
Food Inflation in India: Causes and Consequences

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*Food Inflation in India: Causes and Consequences**

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Abstract

Average food inflation in India during the period 2006-2013 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 in India. We find that both demand and supply factors have contributed to the recent surge in food inflation in India. On the demand side, we test the often-cited hypothesis that rising per capita income and diversification of Indian diets has raised the demand for high-value food products and thereby added to inflationary pressures. We find that rise in demand, relative to the supply of a commodity, results in upward pressure in commodity prices. Moreover, rise in prices of key inputs, minimum support prices and fiscal deficits have also impacted the prices of various commodities. 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-NREGA era. Our analysis indicates limited role of fuel and international prices. Finally, results suggest significant pass-through effects from food to non-food and to the headline inflation.

JEL Classification: E31; E37 and Q11

Keywords: Food Inflation, Engel Curves, QUAIDS Model, SVEC Model, India

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1. Introduction

India experienced one of the highest rates of food inflation among emerging economies at an average rate of more than 9% during the period 2006 to 2013. Moreover, the rate of increase in food prices during this period was nearly double that witnessed in the previous decade. While India has witnessed sporadic spurts in food inflation, episodes of such persistently high inflation have been rare. The welfare impact of such high rate of food inflation is bound to be significant given that on average, food accounts for 48.6% of overall expenditure in rural areas and 38.5% in urban areas. The proportion is significantly higher for 362 million or 29.5% of the population living in abject poverty.¹ On average, the bottom three income deciles in rural areas devote 60.4% of their total expenditure on food products while food accounts for 56.5% of total expenditure in urban areas. Given that this section of population already spends a large proportion of their income on food, they are generally unable to divert additional expenditure on food to neutralise the impact of food inflation, thereby aggravating food and nutrition deficiency.

In this paper, we empirically evaluate some of the major drivers of inflation. The rise in international food prices in 2008, and again in 2010, provides a backdrop where international prices could have influenced domestic prices, especially of tradeable products. The costs of various key agricultural inputs have also increased manifold in recent years. We estimate the impact of rise in prices of selected agricultural inputs such as fuel and agricultural wages on food prices. We analyse the contribution of key input price inflation and global food price inflation to domestic food inflation (aggregate and components) in a Structural Vector Autoregression (SVAR) framework, taking into account the dynamic inter-linkages among these macroeconomic indicators, using monthly data.

An often-cited reason for the recent surge in food inflation is that rising per capita income and diversification of Indian diets has raised the demand for high-value food products like milk, eggs, meat, and fish relative to supply, and thereby adding to inflationary pressures. We estimate aggregate demand using household survey data of the National Sample Survey Organisation (NSSO) to test the validity of this hypothesis.

To gauge the role of some of the government policies as drivers of food inflation, we evaluate the effects of rise in procurement prices on wholesale price of various food commodities in a panel regression framework, using annual data. Finally, we evaluate the extent of transmission of food inflation to non-food and aggregate inflation.

Our main findings include that high food inflation in India during 2006 to 2013 was a result of various factors. On the cost side, we find that the inflation in agricultural wages is 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 Mahatma Gandhi National Rural Employment Act (MGNREGA) era. Fuel inflation has a moderate impact on food inflation and the extent of the effects vary across commodities. Significant pass-through effects from global prices are found for tradeables, such as sugar and edible oil. On the demand side, we find that demand has persistently outstripped supply in the case of pulses, meat and fish, while a positive gap between demand and supply is perceived for milk and vegetables in the recent years. Supply has been persistently higher than demand for cereals (except in 2010, following a drought in 2009) and for fruits. Overall, rise in demand, relative to the supply of a commodity results in upward pressure in commodity prices.

Minimum Support Prices (MSP) are also found to be important drivers of food inflation in India. The rate of increase in minimum support prices has a significant impact on next year's Wholesale Price Index (WPI) inflation. The extent of the impact is highest in the case of pulses and sugar followed by rice and wheat.

Finally, we find that food inflation has a strong and significant pass-through effect on non-food inflation, as well as on the headline inflation in the country.

Our results indicate that overall, both demand and supply factors have contributed to recent surge in food inflation in India. However, looking deep into the components, it seems that rise in cost

¹ Planning Commission (2014)

of production and procurement prices are the main drivers of inflation in cereals. Inflation in milk, vegetables, and meat and fish are primarily driven by increase in cost of production and rise in demand relative to the respective supplies. Input cost inflation, positive demand-supply gap and hike in procurement prices are the major factors behind high pulses inflation. Agricultural wage inflation mainly drives inflation in fruits. Global inflation induces upward pressure on prices of edible oil and sugar, while rise in MSP is an additional factor driving sugar price inflation.

Our paper makes a contribution towards understanding of how various cost- push, demand-pull, global and policy related factors contributed to food inflation in India, in a unified framework and their implications for the over- all inflationary scenario of the economy. Furthermore, this study attempts to fill an important void in the literature by providing a rigorous empirical test of the long debated hypothesis that shift in demand towards high value food items relative to their supply is a driver of inflation in high value food components in India.

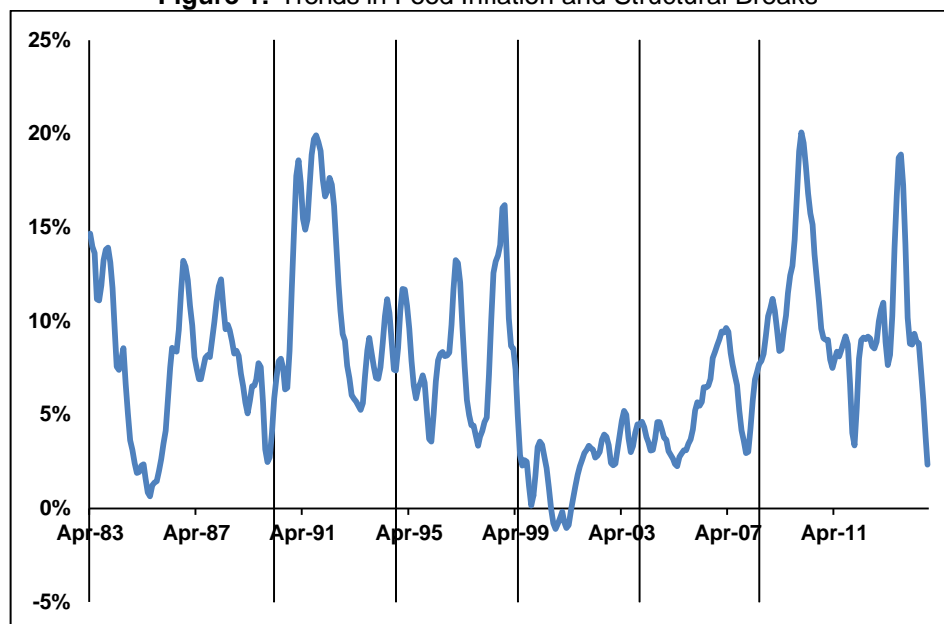
In the remaining paper, Section 2 focuses on the trend and structure of the food inflation in India in recent years. Section 3 reviews the literature on causes of food inflation globally, followed by the discussion specific to India. In Section 4, we evaluate the various factors that have contributed to food inflation. These range from rise in price of inputs to rising demand supply mismatches and to some government policies. Section 5 evaluates the extent to which food prices have influenced non-food prices. Finally, Section 6 concludes the paper.

2. 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, combined). Apart from the new unified CPI for all India level, there are four different consumer price indices, which correspond to different segments of the population - industrial workers, agricultural labourers, rural labourers and urban non-manual employees. Thus there is a lack of historically comparable data. Much of the analysis on inflation in India, including Mishra and Roy (2012), and Nair and Eapen (2012), has employed the WPI. However, the WPI suffers from several limitations. Firstly, the WPI is neither a producer price index nor a consumer price index. Moreover, it does not include services sector and is subject to large revisions. Finally, a major difference between the new unified CPI and the WPI is the weight accorded to food articles. While food articles and food products have a weight of 26.9% in the WPI, it has a much higher weight of 49.7% in CPI. Despite these shortcomings, we employ WPI in this study for two main reasons. First, various versions of the CPI, including the all-India index continues to provide much more aggregated data than required for our analysis. Second, historical data on the all-India CPI index is yet unavailable.

Figure 1 highlights the long-term trend in food inflation. It is evident that over the last three decades, India has witnessed very diverse rates of food inflation rates. Using the methodology developed in Bai and Perron (1998), and modified in Zeileis et al. (2010), we are able to identify 5 major structural breaks in food inflation series. Thus there are 6 distinct phases of food inflation. The most recent phase of high inflation started in June 2008, and is continuing since then, although there has been a perceptible decline in inflation since January 2014. Nevertheless, the average inflation during this period at 10.4% was 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 for 54 months. Thus inflation in most recent period has been quite persistent, which is an increasingly worrying sign.

Figure 1: Trends in Food Inflation and Structural Breaks



We formally test the persistence in food inflation by estimating a simple autoregressive process on monthly year-on-year inflation rate, where inflation is regressed on its lags. The sum of the auto-regressive coefficients provides the degree of persistence in the series. The optimal lag length is selected by using the Schwarz Bayesian Information Criterion (SBIC). We repeat the process for the entire sample as well as the six phases identified above. The results are reported in Table 1. The sum of auto-regressive coefficients shows that there has been a steady increase in the persistence of food inflation across the periods since 1990, with the most recent phase from July 2008 to October 2014 exhibiting the maximum persistence. Thus the factors influencing food and non-food inflation are getting increasingly entrenched, and any positive shock to inflation will continue to have an impact for a much longer time.

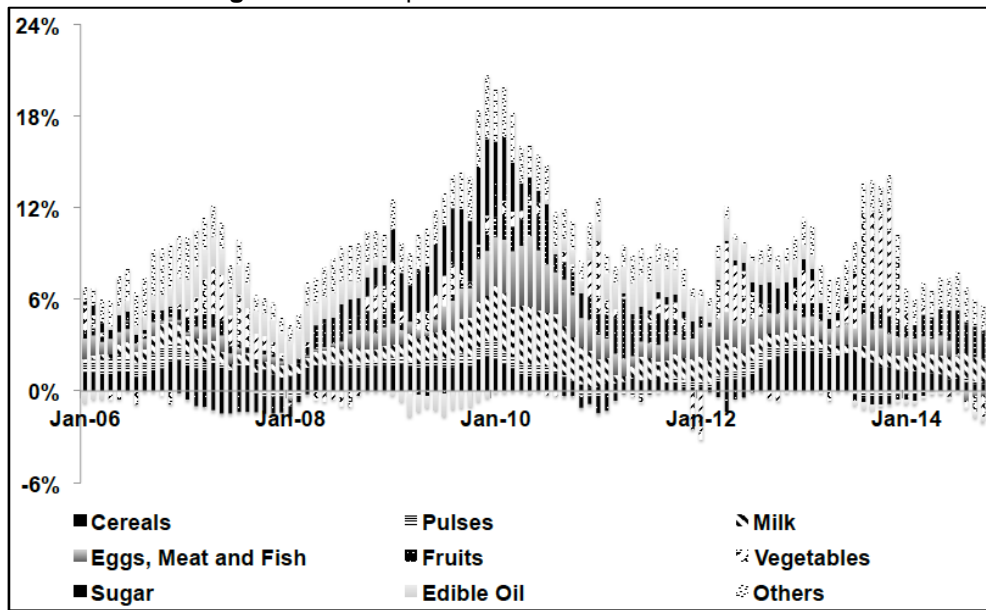
Table 1: Persistence of Food Inflation

	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	1.704*** (15.66)	1.816*** (13.94)	2.147*** (15.75)	2.196*** (14.99)	1.865*** (14.05)	1.804*** (11.93)	1.472*** (8.752)
2 Month Lag	-0.919*** (-4.637)	-1.116*** (-4.374)	-1.690*** (-5.113)	-1.951*** (-5.663)	-1.265*** (-3.813)	-1.039*** (-3.459)	-0.598*** (-2.423)
3 Month Lag	0.151* (1.844)	0.198* (1.840)	0.413* (1.835)	0.955*** (2.754)	0.240 (1.620)	0.301 (1.176)	0.136 (0.645)
4 Month Lag	0.0533* (1.645)	0.092* (1.873)	0.109* (1.790)	-0.219* (-1.869)	0.140* (1.770)	-0.0774* (-1.616)	-0.0163 (-0.130)
Sum of Coefficients	0.989	0.990	0.979	0.981	0.980	0.989	0.994
Observations	376	80	51	51	51	50	73
R-squared	0.989	0.993	0.997	0.992	0.979	0.994	0.980

Source: Authors' Estimates

Next, in Figure 2 we highlight the major contributors of inflation during this period. During the most recent phase i.e. the period from July 2008 to October 2014, when food inflation averaged over 10%, milk was the biggest contributor with an average inflation of 11.8%, and accounted for nearly 16% of the overall inflation. This was followed by eggs, meat and fish, which accounted for 15% of overall food inflation. At 13.3%, cereal was the next largest contributor followed by fruits, vegetables and sugar, with each of these accounting for around 10% of the inflation.

Figure 2: Decomposition of Food Inflation



Source: Authors' Estimates

3. Literature Review

In this section, we briefly review the existing literature regarding the factors driving high food inflation. We first focus on the literature identifying the drivers of food inflation globally before turning our attention to key determinants of food inflation in India.

During the last decade, the global economy witnessed two distinct episodes of surges in food prices. The first spike took place between November 2006 and August 2008, when monthly food inflation averaged 54.4% while the second surge occurred between October 2010 and August 2011, with a monthly average inflation of 33%.

Over the past few years, several studies have delved into the causes of the surge in prices in these episodes. These studies have identified a number of drivers of food inflation including biofuel demand, rapid growth in some of the emerging economies exacerbating demand for food, shocks to money supply, stockpiling and trade restrictions in some of the economies and speculation in commodity futures markets. However, the conclusions of these studies vary significantly.

