

Behaviour of Food Price Inflation in India: An Empirical Analysis

*A thesis submitted to the University of Hyderabad
in partial fulfilment of the requirement for the award of*

**DOCTOR OF PHILOSOPHY
IN
ECONOMICS**

By

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Dedicated to My Beloved Parents



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DECLARATION

I, Asharani Samal, hereby declare that this thesis entitled “**Behaviour of Food Price Inflation in India: An Empirical Analysis**” submitted by me under the guidance and supervision of **Prof. Phanindra Goyari**, School of Economics, University of Hyderabad, is a *bonafide* research work, which is also free from plagiarism. I also declare that it has not been submitted previously in part or full to this University or any other University or Institution for the award of any degree or diploma. I hereby agree that my thesis can be deposited in Shodganga/INFLIBNET.

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A. Publication

Asharani Samal (2020): “An empirical analysis of asymmetry and threshold effect of intergovernmental grants in India: A panel data analysis” in: *Global Business Review*, 21(2), 458-472. ISSN: 0972-1509, Scopus and UGC CARE listed journal, Source: <https://journals.sagepub.com/doi/abs/10.1177/0972150918761083>

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1. Presented a paper: “The impact of macroeconomic factors on food price inflation in India: An Evidence from ARDL bound testing Approach” in: the 54th annual conference of The Indian Econometric Society (TIES) at Shri Mata Vaishno Devi University, Katra, Jammu and Kashmir, 7-9 January 2018.
2. Presented a paper: “The relative price variability and food price inflation in India” in: 55th Annual Conference of The Indian Econometric Society (TIES) at National Institute of Securities and Markets (NISM), Mumbai; during 8-10 January 2019.

Further, the student has passed the following courses towards fulfillment of coursework requirement for Ph.D. degree in Economics.

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LIST OF ABBREVIATIONS

AC	Aggregate Inflation-Combined
ADF	Augmented Dickey-Fuller
ARDL	Autoregressive Distributed Lag
AIF	Aggregate Inflation for Industrial Workers
AP	Asset Price Channel
AW	Agricultural Wages
BC	Bank Credit Channel
BSE S & P	Bombay Stock Exchange
CPI-IW	Consumer Price Index for Industrial Workers
CER	Cereals and Products
CPI-AL	Consumer Price Index-Agricultural Labour
CPI-C	Consumer Price Index-Combined
DAFW	Department of Agriculture & Farmers Welfare
DES	Directorate of Economics and Statistics
EGG	Eggs
EX	Exchange Rate Channel
FRU	Fruits
FAO	Food and Agriculture Organisation of the United Nations
FP	Consumer Price Index-Industrial Workers for Food Indices
FIT	Flexible Inflation Targeting
FITF	Flexible Inflation Targeting Framework
FPC	Combined Price Index-Combined
FDI	Foreign Direct Investment
GF	Global Food Price Index
GDP	Gross Domestic Product
HYV	High Yield Variety
IR	Interest Rate Channel
IFPRI	International Food Policy Research Institute
LCB	Lower Critical Bound
MCI	Ministry of Commerce and Industry
MS	Money Supply

MP	Monetary Policy
MF	Meat and Fish
ML	Milk and Products
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Scheme
MSP	Minimum Support Price
MOSPI	Ministry of Statistics and Programmes Implementations
NF	Non-food Inflation
NREG	National Rural Employment Guarantee
NFG	Net Availability of Food grain
OF	Oils and Fats
OLS	Ordinary Least Square
OEA	Office of Economic Adviser
PP	Phillips-Perron
PDS	Public Distribution System
PUL	Pulses and Products
RBI	Reserve Bank of India
REX	Real Exchange Rate
SU	Sugar and Confectionery
SPI	Spices
TNS	Transportation Cost
UCB	Upper Critical Bound
UECM	Unrestricted Error Correction Model
VEG	Vegetables
WPI	Wholesale Price Index
Y	Per capita GDP
ZA	Zivot-Andrews

Behaviour of Food Price Inflation in India: An Empirical Analysis

Abstract

The present study mainly examines the behaviour of food price inflation in both aggregate and disaggregated levels in India. The study has used different data sets and various estimation techniques to fulfil the stated objectives. The different policy conversations have been suggested from empirical outcomes for India. Chapter 2 examines the decomposition of relative price variability into two components (i.e., inflationary and real factors) on 105 commodities' prices over January 2005-March 2017. The study revealed that 25 commodities are predominately contributing 93% of the variability in relative price changes in the food baskets. Further, the decomposition results indicate that 53% of relative price variability under primary food articles is due to real factors, and 47% due to inflationary factors. For manufactured food products, 30% of relative price variability is due to real factors, and 70% is due to inflationary factors. Finally, the non-food item is significantly contributing to the relative price variability of food prices. Chapter 3 investigates the impact of macroeconomic factors on food price inflation during January 2006-March 2019. The long-run estimates demonstrated that per capita income, money supply, global food prices, and agricultural wages are positively and significantly impacting food price inflation in the short-and long-run. But, the food grain availability negatively impacts food price inflation in the short-and long-run. The Granger causality estimates show that bidirectional causality is confirmed among per capita income, exchange rate, availability of food grain, and food price inflation. Further, unidirectional causality is running from global food prices to food price inflation. However, no causal relationship runs from money supply and agricultural wages to food price inflation in the short-run. Chapter 4 analyzes the role of monetary policy shocks on food inflation spanning January 2009-December 2019. Utilizing a quantile regression analysis, we find that the contractionary monetary policy stabilizes food inflation across quantiles. But the exchange rate and transportation cost destabilize it. Further, the study revealed that the monetary policy transmission through exchange rate and asset price channels increases food inflation across the quantiles. In contrast, bank credit and interest rate channels reduce it in lower and median quantiles. The findings show that monetary policy transmission through different mechanisms is heterogeneous across quantiles. The present study recommends some important policy suggestions based on the findings from main chapters.

