How does Supply Chain Distortion affect Food Inflation in India?

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Abstract

During the recent episode of persistently high food inflation in India, the role of rent seeking activities of food suppliers emerged as the centre of debate in the country. The rent seeking activities of agents in both wholesale and retail marketing of food, catered by the lack of a competitive food market and required infrastructure, often causes large positive shocks to mark ups. This paper estimates the contribution of these mark-up shocks at both wholesale and retail level, in food inflation, an issue unexplored in the literature till date. The study finds moderate but significant pass through of mark-up shocks in food inflation after controlling for other factors. The duration of the transmission effect depends on the origin of the shock in wholesale market, while the effect seems to last for five months in retail food inflation. In the backdrop of advocated competitive national market for food commodities to promote greater competition and stabilise large shocks to mark ups, this paper contributes towards understanding the extent to which stabilisation of mark-up shocks can lower wholesale and retail food inflation in the country.

JEL Classification codes: C51, E31, Q11, Q13

Keywords: Food inflation, India, Mark-up shock, National market for food commodities, SVAR

1. Introduction

Stabilising food inflation has emerged as a major challenge for emerging economies in the past decade. Food inflation in emerging economies, on average, has been historically high and recurred in sequels since 2007-08. In the early phase of surging food inflation, various macroeconomic factors such as, supply-side constraints, weak dollar, fiscal expansion and easy monetary policy have been identified as drivers of food inflation globally (Baffes and Haniotis, 2010). In a different perspective, a limited strand of literature highlight micro level factors, such as speculation on commodity prices in financial markets and incomplete financial markets, behind persistently high and volatile food inflation in emerging economies (Heady and Fan, 2008; Gouel, 2013).

India is no exception to these events of food price surges. During 2006 to 2014, India experienced average food inflation at a rate of 9%, one of the highest rates of food inflation among emerging economies. Such an occurrence of persistently high food inflation in India is rare, compared to the historical experiences of occasional spikes in food inflation. The wealth of empirical literature suggests three major factors contributing to persistently high food inflation, namely, rising cost of production in agriculture, dietary shift and factors related to government policies (Gulati et al., 2013; Gulati and Saini, 2013; Gokarn, 2011; Bandara, 2013; Gulati and Shweta, 2013; Ganguly and Gulati, 2013). Apart from these factors, a limited number of recent studies highlight the rent seeking activities of agents in both wholesale and retail marketing of food commodities behind food price escalation in the country (Chengappa et al., 2012; Tomar, 2013; Lahiri and Ghosh, 2014; ASSOCHAM, 2011; Kumar et al., 2010; Carrasco and Mukhopadhyay, 2012).

This paper estimates the contribution of mark-up shock in wholesale and retail food price inflation in India. The wholesaling activities of food commodities in India are conducted by the state Agricultural Product Marketing Committee (APMC). Under the APMC Act, the whole geographical area of the State is divided into smaller market areas which are managed by Market Committee constituted by the State Governments. The APMC Act primarily prevents any individual or agency to freely conduct wholesale marketing activities. The Act also prohibits farmers from dealing directly with retailers and requires them to sell their produce to licensed middlemen approved by the Committee (Singh, 2008). The purpose of APMC primarily has been to ensure fair prices to farmers and controlling price volatility for consumers by setting the floor price for the retailers. However, being the single wholesaler entity in the market with monopsony power against farmers and monopoly power against retailers, it has the incentive to seek rent via mark-up pricing at the wholesale level.

Micro-level evidence indicates that mark-up pricing by wholesaling agents under this restricted marketing arrangements, not only lead to high and volatile consumer prices, but also reduce returns to farmers (Gandhi and Namboodiri, 2002). Analysing price margins at various levels of wholesaling activities, Gandhi and Namboodiri (2002) report that overall, the average share of the farmers in the consumer price is only around 48 per cent for vegetables and 37 per cent for fruits. The study also shows that the share of marketing costs, an indicator of middlemen's margin in wholesaling activities, is frequently as high as 80-90% of farmer-consumer price difference. In a more recent study by ASSOCHAM (2011), intermediaries' margin in retail prices with respect to farm prices is found to be 70-75% for rice, wheat and maize, while it is around 60% for fruits and vegetables.

A sharp rise in the gap between retail and wholesale prices, accounting for logistics costs, margins and transaction cost, reflects shock to the intermediaries' margins due to hoarding and speculative activities (Kumar et al., 2010). For instance, the authors find a rise in the mark-up in retail prices over wholesale prices of rice to 12% in December, 2009 and that in wheat to 10% in 2008. The findings indicate plausible role of mark-up shocks in rise in food prices in the recent past.

After controlling for other demand-pull and cost-push factors highlighted in the literature, this study evaluates to what extent mark-up shocks at the wholesale and retail level explain wholesale and retail food inflation in a Structural Vector Autoregression (SVAR) framework. Our results show that mark-up shocks, both at the wholesale and retail levels have moderate, but significant effects on wholesale and retail food inflation rates. While the effect of mark-up shock on inflation in retail sector is found to be persistent, the pattern of mark-up shock propagation in wholesale market depends on the origin of the shock. The wholesale mark-up shock has a persistent positive effect on wholesale food articles inflation, when the shock originates in the wheat market. The effect is found to be short lived with the shock coming from wholesale market for potato.

This paper makes a contribution towards understanding the role of mark-up shocks due to distortions in food supply chain in food inflation in India, which to the best of our knowledge, is till void in the literature. In the backdrop of high and volatile food inflation in the country, while a bulk of studies have highlighted the role of supply chain distortions and rent seeking activities of suppliers in the food market, quantifying the contribution of such distortions in food inflation is hardly attempted in the literature. The present study attempts to fill this gap.

Finally, our paper contributes towards the recent policy debates in India on promoting competition in agricultural marketing to contain food inflation. During the recent episode of persistently high food inflation, micro-level policy interventions such as, development of a competitive national market for food, and allowing direct farmer-consumer interactions are

broadly recommended by the policy makers and researchers in the country to control surging food prices (Tomar, 2013; Economic Survey, 2014). Such policies by promoting agricultural market development would be conducive to greater competition and stabilise large shocks to mark up. In this background, our study quantifies the extent to which inflation can be stabilised by stabilising the mark-up shocks.

2. Stylised Facts About Food Inflation in India

India has witnessed sustained high rate of inflation in both wholesale and retail food prices since 2007 and till the beginning of 2014 (Figure 1). Since 2007, the average year-on-year (YOY) inflation rate in WPI food articles and CPI-IW food group have been 9.99 and 10.12 respectively. Both WPI food articles inflation and CPI-IW food inflation crossed 20% marks in December, 2009, while the former remained above the mark till June, 2010.

**Figure 1: Wholesale and retail food inflation in India**
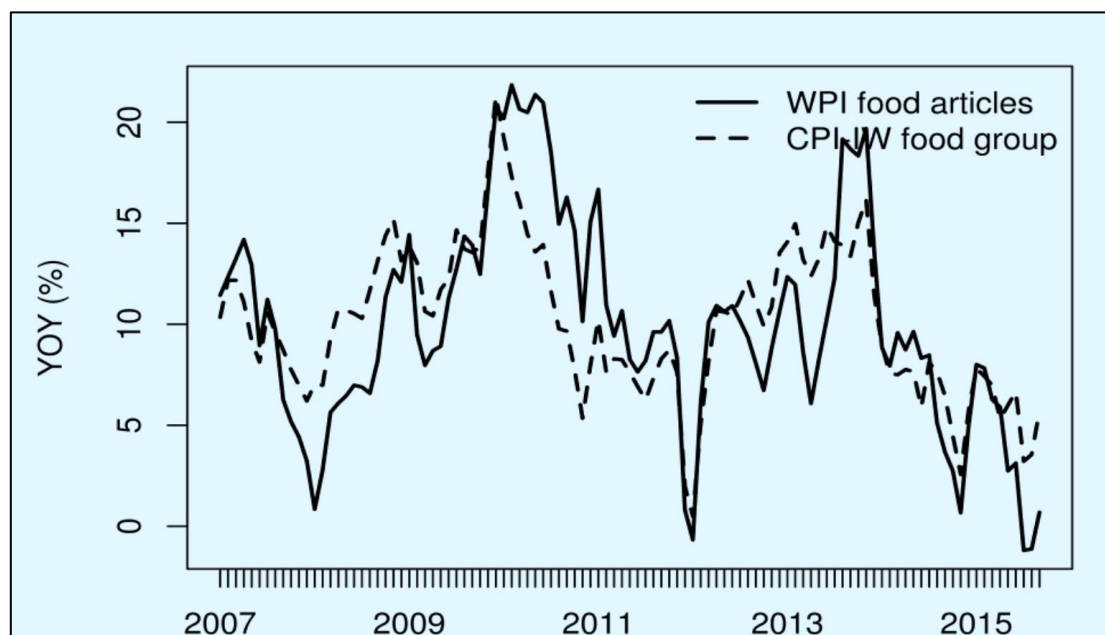
Source: Office of the Economic Adviser, Labour Bureau & Author's Estimates

Inflation in various components of wholesale and retail food prices have driven inflation in the respective food price indices since 2007 (Figure 2). Cereals are found to be consistently contributing to both wholesale and retail food inflation since 2007. Vegetables, Fruits, Milk and Egg, Meat and Fish have been the major sources of WPI food articles inflation during 2007 to 2011. Inflation in Vegetables, Fruits, Egg, Meat, and Fish has mainly driven food articles inflation in the subsequent years. Vegetables and Fruits, Milk and Egg,

Meat, and Fish have been the major drivers of CPI-IW food inflation since 2007. Pulses inflation have contributed significantly to the retail food inflation during 2009 and early 2010, and again during mid-2014 till September, 2015.