A major factor identified as explaining the surge in food prices is increased biofuel production, driven by generous subsidy programmes to offset use of fossil fuels, leading to food commodities being diverted for use as biofuel feed stocks. This has created a direct competition between food and energy markets. Mitchell (2008) argues that biofuel production from grains and oilseeds in the US and the EU accounted for as much as two thirds of the price increase in these commodities between 2002 and 2008. In sharp contrast, Gilbert (2010a) finds little evidence that the price spike during this period was driven by heightened demand for grains and oilseeds as biofuel feed stocks. Several studies have looked at the change in grain prices by simulating an increase in production for biofuel. FAO (2008) compares a scenario where biofuel production will double by 2018 with one where bio-fuel production will remain at its 2007 levels, and finds that in the latter case grain prices would be 12% lower while wheat and vegetable prices would be 7% and 15% lower, compared to the baseline scenario. In a similar study, OECD (2008) finds that eliminating biofuel subsidies would result in vegetable oil prices being 16% percent lower than the baseline, while grains and wheat prices would be lower by 7% and 5%. Comparing the rapid increase in demand for food crops as biofuel feed stock between 2000 and 2007 with more subdued increase in demand from 1990 to 2000, Rosegrant (2008) finds that the increased biofuel demand during the latter period, accounted for 30% of the increase in weighted average grain prices. The impact ranged from 39% in case of maize prices to

21% and 22% of the rise in rice and wheat prices. Freezing biofuel production at 2007 levels for various crops used, as feedstock would result in a decline in maize prices by 6% by 2010 and 14% by 2015.

A substantial literature has argued that excess liquidity and speculation have been important determinants of commodity prices. Excess liquidity, due to the low interest rate environment in developed countries, resulted in a lot of “new” money chasing too few assets and eventually found its way into commodity markets, thereby causing a speculative bubble (Baffes and Haniotis, 2010). Again, the empirical evidence on the impact of speculation on commodity prices has been mixed. IMF (2008), using empirical methods, conclude that although financialisation may have increased the co-movement between some commodities, no apparent systematic connection is found to either price volatility or price changes. Sanders et al. (2010) find very little evidence of a relationship between trader positions and market returns, and thus, do not agree with the assertion that speculation has led to bubbles in agricultural futures prices.

In contrast, Gilbert (2010a) finds that in the United States, investor activity had insignificant impact on metal prices, but in the case of soybeans, future positions of index providers have a strong effect on prices. However, the study failed to find similar evidence for other products including corn, soybean oil and wheat. Gilbert (2010b) further evaluates the role of speculators in causing the commodity price boom between 2006 and 2008, and finds that monetary and financial activities have affected food prices through the index futures investment channel.

Another proximate determinant of food inflation identified in the literature is the surge in demand for grains in countries such as India and China, which experienced high growth in the recent decade. Krugman (2008) points out that the rise in per-capita income in several emerging markets has shifted the dietary habits of the citizens towards meat, which in turn has raised the demand for grains as animal feed. At the same time, the high growth in these economies has made them more energy intensive and thereby increased their demand for fossil fuels, whose prices also witnessed a steady increase, and which is a major input for agriculture. Wolf (2008) present the same argument pointing out the shifts in land use in response to rising demand for meat and related animal feed has reduced the supply of cereals available for human consumption. However, Baffes and Haniotis (2010) refute this line of argument pointing out that growth trends of population and income over the past decades, along with those of demand for food commodities, do not exhibit a discernible increase in food demand growth in recent years. Moreover, in India and China, the period between 2003 and 2008 witnessed a higher growth in consumption of maize and soybeans compared to the period between 1997 and 2002, but no such trend was observed in case of grains, meat and dairy products. Alexandratos (2008) also concludes that the combined domestic consumption of both wheat and rice in India and China has continued to decelerate during recent years of price rise, similar to the trend observed some time earlier. While meat consumption has been rising, especially in China, the trend shows no acceleration in recent years, thereby unlikely to have contributed significantly to the global price increases. Moreover, in both India and China, feed use of cereals per capita flattened out in the years prior to the surge in prices.

Restrictive trade policies pursued by some of the major exporters of food commodities to enhance their domestic food security also impacted global food prices given the thin markets for such commodities. Timmer (2008) highlight the major tax and quantitative export control measures taken by major rice exporters. While Thailand kept its border open and did not restrict rice exports, Vietnam introduced a ban on rice exports in early 2008, which continued till July. Similarly, Alexandratos (2008) notes that both China and India, which have been net exporters of cereals, witnessed a steady drop in export balance from 22 million tons in 2002 to only 5 million tons in 2007. Much of the decline in net exports was driven by China, which witnessed stock depletion during this period due to a decline in domestic production.

Having focused on major drivers of food inflation worldwide we now shift attention to the major determinants of food inflation in India. Mishra and Roy (2012) provide a detailed analysis of some of major issues related to food inflation in India. The paper divides the various food products into four categories based on their inflation rate and weights in the inflation basket. Based on this analysis they identify milk, sugar, cereals, edible oil, fruits and vegetables to be the major contributors to food inflation. The paper then discusses the short- and long-term factors that have influenced prices for these products. Among the long-term factors, the most common one pertains to

increase in demand for these products (except cereals) due to rising per-capita income and population growth that is not matched by a commensurate increase in supply due to low productivity. The short- term factors have focused on negative supply shocks emanating from adverse weather shocks, changes in support prices, policies related to stocking and futures trading and temporary trade policies.

Similarly, Nair and Eapen (2012) undertake a commodity-wise analysis of inflation. The paper focuses on pulses, fruits, vegetables, sugar, spices, meat and milk, and concludes that supply side constraints and cost escalation factors were the major drivers of inflation in most commodities. Barring milk, the paper finds no evidence supporting the view that consumption shift towards high value agriculture products has been driving prices up. Chand (2010) argues that the rise in food prices in recent years was a result of a supply shock driven by the drought of 2009 and low production growth in 2008-09. Rising share of food crops being diverted to export markets as high global prices made exports more lucrative. Another factor, also contributed to the rise in domestic prices. Apart from reducing the amount entering domestic supply, it also facilitated the transmission of some of the increase in global price to domestic price.

In contrast, Kumar et al. (2010) argues that the structural reason for food price rise is the rising gap in per-capita income, which resulted in rise in demand for food products. This, stagnant per-capita availability of these commodities along with rising incomes meant that the better-offs were chasing prices to meet their demand, resulting in higher prices, and driving poor people to make do with lower consumption. Similarly, Gokarn (2011), Bandara (2013), Gulati and Saini (2013) also point out that India 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.

Several studies have identified the increase in Minimum Support Prices (MSPs) as a major driver of inflation in India. The MSP is the floor level price at which the government stands ready to buy whatever volume of crops the farmers are willing to sell. The purpose of MSP is to ensure remunerative and stable price environment, which is equitable and prevents the farmers from resorting to distress sale. However, with MSPs being designed to be the floor for market prices, they have influenced market prices, whenever the increase in MSPs has been substantial. 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 in the system. Gaiha and Kulkarni (2005) corroborate the positive effect of the combined rice and wheat MSP on the WPI. Controlling for this effect, neither the gross fiscal deficit nor the money supply is found to have a significant impact. Bhalla *et al.* (2011) point towards a strong link between MSPs and food inflation in India, with a 10% increase in these prices resulting in 3 percentage point in CPI inflation.

Other factors identified in the literature as influencing food inflation include the widening of fiscal deficit and consequent rise in liquidity for financing the deficit. Gulati and Saini (2013) find that fiscal deficit is the biggest contributor in driving up food prices followed by rural wages and global prices. Gulati and Saini (2013) and Ganguly and Gulati (2013) also conclude that the rise 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.

The sharp increase in rural wages since 2008 have also raised the cost of agricultural production substantially (Gulati et al., 2013). The increase in rural wages coincided with the universal implementation of Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), which promised 100 days of paid work to adult members of every household, thereby raising the reservation wage. 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).

4. Factors Affecting Food Inflation in India

In this section, we first evaluate some of the major factors influencing food inflation since the mid-2000s. In particular, we focus on the impact of international prices, factors that have exacerbated the demand supply mismatch, and the role-played by rise in prices of key inputs. Next, we analyse the contribution of key input price inflation and global food price inflation in domestic food inflation in a

Structural Vector Autoregression (SVAR) framework, taking into account the dynamic inter-linkages among these macroeconomic indicators, using monthly data. Finally, to gauge the role of government policies as drivers of food inflation, we evaluate the effects of inflation in procurement prices on various food commodities inflation in a panel regression framework, using annual data.

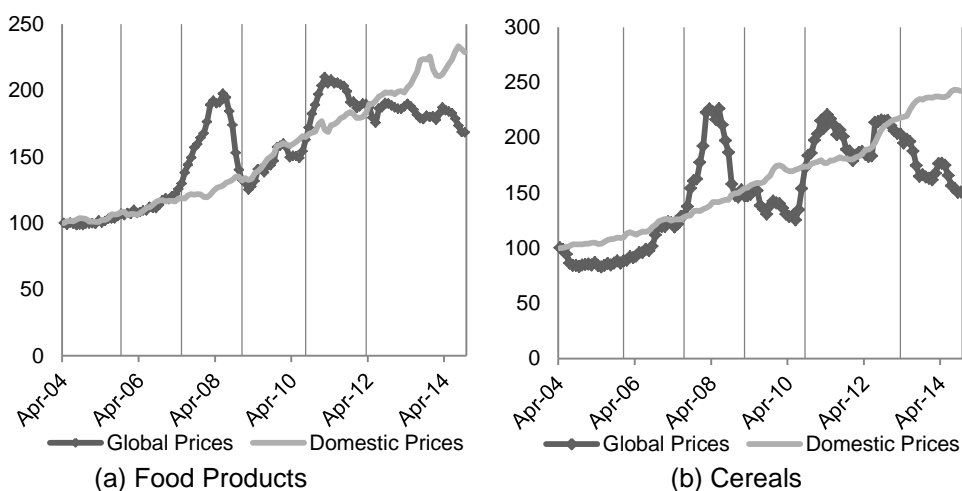
4.1 Global Commodity Prices and Rising Domestic Cost of Inputs

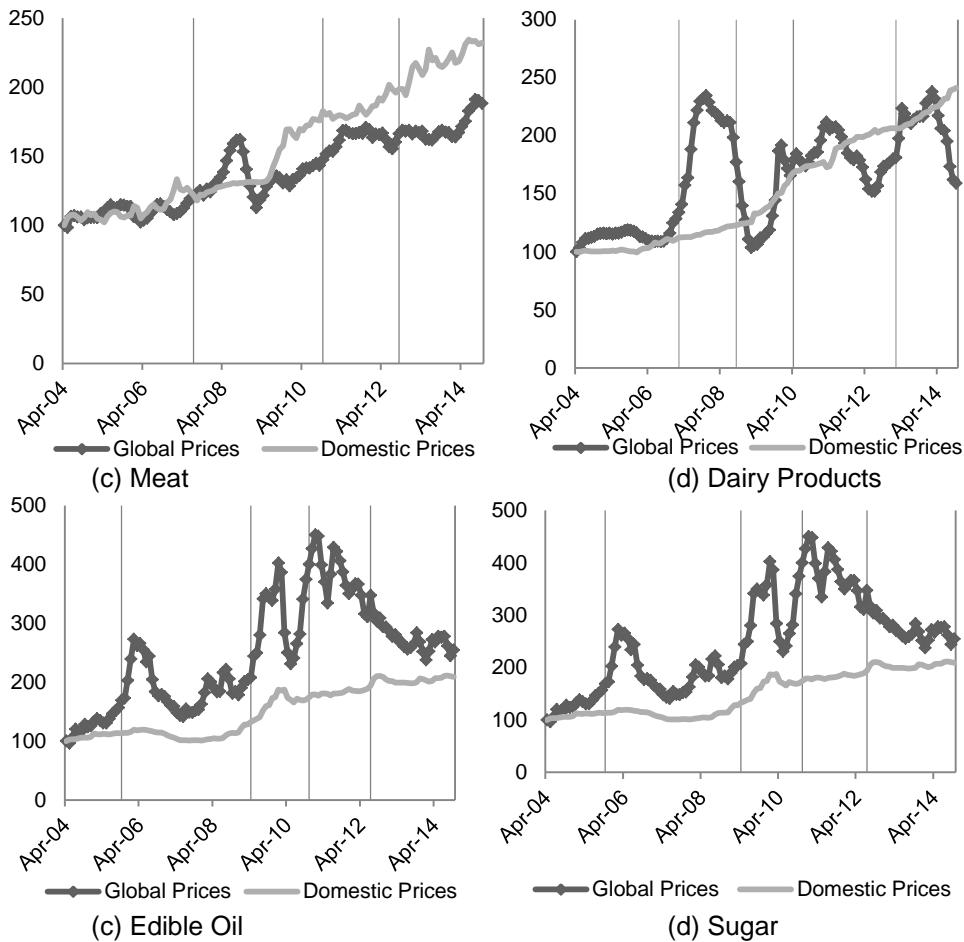
4.1.1 International Prices and Trade Policy

International food prices impact domestic prices through international trade as well as adjustment in domestic policies. This channel becomes important in the backdrop of surge in international prices of food commodities in 2008, and again in 2010. Furthermore, India's agriculture sector has witnessed greater integration with global market, with the share of agriculture trade to agriculture GDP increasing nearly four folds from 5.2% in 1990-91 to around 19% in 2013-14.

However, the extent of co-movement of domestic and international prices differs considerably across commodities. Figure 3 traces out the movement in global and domestic food prices, along with five major constituents viz. cereal, meat, oil, dairy and sugar. Data on prices are sourced from the Food and Agricultural Organization (FAO). Three main conclusions can be drawn from Figure 3. First, both global and domestic prices of food exhibit a rising trend during the period 2004 and 2014 at similar rates. While global food prices increased at an annual average rate of 9%, domestic food prices recorded an increase of 10%. However, there is a great deal of variation at the commodity level. In case of 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.