Keywords: Food price inflation, relative price variability, monetary policy, quantile regression, macroeconomic factors, ARDL bounds test, India

JEL Classifications: E31, Q11, E52, C22, E06, C40

Chapter 1

Introduction

1. Introduction

1.1. Background of the study

The availability of a sufficient amount of food and hygienic drinking water facilities is one of the elementary necessities of all the citizens across the world. The UN Committee on World Food Security defined that “all people should have physical, social, and economic access to sufficient, safe, and nutritious food according to their choice and dietary needs to maintain a healthy life”. Any country which fails to provide the facilities as mentioned earlier, faces food insecurity that affects the welfare of the poor with impoverishment and hunger. The second goal of the UN Division for Sustainable Development Goals (2015) explicitly emphasized food by looking for to “end hunger, achieve food security and improved nutrition and promote sustainable agriculture by 2030”. Further, 193 countries have signed Memorandum of Understanding (MoU) to eliminate extreme poverty and hunger and end all shape of malnutrition by 2030. In 2015, nearly 736 million people internationally still lived below US\$1.90 a day, and most of them do not get food, clean drinking water, and sanitation facilities which are the basic needs for the human beings. The rising price of food items hampers food security which ultimately increases hunger and malnutrition of the nation and finally affects the growth and stability of the economy.

The increasing tendency of global food prices has created many challenges, especially for developing economies where poor people spend their larger share on food items. The high global food price index was observed during 2006–2016, with a y-o-y monthly growth rate of 3–4.5% and high volatility of 15.59–21.36% (Bhattacharya and Jain, 2020). These extreme surges in food prices 2007-2008 are known as the global food price crisis. However, the persistent and continuous increase in food prices worldwide has gained enormous attention by policy makers to keep food price inflation under control. It hampers the welfare of the poor people and retards the food security of the nation. Maintaining stability in prices at a certain level is the main aim of all the central authorities. The importance of food price inflation has gained immense attention and has become a matter of concern for the policy makers in recent years, given the few significant implications. Food contributes a larger share

to total consumption outlay; most of the poor people spend their more considerable amount of income on food. Apart from the significance of food price inflation on the welfare of poor people, food price inflation also has some other macroeconomic implications. The increase in food price inflation also leads to macroeconomic uncertainty. High and volatile food price inflation not only affects headline inflation but also creates uncertainty for the producer and consumers, resulting in rising inflation expectations and hinders public confidence in the central bank in middle-and lower-income countries (Anand et al., 2014; Šoškić, 2015; Pourroy et al., 2016). Most importantly, it also creates problems in forecasting the aggregate inflation rate and attending inflation targets in inflation-targeting countries.

However, India is not free from such high food price inflation, where many of the poor spend their more extensive portion of their income on food. The wholesale price index (WPI) food price inflation was documented at 10.20% during January 2008-July 2010 (Nair & Eapen, 2012). The highest average food price inflation was recorded at 9% in India among emerging market economies during 2006-2014 (Bhattacharya & Sen-Gupta, 2018). The average food price inflation was 7.57%, whereas the WPI inflation rate was 5.3% from January 2006 to March 2017, which is lower than food price inflation (based on 2004-05 prices). On average, inflation in primary food articles has been recorded the highest (9.21%) than the manufactured food product (5.95%). Moreover, the consumer price index for industrial workers (CPI-IW) inflation for food was experienced at 8.05% during 2006-2019 while it was recorded at 13%, especially in 2013. To this connection, Walsh (2011) argued that food price inflation is more explosive and higher than non-food price inflation in lower-income countries. Besides, food price inflation is more persistent than non-food price inflation and is primarily transmitted to non-food price inflation in many countries. The incidence of high food price inflation on the welfare of the people varies across the counties. Because the influence of food price inflation on total inflation depends on economic development and levels of income of the nation. Furthermore, food prices adversely impact health and welfare activities by increasing infant and child mortality and undernourishment in developing nations (Lee et al., 2013). The surge in food prices makes the poor to divert the fund from food to non-food, resulting in a deterioration of health followed by loss of human capital and a decline in productivity that gradually hampers economic growth leading to a welfare loss.

However, high food price inflation has adverse effects on the deprived consumers in developing countries than the developed countries. Hence, high food price inflation retards

the growth and stability of the developing nations, especially country like India, where most of the consumers devote a more substantial share of their income on food products. Further, the high food price inflation plays a substantial role in promoting headline inflation as food donates nearly 43% of weights in the aggregate consumption basket of consumer price index (Anand et al., 2014; Holtemoller and Mallick, 2016). The continuous rise in food price inflation plays a very significant role in boosting aggregate inflation in India (Anand et al., 2014; Patnaik, 2019). According to IFPRI (2020), India ranked 94 among 107 countries and scored 27.2 in the Global Hunger Index, which is worse than Nepal (73), Pakistan (88), Bangladesh (75) and Indonesia (70). According to World Bank (2016), India recorded 22% of the population or 270 million people live below the poverty line, with 25% in rural and 14% in urban areas poverty. Since they spend their larger segment of income on food items, the continuous rise in food price inflation increases poverty and malnutrition, given the limited budget led to a deterioration of their health. On the other hand, the rise in food prices also indirectly imposes inflation tax on the poor in terms of food price inflation, and a rise in food prices reduces the purchasing power of the poor, which pulls them into the situation of malnutrition and hunger. Deshpande and Shah (2010) stated that food price inflation is considered a poor man's tax. In fact, it can be considered a life-threatening tax. Hence, it failed to achieve the food security of the country. Fulfilling the demand for food is a major challenge for the country, where most people spend their significant portion of their income on food.