Figure 2: Contribution of various components in wholesale and retail food inflation
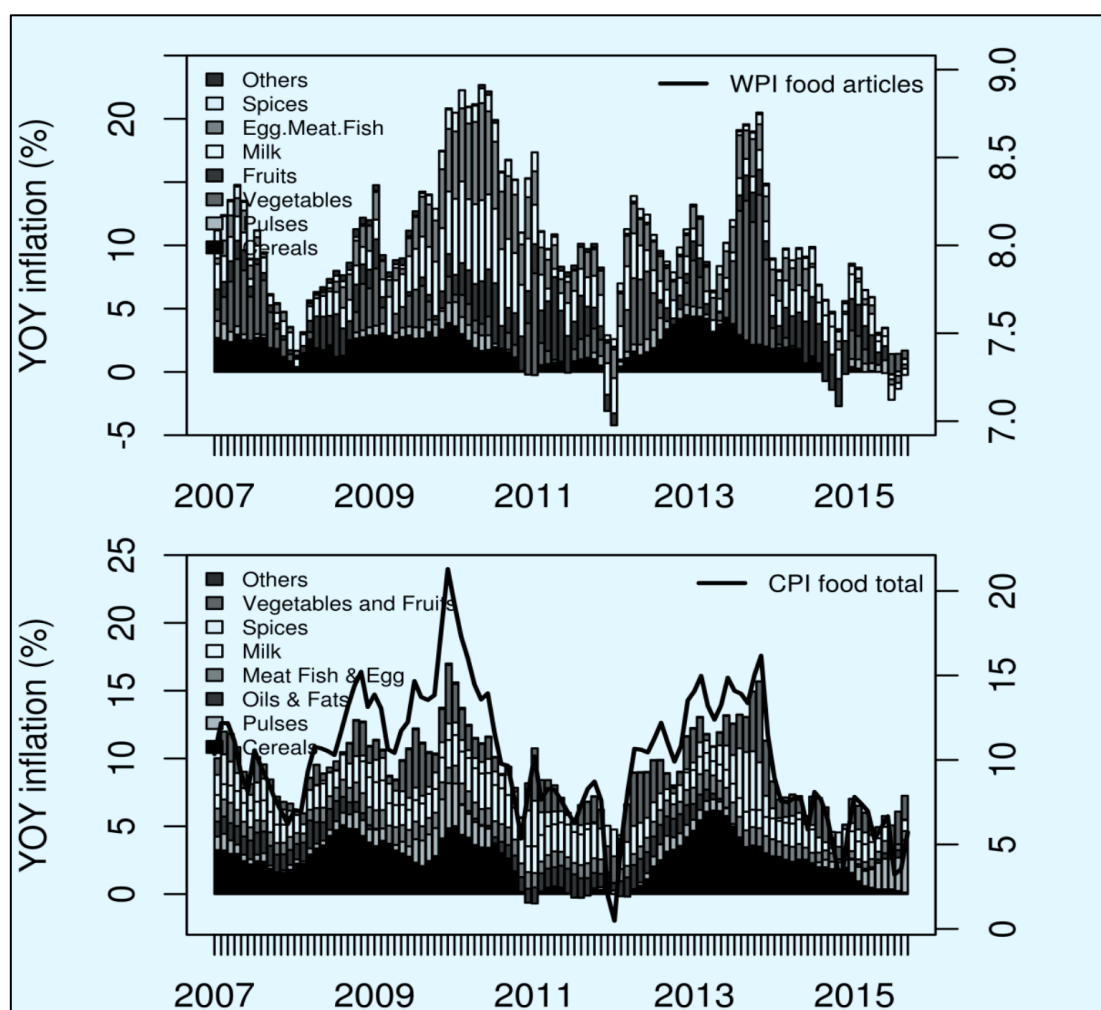
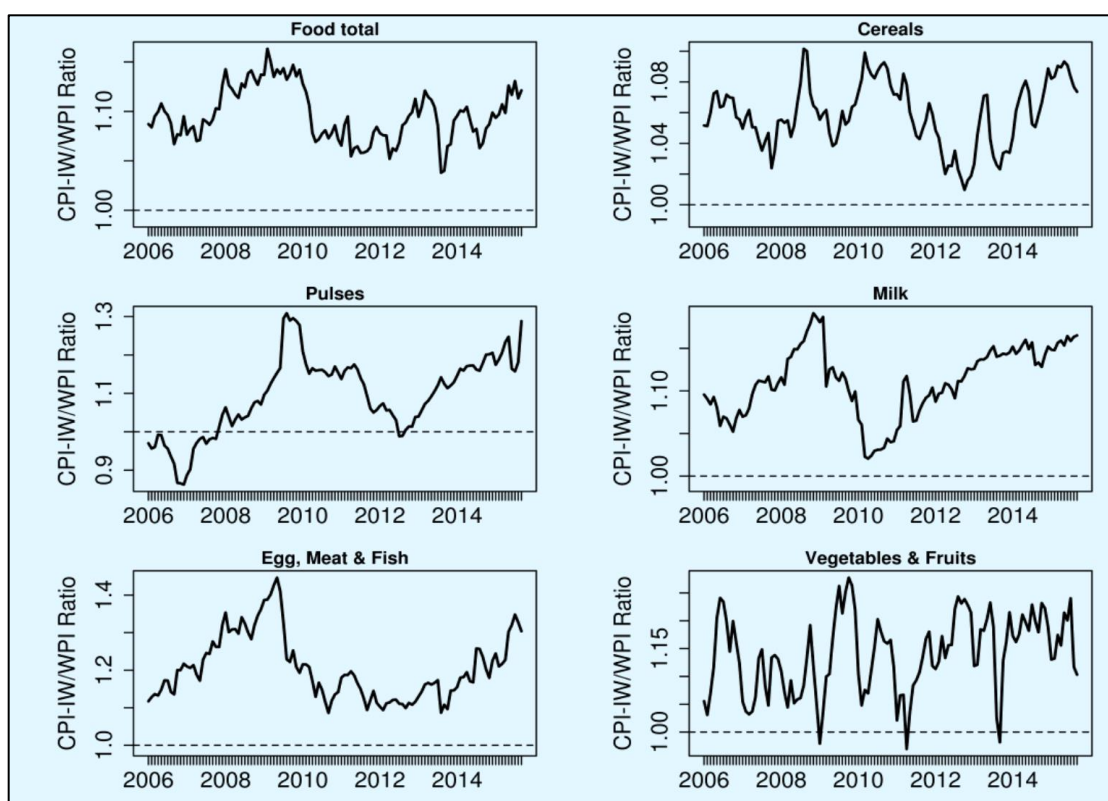*Source:* Office of the Economic Adviser, Labour Bureau and Author's Estimates

By definition, retail prices differ from wholesale prices by the mark up set by retailer. The gross mark up, for total food and a few selected commodities common in CPI-IW food and WPI food articles, show considerable variations over time (Figure 3)[3]

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Retail mark up in aggregate food prices and its components, except for vegetables and fruits show an increasing trend in the period post 2012. The total food category records

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[3] The categories, such as Cereals, Pulses, and Milk in CPI-IW include Cereals and Cereal products, Pulses and Pulses products, and Milk and Milk products respectively. However, the similar categories in WPI food articles, used as a proxy for wholesale food prices in this study, do not include respective manufactured products.

average net mark up of 9.68%[4].The average net mark-up is highest for Egg, Meat & Fish (20.58%), followed by Milk (11.11%), Pulses (9.39%), and Cereals (5.89%). There are considerable fluctuations in the net mark up as well.

Figure 3: Deviation of CPI-IW food from WPI food articles for selected commodities

Pulses records highest volatility in net the mark up, equals to 10.05%, followed by Egg, Meat, and Fish (8.59%), Vegetables and Fruits (7%), Milk (4.08%), and Cereals (2.10%). Moreover, mark up in all the food commodities contain unit root (see Table A.1 and A.2 in Appendix A); implying that any shock to these series will be persistent.

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[4] The ratio of CPI food to WPI food articles i.e., $\frac{CPI\ food}{WPI\ food\ aticles}$ measures the gross Mark-up in retail food sector. The net mark-up is calculated as $\frac{CPI\ food}{WPI\ food\ articles} - 1$. Similarly the gross and net mark ups in various broad subgroups of food commodities are calculated using respective components of CPI food and WPI food articles.

3. Mark up in Wholesale and Retail Activities in Food Commodity Market

3.1   An indicator of mark up in wholesale activities

Wholesale price is broadly defined as the rate at which a relatively large trans-action, generally for further sale is effected (Manual on Agricultural Prices and Marketing, 2010). The wholesale price of an agricultural commodity can be defined at the following levels:

1.   In a primary wholesale market, the wholesale price of a product may refer to the price at which the wholesale buyer purchases from the producer-seller or his agents. This price would differ from the price the producer-seller gets, depending upon whether the buyer or the seller bears the incidental charges.

2.   In a primary wholesale market, the wholesale price of a product may also refer to the price at which the wholesaler offers it for sale to the retailers, etc. This price should exceed the price in (1) above by the wholesaler's margin of profit.

3.   In a secondary wholesale market, the wholesale price of a product may refer to the price at which the wholesaler sells it to the retailers, etc. This price should exceed the price in (2) above by transportation charges, incidental expenses and margin of profit.

The Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture publishes monthly time series of commodity-wise wholesale and retail level prices for selected centres in India. An ideal indicator of mark up at the wholesale level would be the ratio of wholesale prices to farmers' prices. However, monthly time series of farmers' prices are not available in India.

Farm prices have been defined as the average wholesale price at which the commodity is disposed of by the producer at the village site during the specified harvesting period. The Directorate collects farm harvest prices for 25 commodities from 19 States & Union Territories. The Directorate under Ministry of Agriculture publishes annual time series of farm harvest prices of principal crops in India.

To obtain an indicator of mark up at the wholesale level, we interpolate the annual time series of farm harvest prices at monthly frequency, assuming that the price recorded for a year is valid for the 12 months spanning that particular year[5]. The ratio of wholesale price of a commodity to its farm harvest price gives us an indicator of price mark up at the wholesale

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[5] Since farm harvest prices are available for financial years, we assume that the farm price for a particular year, say, for 2008-09, repeats during April, 2008 to March, 2009. We follow this pattern of interpolation of annual farm prices to monthly frequency for all the years spanning the period of our analysis.

level. The monthly wholesale price data are available for January, 2008-December, 2012. The annual data on Farm Harvest Prices for Principal Crops in India are available for the period 1998-99 to 2011-12. The period of our analysis spans from January, 2008 to December, 2012[6]. The number of observation in our analysis is 60.

Among the 18 common commodities for which farm harvest prices and whole-sale prices are available, we choose four commodities for the analysis, namely, Rice, Wheat, Potato and Gram. The choice of these items is mainly based on the maximum share of an item in the respective commodity group in the WPI basket. For instance, Rice and Wheat constitute 53% and 33% share respectively in the Cereals group. Gram has 46.73% share in the Pulses group. Although Potato does not constitute the highest share in the Vegetables group, but it is the only common item in this group, for which farm harvest prices and wholesale prices are available. These four items constitute 24% share of WPI food articles (Table A.3 in Appendix A). The farm harvest prices are available across states, whereas the wholesale prices are available for selected centres in various states. We choose common states to obtain average farm prices series and wholesale price series for each of the four commodities[7]

The pattern of relationship between farm harvest prices and wholesale prices vary across the selected commodities (Figure 4). One common feature observed in all the wholesale prices is the sharp rise in these prices in 2012. Sharp upward movement since 2011 is visible for Gram. For Rice, wholesale prices show a continuous upward trend and leads farm harvest prices. Till 2011, farm harvest prices also show a continuous upward trend, responding to wholesale prices with a lag. For Wheat, farm harvest prices increased during 2008-2009, responding to rising wholesale prices. However, the prices flattened afterwards.