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





Second, despite moving in the same direction as global prices, the domestic prices were able to avoid the sharp spikes and troughs that characterised the former. Barring meat products, global inflation was 4 to 6 times more volatile than domestic inflation. To analyse this in greater detail, we identify the structural breaks in the global price index of various food products (Figure 3) and evaluate the correlation between domestic and global inflation and the extent of volatility across the various phases (Table 2).

Between 2004 and 2014, meat products exhibited the highest correlation between global and domestic food prices. This was followed by sugar, oil, cereal and dairy products. However, the extent of correlation differed significantly across different phases. In the case of aggregate food prices, it is evident that periods of high volatility such as Phase III and Phase V were associated with low correlation between domestic and global prices. A similar trend was observed in the case of cereals, although in this case the correlation between domestic and global prices has been traditionally low, given India's limited trade in these products. The only exception was Phase II, which witnessed a high degree of correlation.

With India's share in global exports of dairy products increasing, the surge in global dairy prices in Phase III was associated with a rise in domestic price, but the extent of increase in domestic prices was a fraction of its global counterpart. Moreover, in the subsequent phases, when there was a decline in global prices, domestic prices continued to rise. Domestic sugar prices have witnessed far less volatility than their global counterparts, and the extent of the correlation between the two has declined in recent phases. Finally, with India being a large importer of edible oils, movements in global prices were reflected in domestic prices, albeit to a lower extent.

Table 2: Correlation between Domestic and Global Food Prices

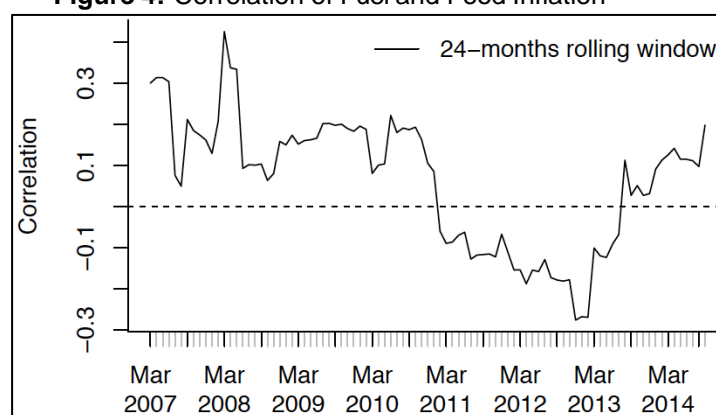
	Phase I	Phase II	Phase III	Phase IV	Phase V	Phase VI
Food	0.768 (2.441)	0.84 (6.820)	-0.174 (21.518)	0.896 (9.291)	0.301 (12.432)	-0.658 (5.854)
Cereals	-0.435 (4.755)	0.98 (14.377)	-0.133 (32.009)	-0.118 (11.545)	0.356 (13.236)	-0.916 (14.839)
Meat	0.416 (5.054)	0.23 (11.920)	-0.134 (5.720)	0.59 (9.047)		
Dairy	0.319 (6.334)	0.311 (27.037)	0.716 (31.006)	-0.523 (16.195)	-0.632 (21.844)	
Oil	0.768 (7.906)	0.736 (41.333)	-0.296 (13.932)	0.001 (24.791)	0.629 (9.692)	
Sugar	0.877 (18.711)	0.612 (35.209)	0.437 (58.300)	-0.722 (41.150)	0.257 (19.385)	

Note: Volatility in price series is measured using the standard deviation and is reported in parenthesis.
Source: Food and Agriculture Organization

The relatively limited extent of correlation between movement in global and domestic prices, even in the case of tradeables, was a result of agriculture trade policy adopted. In the face of adverse price movements, the government resorted to trade, tariff and administrative means to restrict agriculture trade. The export ban on wheat and non-basmati rice from 2007 to 2011, a period of high global prices, was meant to divert domestic production towards domestic consumption and cool down inflationary pressures. Similarly, there continues to be a ban on export of pulses since 2006 even though India is one of the largest producers of pulses. Exports of edible oils, barring some minor constituents, also continue to remain banned since March 2008. Finally, during the last ten years, India has been a net exporter of sugar, although there have been constant government interventions with intermittent ban on exports.

4.1.2 Fuel Inflation

Fuel prices play an important part in influencing food prices through several channels. Fuel is used to transport the produce from the producer to the consumer, and hence a rise in fuel price widens the gap between farm gate price and retail price. Moreover, fuel is used to power several machines used in agriculture such as tube wells, tractors etc.

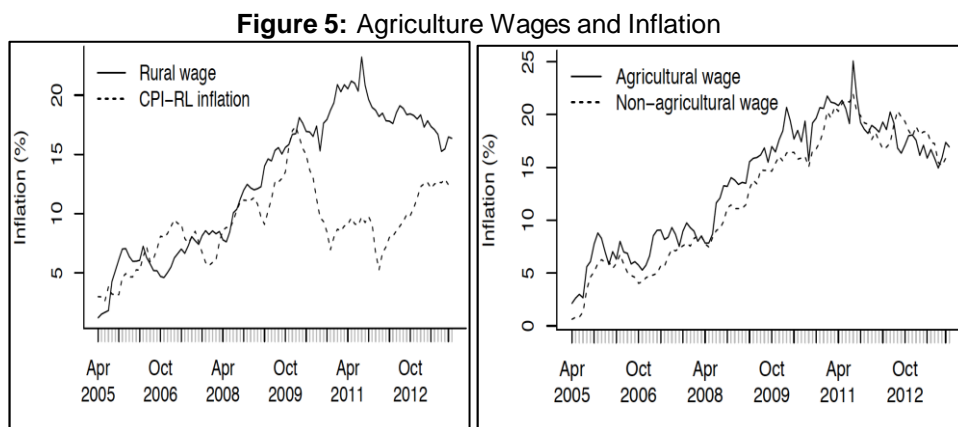
Figure 4: Correlation of Fuel and Food Inflation

In India, fuel prices have been administered to a large extent. Greater integration of oil prices with market forces is presently on the reform agenda with petrol and diesel prices having been decontrolled in 2010 and 2014 respectively. The point-on-point (POP) inflation in food and fuel indices shows moderate positive contemporaneous correlations since 2005, except for the period from November 2010 to July 2013 (Figure 4).²

² The price series are WPI monthly series from Office of the Economic Adviser, Ministry of Commerce and Industry. WPI series at bases 1993-94 and at 2004-05 are linked. Food price is proxied by the weighted sum of WPI food articles and WPI food products, while fuel price is proxied by WPI fuel, power, light and lubricants. Food prices are seasonally adjusted using x-12 ARIMA of U.S. Census Bureau. Fuel prices are not adjusted for

4.1.3 Agricultural Wages

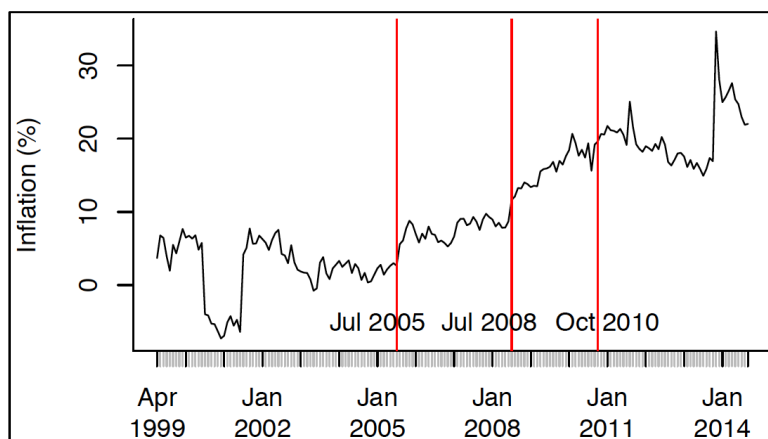
A key factor influencing the prices of food products is the wages of the agricultural workers. As can be seen from Figure 5, while until 2007, wages grew in line with CPI inflation, since then rural wages have risen at a pace far in excess of the inflation rate. However, the gap has narrowed down in the recent years. Within rural wages, agricultural wages have risen at a faster pace than non-agricultural wages till mid-2011.³



Source: Labour Bureau and Authors' Estimates

We again employ the Bai and Perron (1998) structural break test to determine the presence of structural breaks in the year-on-year inflation rate of the average agricultural wage. These breaks and the corresponding phases in the inflation in average agricultural wage rate are highlighted in Figure 6 and Table 3.

Figure 6: Structural Break in Agricultural Wage Inflation



Source: Labour Bureau and Authors' Estimates

seasonality since the series is not a candidate for adjustment due to weak seasonal pattern in it.

³ In our analysis, agricultural activities include ploughing, sowing, weeding, transplanting, harvesting, winnowing, threshing and picking. Non-agricultural activities involve herdsman, well digging, cane crushing, carpenter, blacksmith, cobbler, mason, tractor driver, sweeper and unskilled labourers. From November, 2013 onwards, Labour Bureau replaces herdsman, well digging, cane crushing by a few new categories. To ensure consistency, our non-agricultural and rural wage data span till October, 2013.

Table 3: Phases of Agriculture Wage Inflation

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

Source: Labour Bureau and Authors' Estimates

There has been a sustained increase in the average wage inflation for agricultural activities. The average wage inflation rate was 20% during the last phase of the growth in average agricultural wage rate. The growth rate in agricultural wages entered the double digits in mid-2008.

Several studies have linked the rise in agriculture wages to the introduction of the MGNREGA Public Works Programme.⁴ Imbert and Papp (2012) find that MGNREGA raises public works employment by 0.3 person days per month and casual wage income increases by 4.5%. Similarly, Berg et al. (2012) conclude that on average 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. Gulati et al. (2013) also points out that 10% increase in employment pushed agriculture wages by 0.3% to 0.5%, although economic growth have also contributed to increase in farm wage.

4.1.4 Contribution of Global versus Domestic Factors: A Structural Vector Autoregression Analysis

We analyse the effects of above discussed global and various domestic factors on aggregate food inflation and its components in a Structural Vector Autoregression (SVAR) framework. We estimate individual models for inflation in aggregate domestic food index as well as individual commodities including cereals, dairy, sugar, edible oil and meat, using inflation in fuel prices, agricultural wages 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 in Tables A.2 and A.3 suggest that the variables are I(1).. Hence, we estimate our SVAR models on the first difference of the variables in logs, that is, on the POP inflation rates of the variables.⁶ The period of our analysis is April 1998 to September 2014. Given that the year 2008, the year of universal implementation of MGNREGA, corresponds to the structural break date in agricultural wage inflation, we re-estimate the SVAR model for aggregate food inflation from the period January 2008. We compare the impacts of shocks to wage inflation on food inflation for the full sample period with the analysis for the truncated period beginning in 2008. This allows us to investigate any significant change in the pass-through of wage inflation to food inflation since 2008.

We estimate the following SVAR model:

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

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 denotes a vector consisting of domestic food prices and its determinants. The vector includes

⁴ The MGNREGA aims to enhance livelihood security of the rural households by providing 100 days of guaranteed wage employment to every adult member of the household in unskilled manual work. The scheme was introduced in 2006 and extended to all the districts in India by 2008 in three distinct phases. In recent years the wages under the programme have been indexed to consumer price inflation.

⁵ The details of the data series used in our analysis and their time series properties are discussed in Appendix A.

⁶ For the variables with significant seasonal variations, POP growth rates are calculated on their seasonally adjusted values.

global food price index (aggregate and components), $\ln P_t^*$; WPI fuel index, $\ln P_t^{fuel}$; seasonally adjusted index of average agricultural wage, $\ln w_t$; seasonally adjusted Index of Industrial Production as a proxy for demand from industrial sector, $\ln y_t$; and seasonally adjusted WPI food price index (aggregate and components), $\ln P_t$. The model is estimated using the first difference of the variables ΔY_t , that is on the POP growth rates of the variables.⁷

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

$$A^{-1}u_t = B\varepsilon_t,$$

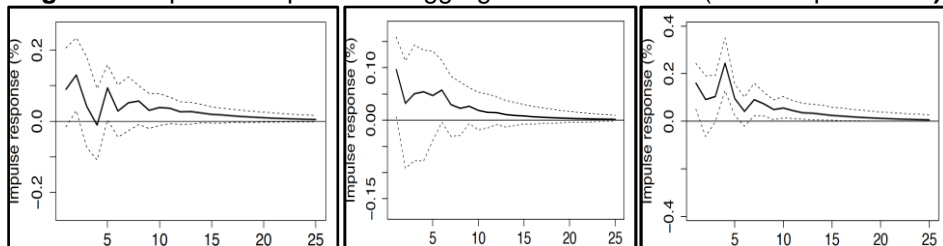
where u_t denotes the vector of reduced form errors, whereas ε_t represents the vector of structural errors. We assume the following restrictions on the structural parameters:

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

The restrictions are imposed following the assumption that shocks to global food inflation, WPI fuel inflation and agricultural wage inflation, affect domestic food inflation instantaneously. But a shock to domestic food inflation does not impact these variables instantaneously. Shock to demand growth in the industrial sector, proxied 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 global food inflation, fuel inflation and agricultural wage inflation 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 wage inflation at period t causes an impulse on domestic food inflation in period $t+1$, which in turn may affect wage inflation and food inflation in the subsequent periods due to endogeneity among these prices over time. These dynamics of transmission mechanism are captured by impulse responses. Figure 7 depicts results of impulse response analysis for the aggregate food inflation for the full sample period. In this analysis, inflation in aggregate global food price index serves as a proxy to the global food inflation.