Both demand and supply-led factors are responsible for the determination of food price inflation. However, other factors also contribute to the inflation in food prices, such as macroeconomic factors. Theoretically, the reasons for rising food prices are two factors in the literature, i.e., real and monetary shocks. These shocks are explained by structuralist and monetarist approaches. According to structuralists, the money supply is sluggish, and the real shocks such as supply-related shocks are responsible for an upsurge in food and relative prices. The surge in these prices is ultimately confirmed through the rise in money supply. Hence, inflation occurs in the price of commodities. However, monetarists argued that inflation is driven by the autonomous increase in money supply via generating aggregate demand, which increases the relative price of commodities. Hence, a surge in inflation is a result of rise in money supply, it is not necessarily because of response to accommodate by real shocks. Further, the global food prices and real exchange rate are also accountable for food price inflation in the domestic countries. The depreciation of the real exchange rate

surges the food price inflation via increasing the import of petroleum products, fertilizer, and other finished products relating to agricultural commodities. The import of certain agricultural commodities increases food price inflation by raising the cost of the agricultural products, pursued by an upsurge in food prices. As India is the largest importer of fertilizers and pesticides from abroad. The increase in the price of these products may add the cost of production to the domestic country, resulting a surge in the prices of food items. Further, a growth in per capita income positively affects food price inflation through the increasing purchasing power of the money in the hands of the people, which leads to a surge in demand for food items resulting in a rise in food prices. The rise in income due to high economic growth leads to changes in the dietary habits of the people by shifting demand from cereals-based food to protein-based products, thereby upsurge in demand for these proteins rich products like milk, fish, and meat resulting in food price inflation. Furthermore, a rise in economic growth leads to a rise in demand for energy. To get the low cost-based energy, there is a rising need of demand for biofuel energy which can be produced from agricultural supplies such as maize, rapeseed oil, and other grains and edible oils. The use of agricultural products for the purpose of extracting biofuel energy eventually reduces the agricultural output available in the market, resulting in a rise in the prices of food products. Moreover, the increase in the global food price of the commodity can influence the domestic price of commodity via international trade mechanism. The extent of transmission of global food price on the domestic supply or price hike in the domestic market depends on which extent or magnitudes commodity trade takes place. Further, an increase in prices from the global to domestic market can be transmitted based on at what magnitude agricultural sector is integrated with the global market. At the same time, an increase in agricultural production decreases food price inflation by increasing the supply of food items. Thus, food price inflation decreases. However, there has been a rising trend of food price inflation due to high economic growth, given the low growth rate of agricultural production, which increases the demand for food items further pushes the price upward. Further, the low and unequal growth of agricultural sectors compared to the service and industry sectors put the price in an upward direction. With the increased agricultural production to another level, the government has to improve the agricultural sector by investing funds in irrigation, and the adaptation of new and modern technology. However, investment in the agricultural sector has been declined in recent years. Therefore, huge investment should be undertaken in the agricultural sector by the government to increase agricultural production and productivity, resulting in a decline in food price inflation.

Further, theoretically, it is also recognized that contractionary monetary policy stabilizes prices by reducing food price inflation. The monetary authority adopts the contractionary monetary policy by increasing the interest rate to reduce the food price inflation. The rise in interest rate declines the circulation of money supply in the economy. The reduction in money supply lowers bank deposits. It became expensive for the bank to refinance for new lending activities, which causes to decline in bank lending. As the interest rate rises, the risk associated with the previous loan also rises. Therefore, banks stop providing the new loan that puts downward pressure on the supply of credit. The decline in bank credit hurts the consumption and investment for households and investors as well. Thus, a reduction in aggregate demand and gradually inflation declined. However, the contractionary monetary policy decreases food price inflation by increasing the supply of the commodities via increasing storage cost resulting decline in food price inflation. Moreover, the government has taken several policy stances to reduce food price inflation in India. To tame high inflation under control, the government has recently established a new FITF with the range of 2-6% with the supervision of monetary policy authority. However, the prevalence of high food price inflation is persisting in the Indian context compared to headline inflation which is a serious discussion topic.

Given the above background, it is essential to recognize the responsible commodities that contribute to the fluctuations in the relative prices of food commodities and its relative importance of both demand and supply-led factors to the variation in the relative price of food items; behaviour of food price inflation with both demand and supply-side factors, and finally, the role of monetary policy to reduce the food price inflation in India. The present study attempts to examine all these issues.

1.2. Outline of topics, inspiration, and research query

1.2.1. Decomposition of relative price variability of food items

One of the significant economic challenges faced by the Indian economy is high food price inflation. Therefore, the monetary authority must look into the matter and take necessary policy initiatives because it created several issues concerning the instability and it affects the country's welfare implications. However, the importance of the high relative price of food items on the growth and stability varies across the nations. It affects the country where the poverty rate is high, as most people devote a more extensive share of their income on food. Inflation affects the economy through its relative price changes which turn to a welfare loss.

Ukoha (2007) argued that high inflation would increase the relative price variability among the agriculture commodities, inefficiency, and misallocation of resources in agriculture. The fluctuation in relative prices reduces the economy's welfare in the general and agricultural sector in particular. The inflation and relative price variability are grounded on the menu cost approach and rational expectation model. Inflation has an adverse consequence on the real sector of the economy through its relative price variability. Under the menu cost model, when a higher level of inflation prevails, prices become more scattered. Hence, higher variability in relative price changes (Sheshinski and Weiss, 1977). Ball and Mankiw (1995) argued that large shocks to a few commodities have a disproportionate effect on aggregate inflation due to the firms' price adjustment. Hence, the distribution of relative price changes promotes aggregate inflation. It suggests that change in the price level is positively associated with the skewness of relative price changes and vice versa. The measures of supply shocks, namely, relative prices of food and energy, are responsible for the innovation of aggregate inflation.