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[6] Since the monthly interpolated farm price series span from April, 2008 to March, 2012, we extend the series back till January, 2008, assuming that farm prices from January to March, 2008 have been same as the value in April, 2008. Again, we extend the series till December, 2012, assuming that the farm price in March, 2012 repeats during April to December, 2012.

[7] The treatment of missing values in the wholesale price series are conducted as follows. The missing values in the middle of the series are obtained by linear interpolation method. If values are missing for a few months in the beginning/end, we obtain such values by back-casting/forecasting of those months, using the year-on-year growth rates of the series, available for the corresponding months in the next/previous year. This method allows us to preserve the pattern of seasonal fluctuations while interpolating the missing values for those months. In few cases, where values corresponding to some of the months in a year are missing, but other months of the year repeat a constant value, we use that constant number to replace the missing observations.

Figure 4: Farm harvest prices versus wholesale prices for selected commodities
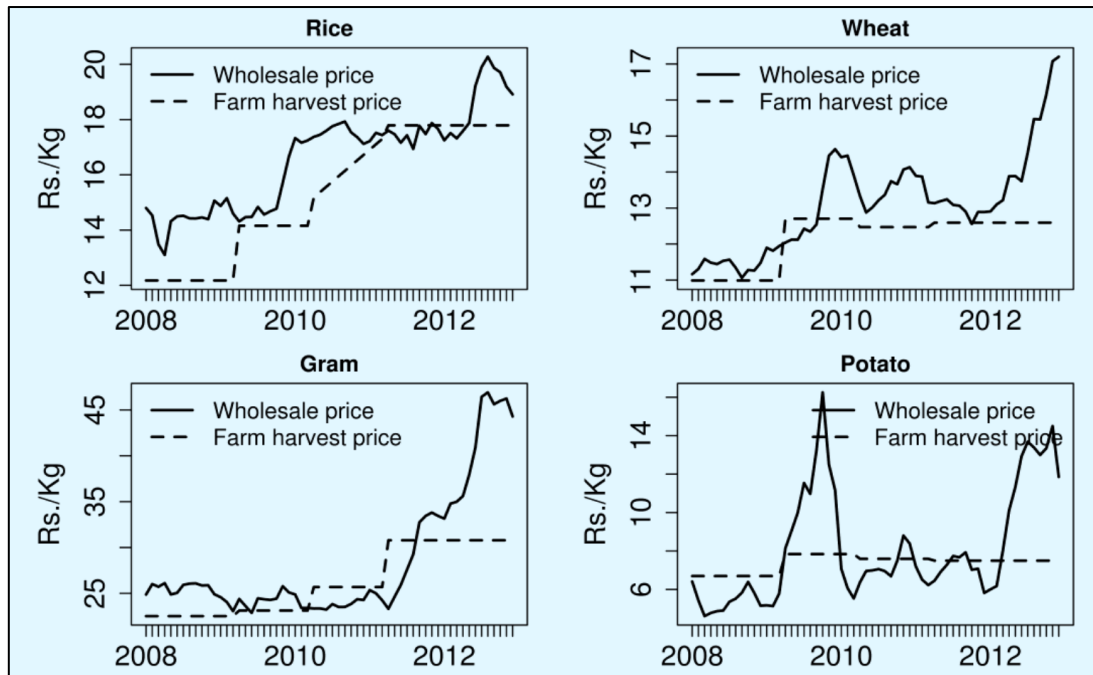
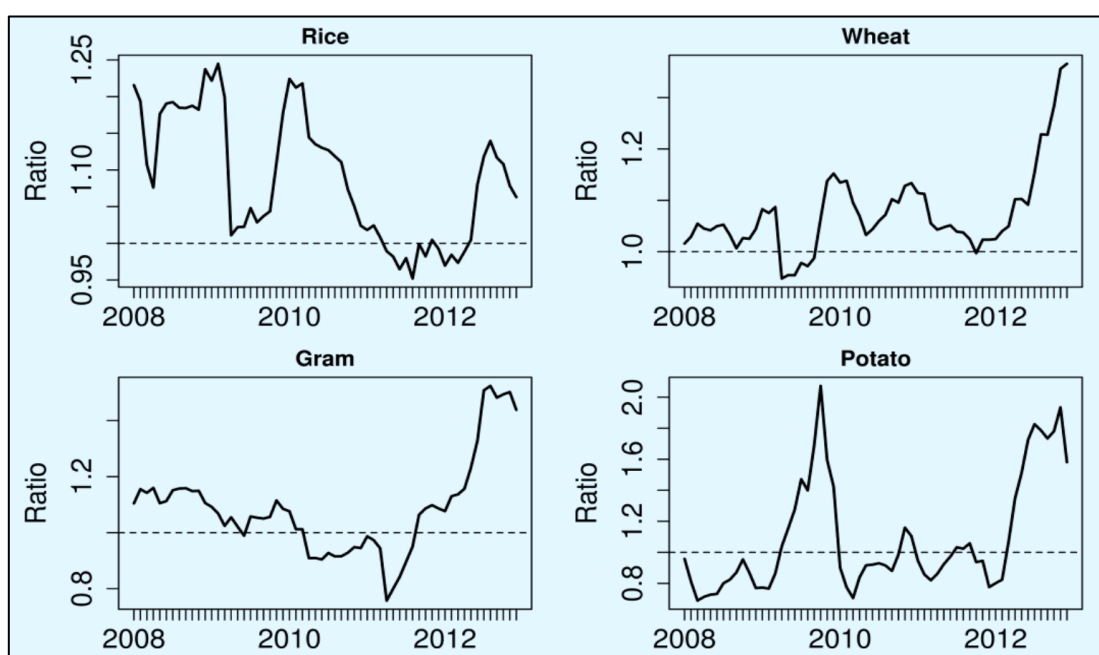**Source:** Ministry of Agriculture and Author's estimates

The opposite nature of relationship between farm prices and wholesale prices is observed for Gram. Farm harvest prices for gram started rising since 2010. Wholesale prices for Gram has also been increasing following farm prices and rose sharply in post 2011. The wholesale price of gram has almost doubled between 2008 and 2012. It increased from Rs. 24.87/Kg in January, 2008 to Rs. 46.91/Kg in August, 2012. Both farm prices and wholesale prices of Potato do not show any secular trend in their movements. However, between 2008 and 2012, there are two episodes of drastic rise in wholesale prices of Potato. It almost doubled from Rs. 4.61/Kg in March, 2008 to Rs. 8.14/Kg in April, 2009, and eventually increased 4 times to Rs. 16.25/Kg in October, 2009. The price pressure subsided afterwards. Again, the wholesale price of Potato started rising from 2012. From a rate of Rs. 6/Kg in January, 2012, it more than doubled to Rs. 14.49/Kg in November, 2012.

For all the selected food commodities, there are a few set of months when farm harvest prices are higher than wholesale prices. This is due to the lack of inter month fluctuation in farm harvest prices. Farm harvest price for a particular food commodity is the average price recorded in the few weeks spanning the harvest season in that year (Manual on

Agricultural Prices and Marketing, 2010)[8]. Hence, farm harvest price lacks inter-month fluctuations.

However, on average, the extent by which farm prices exceed wholesale prices is small. It is less than a rupee/Kg for Rice and Wheat; less than Rs. 2.50/Kg for Gram, while it is hardly Rs. 1/Kg for Potato.

Figure 5: Mark up in wholesale activities for selected food commodities

Source: Ministry of Agriculture and Author's estimates

The maximum mark up in wholesaling activities is observed for Potato, followed by Gram, Wheat and Rice (Figure 5). The maximum ratio of wholesale to farm price is 2.07 for Potato, followed by 1.52 for Gram, 1.37 for Wheat, and 1.25 for Rice. Mark ups in all the four selected commodities show a common pattern in their dynamics. The mark ups depict spikes in all these four commodities in 2012.

The wholesale price in Rice has been persistently higher than the farm price, except for a short period during April, 2011 to April, 2012. Barring these periods, on average, the wholesale price of Rice has been 11% higher than the farm price of rice. In February 2009, the whole sale Rice price shows maximum divergence from the farm price, when the former has been 25% higher than the latter (Figure 5).

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[8] The harvest period for each crop is fixed by the state government for the purpose of proper recording. The harvest period is usually of 6 to 8 weeks. Price data during the harvest period are recorded every Friday. The simple arithmetic average of price data recorded during the harvest season represents harvest price for a crop in a particular year.

During the entire sample period, wholesale price of Wheat has been moderately higher than the farm price, except for the period of April, 2009 to September, 2009. The mark-up in wholesale activities in the Wheat market shows upward trend since July 2012, persisting till the end of the year (Figure 5). During this later period, on average, the wholesale price of Wheat has been 27% higher than the farm price.

The wholesale mark up in Gram shows similar dynamics as in Wheat. The wholesale price of Gram has remained moderately higher than the farm price, barring the period of April, 2010 to August, 2011 (Figure 5). The mark up in Gram shows a sharp rise since February, 2012 and attained the highest value in August, 2012. In this month, the wholesale price of Gram has been 52% higher than the farm price. During this period of rising mark up in 2012, on average, the wholesale price of Gram has been 35% higher than the farm price.

The wholesale price of Potato has become twice the firm price in two occasions. Wholesale price has been double the farm price in November, 2009, and again has been slightly lower than double the farm price in November, 2012 (Figure 5). The mark up in wholesale activities in Potato market witnessed spikes twice during the period of analysis. There are sharp and persistent rise in the mark up once during, May, 2009 to December, 2009, when on average, wholesale price has been 56% higher than the farm price. The second spike in mark-up is visible during April, 2012 to December, 2012, when on average, the wholesale price rose to 69% higher than the farm price.

The variations in the mark up in wholesale activities indicate that marketing and transportation costs are not the sole factors driving the difference in wholesale prices and farm harvest prices. The spikes in the mark-up are indicative of large variations in wholesalers' margin of profit, representing rent seeking activities by layers of intermediaries, and hence distortions in the supply chain.

3.2 An indicator of mark up in retail activities

As defined in Manual on Agricultural Prices and Marketing (2010), retail prices are established in transactions, in which, quantities dealt with are relatively smaller than in wholesale transactions and in which, the final consumers of the agricultural product participate as buyers. The Labour Bureau, Ministry of Labour, Government of India is in charge of collecting retail prices at the national level. The retail prices of few commodities are collected through the National Sample Survey Organisation (NSSO) from a set of 422 villages for building up the consumer price index numbers.

Apart from that, The Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture also collects daily retail prices of vegetables, fresh fruits, fish, livestock products and food grains from 90 centres and weekly retail prices of agricultural commodities from 215 centres.