Figure 7: Impulse Response for Aggregate Food Inflation (Full Sample Period)

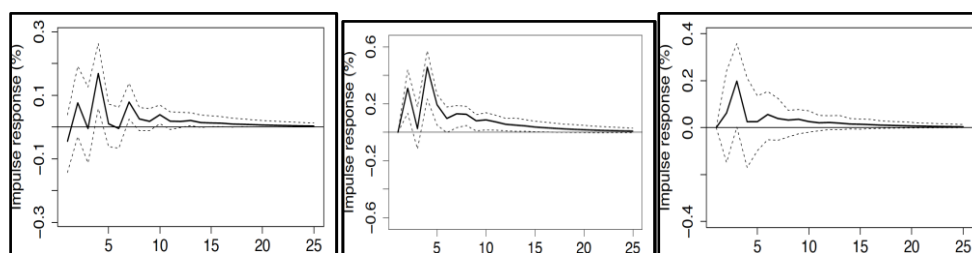


(a) Response of Food to Global Food Inflation

(b) Response of Food to Fuel Inflation

(c) Response of Food to Wage Inflation

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



(a) Response of Food to IIP Growth

(b) Response of Wage to Fuel Inflation

(c) Response of IIP Growth to Food Inflation

The results of impulse response analysis show that 10% rise in the global food inflation, has a transitory impact on WPI food inflation. It increases WPI food inflation by 1.3% after two months of the shock. The impact does not remain significant after that. A 10% rise in fuel inflation instantaneously increases food inflation by 1%, but the effect is transitory. Again, a 10% rise in wage inflation immediately increases food inflation by 1.6% and the effect increases to 2.4% after 4 months of the shock. The impacts decline afterwards, but remain significant for long time. IIP growth, capturing the demand from industrial sector, has small but significant impact on food inflation. We also find substantial and significant second round effect from food to wage inflation.

The Forecast Error Variance Decomposition (FEVD) analysis in Table 4 shows that after 10 months out, 10.0% 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 14.0% of the variation in agricultural wage inflation is due to food inflation. Global food inflation explains a significant component of the performance of industrial sector (8.5%).⁸

Table 4: FEVD Analysis: Full Sample Analysis

	Horizon	Global food	Fuel	Wage	IIP	Food
FEVD for	1	100	0	0	0	0
global food	5	95.049	1.164	0.294	2.312	1.182
inflation	10	94.304	1.654	0.371	2.452	1.22
FEVD for	1	0	100	0	0	0
fuel	5	5.999	87.23	1.725	2.15	2.897
inflation	10	8.053	84.528	2.079	2.42	2.92
FEVD for	1	0	0	100	0	0
wage	5	1.129	3.433	80.947	1.813	12.678
inflation	10	1.662	3.74	78.348	2.378	13.872
FEVD for	1	0	0.685	0	99.315	0
IIP	5	7.772	0.936	0.552	89.6	1.141
growth	10	8.458	0.92	0.942	88.378	1.303
FEVD for	1	0.856	1.001	2.756	0.215	95.171
food	5	2.873	1.46	9.147	2.936	83.585
inflation	10	3.436	1.823	10.274	3.452	81.015

Source: Authors' Estimates

The structural break test in the previous section detects structural break in agricultural wages in 2008 due to universal implementation of MGNREGA in 2008. We re-estimate the SVAR model for aggregate food inflation from January 2008 to investigate any possible change in the degree and pattern of transmission of wage inflation to food inflation post 2008. Figure 8 shows the impulse response results for the sub-sample analysis. The results show a sharp rise in the magnitude of the impact of wage inflation on food inflation in the post MGNREGA period. A 10.0% rise in wage inflation increases food inflation by 5.5% and the effect is significant. This result supports to our hypothesis that post MGNREGA wage rise acts as a cost-push and to some extent demand-pull

⁸ In our analysis, aggregate IIP which includes industries using commodities as inputs is used as an indicator of performance of the industrial sector.

factors for food inflation. We do not see any transmission of global food inflation to domestic food inflation in the recent period. This supports our preliminary observation that domestic inflation does not move with global inflation during the recent period of global food price spike. Effect of fuel inflation shock does not seem to have changed significantly in the recent period.

Table 5 reports the FEVD analysis for the post-2008 period. Comparing with the FEVD results for the full sample, we find that the sources of variation in the food inflation have changed in the post-2008 period. The contribution of the global food inflation in domestic food inflation is halved after 2008. After 10 months out, global food inflation explains only 1.5% variation in food inflation after 2008, whereas its contribution has been more than 3% during the period since 1998. This result again conforms to our preliminary observation that the recent global price spikes have not been transmitted to domestic food inflation, due to the restricted trade policies adopted by India. The FEVD results also show that after 10 months of a shock, more than 21.0% variation in the food inflation is due to wage inflation. This implies that the contribution of wage inflation has doubled in the recent periods. The contribution of fuel inflation has also increased to 3.4% from 1.8% in the full sample scenario. In the post-2008 period, we do not observe significant second round effect on wage inflation from food inflation. Interestingly we find that 10.0% of the variation in wage inflation, after 10 months of a shock, is caused by fuel inflation.

Figure 8: Impulse Response Analysis (Since 2008)

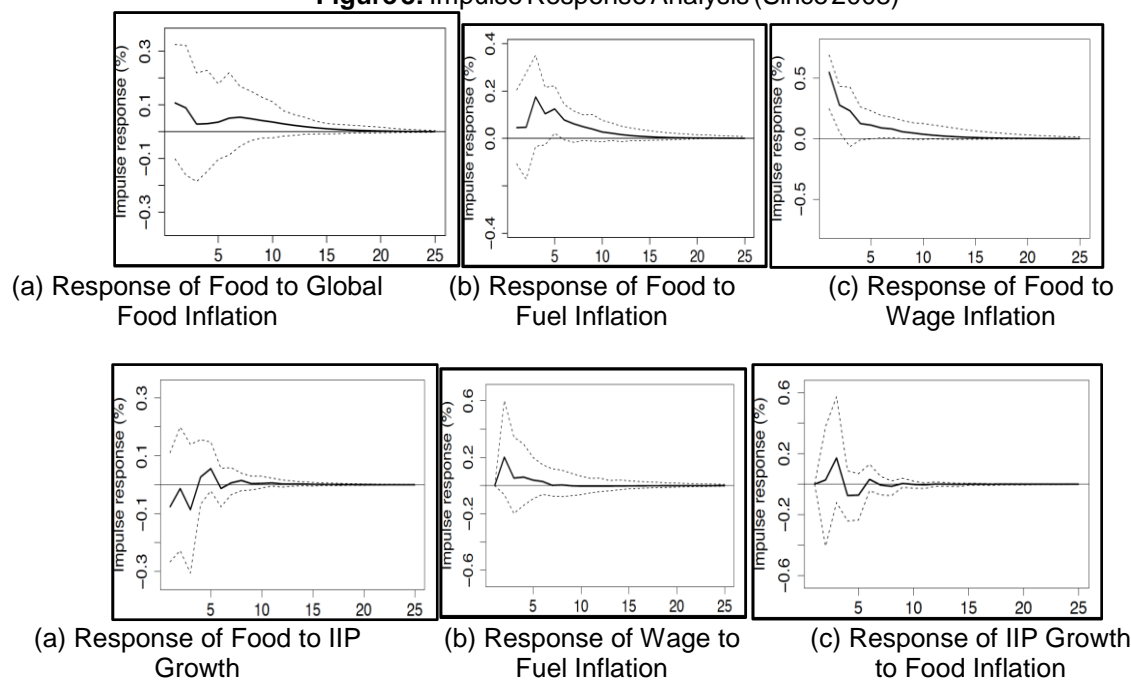


Figure 16 in Appendix A depicts impulse response results for inflation in various food commodities.⁹ The results show that the drivers of inflation vary across commodities. While wage inflation is a common factor for all commodity inflation, fuel inflation has transitory effects on cereal, dairy and sugar inflation. Domestic sugar and edible oil inflation are highly responsive to their respective global inflation, that is, significant global pass-through is observed for tradeables. We find that 1% rise in global sugar inflation leads to 0.5% rise in domestic sugar inflation, while we observe almost one- to-one response of domestic edible oil inflation to global edible oil inflation.

The results of FEVD analysis for the various food commodities inflation are reported in Tables A.4 and A.5 in Appendix A. We find that factors contributing to the variation in commodity inflation vary across commodities. Rural agriculture wage inflation is found to be the common source

⁹ In each of these analyses, global food inflation is represented by the corresponding global commodity price inflation. For example, in the SVAR specification with WPI cereal inflation, global cereal inflation is used as the indicator to capture the inflation dynamics for cereals in the global market.

of variation in inflation in cereals, dairy and sugar and meat. After 10 months of a shock, 4.8-8.0% of the variation in inflation in these commodities is due to wage inflation. Fuel inflation is found to be a significant driver of inflation in cereals, dairy and sugar (2.5-6.5%). A substantial proportion of variation in inflation in sugar and edible prices are driven by their global counterparts. While 34% variation in the domestic edible oil inflation is caused by global edible oil inflation, global sugar inflation drives 10% variation in domestic sugar inflation.

Table 5: FEVD Analysis: Since 2008

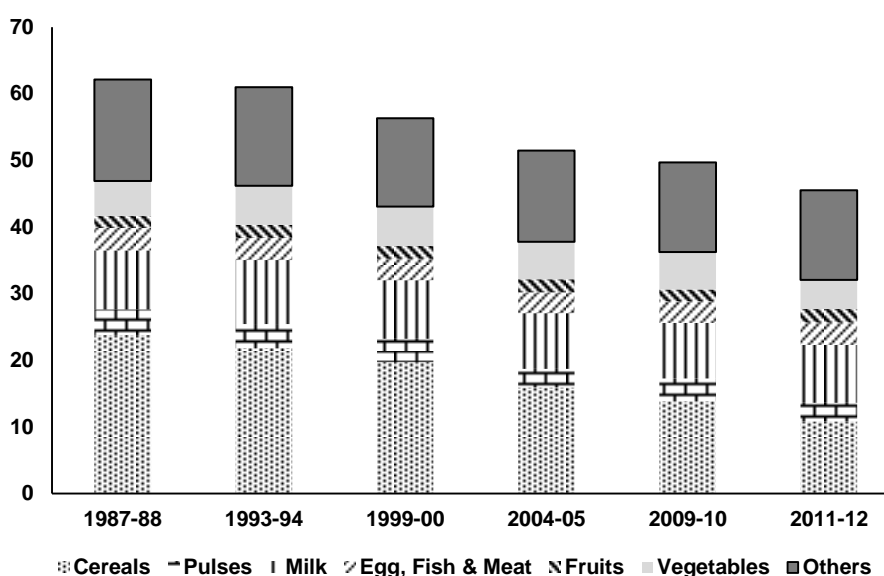
	Horizon	Global food	Fuel	Wage	IIP	Food
FEVD for	1	100	0	0	0	0
global food	5	95.058	1.606	0.452	0.958	1.927
inflation	10	94.148	2.173	0.75	0.993	1.935
FEVD for	1	0	100	0	0	0
fuel	5	13.242	80.139	5.802	0.684	0.133
inflation	10	15.576	77.016	6.505	0.715	0.189
FEVD for	1	0	0	100	0	0
wage	5	2.193	9.101	86.101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

Source: Authors' Estimates

4.2 Rising Demand Supply Mismatch

As discussed in Section 3, a plausible reason put forward for rising global food inflation has been the increase in per-capita income in emerging markets such as China and India. While the literature has found little evidence of this channel at the global level, it remains to be seen whether high per-capita income growth in India resulted in high food inflation, by exacerbating the demand supply mismatch.

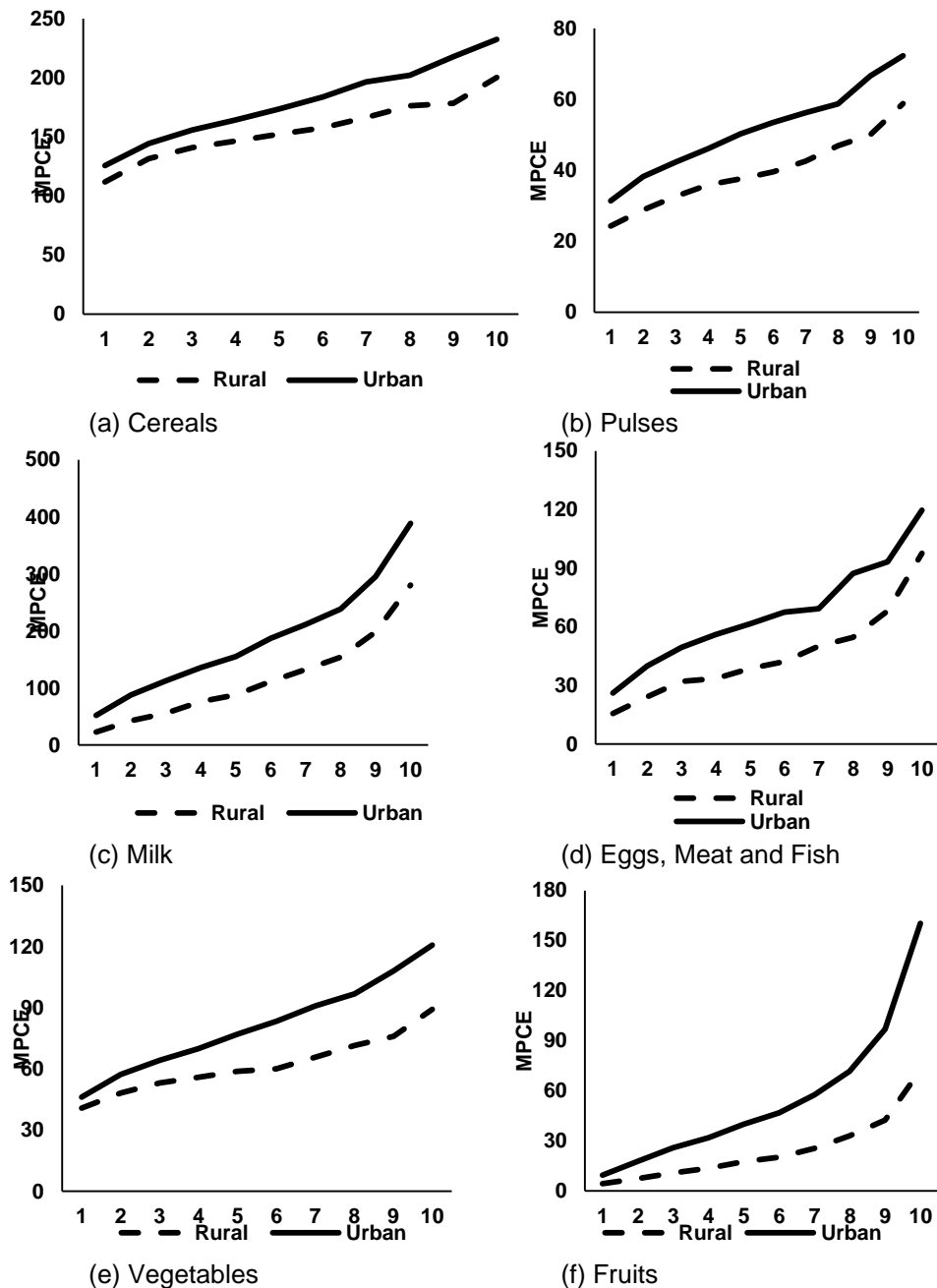
Figure 9: Decomposition of Food Consumption



Using the data from National Statistical Sample Survey Organisation, we document the

trend in share of household consumption on various food items since 1980s (see Figure 9). We concentrate on six major food products viz. cereals, pulses, milk, eggs, meat and fish, fruits and vegetables. It is evident that there has been a steady decline in the share of income spent on consuming food. Over a 24-year period, the share has fallen by nearly 17 percentage points. Moreover, over the period 2004-05 to 2011-12, the proportion of income spent has declined most for cereals, followed by vegetables and pulses. In contrast, a higher share of income was spent on milk, fruits and eggs, meat and fish, providing support to the hypothesis that consumption of high value added agriculture products have increased.