However, along with inflationary factors (supply-side) like variation in technology, resource availability, and other factors of supply, variability in relative price is also originated from real factors, namely, real income, family structure, and various other factors of demand (Parks, 1978; Rather et al., 2014). The change (increase) in income stimulates consumer demand, resulting in relatively proportional changes in prices. To this line, Fischer (1981) also argued that food and energy shocks are the significant determinants of higher relative price variability in the US throughout the post-1956 period. It contradicts the classical monetarist who believed that relative price changes arise due to real factors but not due to inflation. Hence, inflation occurs owing to changes in the money supply. The increase in food price inflation hampers the welfare and growth of the economy. Thus, it is necessary to know at what magnitude variability of relative prices in food items is determined by real factors and inflationary factors in the distribution of relative food prices.

With the given background of the effects of inflation on relative price variability of the food basket and its negative impact on the economy's growth and stability, India has implemented inflation targeting through a monetary policy framework to keep inflation under control. There has been a growing importance of decomposition of relative price changes over the period as inflation affects real sectors through the relative price changes. Suppose relative price changes occur due to real factors such as changes in demand shift variables, resources, weather, and technology that bring to an efficient allocation of resources because these forces

arise from market forces of the economy. On the other hand, if variability in relative prices changes in the food items due to inflation, it decreases the economic welfare benefits in the economy largely by an inefficient allocation of resources and agricultural sectors in particular. The lack of actual information about the uncertainty in price creates a problem for producers and consumers in their investment and production decisions and households' consumption decisions due to the rise in inflation. Thus, the producer faces a loss of real income. Therefore, it is essential to know whether relative price changes occur due to inflation, and if so, then what is the magnitude of change due to inflation. When inflation contributes to larger variation in relative price changes, it reduces the economic welfare by an inefficient allocation of resources. The study aims to empirically inspect the subsequent research questions as tracks: 1) Identify each commodity in the food basket, which contributes to the higher relative price variability. 2) decomposition of relative price variability of food items into two components, i.e., real factors (demand-side) and inflationary factors (supply-side). This will provide useful insights for the policymakers to implement policy verdicts regarding the responsible commodities of higher relative price variability and forecast inflation accurately. The information regarding the commodities in the variability of relative prices would help the central authority take appropriate policy suggestions regarding its contribution. The quantifying relative significance of both demand and supply-side factors in the variability of relative price would give an idea of specific policy suggestions regarding demand and supply to tame the high relative price of the food basket and protect the consumer from food insecurity. Finally, identifying a particular commodity could help the producer plan to invest in which specific commodities given the larger variability in relative prices in food items to avoid the risk and uncertainty associated with each of the commodities. This study can also offer some policy initiatives relating to disaggregated commodities on how variation in the relative price of a particular commodity can affect the economy's stability, followed by the welfare of the people to a larger extent.

However, a little study has identified the commodities which led to variability in relative price changes in the food basket using different data periods and methodology. Although, few studies have investigated the decomposition of relative price variability for the aggregate price level, namely Clements and Nguyen (1981, 1982) for Australia, Ram (1990) for the U.S, and Rather et al., (2014) for India. However, none of the studies have explored the decomposition of relative price variability of food items in India's case. This study also reflects on verifying to what extent non-food commodities are accountable for variation in

relative price changes. The study also finds out their relative contribution of real and inflationary factors in variability of relative price changes of food items taking both WPI and CPI non-food commodities. Finally, to best of my information, this is the primary study investigating the decomposition of relative price variability into two elements owing to real and inflationary factors. Therefore, this study accomplishes a gap in the existing literature.

1.2.2. Macroeconomic factors and food price inflation

There has been a growing significance of macroeconomic effects of food price inflation in recent years due to globalization and the global market's financial integration. Therefore, change in economic conditions of domestic and global markets may affect the domestic market price through international trade. The high inflation can also destabilize the other macroeconomic variables if the second-round effect of food price occurs. World Bank (2009) declared that "high volatility in food prices, combined with the impact of the financial crisis, threatens to further increase food insecurity." The recent increase in food price has gained larger attention by the policymakers on the factors that drive food price inflation.

The change in macroeconomic factors may have a substantial consequence on food price inflation in the domestic markets. An increase in money supply promotes food prices through aggregate demand channels. For instance, if the money supply positively affects food prices, the consumer suffers from welfare loss. If it negatively impacts food prices, the producer suffers from welfare loss. A surge in per capita income is positively affected food price inflation via the rising purchasing power of money, increasing demand for food items tracked by an escalation in prices. If per capita income increases food prices, it adversely affects the welfare of the country by increasing infant and child mortality and undernourishment with the rise in the level of poverty where expenditure on food is higher in the aggregate consumption basket. On the other hand, intensification in food prices in the future creates a positive atmosphere from the producer's point of view. They can predict the future prices of the commodities and take investment decisions on the production of commodities and other economic activities.

Further, the depreciation of the real exchange rate upsurges the food price inflation through the import of petroleum products and fertilizer, and other related goods. In depreciation, the import is costlier than export. So, there is food price inflation. The rising import makes the balance of payment crisis in the future. Moreover, the increase in the global food price

influences the domestic price of commodities via an international trade mechanism. However, this important relationship of macroeconomic factors has not been empirically analyzed significantly with respect to food price inflation in India. The macroeconomic factors are significantly influencing the food price through changes in demand and supply conditions in the food sector. The surge in price plays a very crucial role in price volatility.