**Table 1: Share of selected commodities in WPI food articles and total WPI**

Groups	Share in Group	Share in WPI food articles	Share in WPI basket
Cereals			
Rice	53.17	12.51	1.73
Wheat	33.08	7.78	1.12
Jowar	2.84	0.67	0.095
Bajra	3.42	0.80	0.11
Maize	6.44	1.52	0.22
Pulses			
Gram	46.73	2.34	0.33
Arhar	19.17	0.96	0.14
Urad	14.29	0.71	0.10
Vegetables			
Potato	11.61	1.41	0.20
Onion	10.25	1.24	0.18
Milk	100	22.58	3.24
Egg	100	1.30	0.19
Total		**53.82**	**7.66**

Source: Office of Economic Adviser & Author's Estimates

The Directorate of Economics and Statistics, Ministry of Agriculture publishes monthly time series of commodity-wise wholesale and retail level prices for selected centres in India. The ratio of retail to wholesale price of a commodity provides an indicator of mark up in the retail marketing of that commodity.

We create an aggregate indicator of mark up using commodity-wise retail mark up. The broad set of commodities is chosen from WPI basket. Based on the availability of monthly time series of wholesale and retail prices in common centres, the broad food groups considered in the analysis are Cereals, Pulses, Vegetables, Milk and Egg. From the set of commodities that have 80% share in each of these broad food groups, we narrow down the list to 12 commodities, which constitute 7.66% of the total WPI basket and 53.82% of the WPI food articles basket (Table 1). Given the availability of data, our sample spans from January, 2008 to December, 2012. The length of the sample period consists of 60 observations for each variable[9].

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[9] The methodology for treating missing values in wholesale and retail prices is described in Footnote 3.

Figure 6: Wholesale prices versus retail prices for selected commodities
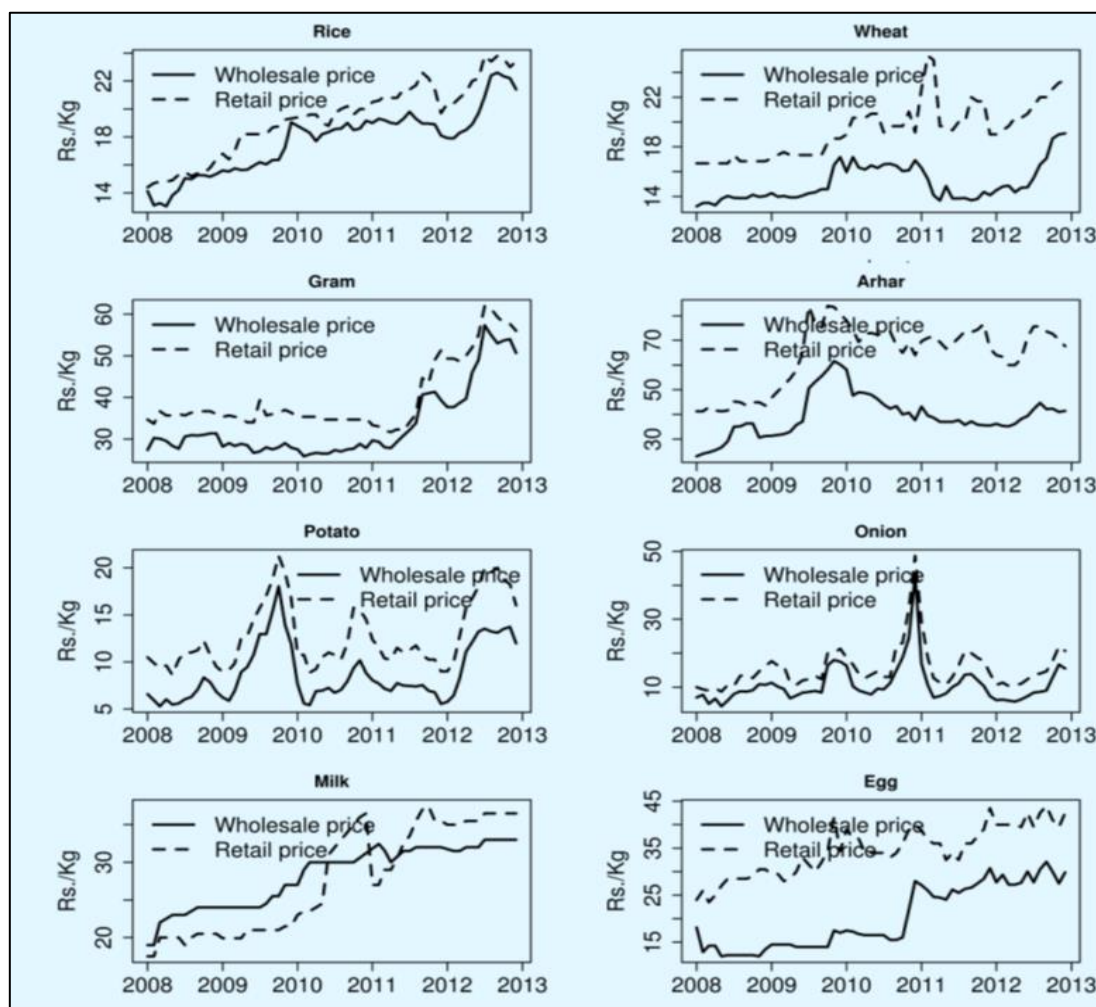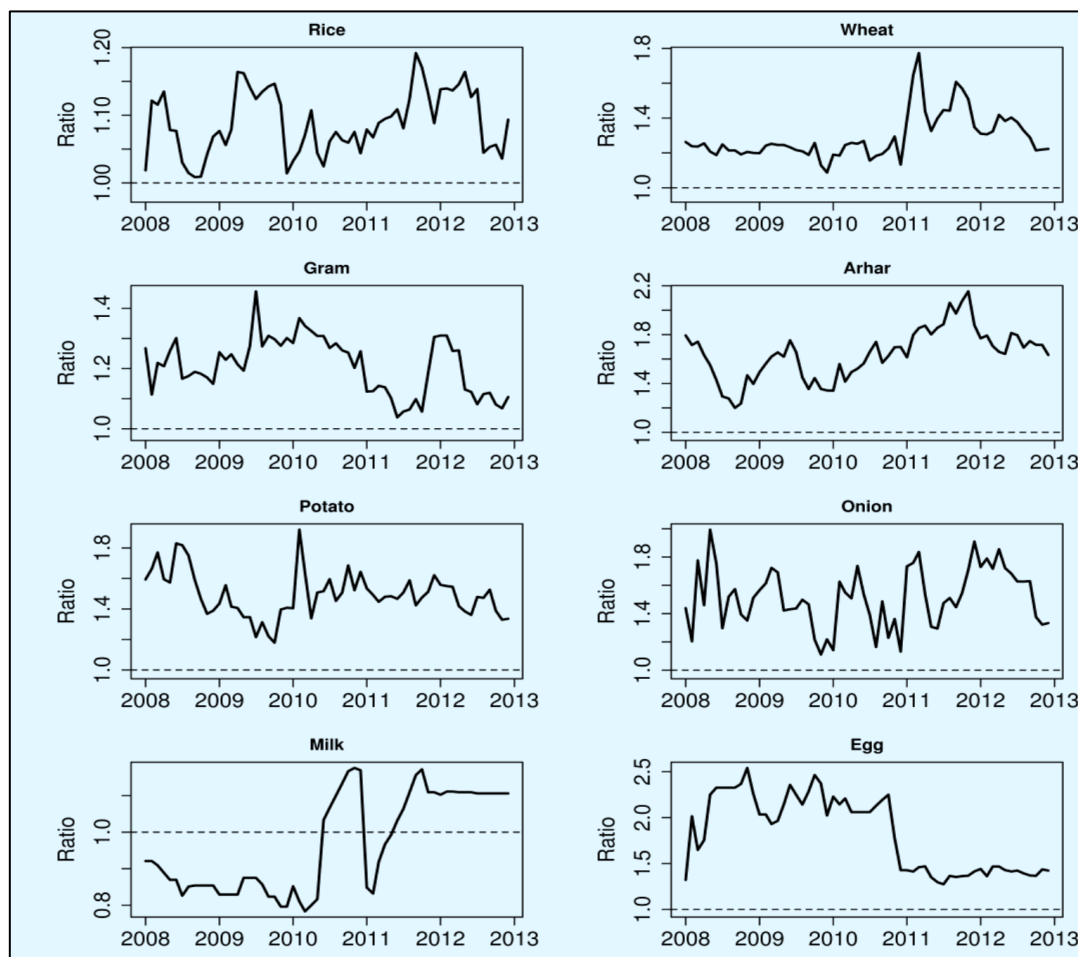

Source: Ministry of Agriculture and Author's estimates

Figure 6 depicts wholesale versus retail prices for a few selected commodities. The wholesale and retail prices show comoving pattern for Wheat, Arhar, Anion, Potato and Egg. However, the sharp spikes in retail price of wheat widen the difference between the wholesale and retail prices of Wheat. On the contrary, spikes in retail prices of Onion and Potato are in fact driven by spikes in the respective wholesale prices. The spikes in the wholesale prices of these two commodities show immediate transmission to their respective retail prices. Surprisingly, retail price of Milk is lower than its wholesale price till 2011, except for a few months in 2010. The retail price of Milk remained persistently higher than the wholesale price since mid-2011.

Figure 7 presents dynamics in retail mark up for selected commodities. Among these selected commodities, the highest mark up in retail activities is observed for Egg. On average, the retail price of Egg is 82% higher than the wholesale price. The retail price of Egg has

remained persistently more than double the wholesale price during the period of May, 2008 to October, 2010.

Figure 7: Retail mark up for selected commodities

Source: Ministry of Agriculture and Author's estimates

The retail price of vegetables i.e., Onion and Potato are, on average, 50% higher than their respective wholesale prices. In the Cereals group, the retail price of Wheat is, on average, 29% higher than the wholesale price; and has been 77% higher in March 2011, before stabilising at the end of 2012. The retail price in Rice, on average, is 8% higher than the wholesale price. The mark up in Rice reached its maximum in September, 2011, when the retail price has been 19% higher than the wholesale price; and finally stabilised after a year.

In the Pulses group, retail price of Arhar, on average, is 64% higher than the wholesale price; while, the retail price of Gram is, on average 20% higher than its wholesale price. During August, 2011 to November, 2011, the retail price of Arhar has been double the wholesale price. Surprisingly, the ratio of retail to wholesale price of Milk has been less than one for most of the sample period. 16

The retail price of Milk persistently outstripped the wholesale price by 10% from June, 2011.