Figure 10: Rural & Urban Engel Curves



Source: National Sample Survey Organisation

Cross-sectional data from the household consumer expenditure survey of 2011-12 also validates a faster increase in consumption of high value agricultural products such as milk, fruits and eggs, fish and meat relative to staples such as cereals and pulses. Figure 10 plots the household monthly per-capita expenditure of six major food items across consumption deciles. For

the rural households, the ratio of average consumption of the top two expenditure deciles to that of the bottom two deciles at 9.8 is highest for fruits, followed by milk at 7.4 and eggs, and meat and fish at 4.2. In contrast, the ratio is less than 2.0 for cereals, pulses and vegetables. A similar pattern is observed in the case of urban consumers where the ratio is again highest for fruits, milk and eggs, meat and fish. The ratio remains below 2.0 for cereals and pulses, while it is 2.2 for vegetables. Thus increases in household income are associated with a significantly larger incremental expenditure on fruits, milk and eggs, meat, fish relative to cereals, pulses and vegetables.

Having corroborated a dietary shift towards products, which have contributed significantly to the food inflation in recent years, we focus on the change in aggregate demand resulting from this shift in diet. We estimate expenditure elasticity of the above selected food items using household consumer data. We cover the period from 2005 to 2014. During this period, three large household surveys were conducted in 2004-05, 2009-10 and 2011-12. Given that expenditure elasticities change over a period of time, we use the middle 2009-10 household survey to compute these elasticities to mitigate this risk. The six selected food items comprise 76% of average Monthly Per Capita Expenditure (MPCE).

We compute aggregate demand as the sum of aggregate household demand and indirect demand requirements from industries using these food items as inputs (seed, feed and wastage [SFW]). We estimate per capita household demand and associated expenditure elasticities for the selected food items using the Quadratic Almost Ideal Demand System (QUAIDS) following Banks et al. (1997). For India, Mittal (2010) have also used the QUAIDS model to estimate the expenditure elasticity in India. However, the elasticities computed in Mittal (2010) are based on household expenditure data from surveys conducted till 1999-2000. We use more recent survey data to compute these elasticities, to accurately capture the role played by rising demand in influencing food prices.

The QUAIDS are specified with expenditure shares as the dependent variable. A household's expenditure share for good i is defined as $w_i = \frac{p_i q_i}{m}$, where p_i is the unit price of good i and q_i is the quantity of good i purchased or consumed and m is the total expenditure on all goods in the demand system. With this definition of m , $\sum_{i=1}^K w_i = 1$, where K is the number of goods in the system. The functional form of the expenditure share under QUAIDS is as follows:

$$w_i = \alpha_i + \sum_{j=1}^K \gamma_{ij} \ln p_j + \beta_i \ln \left\{ \frac{m}{P(p)} \right\} + \frac{\lambda_i}{b(p)} \left[\left\{ \frac{m}{P(p)} \right\} \right]^2 \quad (3)$$

where p is the vector of all prices and $b(p)$ is defined as $b(p) = \prod_{i=1}^K p_i^{\beta_i}$. The aggregate price index is defined as

$$\ln P(p) = \alpha_0 + \sum_{i=1}^K \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^K \sum_{j=1}^K \gamma_{ij} \ln p_i \ln p_j \quad (4)$$

The parameters are subject to the following restrictions

$$\sum_i \alpha_i = 1; \quad \sum_i \beta_i = 0; \quad \sum_i \gamma_{ij} = 0 \quad \forall j; \quad (5)$$

and Slutsky symmetry implies that $\gamma_{ij} = \gamma_{ji}$.

Table 6: Expenditure Elasticity

Products	Mittal (2010)	Kumar et al (2011)	Present study
Cereals	0.165	0.187	0.226
Pulses	0.59	0.716	0.515
Fruits and Vegetables	0.72	0.817	
Vegetables			1.535
Fruits			2.210
Milk and Milk Products			2.185
Milk	1.19	1.640	
Eggs, Meat and Fish	1.300		
Meat and Fish			0.796

Source: Mittal (2010), Kumar et al. (2011) & Authors' estimates

Table 6 shows the estimated expenditure elasticities for the selected food items and provides a comparison with some other recent studies. While Mittal (2010) uses household surveys till 1999-2000, Kumar et al. (2011) uses surveys till 2004-05 to compute the elasticities. As expected, the elasticities for all the products are positive implying an increase in household expenditure is associated with a rise in demand for these products. In particular, with an elasticity of greater than one, the increase in demand for milk and milk products, fruits and vegetables was proportionally more than the increase in household expenditure. With an elasticity of 0.8, demand for meat and fish also increased at a fair pace with overall expenditure. Compared to Mittal (2010), our elasticities are higher for cereals, vegetables and fruits, and lower for pulses, meat and fish.

We compute aggregate household demand using the following equation:

$$D_{i,t}^H = d_{i,0} N_t \prod_{n=1}^t (1 + g_n * e_i) \quad (6)$$

where $D_{i,t}^H$ is the aggregate household demand for commodity i in year t , $d_{i,0}$ is the per capita demand for commodity i in the base year, N_t is the population in year t , g_n is the per capita income growth rate in year n where n goes from 1 to t , and e_i is the expenditure elasticity for the commodity i . Since our base year per capita household demand $d_{i,0}$ is estimated for 2009-10, household demand series from 2004-05 till 2014-15 is estimated by iterating equation (6) backward and forward.

Apart from household consumption, these products are also consumed as inputs in the form of seed, feed and wastage (SFW). Thus aggregate demand for these products must combine direct household demand as well as indirect demand for these products. Estimates of the share of demand for SFW in overall demand are sourced from Planning Commission (2012), and are presented in Table 7. We use the average of the estimates for 2004-05 and 2011-12 to compute aggregate demand for 2004-2013. In addition, an average of estimates for rice and wheat is used to compute the indirect demand for cereals.

Table 7: Indirect Demand for Food Items in India (% of Total Demand)

Commodity	2004-05	2011-12	Average
Rice	12.97	13.43	13.20
Wheat	17.08	17.69	17.39
Cereals	15.03	15.56	15.29
Pulses	37.00	41.71	39.36
Milk	40.58	41.58	41.08
Fish and Meat	39.45	40.83	40.14
Vegetables	37.76	38.43	38.10
Fruits	81.47	82.90	82.19

Source: Planning Commission (2012)

Finally, we compute aggregate demand using the following equation:

$$D_{i,t} = \frac{D_{i,t}^H}{1 - x_i} \quad (7)$$

where $D_{i,t}$ is the aggregate demand for commodity i in year t and x_i is the share of indirect demand in total demand for commodity i .

In estimating the aggregate supply, domestic production needs to be adjusted for post-harvest losses. Nanda et al. (2012) estimate the extent of losses for a variety of commodities and find that these losses range from 2.8% to 4.7% in case of cereals; 3.4% to 5.0% for pulses; 5.8% to 18% for fruits; 7.5% to 13% for vegetables; 0.8% to 6.9% for milk; and 0.8% to 6.8% for fish and meat. We use the mid-point of these ranges to calculate the supply available for consumption.

Figure 11 compares the estimated aggregate demand for the selected commodities with the domestic supply during the period 2004 to 2013. Robust production of rice and wheat ensured that supply of cereals have been consistently higher than demand, with the latter growing at a subdued rate due to low expenditure elasticity. Supply dropped sharply during 2010 following a drought in 2009, and was almost equal to demand. In contrast, supply of pulses has been consistently inadequate compared to the level of domestic demand, forcing India to import pulses to meet the shortfall. However, historical data indicates that import of pulses have not been able to augment supply to fully satiate the demand as global market is very thin, thereby resulting in price pressures. At the same time, import of pulses made domestic prices vulnerable to shocks in global prices.

The high expenditure elasticity in the case of milk translated into demand exceeding supply in 2007, with the former accelerating after 2010. Production growth also declined in 2009 and 2010, exacerbating the demand supply gap. Production of meat and fish has also been persistently lower than demand, with excess demand increasing from 6.8 million tonnes in 2008 to over 8.5 million tonnes in 2013.

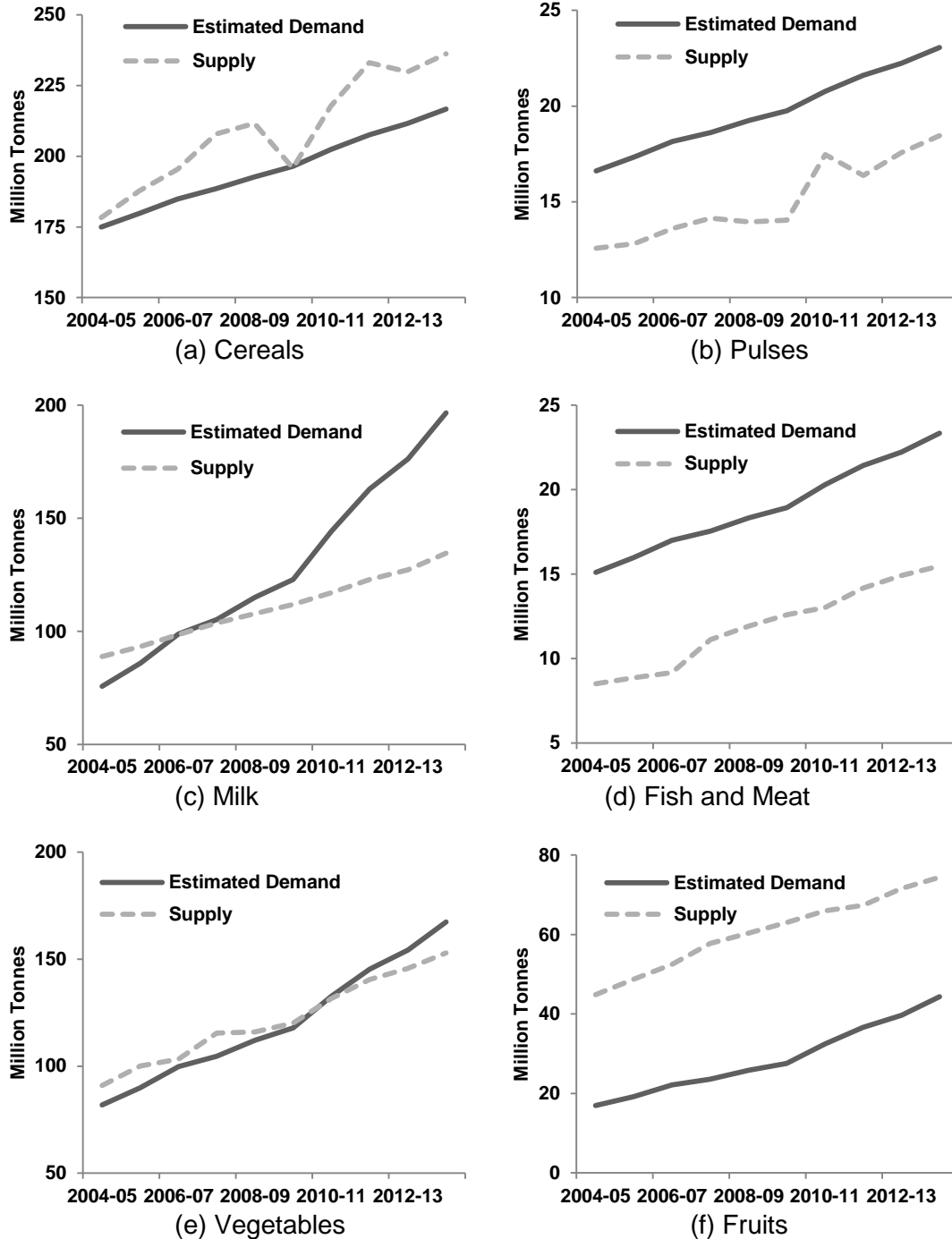
With an elasticity of greater than one, demand for vegetables have grown at a rapid rate. As a result, the extent of excess supply reduced steadily from 2004, and was completely nullified by 2010. Since then, supply has consistently lagged demand and the quantum of excess demand has increased. Although, fruits have also exhibited a elasticity of greater than one, supply response has been robust, with there being a significant excess supply. Thus factors other than demand supply gap explain the surge in fruit prices.