Moreover, if macroeconomic factors positively affected food price volatility, it would help policymakers take appropriate policy decisions of the price associated with the agricultural sector. Identifying the causes of food price inflation will help both consumers and producers about the dynamics of macroeconomic factors. The producers can be benefited by receiving the price information regarding the effects of macroeconomic factors on food price inflation and can produce the commodities accordingly. Moreover, the analysis will help consumers manage their consumption expenditure with the presence of dynamic macroeconomic conditions.

Given the significance of macroeconomic factors on food price inflation, various studies have explored the impact of macroeconomic factors on food price inflation worldwide. For example, (Kargbo (2000) for Eastern and Southern Africa; Kargbo (2005) for West Africa; Reziti (2005) for Greece; Kargbo (2007) for South Africa; Yu (2014) for China and Sasmal (2015) for India. Most of the previous researches have inspected the dynamics of macroeconomic factors on aggregate inflation. Nevertheless, few researches are empirically scrutinized the influence of macroeconomic factors on food price inflation by incorporating other control variables like net availability of food grain into account. To the best of my information, few studies exist in India, which have included both demand and supply-side factors in our study. Therefore, the goal of the current work is to assess the long-run and short-run influence of macroeconomic factors on food price inflation and verify the causal relationship aspect of these variables in the case of India.

1.2.3. Monetary policy and food price inflation

The high food price inflation rate has paid larger attention in recent times by the policymakers as it has significant welfare implications. The inflation in primary food articles has started increasing in 2006 and peaked at 21.85 % in May 2010 and finally reached 19.69% in December 2013. Similarly, the inflation rate of manufactured food products was significantly high at 10.43% and 19.30% in July 2008 and March 2010, respectively.

However, inflation was reduced in 2014 onwards and further reached 12.60% in June 2016. The primary reason behind the high inflation rate (10.9%) of overall commodities in May 2010 was due to high food price inflation. The average food price inflation was 7.57%, whereas the WPI inflation rate was 5.3% (based on 2004-05 prices) from January 2006 to March 2017. On average, inflation in primary food articles has been recorded the highest (9.21%) than the manufactured food product (5.95%). Whereas CPI food price inflation was high during 2012 and continued in the middle of 2014. The highest CPI inflation was recorded at 15.6% in November 2013. Further, it started increasing in 2015 and continued till the end of 2016. Overall, the average inflation during that period exceeded 6%. However, average food price inflation during January 2012-September 2020 was high for meat and fish, eggs, milk, vegetable, pulses at 7.95%, 6.24%, 6.35%, 8.84%, and 6.43%, respectively.

Given that food consists of a higher contribution to aggregate consumption expenditure and most individuals spend their larger amount on food and its weights, it also contributes nearly 43% of the aggregate consumption basket of CPI. Further, India has ranked as highest numbers of poor people, over 170 million, which accounts for nearly one-fourth of global poverty in 2015 and comprises four extreme poor out of five are lived in India, among the South Asia regions. On the other hand, it is also identified as one of the world's rapidly growing countries. Furthermore, food prices adversely impact health and welfare activities by increasing infant and child mortality and undernourishment in developing nations (Lee et al., 2013). High and volatile food price inflation not only affects headline inflation but also creates uncertainty for the producer and consumers, resulting in rising inflation expectations and hinders public confidence in the central bank in middle-and lower-income countries (Anand et al., 2014; Šoškić, 2015; Pourroy et al., 2016).

Most importantly, it also creates problems in forecasting the accuracy of the aggregate inflation and attending inflation targets in inflation-targeting countries. However, despite several economic and social welfare implications, the impact of monetary policy on food price inflation has been ignored. Most of the literature has emphasized the behavior of aggregate inflation and other macroeconomic variables by following monetary policy shocks. Maintaining stability in food price inflation provides many welfare benefits for developing countries like India. If contractionary monetary policy increases food price inflation, it provides the information that food price inflation is determined by the supply-side factors through production cost channels. The contractionary monetary policy promotes food price

inflation via raising the cost of capital by the non-food sector followed by the cost of production, resulting in a price rise. In the presence of Engel's Law, monetary policy does not reduce food price inflation; instead, it imposes a harmful impact on the non-food sector. Therefore, selecting aggregate inflation as optimal policy measures of inflation targeting put upward pressure on both the food and non-food sector, resulting in a rise in core inflation. If contractionary monetary policy reduces food price inflation, it will help monetary policy authority implement the contractionary monetary policy to reduce the high food price inflation followed by aggregate inflation as its weights contribute higher to CPI baskets. Further, stability in food prices not only stabilizes aggregate inflation and other aggregate macroeconomic variables but also helps in achieving inflation targets in inflation-targeting countries and maintains forecasting accuracy of the aggregate inflation. Several factors, such as demand and supply-side factors, determine the high inflation in food prices. Therefore, the government has taken several appropriate policy steps to stabilize the high food price inflation. However, it is also essential to know whether policy initiatives taken by the central authority are effective enough to stabilize food price inflation for India. The sustainable growth of the economy can be achieved if contractionary monetary policy stabilizes inflation in a prescribed manner. From the beginning of 1998, monetary policy was conducted by RBI using a multiple indicator approach. After the 2008 global economic crisis, the rising importance of stagflation creates many economic challenges for the monetary policy and its trustworthiness of multiple indicator approach. Thus, to tame high inflation under control, a new monetary policy agreement with a flexible inflation targeting framework (FITF) was implemented in India with the endorsement of the Urjit Patel committee in 2015. Since then, the RBI has activated a FITF in 2016 to perform the monetary policy. With this new inflation targeting outline, the RBI targets CPI inflation at 4% with a ($\pm$) 2% tolerance band. Therefore, the central goal is to response the subsequent questions: 1) whether the increase in food price inflation driven by various factors can stabilize with the response of contractionary monetary policy shocks. 2) the study also investigates whether the effectiveness of monetary policy transmission through different channels, stabilizes food price inflation and various component of food items?