Figure 8: Average wholesale versus retail prices and mark up for selected commodities
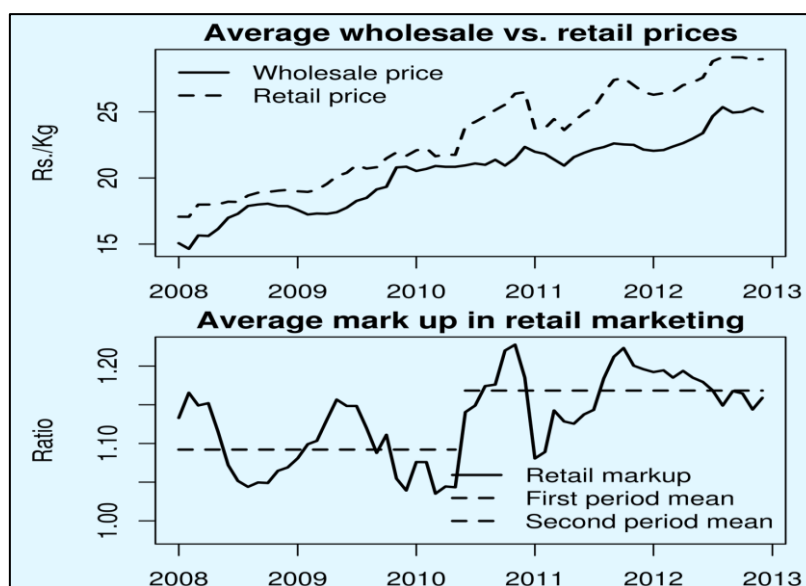
Finally, we construct an aggregate indicator for mark up using the set of commodities in Table 1. The average wholesale and retail price of these commodities are obtained using the following formula:

$$P^j = \sum W_i PC_i^j / \sum W_i, \qquad j = \text{Wholesale, Retail} \qquad (1)$$

where, P^j is the average wholesale or retail price. Here PC_i^j is the wholesale or retail price of ith commodity in Table 1 with W_i denoting their respective shares in the WPI basket. Finally, the ratio $P^{Retail}/P^{Wholesale}$ provides an aggregate indicator of mark up in retail activities in food sector. The gap between the average wholesale and retail prices widens from mid-2010, owing to a few spikes in the retail prices (Figure 8). This is reflected the higher average mark up since 2010. On average, the deviation of the retail prices from wholesale prices increased from 9% during 2008 to mid-2010 to 16% in post mid-2010.

3.3 Food inflation and mark up growth

Figures 9 and 10 depict the relationship between mark-up growth and commodity price inflation. In general, mark up growth in Rice, Wheat, Gram and Potato is seen to lead the point-on-point inflation rate in WPI rice, wheat, gram and potato prices respectively

(Figure 9). The growth in the indicator for retail mark-up is also found to lead CPI-IW food inflation during the period of analysis (Figure 10). In the next section, we gauge the contribution of mark-up growth shock at the wholesale and retail levels to WPI food articles and CPI food inflation in a Structural Vector Autoregression framework, controlling for the other cost-push and demand-pull factors.

4) Transmission of Markup Shock to Food Inflation in India

The wealth of empirical literature highlights three major factors contributing to persistent food inflation, namely, rising cost of production in agriculture, dietary shift and factors related to government policies. India, an emerging economy, has witnessed shifts in its food basket from calorie-rich Cereals to protein and vitamin-rich diets, such as Pulses, Milk, Egg, Meat and Fish and Vegetables, causing upward pressure on prices of these commodities (Gokarn, 2011; Bandara, 2013; Gulati and Saini, 2013). Phased deregulation of administered fuel prices is also likely to transmit rising fuel prices to fertiliser and transport costs, pushing up food inflation in India (Bandara, 2013). Rural unskilled wages in India grew significantly since 2008 after the universal implementation of Mahatma Gandhi National Rural Employment Guarantee Act, raising the cost of agricultural production substantially (Gulati et al., 2013; Gulati and Saini, 2013). However, unlike other emerging economies, global food inflation does not seem to have significant transmission to domestic food inflation in India. Apart from these economic factors, increase in liquidity in the economy for financing the widening fiscal deficit in the post crisis period, and hike of procurement prices also contributed to rising food inflation in the country (Gulati and Saini, 2013; Ganguly and Gulati, 2013).

In this section, we evaluate the major factors influencing WPI and CPI food inflation during January, 2008 to December, 2012. In particular, we focus on the impact of mark-up shock, controlling for the impacts from other factors. We analyse the contribution of mark-up shock in wholesale and retail food inflation, controlling for other factors in a Structural Vector Autoregression (SVAR) framework, using monthly data.

In analysing the effect of mark-up shock on WPI food inflation, we estimate individual SVAR models for mark up in Rice, Wheat, Gram and Potato, with inflation in fuel prices, agricultural wages, demand growth for food from industrial sector, and WPI food inflation as other common variables used in each of the models.

Figure 9: Wholesale mark-up growth and commodity inflation
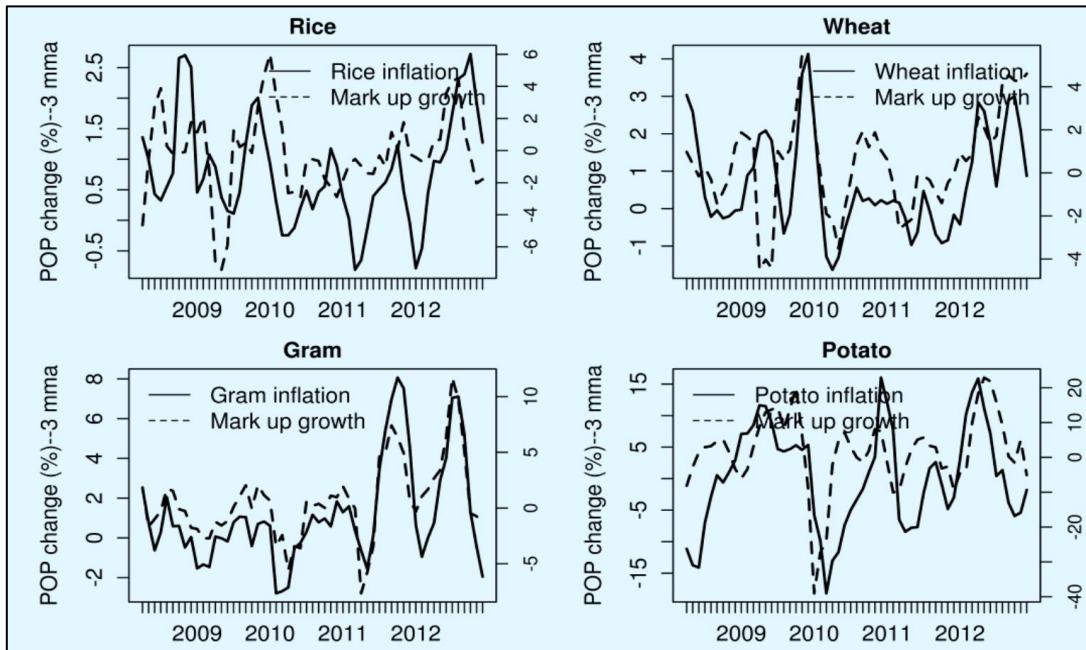
Source: Ministry of Agriculture and Author's estimates

Figure 10: Retail mark-up growth and consumer food price inflation
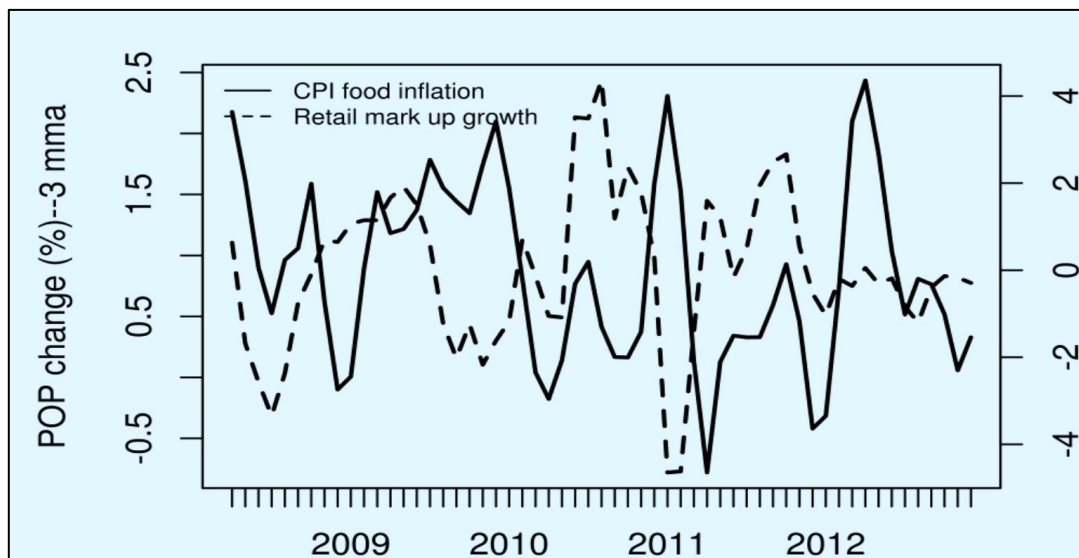
Source: Ministry of Agriculture and Author's estimates

In the model for gauging the impact of retail level mark-up shock on CPI food inflation, the other controlling factors include inflation in WPI food articles and food products, fuel and agricultural wage inflation and growth in demand for food from the industrial sector.

4.1   Data

We use monthly data for the period of January, 2008 to December, 2012. In our analysis, mark ups at the wholesale level are measured for the components in food articles, namely, Rice, Wheat, Gram and Potato. Hence, WPI food inflation is captured by WPI food articles prices, sourced from the Office of Economic Adviser. Fuel prices and prices of food products are also captured by the components of WPI, sourced from the Office of Economic Adviser. The component of food in Consumer Price Index, sourced from the Labour Bureau constitutes the series of retail food prices.

The monthly time series for average daily agricultural wage rates for men, for various occupational categories, such as ploughing, sowing, weeding, trans-planting, harvesting, winnowing, threshing and picking are sourced from Reserve Bank of India. The series span from July, 1995 to September, 2014. We convert the series to an index with 2004-05 as the base year, by dividing the series by the average wage rate during April, 2004 to March, 2005. The agricultural wage index for the period of January, 2008 to December, 2012 is considered in the analysis.

The demand for food from industrial sector is captured by the growth in Index of Industrial Production (IIP) and sourced from the Central Statistics Office. Construction of mark-up series at the wholesale and retail levels are described in Section 3.