It is evident that shortfall in production has created excess demand pressure for a number of commodities such as pulses, milk, fish and meat and vegetables. The shortfall in production has been driven by limited gains in agricultural productivity in recent decades, with the latter in turn being driven by a myriad of factors including fragmented land holdings, outdated farming techniques, inadequate use of modern inputs, declining share of public investment in agriculture and rising share of subsidies, and lack of organised agricultural marketing.¹⁰

Next, we focus on whether the gap between demand and supply for the various commodities contribute to a rise in prices in India as has been claimed in a number of studies. We empirically estimate the impact of a demand supply gap on food prices after controlling for some of variables found in the literature to have affected food prices. We focus on six food product groups identified above i.e. cereals, pulses, milk, meat and fish, vegetables and fruits.

¹⁰ For a comprehensive review of challenges facing Indian agriculture please see Chand et al. (2012) and Dev (2008).

Figure 11: Estimated Demand Supply Gap



Source: National Sample Survey Organisation and Authors' Estimates

Major factors, which have been found to have impacted food prices, include global prices of various food commodities, minimum support prices, agricultural wages and fiscal deficit. Rising agricultural trade openness and surge in international food prices in 2008 and 2010 provide a proximate reason for influencing domestic food prices. We compile the data on international food prices for the six food groups from FAOSTAT database. A rise in minimum support price (MSP) also fuels food inflation, given that it is meant to be the floor price for various crops i.e. the minimum price at which the government stands to procure crops from farmers. The wholesale prices are typically higher than these floor prices, and if the floor price keeps rising, as has been the case in India, it leads to a rise in wholesale prices as well.

The data on crop wise MSP is compiled from Ministry of Agriculture. In the case of vegetables,

fruits, milk and meat and fish, for which there is no MSP, we set the MSP at zero. Rise in the price of agricultural labour, which is an intrinsic input, could also be a major driver of food prices, particularly as agricultural wages grew by an average annual rate of 17.3% between 2008-09 and 2012-13, nearly four times higher than the average annual growth between 2003-04 and 2007-08. A high fiscal deficit, and a consequent rise in the liquidity for financing the deficit, could also drive food prices up. Data on agricultural wages and aggregate state and central government fiscal deficit as a percentage of GDP, are taken from the Database on the Indian Economy, Reserve Bank of India.

Table 8: Effect of Demand Supply Gap on Food Price

	I	II	III	IV	V	VI
Constant	5.047*** [133.856]	3.578*** [13.057]	0.557 [1.321]	4.634*** [28.108]	4.603*** [84.904]	3.731*** [7.994]
Demand Supply Gap	0.011*** [3.430]	0.013*** [4.769]	0.006*** [2.946]	0.009** [2.561]	0.006*** [2.714]	0.003** [2.188]
Minimum Support Prices		0.884*** [5.395]				0.07 [0.643]
Global Prices			0.901*** [10.594]			0.172 [1.554]
Fiscal Deficit (% of GDP)				0.052** [2.311]		-0.013 [-1.337]
Wage Growth					3.527*** [9.097]	3.092*** [7.522]
Observations	60	60	57	54	60	54

Note: Robust t-statistic in brackets. ***, **, and * imply significance at 1%, 5% and 10% respectively.

Source: Author's calculations.

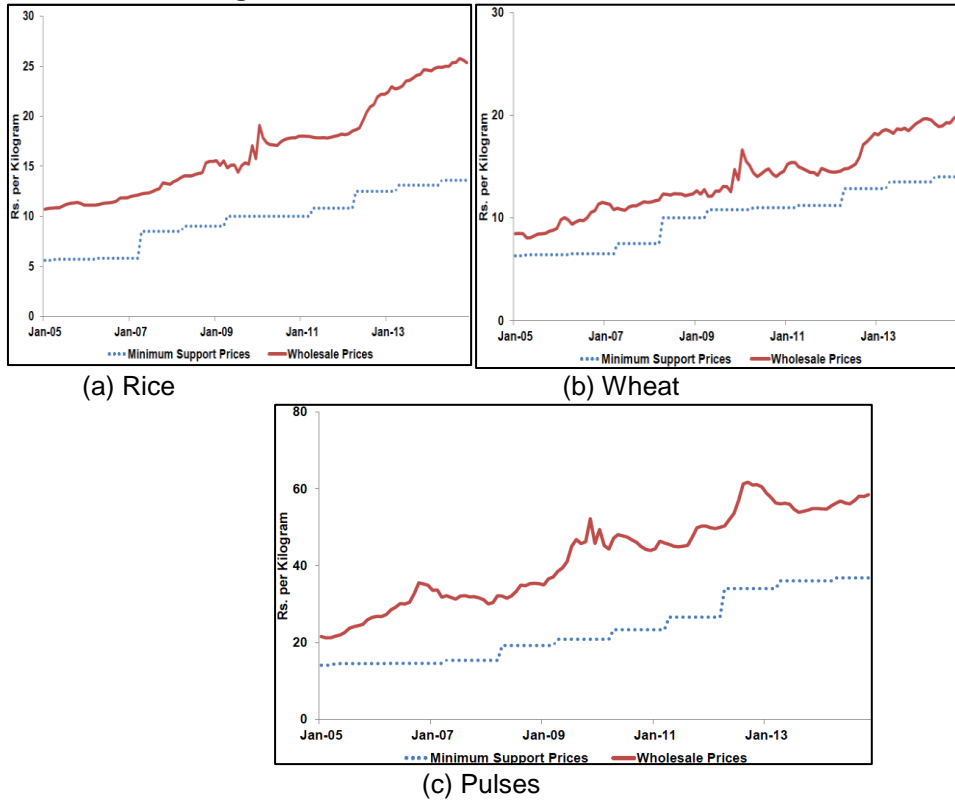
In Table 8, we examine the relationship between commodity prices and the demand-supply gap in these commodities in a panel regression framework for the period 2004-05 to 2013-14. While column (I) focuses on the relationship between demand-supply gap and food prices, in columns (II) to (V) we control for other factors that have been found in the literature to impact food prices. Initially, we introduce these factors one at a time, to evaluate their role in determining food prices. In column (VI), we focus on all the major drivers of food prices. We find the demand supply gap has a significant and positive impact on food prices across all the specifications, although there is considerable variation in the size of the coefficient. Thus the results indicate that an additional gap of 1 million tonnes in demand for food and supply of food would result in food prices increasing by 0.3% to 1.1% annually. Turning to other drivers, we find that each is positive and statistically significant when introduced one at a time. The results suggest that an increase in global prices, minimum support prices, fiscal deficit (% of GDP) and faster wage growth, has a positive and significant impact of food prices. When introduced simultaneously, it is only wage growth, which has a significant impact on food prices, apart from demand supply gap.

4.3 Increases in Minimum Support Prices

As discussed in Section 3, several studies have identified hikes in Minimum Support Prices as a major contributor to food prices in India. A rise in MSP impacts food prices as the 25 commodities on which MSP are announced, constitute nearly 7.3% of the WPI basket. Moreover, the MSP forms a floor price for various crops, as it is the “minimum” price at which the government stands to procure crops from farmers. The wholesale prices are typically higher than these floor prices, and if the floor price keeps rising it leads to a rise in wholesale prices as well. As shown in Figure 12 this is indeed the case for rice, wheat and pulses where wholesale prices have been rising in line with rising MSPs.¹¹

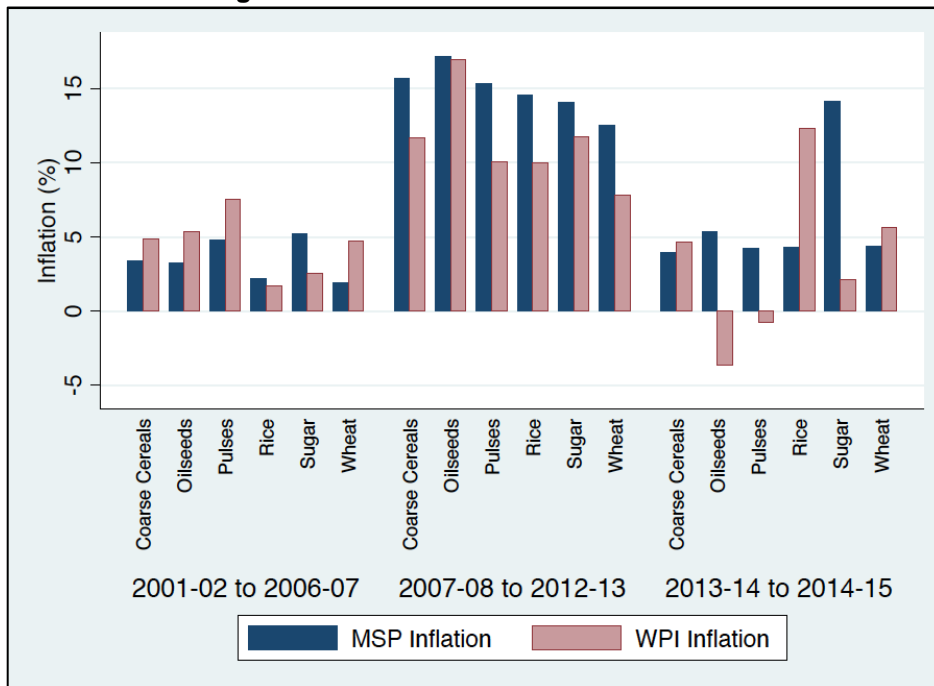
¹¹ For pulses, the wholesale and minimum support prices are calculated as the weighted average of the prices of the various pulses, with the weights based on the WPI basket.

Figure 12: MSPs and Wholesale Prices



Source: Ministry of Agriculture, Government of India & Authors' Estimates

Figure 13: MSPs and Wholesale Prices



Source: Ministry of Agriculture, Government of India & Authors' Estimates

It is also evident from Figure 12 that there was a sharp increase in the amount by which MSPs for rice, wheat and pulses have been raised since 2007. In fact, as depicted in Figure 13, compared to the period 2001-02 to 2006-07, the rate of growth of MSP during 2007-08 to 2012-13 was significantly higher for all major food grains. Not surprisingly, the later period witnessed substantial increase in wholesale prices of these food grains. The high level of MSPs was a major contributing factor in keeping cereal inflation in double digits in five out of the previous eight years.

While rice inflation averaged 8.8% between 2005-06 and 2012-13, wheat inflation was even higher at 9.0%. In recent years, the average MSP growth has moderated around 5% for all MSP crops, except for sugar. The average WPI inflation in these commodities, except for rice, have also shown a declining trend during this period.

We empirically evaluate the effect of commodity-wise MSP inflation on WPI inflation. We focus on 6 food articles, for which the MSP is declared. These include rice, wheat, coarse cereals, pulses, oilseeds and sugar. The aggregate WPI and MSP inflation for coarse cereal, pulses and oilseeds is based on their weights in the WPI basket. For sugar, the corresponding MSP inflation is based on MSP rates for sugarcane. Following the literature we control for lagged inflation and world inflation as well as fiscal deficit, and money supply.¹² We also control for growth difference between agricultural GDP and non-agricultural GDP to gauge the extent of demand arising on the agriculture sector from the non-agricultural sector. All the coefficients are expected to have a positive sign except the one on growth difference as the latter measures the excess of agriculture growth over non-agriculture growth.

Table 9: Relationship between MSP and WPI Inflation

VARIABLES	Rice	Wheat	Coarse Cereals	Oilseeds	Pulses	Sugar
Constant	-0.050 [-0.661]	-0.005 [-0.039]	-0.030 [-0.192]	-0.023 [-0.102]	-0.203 [-0.929]	-0.130 [-0.641]
Lagged Inflation	-0.029 [-0.141]	-0.140 [-0.762]	-0.177 [-0.944]	0.175 [0.810]	-0.382 [-1.218]	-0.262 [-1.069]
Lagged MSP Inflation	0.205** [2.527]	0.196** [2.395]	0.178 [0.688]	0.060 [0.200]	1.048*** [3.102]	1.081** [2.086]
Lagged World Inflation	0.065 [1.431]	0.033 [0.415]	-0.091 [-0.790]	-0.028 [-0.256]	-0.121 [-0.886]	0.101* [-1.763]
Fiscal Deficit	1.455*** [3.731]	0.245 [0.339]	0.005 [0.003]	-2.319 [-1.096]	4.806*** [3.571]	3.501*** [3.645]
Money Supply Growth	0.654 [1.520]	0.559 [0.761]	0.621 [0.704]	0.430 [0.324]	1.631 [1.108]	0.689 [0.631]
Growth Difference	-0.265* [-1.818]	-0.513** [-2.097]	0.314 [0.876]	0.622 [1.244]	-0.366 [-0.566]	0.269 [0.511]
Observations	30	30	30	30	21	30
R-squared	0.288	0.191	0.093	0.096	0.396	0.416

Source: Ministry of Agriculture, Government of India & Authors' Estimates

Next, we perform standard unit root tests to the aforementioned variables. We find that variables such as money supply and fiscal deficit are integrated of order 1. This implies that these variables are non-stationary in levels but stationary in first differences. We employ dynamic least square estimates to identify the impact on MSP inflation on WPI inflation and the results are reported in Table 9.

It is evident that the results vary considerably across the commodities. The rate of increase in MSP prices has a significant impact on next year's WPI inflation in the case of rice, wheat, pulses and sugar. The extent of the impact is highest in the case of pulses and sugar followed by rice and wheat. Thus large hikes in MSP rates have resulted in higher prices for these commodities. Consider the most recent phase of high inflation identified in Section 2 (from June 2008 onwards) when WPI inflation rates of rice, wheat, pulses and sugar averaged 10.9%, 8.1%, 8.3% and 13.8% respectively. The lagged MSP inflation for these crops averaged 14.3%, 10.8%, 16.7% and 14.9%. This can be contrasted with the six-year period prior to 2008 when average inflation rates were significantly lower. During this period, average WPI inflation rates for rice and wheat were 3.6% and 6.0%, while that for pulses and sugar were 5.7% and 0.9%. This was associated with much smaller increases in MSP rates. While minimum support prices for rice and wheat grew by an average of only 2.1% and 3.6%, in the case of pulses and sugar, the increase was limited to 4% and 5.3%.

