256	3.167	82.908
		Horizon	Global Dairy	Fuel	Wage	IIP	Dairy
Dairy	Global Dairy	1	100	0	0	0	0
		5	96.949	0.065	0.952	1.182	0.854
		10	96.788	0.068	1.018	1.196	0.93
	Fuel	1	0	100	0	0	0
		5	2.067	90.383	3.571	1.104	2.875
		10	2.166	90.152	3.627	1.111	2.944
	Wage	1	0	0	100	0	0
		5	0.119	2.708	91.694	0.099	5.38
		10	0.122	2.723	91.666	0.099	5.39
	IIP	1	0	0.266	0	99.734	0
		5	0.384	2.08	1.195	93.854	2.488
		10	0.391	2.085	1.202	93.824	2.497
	Dairy	1	0.025	5.434	4.694	0.002	89.845
		5	0.439	6.503	8.766	1.131	83.161
		10	0.453	6.516	8.77	1.132	83.13
		Horizon	Global Sugar	Fuel	Wage	IIP	Sugar
Sugar	Global Sugar	1	100	0	0	0	0
		5	93.561	2.047	1.198	1.354	1.839
		10	93.519	2.051	1.229	1.354	1.847
	Fuel	1	0	100	0	0	0
		5	2.394	90.225	2.421	4.578	0.382
		10	2.443	89.936	2.584	4.64	0.397
	Wage	1	0	0	100	0	0
		5	0.566	5.138	92.462	1.018	0.817
		10	0.646	5.749	91.622	1.094	0.889
	IIP	1	0	0.8	0	99.2	0
		5	0.489	2.608	1.552	94.89	0.461
		10	0.504	2.677	1.613	94.734	0.472
	Sugar	1	2.273	2.364	1.9	0.145	93.317
		5	10.019	2.453	4.646	0.861	82.021
		10	10.034	2.563	4.761	0.888	81.754

Table A.3: FEVD Analysis: Edible Oil and Meat

		Horizon	Global Edible Oil	Fuel	Wage	IIP	Edible Oil
Edible oil	Global Edible Oil	1	100	0	0	0	0
		5	96.715	2.589	0.5	0.121	0.074
		10	96.65	2.616	0.51	0.129	0.095
	Fuel	1	0	100	0	0	0
		5	2.274	90.602	2.998	3.709	0.418
		10	2.435	90.201	3.209	3.736	0.419
	Wage	1	0	0	100	0	0
		5	1.215	5.193	89.695	0.945	2.952
		10	1.54	5.598	88.776	1.019	3.067
	IIP	1	0	0.61	0	99.39	0
		5	1.042	2.263	1.465	95.12	0.109
		10	1.065	2.289	1.507	95.024	0.116
	Edible oil	1	33.279	0.38	0.129	2.338	63.874
		5	34.364	0.946	1.749	3.286	59.656
		10	34.266	0.975	1.841	3.284	59.634
Meat		Horizon	Global Meat	Fuel	Wage	IIP	Meat
	Global Meat	1	100	0	0	0	0
		5	95.612	2.704	1.392	0.101	0.191
		10	95.585	2.722	1.4	0.101	0.191
	Fuel	1	0	100	0	0	0
		5	2.062	93.492	3.493	0.94	0.013
		10	2.054	93.524	3.469	0.939	0.013
	Wage	1	0	0	100	0	0
		5	0.053	2.645	96.818	0.047	0.436
		10	0.055	2.658	96.803	0.047	0.436
	IIP	1	0	0.43	0	99.57	0
		5	1.413	1.73	1.279	95.149	0.429
		10	1.415	1.736	1.282	95.138	0.429
	Meat	1	0.152	0.562	0.467	1.032	97.787
		5	0.96	0.775	6.055	1.328	90.882
		10	0.96	0.778	6.057	1.328	90.877

Table A.4: FEVD Analysis: Model with MSP

	Horizon	Global Food	Fuel	MSP	Wage	IIP	Food
Global Food	1	100	0	0	0	0	0
	5	99.233	0.290	0.039	0.024	0.043	0.372
	10	99.220	0.300	0.039	0.025	0.043	0.374
Fuel	1	0	100	0	0	0	0
	5	3.730	92.525	0.617	1.837	0.929	0.362
	10	3.94	92.304	0.617	1.844	0.930	0.366
MSP	1	0.008	0.684	98.766	0.542	0	0
	5	0.160	0.784	94.837	0.974	1.661	1.583
	10	0.174	0.787	94.819	0.975	1.662	1.584
Wage	1	0	0	0	100	0	0
	5	0.471	1.930	1.040	90.622	0.280	5.657
	10	0.529	1.944	1.039	90.552	0.281	5.655
IIP	1	0	0.295	0	0	99.705	0
	5	2.718	1.819	0.052	1.173	93.944	0.294
	10	2.759	1.825	0.052	1.175	93.896	0.294
Food	1	0.748	0.582	1.726	6.351	0.004	90.59
	5	2.721	1.587	1.952	7.196	2.034	84.51
	10	2.820	1.605	1.950	7.191	2.034	84.399

Authors' estimates

Table A.5: FEVD Analysis: Model with Industrial Wages

	Horizon	Global Food	Fuel	Agricultural Wage	Industrial Wage	Food
Global Food	1	100	0	0	0	0
	5	96.004	0.961	0.333	2.092	0.611
	10	95.498	1.325	0.483	2.044	0.65
Fuel	1	0	100	0	0	0
	5	5.866	79.973	1.20	10.055	2.905
	10	7.952	77.226	1.631	10.21	2.981
Agricultural Wage	1	0	0	100	0	0
	5	0.836	3.07	80.08	1.687	14.327
	10	1.314	3.485	77.591	2.529	15.082
Industrial Wage	1	0	0	0	100	0
	5	1.408	1.812	1.218	93.794	1.768
	10	1.578	1.847	1.39	92.978	2.207
Food	1	0.976	0.601	2.565	0.004	95.854
	5	3.538	1.504	7.214	2.365	85.379
	10	4.137	1.892	7.735	3.009	83.228

Authors' estimates