WPI food articles and manufactured food products, CPI food, agricultural wage index, and IIP are seasonally adjusted using x-12 ARIMA of U.S. Census Bureau. WPI fuel, WPI food products, and indicators of wholesale and retail mark ups are not adjusted for seasonality since the series are not candidates for adjustment due to weak seasonal pattern in them. Tables A.4 and A.5 in Appendix A report the results of unit root tests for the variables using Augmented-Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests respectively.[10] The unit root test results suggest that the variables are I(1)[11].

4.2   Estimation strategy

We assess the contribution of mark-up shocks in wholesale and retail food inflation in a SVAR framework. The SVAR model allows gauging the structural relationship among the

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[10] The unit root tests are performed on the seasonally adjusted values of the series which are candidates for seasonal adjustments.
[11] For unit root test at levels, all price series and IIP are in log. The first difference of log of these series implies point-on-point (POP) growth rate of these variables. Since mark ups are in ratio, these series are not in log.

variables, taking into account their dynamic interlinkages. We estimate the following SVAR model for estimating propagation of mark-up shock to wholesale food inflation:

$$A\Delta Y_t = A_1\Delta Y_{t\text{-}1} + A_2\Delta Y_{t\text{-}2} + A_3\Delta Y_{t\text{-}3} + B\in_t \qquad (2)$$

where,

$$Y_t = \begin{pmatrix} ln\ P_t^{fuel} \\ ln\ w_t \\ \mu_t \\ ln\ y_t \\ ln\ P_t \end{pmatrix}$$

Here, Y_t denotes a vector consisting of domestic food prices and its determinants. The vector includes WPI fuel index, $ln\ P_t^{fuel}$; seasonally adjusted index of average agricultural wage, $ln\ w_t$; mark up at the wholesale level, μ_t ; seasonally adjusted Index of Industrial Production as a proxy for demand from industrial sector, $ln\ y_t$; and seasonally adjusted WPI food articles price index, $ln\ P_t$. Given that the variables are I(1), the model is estimated using the first difference of the variables, Y_t; implying POP growth rates of the variables in log.[12]

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

$$Au_t = B\in_t;$$

Where, u_t denotes the vector of reduced form errors, and $\in_t$ represents the vector of structural errors. We assume the following restrictions on the structural parameters:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u_t^{fuel} \\ u_t^{w} \\ u_t^{\mu} \\ u_t^{y} \\ u_t^{P} \end{bmatrix} = \begin{bmatrix} b_{fuel}^{fuel} & 0 & 0 & 0 & 0 \\ 0 & b_w^{w} & 0 & 0 & 0 \\ 0 & 0 & b_\mu^{\mu} & 0 & 0 \\ b_y^{fuel} & 0 & 0 & b_y^{y} & 0 \\ b_P^{fuel} & b_P^{w} & b_P^{\mu} & b_P^{y} & b_P^{P} \end{bmatrix} \begin{bmatrix} \in_t^{fuel} \\ \in_t^{w} \\ \in_t^{\mu} \\ \in_t^{y} \\ \in_t^{P} \end{bmatrix} \qquad (3)$$

The restrictions are imposed following the assumption that shocks to WPI fuel inflation, agricultural wage inflation and change in mark-up affect WPI food articles inflation instantaneously. But a shock to food inflation does not impact these variables instantaneously. Shock to demand growth in the industrial sector, captured by IIP, instantaneously affect domestic food inflation, but not vice versa. Again shock to fuel inflation affects IIP growth instantaneously, but not vice versa. The dynamics of each of fuel inflation,

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[12] The lag order of 1 for the VAR model is chosen following the Schwartz criterion.

agricultural wage inflation and change in mark-up are independent of instantaneous effects from shock to the other variables.

To quantify the contribution of mark-up shock to retail food price inflation, the following SVAR model is estimated:

$$A\Delta Y_t = A_1\Delta Y_{t-1} + A_2\Delta Y_{t-2} + A_3\Delta Y_{t-3} + B\epsilon_t \tag{4}$$

where,

$$Y_t = \begin{bmatrix} \ln P_t^{fuel} \\ \ln w_t \\ \ln P_t^A \\ \mu_t^R \\ \ln y_t \\ \ln P_t^F \end{bmatrix}$$

Here, Y_t denotes a vector consisting of domestic food prices and its determinants. The vector includes WPI fuel index, ln P_t^{fuel}; seasonally adjusted index of average agricultural wage, ln w_t; seasonally adjusted WPI food articles, ln P_t^A; WPI food products, ln P_t^M ; mark up at the retail level, μ_t^R ; seasonally adjusted Index of Industrial Production as a proxy for demand from industrial sector, ln y_t; and seasonally adjusted CPI food, ln P_t^F . Given that the variables are I(1), the model is estimated using the first difference of the variables, Y_t; implying POP growth rates of the variables in log.[13] The relation between structural and reduced form errors are specified as follows:

$$Au_t = B\epsilon_t$$

Here, u_t and ϵ_t denote the vectors of reduced form errors and structural errors respectively. The restrictions on structural parameters assumed are the following:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u_t^{fuel} \\ u_t^w \\ u_t^A \\ u_t^M \\ u_t^{\mu^R} \\ u_t^y \\ u_t^{P^F} \end{bmatrix}$$

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[13] The lag order of 1 for the VAR model is chosen following the Schwartz criterion.

$$= \begin{bmatrix} b_{fuel}^{fuel} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & b_w^w & 0 & 0 & 0 & 0 & 0 \\ b_A^{fuel} & b_A^w & b_A^A & 0 & 0 & 0 & 0 \\ b_M^{fuel} & 0 & 0 & b_M^M & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{\mu^R}^{\mu^R} & 0 & 0 \\ b_y^{fuel} & 0 & 0 & 0 & 0 & b_y^y & 0 \\ b_{P^F}^{fuel} & b_{P^F}^w & b_{P^F}^A & b_{P^F}^M & b_{P^F}^{\mu^R} & b_{P^F}^y & b_{P^F}^{P^F} \end{bmatrix} \begin{bmatrix} \in_t^{fuel} \\ \in_t^w \\ \in_t^A \\ \in_t^M \\ \in_t^{\mu^R} \\ \in_t^y \\ \in_t^{P^F} \end{bmatrix} \quad (5)$$

The restrictions are based on the assumption that shocks to WPI fuel inflation, agricultural wage inflation, inflation in WPI food articles and food products and change in retail mark-up affect CPI food inflation instantaneously. But a shock to CPI food inflation does not impact these variables instantaneously. Shock to demand growth in the industrial sector, captured by IIP, instantaneously affects CPI food inflation, but not vice versa. WPI fuel inflation and agricultural wage inflation affect inflation in WPI food articles, but not vice versa. Again, shock to fuel inflation affects inflation in WPI food products and IIP growth instantaneously, but not vice versa. The dynamics of each of fuel inflation, agricultural wage inflation and change in retail mark-up are independent of instantaneous effects from shock to the other variables.

The dynamic effects of a shock to any determinant of food inflation on food inflation are captured by the impulse response analysis. For example, a shock to the change in wholesale mark up at period t causes an impulse on food articles inflation in period t + 1, which in turn may affect changes in mark up and food articles inflation in the subsequent periods due to endogeneity among these variables over time. Similarly, a shock to the change in retail mark up at period t causes an impulse on CPI food inflation in period t + 1, which in turn may affect changes in mark up and CPI food inflation in the subsequent periods. These dynamics of transmission mechanism are captured by impulse responses. Finally, the Forecast Error Variance Decomposition (FEVD) analysis shows how much of the variations in a variable can be explained by exogenous shocks to other variables over a time horizon.

4.3   Effect of mark-up shock on wholesale food inflation

This section discusses impacts of mark-up shock at the wholesale level for selected commodities, along with other cost-push and demand-pull factors on food articles inflation. Figure 11 depicts results of impulse response analysis for the food articles inflation. In these analyses, mark up at the wholesale level is captured by wholesale mark up for the selected commodities.

The results of impulse response analysis show that the pattern of impacts of mark-up shocks on food articles inflation depends on the origin of the shock. A positive shock to the wholesale mark-up growth in Wheat market has a persistent positive effect on WPI food articles inflation, while the effect is transitory when the shock arises in wholesale market for Potato. With other things unchanged, a 10% increase in mark-up growth increases WPI food articles inflation by 3.1-3.5%, after two months of occurrence of the shock (see the first column of Figure 11). The impact of mark-up shock dies down after that, but remains significant when the shock originates in Wheat market. Wage inflation is found to be a major contributor to food articles inflation. A 10% rise in wage inflation increases WPI food articles inflation immediately by 4.57-5.22% (see the first column of Figure 11). The impacts subside after that, but remain significant for the subsequent periods. Fuel inflation and IIP growth do not have significant effects on WPI food articles inflation.

The FEVD analysis in Table 2 and 3 show that after five months of the occurrence of the shock, variations in WPI food articles inflation due to mark-up shock ranges from 0.21-7.45%, depending on the origin of the shock (see the third column of Table 2 and 3). Again, FEVD analysis shows that wage inflation is the major contributor to food articles inflation. After 5 months of the shock, 17-22.298% of the variation in WPI food articles inflation is due to wage inflation. The contribution of fuel inflation in the variation of food articles inflation is found to range from 1.26-1.97%, while variation in IIP growth does not have any substantial contribution to variation in food inflation.

4.4   Effect of mark-up shock on retail food inflation

The dynamic impacts of a shock to the changes in mark up at the retail level on CPI food inflation are depicted in Figure 12. An increase in the retail mark-up growth by 10% causes CPI food inflation to increase by 2.7% after two months of the shock, and the effect remains significant for the subsequent months. Inflation in WPI food articles is found to have substantial impact on CPI food inflation, although, the effect is short lived. A 10% rise in food articles inflation increases CPI food inflation by 8.25% immediately, but the effect becomes insignificant after two months. However, shocks to WPI food products inflation do not have significant effect on CPI food inflation.

Shocks to agricultural wage inflation affects CPI food inflation directly as well as indirectly, through its impact on WPI food articles inflation. A 10% in-crease in agricultural wage inflation causes CPI food inflation to rise directly by 4.6% after two months of the shock. The effects subside down eventually, but remain significant for quite a few subsequent periods. Again, a 10% increase in wage inflation raises food articles inflation by 4.73% after two months and the impacts remain significant in the subsequent periods. Given the degree

of pass-through of food articles inflation to CPI food inflation, a 10% increase in wage inflation also increases CPI food inflation by 3.90% via its effect on food articles inflation. Shocks to IIP growth do not seem to have significant effects on CPI food inflation. Shocks to fuel inflation do not affect any of CPI food inflation, food articles and food products inflation significantly.