We do not find world inflation in most of these products having a significant impact on WPI inflation, the only exception being sugar, although the result is significant only at 10% level. India is

¹² We employ both fiscal deficit and money supply growth in our estimations as in India there has been limited correlation between the two variables. Factors other than a high fiscal deficit, such as unsterilized intervention have contributed to money supply growth rate being high.

the second largest producer of sugar, and sixth largest exporter of sugar, and hence is impacted by global prices. The coefficient on fiscal deficit also has the expected sign across all products, except oilseeds, but it is significant only in the case of rice, pulses and sugar. Growth in money supply does not impact the inflation rates in these commodities. Finally, the growth difference significantly impacts inflation in the case of rice and wheat only.

5. Transmission from Food to Non Food and Aggregate Inflation

In the backdrop of persisting high food inflation in India, it is important to gauge the transmission of food inflation to non-food inflation and finally to the aggregate inflation for the effective implementation of policies in the economy. We gauge the transmission of food inflation to core (non-food non-fuel) inflation and to headline inflation.

Food inflation may have positive impact on core inflation via rise in cost of labour inputs, substitution effects of higher relative food prices as well as the real income effect of producers in the food sector. Rise in food inflation will induce labourers to bargain for higher wages, if food constitutes a significant part of their consumption basket. This would raise 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 producers in the food sector, as their real income increases with rise in relative price of food (Anand et al., 2010). Food inflation can raise aggregate inflation substantially if food constitutes a significant share of the consumption basket. The aggregate inflation also increases as a second round effect via the rise in non-food inflation caused by the rise in food inflation. However, in the long run, high and persistent food inflation can have negative impact on non-food inflation in an economy where food has a large share in the subsistence consumption basket. Persistently high food inflation reduces real income in the long run, causing proportionately greater decline in non-food items than food (Engel's law), and hence negative impact on non-food prices.

In our analysis, the non-food and non-oil component of WPI is used as the proxy for non-food prices.¹³ We use Consumer Price Index (CPI, combined) as a proxy for the aggregate inflationary scenario.¹⁴ Figure 14 depicts the movements in food, non-food and aggregate prices over time.

The figure shows a clear co-moving pattern among all the three price levels. We investigate time series properties of food, non-food and aggregate prices and possible co-integrating relation among the three.¹⁵ Our analysis spans the period from January 2001 to September 2014. The price series are found to be I(1) as we cannot reject the null of existence of unit root at 1%, 5%, and 10% level of significance. The first difference of logged price series, i.e., month-on-month inflation rates are found to be stationary as the null of unit root is rejected at 1%, 5% and 10% level of significance. The results of the unit root tests are given in Table B.2, and B.3 in Appendix B.

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. The results are reported in Table B.4 in Appendix B.¹⁶

¹³ The non-food price series is obtained using the following formula:

$$\text{Non-food price} = \frac{\text{WPI} - w_{fa} \text{WPI food articles} - w_{fm} \text{WPI food products} - w_{fu} \text{WPI fuel}}{1 - w_{fa} - w_{fm} - w_{fu}}$$

where the weights used in the above formula are given in Table B.1 in Appendix II.

¹⁴ The Central Statistical Organisation (CSO) publishes rural, urban and aggregate CPI for India, with base year 2010, from January, 2011. Due to the short span of this series, we backcast it using the CPI for Industrial Workers, sourced from Labour Bureau. CPI- IW from January, 1989 to December, 2005 has the base 1982=100, while the series since January 2006 is with the base 2001=100. First, we chain link the two series to a common base of 2001. Finally, we change its base to 2010 using the average value of the series during January 2010 to December, 2010. We backcast the CPI series by the CPI-IW series with 2010 base till 2001 which is the base year of the original CPI-IW series.

¹⁵ CPI, food non-food prices are seasonally adjusted using x-12 ARIMA of U.S. Census Bureau.

¹⁶ The Johansen co-integration trace test statistic tests the null hypothesis: "there are at most r co-integrating

We estimate a Structural Vector Error Correction Model (SVECM) among food, non-food and aggregate prices to gauge the structural relationship in these variables. The VECM specification allows us to capture the long-run as well as short run relationships among the variables. The ordering of the variables follows from food prices to non-food prices and finally to the aggregate price index captured by CPI. The short-run shock-structure assumes that food price instantaneously affects non-food and aggregate prices but not vice versa. On the other hand, on-food price affects aggregate price instantaneously but not vice versa. The SVECM model estimated for food, non-food and aggregate prices is as follows:

$$\Delta y_t = \mu + \alpha \beta y_t + A_1 \Delta y_{t-1} + \dots + A_{p-1} \Delta y_{p-t+1} + u_t \quad (8)$$

where,

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

$$\begin{bmatrix} u_t^{food} \\ u_t^{non-food} \\ u_t^{cpi} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ b_{non-food}^{food} & 1 & 0 \\ u_{cpi}^{food} & u_{cpi}^{non-food} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_t^{food} \\ \varepsilon_t^{non-food} \\ \varepsilon_t^{cpi} \end{bmatrix} \quad (9)$$

where u_t is the reduced form error, and ε_t denotes structural error.¹⁷

The estimated long run cointegration relation in Table 10 suggests that in the long run, 10% wholesale food inflation causes 7.6% aggregate CPI inflation, whereas 10% wholesale non-food inflation causes 4.5% aggregate CPI inflation. However, we find that in the long run, food inflation exerts a negative impact on non-food inflation.¹⁸

Table 10: 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 first column of this table reports the long-run static relationship among food, non-food and aggregate prices. The cointegration coefficients are normalised with respect to the coefficient of log CPI. The second column reports the adjustments parameters of each series to the long run relationship (p- values are in parenthesis). The adjustment parameter of a series reveals how the series respond to the long run relationship.

The adjustment parameters in Table 10 show how different variables adjust to the long run relation. The adjustment parameter of CPI in the co-integration relation is -0.096, saying that CPI adjusts by 9.6% as a response to a 100% deviation from the long run relation. Similarly, WPI food and non-food prices adjust by 13.50% and 9.9% respectively, in response to a 100% deviation

relations" against the alternative of m co-integrating relations, $m=0,1,2,\dots,m-1$.

¹⁷ The parameters β and α represent the vector of long run elasticities and adjustment parameters respectively. Since y_t is the vector of prices in log, Δy_t in equation 8 represents vector of inflation rates.

¹⁸ 1% food inflation causes 0.59% deflation in non-food prices.

from the long run relationship. This implies that food prices respond to a deviation from the long run relation faster than any other variables.

While the cointegration relation reveals the static relationship among the variables in the long run, impulse responses from the estimated Vector Error Correction specification capture the dynamic relationship among variables over a period of time.

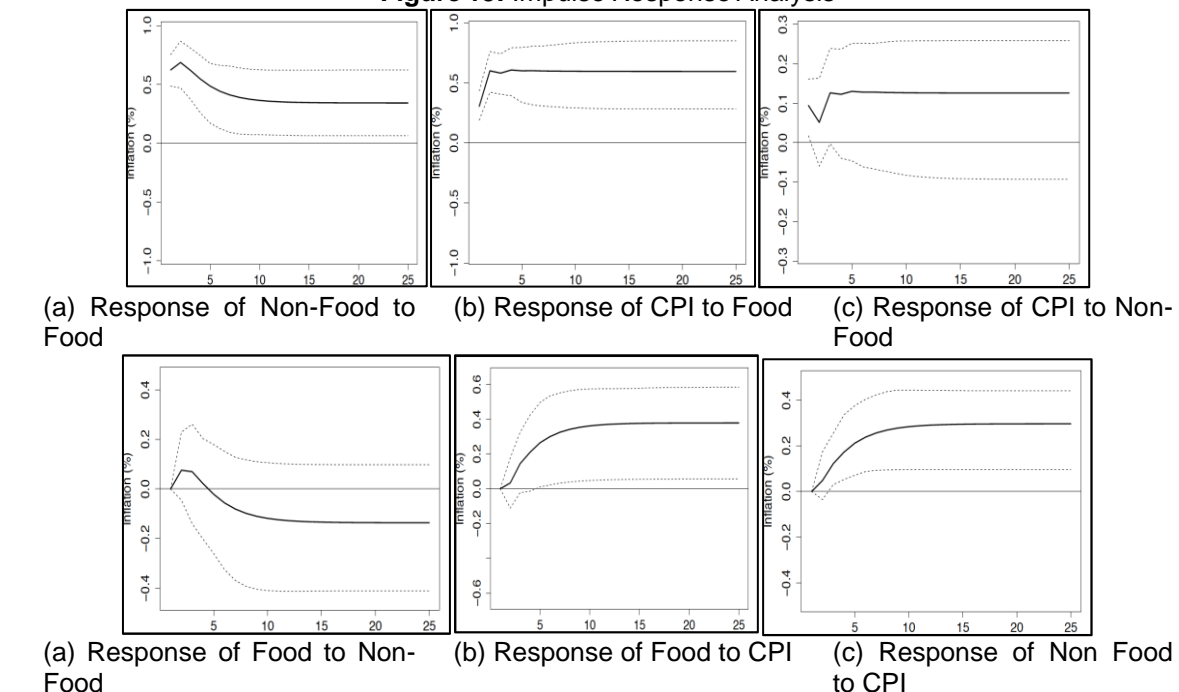
The dynamic effects of a shock to food inflation on non-food and aggregate inflation are captured by the impulse response analysis. Since all three prices are endogenous to each other in a dynamic framework, a shock to food inflation at period t causes an impulse on non-food and aggregate inflation in period $t + 1$, which in turn affects food, non-food and aggregate inflation in the subsequent periods via endogeneity among these prices over time. These dynamics of transmission mechanism are captured by impulse responses.

Figure 15 depicts results of impulse response analysis. One unit shock to food prices, which causes 1% food inflation, will raise non-food inflation by 0.62% immediately after the occurrence of the shock. The effect increases to 0.68% in the next period followed by a reduction to 0.34% that persists till 25 months after the shock. One unit shock to food prices, that causes 1% food inflation, raises CPI by 0.60% after two months of the shock and the effect persists over a horizon of two years.

Non-food inflation exerts upward pressure on CPI 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.

Finally, the results of Forecast Error Variance Decomposition (FEVD) analysis convey the variations in non-food and aggregate inflation due to food inflation. Table 11 reports the FEVD results.

Figure 15: Impulse Response Analysis



Source: Authors' Estimates

The FEVD analysis shows that 1 month out, 60% of variation in non-food inflation is due to variation in food inflation, whereas food inflation contributes 16% variation in aggregate inflation after 1 month of the shock. The variation in non-food inflation due to food inflation declines to 40% after 10 months. The variation in aggregate inflation due to food inflation increases to 60% after 10 months of the shock.

Table 11: FEVD analysis

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

Source: Authors' Estimates

6. Conclusion

With food inflation becoming increasingly persistent and broad-based, it has become imperative to identify factors that are driving the rapid increase in food prices. Our analysis indicates limited role of international prices, although significant pass-through effects from global prices are found for some tradeables such as sugar and edible oil.

The widening gap between demand and supply of major food groups is a significant contributor to food inflation. Our analysis indicates that demand has persistently outstripped supply in the case of pulses, meat and fish. In recent years there has been an excess demand in the case of milk and vegetables as well. Overall, the effect of a rise in food commodity demand relative to supply is found to induce upward pressure on respective prices.

Rise in prices of key inputs have also impacted the prices of various commodities. The rapid increase in price of fuel in recent years is found to exert a moderate influence in food prices. Again, agricultural wage inflation is 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. Large hikes in minimum support prices have also contributed to bolstering food inflation.

Overall, both demand and supply factors have contributed to recent surge in food inflation in India. However, looking deep into the components, contributions of various factors in inflation seem to vary across food commodities. Rise in cost of production and procurement prices are the main drivers of inflation in cereals. Inflation in milk, vegetables, and meat and fish are primarily driven by increase in cost of production and rise in demand relative to the respective supplies. Input cost inflation, positive demand-supply gap and hike in procurement prices are the major factors behind pulses inflation. Agricultural wage inflation mainly drives inflation in fruits prices. Global inflation induces upward pressure on prices of edible oil and sugar, while rise in MSP is an additional factor driving sugar price inflation.

Finally, our analysis also indicates that there is a significant evidence of transmission of food inflation to non-food inflation and aggregate inflation. A rise in food inflation has an impact on non-food and aggregate inflation, with the effects being quite persistent. Moreover, in both the cases, the impact turns out to be quite persistent and takes a long time to die out.

The wealth of empirical literature on food inflation in India highlights various cost-push, demand-pull, global and policy related factors as drivers of inflation in food commodities in the country. The present study evaluates the role of these factors in a consolidated framework, and assesses the diverse pattern of sources in inflation across food commodities. Our work also makes a contribution in testing the long-debated hypothesis of the contribution of dietary shift to food inflation through rigorous empirical analysis.

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Appendix A

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

Components	1993-94 base	2004-05 base
Food		
Food articles	15.40246	14.33709
Food products	11.53781	9.97396
Cereals	4.40629	3.37323
Dairy		
Milk	4.36708	3.23818
Dairy	0.68696	0.56798
Meat		
Mutton	0.44499	0.34586
Beef	0.14860	0.11585
Chicken	0.45163	0.41028
Pork	0.04306	0.05995
Sugar		
WPI sugarcane	1.30493	3.61883
WPI sugar	0.63556	1.73731
Edible oil	2.75515	3.04293
Fuel and Power	14.22624	14.91021

In our analysis, the domestic food and fuel prices are proxied by the components of the WPI, sourced from the Office of Economic Advisor. Data on WPI with base 1993-94 are available for April 1994 to August 2010. The WPI series with the new base year 2004-05 are available from January 2005. We construct an index for food as a weighted average of food articles and food products in WPI. The aggregate food indices are constructed for both old and new bases, using the weights of food articles and food products specified in the respective baskets (Table B.1). Finally, the food indices for the two base years are linked to a common series with the new base year of 2004-05. Similarly, we construct an index of sugar prices as a weighted average of price of sugarcane and the manufactured sugar prices. An index of dairy prices is also constructed using price indices of milk and dairy products. The components mutton, beef, chicken and pork in WPI are used to build an index of meat prices. The weights of the subcomponents used in all these indices, for the two base years are given in Table B.1. Finally, each of the WPI indices for cereals, edible oil, and fuel and power for 1993-94 and 2004-05 bases are linked to the new base of 2004-05.