Numerous researches have focused on the outcome of monetary policy on aggregate inflation and other different macroeconomic factors. But very few studies have carried out on the behavior of food price inflation due to contractionary monetary policy shocks. However, unfortunately, few researchers are empirically analyzing whether monetary policy shocks

stabilize food price inflation. (Frankel, 2008; Akram, 2009; Moorthy and Kolhar, 2011; Scrimgeour, 2014; Hammoudeh et al., 2015; Anand et al., 2014; Holtemoller and Mallick, 2016; Iddrisu and Alagidede, 2020; Bhattacharya and Jain, 2020). Out of them, these are studies that attempt in the case of India (Moorthy and Kolhar, 2011; Anand et al., 2015; Holtemoller and Mallick, 2016). Examining the influence of monetary policy on food price inflation in India is a crucial issue. It helps governments and policymakers implement various policy measures concerning food price inflation. Regarding the achievement of multiple monetary policy channels, this is the first study that emphasizes the role of monetary policy in stabilizing food, non-food and aggregate inflation, and sectoral food price inflation in India.

1.3. Overview of India's food price inflation

In this segment, we discuss the existing trends and patterns of food price inflation in India, both in aggregate and disaggregate terms. From this statistical analysis, we can notice the recent trend of total food price inflation and disaggregated food commodities patterns. It enables us to classify the associated food items, which largely contributes to food price inflation in India. Therefore, the monetary authority can take possible policy initiatives to stabilize the food price inflation to maintain stability and growth of the economy at large.

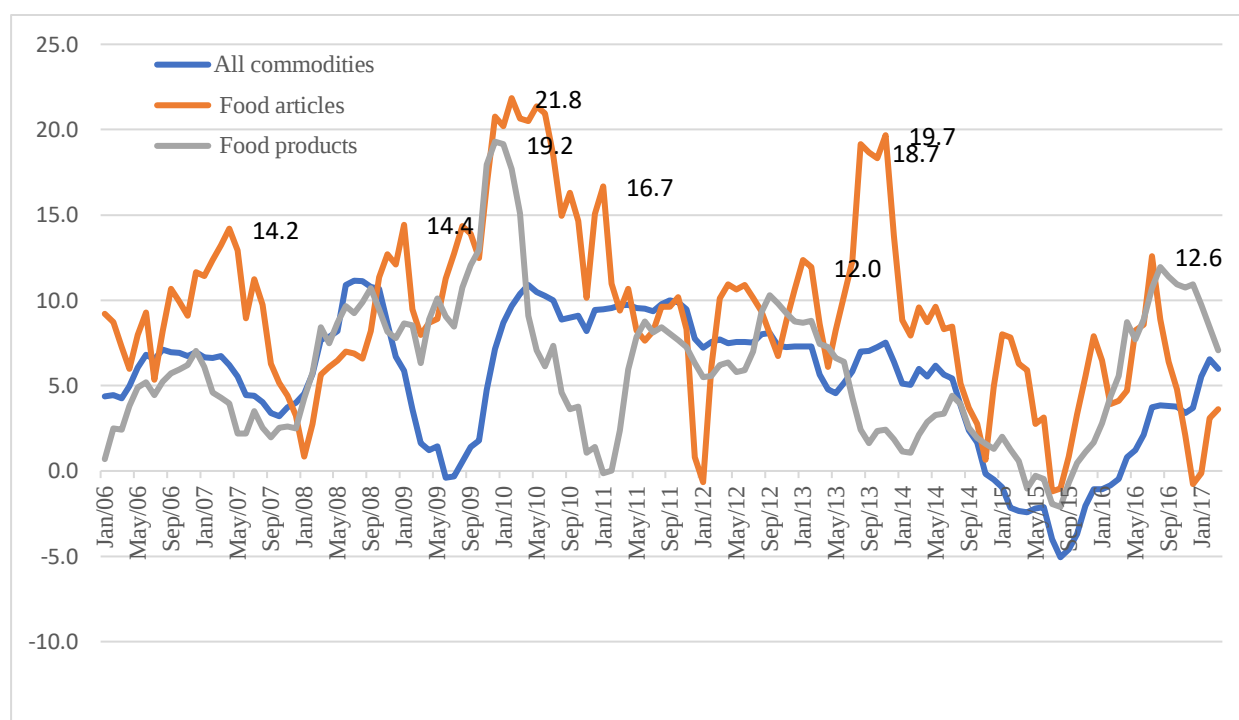
1.3.1. Trends and patterns of CPI and WPI aggregate inflation and WPI disaggregated food price inflation

This sub-section describes the trend and patterns of WPI food price inflation and WPI aggregate inflation in India. In Figure-1.1, it shows the trends of food articles, food products, and all commodities. It indicates that inflation in food articles was started increasing in the year 2006 and peaked at 21.85 % in February 2010, and finally reached 19.69% in November 2013. Similarly, the inflation rate of food products was significantly high at 10.43% and 19.30% in July 2008 and March 2010 and again reached 12.60% in June 2016. However, the inflation rate of overall commodities has increased at a slower rate compared to food articles and food products during the period except for the year November 2011. The major reason behind the high inflation rate (10.9%) of all commodities in May 2010 was due to high food price inflation in 2010.