The FEVD analysis in Table 4 shows that after five months of a shock, the largest contributor to variations in CPI food inflation are food articles and wage inflation. These two factors contribute to 41.475% and 20.476% of variations in CPI food inflation respectively after 5 months of the shock. Shock to mark up at the retail level contributes to 8.850% of variations in CPI food inflation, followed by fuel inflation (3.761%) and IIP growth (2.017%) after five months of the shock.

Figure 11: Response of wholesale food articles inflation to various shocks
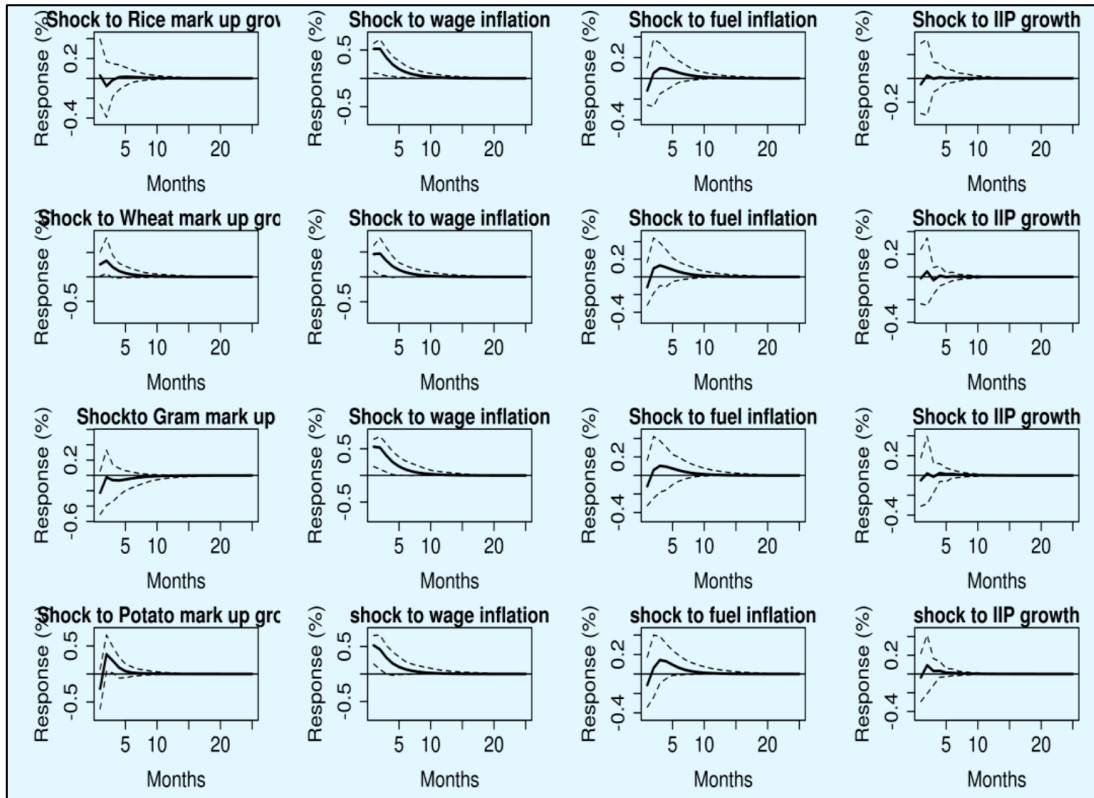
Source: Author's estimates

Table 2: FEVD Analysis (SVAR model for wholesale sector)

Model		Horizon	Fuel	Wage	Rice mark up	IIP	Food articles
Rice mark up	FEVD for fuel inflation	1	100	0	0	0	0
		5	91.333	5.027	2.061	1.011	0.569
		10	90.732	5.512	2.066	1.004	0.687
	FEVD for wage inflation	1	0	100	0	0	0
		5	2.794	91.279	0.203	0.052	5.672
		10	3.056	90.815	0.224	0.052	5.854
	FEVD for Rice mark up change	1	0	0	100	0	0
		5	0.01	0.383	99.106	0.468	0.034
		10	0.013	0.396	99.085	0.468	0.038
	FEVD for IIP growth	1	2.096	0	0	97.904	0
		5	2.657	1.388	0.545	95.241	0.169
		10	2.673	1.444	0.545	95.158	0.18

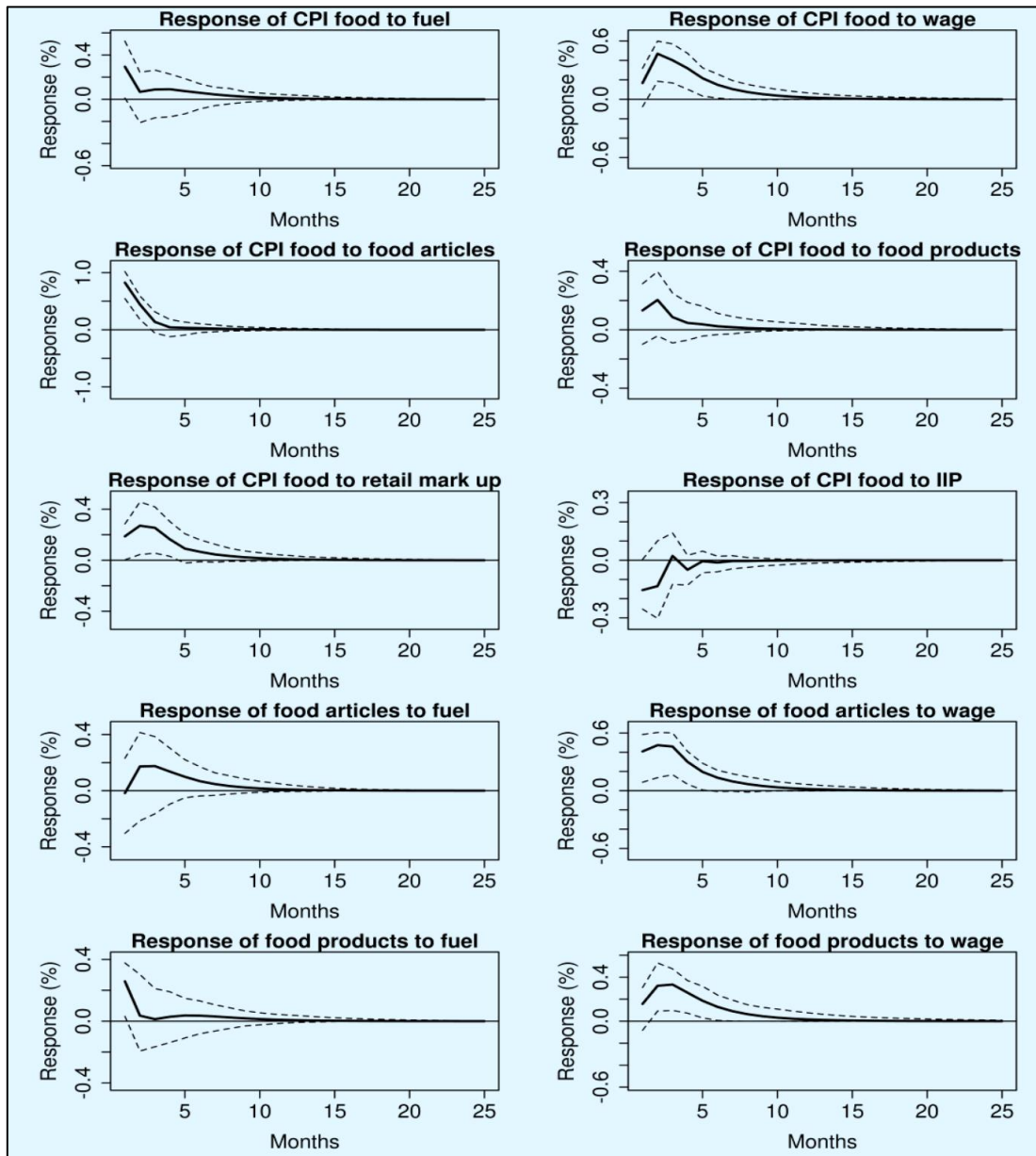| Model		Horizon	Fuel	Wage	Wheat mark up	IIP	Food articles
Wheat mark up	FEVD for fuel inflation	1	100	0	0	0	0
		5	93.472	3.765	1.363	1.164	0.236
		10	92.99	4.1	1.457	1.157	0.296
	FEVD for wage inflation	1	0	100	0	0	0
		5	3.418	89.354	2.771	0.026	4.431
		10	3.71	88.77	2.967	0.026	4.519
	FEVD for Wheat mark-up change	1	0	0	100	0	0
		5	0.002	0.103	98.6	1.286	0.009
		10	0.003	0.105	98.596	1.287	0.009
	FEVD for IIP growth	1	1.708	0	0	98.292	0
		5	2.647	1.302	0.157	95.724	0.171
		10	2.664	1.342	0.168	95.65	0.176
	FEVD for Food articles inflation	1	0.504	7.73	2.433	0.005	89.328
		5	1.645	17.091	6.701	0.099	74.464
		10	1.804	17.389	6.772	0.099	73.936

Source: Author's Estimates

Table 3: FEVD Analysis (SVAR model for wholesale sector)

Model		Horizon	Fuel	Wage	Gram mark up	IIP	Food articles
Gram mark up	FEVD for fuel inflation	1	100	0	0	0	0
		5	91.614	5.325	1.46	1.275	0.325
		10	91.048	5.754	1.527	1.277	0.394
	FEVD for wage inflation	1	0	100	0	0	0
		5	2.728	89.692	2.586	0.184	4.81
		10	2.965	89.238	2.686	0.195	4.915
	FEVD for Gram mark up change	1	0	0	0100	0	0
		5	0.119	2.315	90.195	6.121	1.25
		10	0.152	2.46	90.004	6.109	1.275
	FEVD for IIP growth	1	1.719	0	0	98.281	0
		5	2.532	1.573	0.158	95.58	0.156
		10	2.547	1.625	0.166	95.499	0.163
	FEVD for food articles inflation	1	0.481	10.266	1.83	0.084	87.338
		5	1.157	21.883	1.737	0.1	75.124
		10	1.298	22.298	1.797	0.108	74.498
Model		Horizon	Fuel	Wage	Potato mark up	IIP	Food articles
Potato Mark up	FEVD for fuel inflation	1	100	0	0	0	0
		5	93.079	5.144	0.306	0.947	0.524
		10	92.552	5.558	0.324	0.946	0.619
	FEVD for wage inflation	1	0	100	0	0	0
		5	3.088	90.785	0.625	0.103	5.399
		10	3.426	90.293	0.684	0.111	5.487
	FEVD for Potato mark-up change	1	0	0	100	0	0
		5	1.316	0.163	96.395	0.761	1.365
		10	1.316	0.163	96.394	0.761	1.365
	FEVD for IIP growth	1	1.683	0	0	98.317	0
		5	2.398	1.876	0.716	94.66	0.35
		10	2.417	1.928	0.718	94.578	0.359
	FEVD for food articles inflation	1	0.488	10.216	2.591	0.051	86.654
		5	1.781	17.352	7.452	0.351	73.064
		10	1.967	17.613	7.429	0.354	72.637