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 demand for food from industrial sector is proxied by the growth in Index of Industrial Production and sourced from Central Statistics Office. The global prices are sourced from Food and Agricultural Organization of the United Nations.

All the domestic variables, except for fuel, and global sugar prices are seasonally adjusted using x-12 ARIMA of U.S. Census Bureau. WPI fuel index and the global food price indices are not adjusted for seasonality since the series are not candidates for adjustment due to weak seasonal pattern in them. Tables A.2 and A.3 report the results of unit root tests for the variables using Augmented-Dickey-Fuller (ADF) and Kwiatkowski-Pillips-Schmidt-Sin (KPSS) tests respectively. The unit root tests are performed on the seasonally adjusted values of the series which are candidates for seasonal adjustments.

Table A.2: Results of ADF Unit Root Tests

Variable	Test statistic	
	Log price level	POP inflation rate
Global food	-2.720	-5.565
Global meat	-3.081	-6.886
Global dairy	-3.343	-5.825
Global cereal	-2.503	-7.010
Global edible oil	-3.008	-8.717
Global sugar (SA)	-2.872	-8.421
WPI food (SA)	-1.434	-8.788
WPI meat (SA)	-1.352	-9.544
WPI dairy (SA)	-0.779	-7.174
WPI cereal (SA)	-0.771	-6.941
WPI edible oil	-2.391	-8.010
WPI sugar (SA)	-1.580	-6.752
WPI fuel	-2.481	-6.944
WPI wage (SA)	-0.081	-6.583
IIP (SA)	-0.439	-10.859

Critical values for the specification with drift and trend, at 1%, 5% and 10% significance level, are respectively -3.99, -3.43, and -3.13. The ADF test suggests that all the global prices, and WPI edible oil and sugar are unit root processes without any drift and trend; WPI food, meat, dairy, cereal, fuel and IIP are unit root processes with drift; the index of average agricultural wage is a unit root process with both drift and trend.

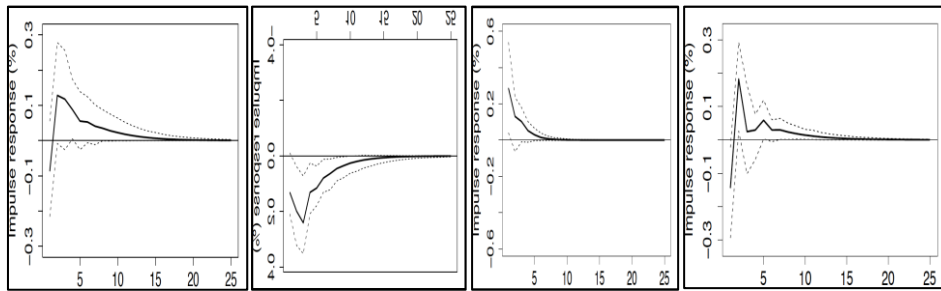
For testing the existence of unit root in POP growth rates, we do not include drift and trend in the specification of the ADF test. The critical values for the specification with no drift and no trend, at 1%, 5% and 10% significance level, are respectively -2.58, -1.95, and -1.62. The POP growth rates of all the global and domestic variables are stationary.

Table A.3: Results of KPSS Unit Root Tests

Variable	Test statistic	
	Log price level	POP inflation rate
Global food	3.685	0.140
Global meat	3.734	0.174
Global dairy	3.311	0.062
Global cereal	3.500	0.098
Global edible oil	2.974	0.133
Global sugar (SA)	3.211	0.098
WPI food (SA)	3.885	0.653
WPI meat (SA)	3.551	0.427
WPI dairy (SA)	3.836	0.481
WPI cereal (SA)	3.814	0.288
WPI edible oil (SA)	3.509	0.101
WPI sugar (SA)	3.579	0.202
WPI fuel	3.859	0.080
WPI wage (SA)	3.595	2.036
IIP (SA)	4.035	0.283

Critical values at 1%, 5% and 10% significance level are respectively 0.739, 0.463, and 0.347. For all the global and domestic variables in levels, we reject the null that the series is stationary around a constant. The POP growth rates of all these series, except for wage rate, are stationary.

Figure 16: Impulse Response for Commodities

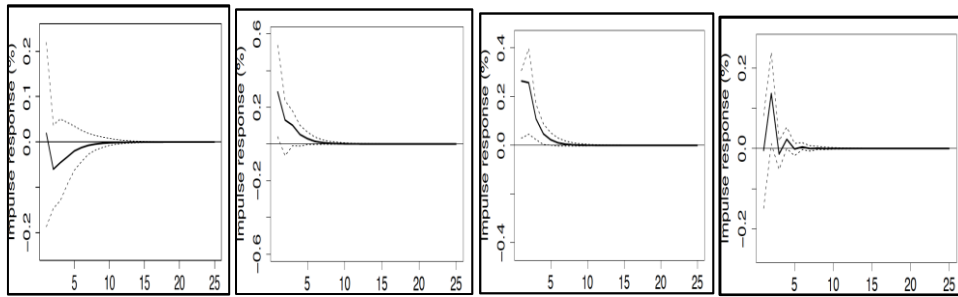


(a) Response of Cereal to Global Cereal Inflation

(b) Response of Cereal to Fuel Inflation

(c) Response of Cereal to Wage Inflation

(d) Response of Cereal Inflation to IIP Growth

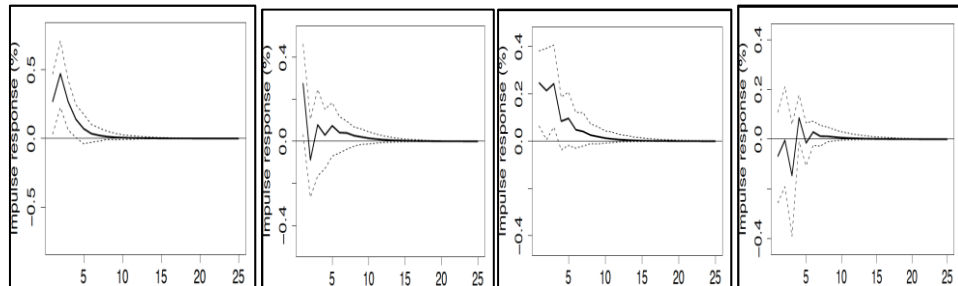


(a) Response of Dairy to Global Dairy Inflation

(b) Response of Dairy to Fuel Inflation

(c) Response of Dairy to Wage Inflation

(d) Response of Dairy Inflation to IIP Growth

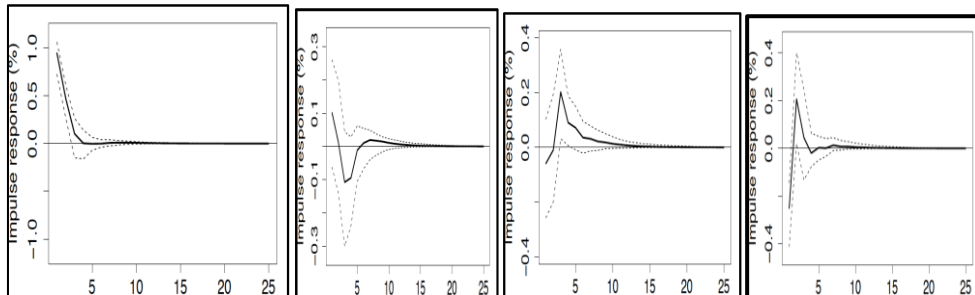


(a) Response of Sugar to Global Sugar Inflation

(b) Response of Sugar to Fuel Inflation

(c) Response of Sugar to Wage Inflation

(d) Response of Sugar Inflation to IIP Growth



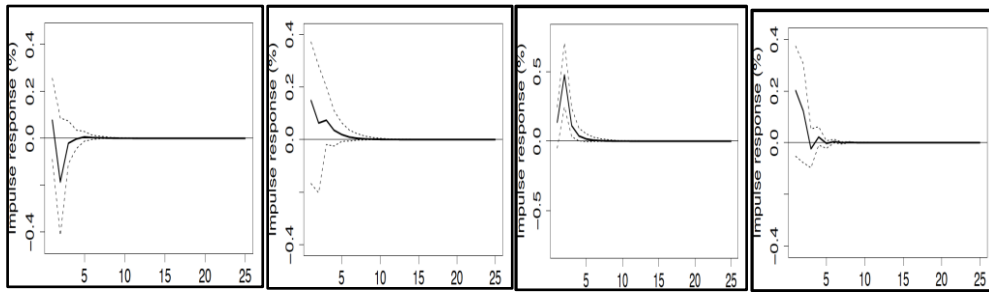
(a) Response of Oil to Global Oil Inflation

(b) Response of Oil to Fuel Inflation

(c) Response of Oil to Wage Inflation

(d) Response of Oil Inflation to IIP Growth

Figure 16: Impulse Response for Commodities (continued)



(a) Response of Meat to Global Meat Inflation

(b) Response of Meat to Fuel Inflation

(c) Response of Meat to Wage Inflation

(d) Response of Oil Inflation to IIP Growth

Table A.4: FEVD analysis: Cereal, Dairy and Sugar

	Horizon	Global Cereal	Fuel	Wage	IIP	Cereal
Cereal	FEVD for	1	100	0	0	0
	global cereal	5	97.565	0.072	0.553	1.683
	inflation	10	97.523	0.089	0.571	1.688
	FEVD for	1	0	100	0	0
	fuel	5	2.919	90.891	2.116	3.823
	inflation	10	3.405	90.097	2.22	3.908
	FEVD for	1	0	0	100	0
	wage	5	2.245	4.772	88.153	1.168
	inflation	10	2.628	5.348	86.616	1.343
	FEVD for	1	0	0.752	0	99.248
	IIP	5	2.064	2.252	0.873	93.196
	growth	10	2.179	2.311	0.949	92.878
FEVD for	1	0.472	1.932	1.118	1.312	
cereal	5	2.551	2.42	7.682	3.091	
inflation	10	2.851	2.818	8.256	3.167	
	Horizon	Global Dairy	Fuel	Wage	IIP	Dairy
Dairy	FEVD for	1	100	0	0	0
	global dairy	5	96.949	0.065	0.952	1.182
	inflation	10	96.788	0.068	1.018	1.196
	FEVD for	1	0	100	0	0
	fuel	5	2.067	90.383	3.571	1.104
	inflation	10	2.166	90.152	3.627	1.111
	FEVD for	1	0	0	100	0
	wage	5	0.119	2.708	91.694	0.099
	inflation	10	0.122	2.723	91.666	0.099
	FEVD for	1	0	0.266	0	99.734
	IIP	5	0.384	2.08	1.195	93.854
	growth	10	0.391	2.085	1.202	93.824
FEVD for	1	0.025	5.434	4.694	0.002	
dairy	5	0.439	6.503	8.766	1.131	
inflation	10	0.453	6.516	8.77	1.132	
	Horizon	Global Sugar	Fuel	Wage	IIP	Sugar
Sugar	FEVD for	1	100	0	0	0
	global sugar	5	93.561	2.047	1.198	1.354
	inflation	10	93.519	2.051	1.229	1.354
	FEVD for	1	0	100	0	0
	fuel	5	2.394	90.225	2.421	4.578
	inflation	10	2.443	89.936	2.584	4.64
	FEVD for	1	0	0	100	0
	wage	5	0.566	5.138	92.462	1.018
	inflation	10	0.646	5.749	91.622	1.094
	FEVD for	1	0	0.8	0	99.2
	IIP	5	0.489	2.608	1.552	94.89
	growth	10	0.504	2.677	1.613	94.734
FEVD for	1	2.273	2.364	1.9	0.145	
sugar	5	10.019	2.453	4.646	0.861	
inflation	10	10.034	2.563	4.761	0.888	

Table A.5: FEVD analysis: Edible Oil and Meat

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

Appendix B

Table B.1: Weights in Sub-components of WPI

Weights		1993-94 base	2004-05 base
Weight of WPI food articles	w_{fa}	15.40246	14.33709
Weight of WPI food products	w_{fm}	11.53781	9.97396
Weight of WPI fuel	w_{fu}	14.22624	14.91021

Table B.2: Results of ADF Unit Root Tests

Variable	Test statistic	
	Log price level	POP inflation rate
Food (SA)	-1.434	-8.788
Non food (SA)	-1.857	-6.666
CPI (SA)	-1.538	-6.057

Critical values for the specification with drift and trend, at 1%, 5% and 10% significance level, are respectively -3.99, -3.43, and -3.13. The ADF test suggests that WPI food and non-food series contain unit root with drift, while CPI contains unit root, drift and trend.

For testing the existence of unit root in POP growth rates, 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. The POP inflation rates in food, non-food and CPI series are stationary.

Table B.3: Results of KPSS Unit Root Tests

Variable	Test statistic	
	Log price level	POP inflation rate
Food (SA)	3.885	0.653
Non food (SA)	4.007	0.155
CPI (SA)	3.325	1.071

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

Table B.4: Johansen Co-integration Test for Food, Non-food and CPI Price Levels

		test statistics	10pct	5pct	1pct
Trace test	$r \leq 2$	3.91	10.49	12.25	16.26
	$r \leq 1$	18.70	22.76	25.32	30.45
	$r = 0$	45.64	39.06	42.44	48.45
Maximal eigen value test	$r \leq 2$	3.91	10.49	12.25	16.26
	$r \leq 1$	14.80	16.85	18.96	23.65
	$r = 0$	26.93	23.11	25.54	30.34