However, the food price inflation was higher than CPI overall inflation from 2012 to end of 2014 and crossed double-digit during the same period. The reasons for rising food price

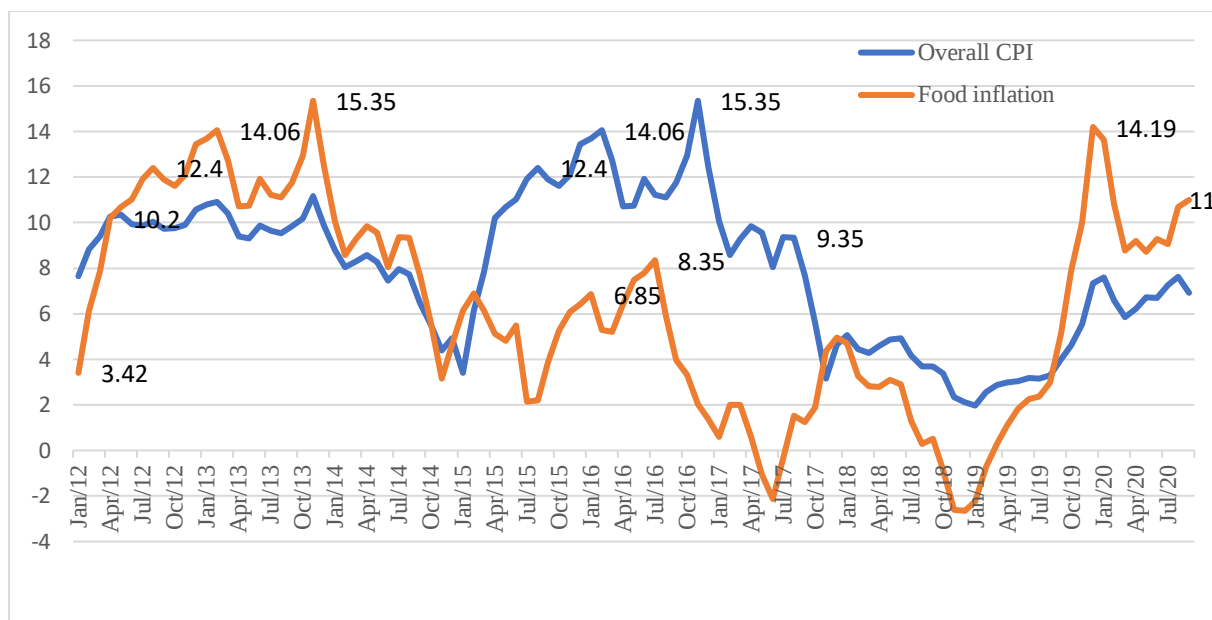
inflation are the rise in inflation in meat and fish, egg, milk, and vegetables. The highest inflation was recorded at 15.6% in November 2013 and declined gradually at the end of 2015. Further, it started rising in early phase of 2016 and continued till the end of 2016 and peaked at 14% in December 2019. The inflation in these food items has pushed overall food price inflation high, followed by aggregate inflation. Overall, the average food price inflation exceeded 6%, and overall CPI inflation was 8% during January 2012-September 2020 (based on 2011-12 base year). The overall CPI and food price inflation are depicted in Table 1.2. This figure clearly demonstrated that aggregate inflation is lagging behind food price inflation. When food price inflation is high, overall inflation is also high and vice versa. The trend and patterns of both the food and overall CPI inflation are quite similar to each other. Therefore, we can conclude that food price inflation is one of the driving indicators of rising aggregate inflation in India. The trend and patterns of disaggregated data analysis have been carried out using WPI food indices (2004-05 base year).

Figure 1.1: WPI food and headline inflation in India (%)



Source: Office of Economic Adviser, Ministry of Commerce and Industry (MCI)

Figure 1.2: CPI food price inflation and overall CPI inflation in India (%)