Source: Author's Estimates

Figure 12: Response of retail food inflation to various shocks

Table 4: FEVD Analysis(SVAR Model for retail sector)								
	Horizon	Fuel	Wage	Food Article	Food Product	Retail mark-up	IIP	CPI Food
FEVD for Fuel Inflation	1	100	0	0	0	0	0	0
	5	93.505	3.92	0.237	0.564	0.533	1.04	0.202
	10	92.651	4.544	0.296	0.603	0.676	1.03	0.201
FEVD for Wage Inflation	1	0	100	0	0	0	0	0
	5	3.198	85.683	5.267	0.574	5.139	0.036	0.103
	10	3.314	85.204	5.291	0.656	5.394	0.039	0.102
FEVD for food articles Inflation	1	0.512	6.849	92.639	0	0	0	0
	5	1.518	17.835	70.317	0.123	10.005	0.192	0.011
	10	1.602	18.445	69.518	0.168	10.064	0.191	0.012
FEVD for food products inflation	1	5.919	0	0	94.081	0	0	0
	5	3.769	13.042	4.003	71.241	7.218	0.406	0.321
	10	3.734	14.319	4.073	69.704	7.446	0.406	0.317
FEVD for retail mark-up growth	1	0	0	0	0	100	0	0
	5	1.682	3.446	11.757	0.045	81.677	1.25	0.143
	10	1.688	3.46	11.755	0.046	81.658	1.25	0.143
FEVD for IIP growth	1	1.832	0	0	0	0	98.168	0
	5	2.809	1.204	0.072	0.095	0.498	95.168	0.154
	10	2.817	1.292	0.08	0.101	0.521	95.035	0.155
FEVD for CPI food inflation	1	6.195	1.149	52.225	2.291	2.079	1.885	34.176
	5	3.761	19.329	41.475	5.045	8.85	2.017	19.523
	10	3.786	20.476	40.657	5.021	9.015	1.978	19.066

Source: Author's estimates

5. Policy Implications

The evidence of moderate but significant pass through of mark-up shocks in both wholesale and retail commodity markets into food inflation has considerable implications for the recent policy debate in India. In the backdrop of high and volatile food inflation, micro-level policy interventions such as, development of a competitive national market for food, and allowing direct farmer-consumer interactions are broadly recommended by the policy makes and researchers in the country for stabilisation of random mark-up shocks in commodity trading activities. As our findings suggest, such policies, by stabilising mark-up shocks would lower the average rate of food inflation and stabilise inflation fluctuations.

Our results suggest that a positive shock, increasing wholesale mark-up growth by 1%, would have an annualised positive effect on food articles inflation of 3.7-4.2%. During January, 2009-December, 2012, WPI food articles recorded an average monthly year-on-year inflation rate of 12% and an average volatility of 5.11%, of which, 0.01-0.38% fluctuations are due to mark-up shocks. Hence, in a counterfactual scenario, in absence of mark-up shocks under agricultural market development, the annualised inflation rate in wholesale food prices would have been at least 3-4% lower than the ex post scenario.

Again, during the same period, CPI food recorded an average monthly year-on-year inflation rate of 10% with an average inflation volatility of 4, while 0.35% of these variations in retail food inflation are due to fluctuations in retail mark-ups. Our results suggest that in absence of positive shocks to retail mark-up growth under policies facilitating supply chain reform, the annualised inflation rate in retail food prices would have been at least 3% lower than the realised inflation rate.

6. Conclusion

India has experienced a decade of high and persistent food inflation in the recent past. Apart from various factors such as rising cost of production, dietary shifts, fiscal and monetary expansions, rise in procurement prices behind surging food inflation, the role of supply chain distortions has been brought into the centre of policy debate as well. The rent-seeking activities of agents in both wholesale and retail marketing of food commodities, catered by the lack of a competitive food market and required infrastructure, often causes large positive shocks to mark up. This paper estimates the contribution of these mark-up shocks at both wholesale and retail level in food inflation, an issue still unexplored in the literature. The study finds moderate but significant pass through of mark-up shocks in food inflation after controlling for other factors.

Our findings make a contribution towards understanding the impact of intensifying competition on food inflation. The results from impulse response analysis provide preliminary insights about the extent to which stabilisation of mark-up shocks at both wholesale and retail level can lower wholesale and retail food inflation in the country. However, in an economy, where food producers and food suppliers are two different entities, with the latter having market power, larger shocks to mark ups at various levels between farmers' price to consumers' price affect wellbeing of different agents in the economy in different ways. The ultimate welfare impact of mark-up shocks stabilisation, thus, is to be analysed in a general equilibrium framework as in Aoki, (2001); Anand and Prasad, (2010); Pourroy et al., (2016).

In the process of evaluating the role of mark-up shock in food inflation, this paper develops indicators for mark up at the wholesale and retail marketing activities using farm, wholesale, and retail prices of various food commodities data, sourced from the Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture. In our study, the ratio of wholesale to farm harvest prices defines the indicator for wholesale mark up, while the ratio of retail to wholesale food commodity prices captures the mark up at retail level. However, several limiting factors related to availability of data limits an accurate analysis of the issue at hand. An ideal and more accurate indicator of mark up at the wholesale level would be the ratio of wholesale prices to farmers' prices, captured by farm gate prices, i.e., the net value of the product when it leaves the farm, after subtracting marketing costs. Farm harvest prices on the other hand, defined as the average wholesale price at which the commodity is disposed of by the producer at the village site, captures price of agricultural commodities at the first layer of wholesaling activities, not the actual producer price. Secondly, due to the lack of monthly time series of farmers' prices, we rely on annual time series of farm harvest prices, interpolated at monthly frequency. The consequent loss of monthly variation in the indicator for wholesale mark-up limits a more rigorous analysis of mark up in agricultural pricing.

The mark up between farm price and wholesale price, by definition, consists of transport cost, marketing cost, and wholesalers' profit margin. Similarly, the retail mark-up consists of cost of transport from wholesale to retail market, marketing cost and retailers' profit margin. Unless there is rapid deterioration of transport system and drastic rise in fuel prices, mark ups are ideally expected to remain constant. That is, although the time series of farm prices, wholesale, and retail prices would trend upward over time, these series are ideally expected to be co-integrated. A co-integration analysis would be appropriate to judge whether shocks to mark ups are causing deviations in these prices in a sustained manner. The short span of the data available on wholesale and retail food commodity prices serves as a constraining factor to conduct co-integration analysis in the present study.

Appendix A

Table A 1: Results of ADF Unit Root Test for Mark up

Variable	Test Statistic	
	Mark up level	First difference of mark up
Mark up in Food (Total)	-0.364	-7.856
Mark up in Cereals	-0.974	-7.687
Mark up in Pulses	-0.318	-6.094
Mark up in Milk	-0.029	-7.508
Mark up in Egg, Meat & Fish	-0.350	-8.260
Mark up in Vegetables & Fruits	-1.914	-8.515

Source: Author's estimates

For testing the existence of unit root in mark-up series and its first difference, we do not include drift and trend in the specification of the ADF test. The critical values for the specification with no drift and no trend, at 1%, 5% and 10% significance level, are respectively -2.58, -1.95, and -1.62.

Table A 2: Results of KPSS Unit Root Test for Mark up

Variable	Test Statistic	
	Mark up level	First difference of mark up
Mark up in Food (Total)	0.345	0.057
Mark up in Cereals	0.147	0.040
Mark up in Pulses	0.954	0.090
Mark up in Milk	0.558	0.085
Mark up in Egg, Meat & Fish	0.433	0.129
Mark up in Vegetables & Fruits	0.514	0.035

Source: Author's estimates

Critical values at 1%, 5% and 10% significance level are respectively 0.739, 0.463, and 0.347. Mark up series in most of the food commodities, except for total Food and Cereals are non-stationary at 10% level of significance.

Table A 3: Weights Associated to sub-components of WPI

Components	Weight in WPI (%)	Weight in WPI food articles (%)
Food articles	14.33709	100.00000
Rice	1.79348	12.50937
Wheat	1.11595	7.783658
Gram	0.33490	2.335899
Potato	0.2015	1.405446
Total	**5.70311**	**24.034373**

Source: Office of the Economic Advisor & Author's estimates

Table A.4: Results of ADF Unit Root Test for variables used in the analysis

Variable	Test statistic	
	Series in level	First difference of series
WPI food articles (SA)	-2.341	-5.079
WPI food products	-2.689	-3.599
WPI fuel	-1.971	-3.058
CPI food (SA)	-2.671	-4.322
Agri wage (SA)	-2.667	-1.396
IIP (SA)	-2.350	-7.925
Rice mark up	-0.518	-5.079
Wheat mark up	0.968	-4.155
Gram mark up	0.360	-4.108
Potato mark up	-0.311	-4.040
Retail mark up	-0.149	-5.442

Source: Author's estimates

Critical values for the specification with drift and trend, at 1%, 5% and 10% significance level, are respectively -4.04 -3.45 -3.15. The ADF test suggests that WPI food articles, food products, CPI food and agricultural wages are unit root processes with drift, but no trend; WPI fuel and IIP are unit root processes without any drift and trend. Again, critical values for the specification with no drift and trend, at 1%, 5% and 10% significance level, are respectively -2.6 -1.95 -1.61. All wholesale and retail mark-up shows unit root processes according to this specification of the ADF test.

For testing the existence of unit root in first difference of a series, we do not include drift and trend in the specification of the ADF test. The critical values for the specification with no drift and no trend, at 1%, 5% and 10% significance level, are respectively -2.6, -1.95, and -1.61 respectively. The first difference of all variables, except for agricultural wage index is stationary.

Table A.5: Results of KPSS Unit Root Test for variables used in the analysis

Variable	Test statistic	
	Series in level	**First difference of series**
WPI food articles (SA)	1.573	0.184
WPI food products	1.529	0.079
WPI fuel	1.439	0.087
CPI food (SA)	1.563	0.222
Agri wage (SA)	1.603	0.324
IIP (SA)	1.421	0.070
Rice mark up	0.759	0.064
Wheat mark up	0.544	0.226
Gram mark up	0.388	0.285
Potato mark up	0.410	0.062
Retail mark up	0.725	0.052

Source: Author's estimates

Critical values at 1%, 5% and 10% significance level are respectively 0.739, 0.463, and 0.347. For all the variables in levels, we reject the null that the series is stationary around a constant. The first difference of all these series is stationary.

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