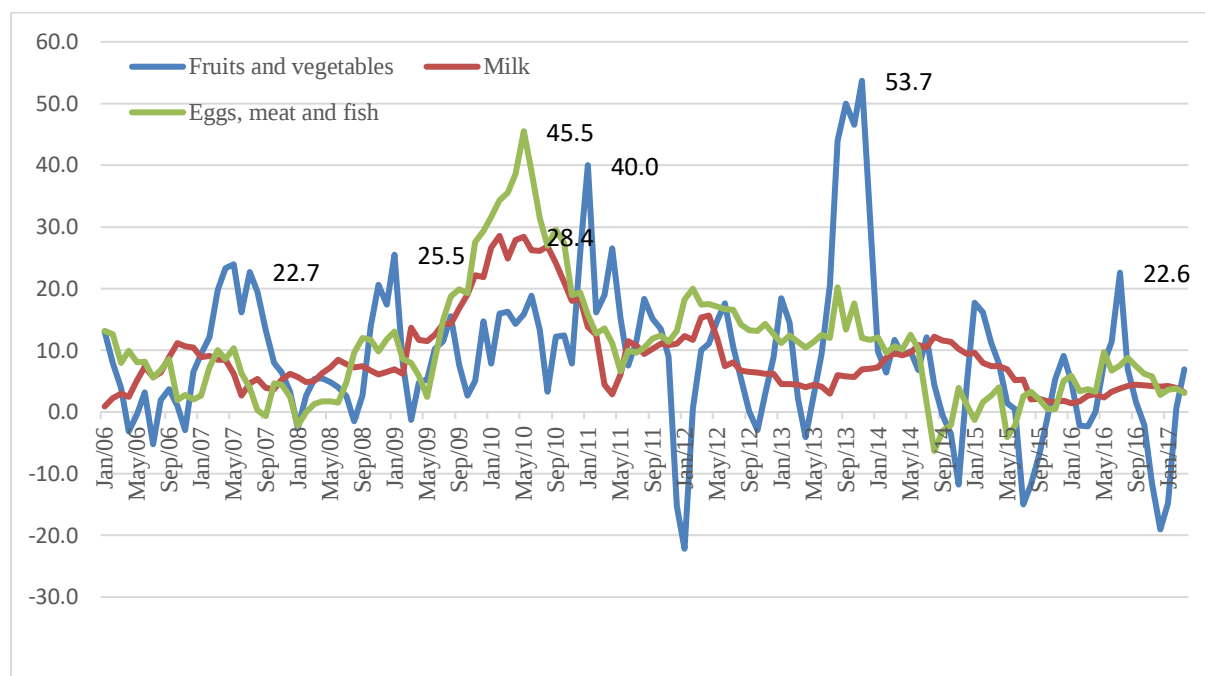


Source: Ministry of Statistics and Programmes Implementations (MOSPI)

1.3.2. Inflation in protein-based food items

Further, the inflation rate of all these food items is significantly increasing over the last couple of years. The behavior of inflation in vitamin and protein-based food items is presented in Figure 1.3. The inflation in fruits and vegetables was 22.7% in July 2007 and reached 40% in January 2011. Whereas, inflation in egg, meat, and fish have an inflationary trend during 2009-2011 and reached highest at 45.5% in March 2010 and reduced in the latter part of 2014. It is very clear from this figure that fruits and vegetables, eggs, meat and fish, and milk are the principal reasons of high food price inflation in India. The food price inflation in aggregate as well in disaggregated food items are displayed in Table 1.1. The other factors behind the rise in food price inflation are changing dietary habits of the people from cereal-based products to high protein and vitamin-based food items, which surges the demand for these food products and reported nearly double-digit inflation. Inflation in these items has reached double-digit for fish and mutton. Thereby, increase in the price of protein and vitamin-rich food items.

Figure 1.3: Food price inflation of protein-based products in India (%)

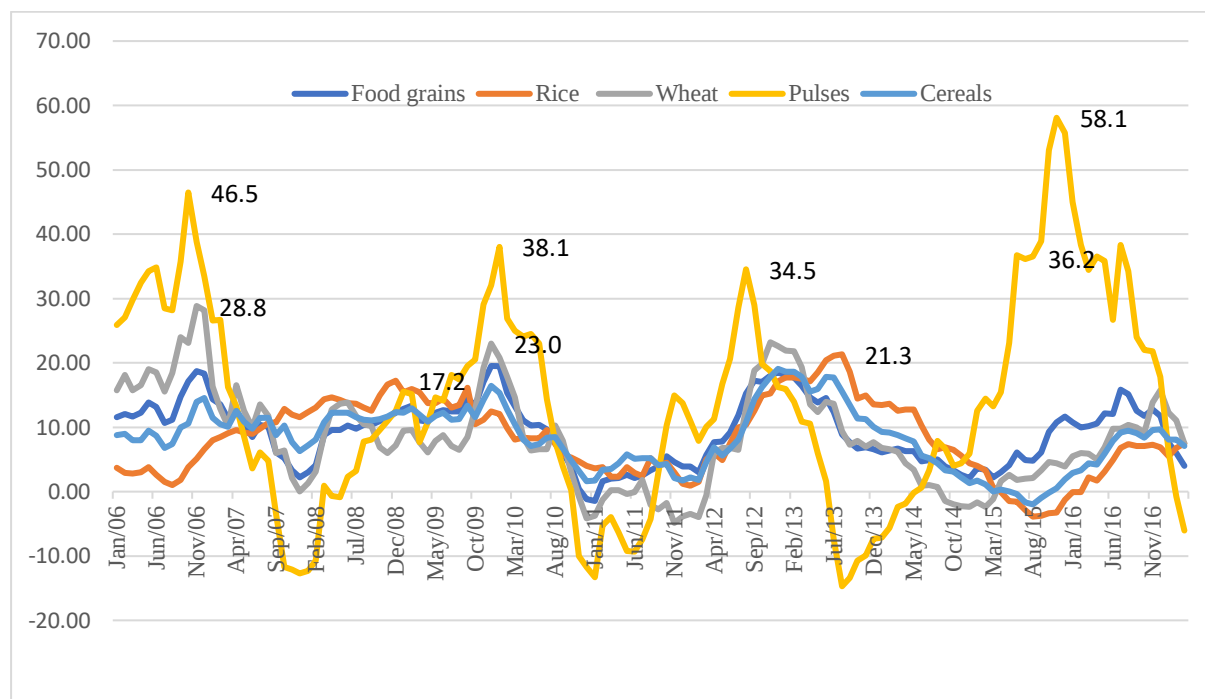


Source: OEA

1.3.3. Food price inflation in major food grain articles

This Figure 1.4 illustrates the behavior of inflation of major food grain items over the period. On average, wheat has experienced high food price inflation in November 2006, December 2009, and November 2012 with three clear spikes 28.8%, 23.99%, and 23.3%, respectively. However, food grain inflation is spiked at 18.7% in November 2006 and further declined and again reached an inflationary level around 19.5% in January 2010 and finally reached 18.5% in December 2012. Whereas, high inflation was experienced in pulses at 46.5% in October 2006 and 38% in January 2010 and spiked at 58% in November 2015, respectively. Further, the average inflation in pulses was 14% during 2006-2016. Simultaneously, inflation in moong dal was highest among the pulses, and pulses inflation across the commodities has recorded nearly 15%, which is shown in Table 1.1.

Figure 1.4: Food price inflation of major food grain articles in India (%)



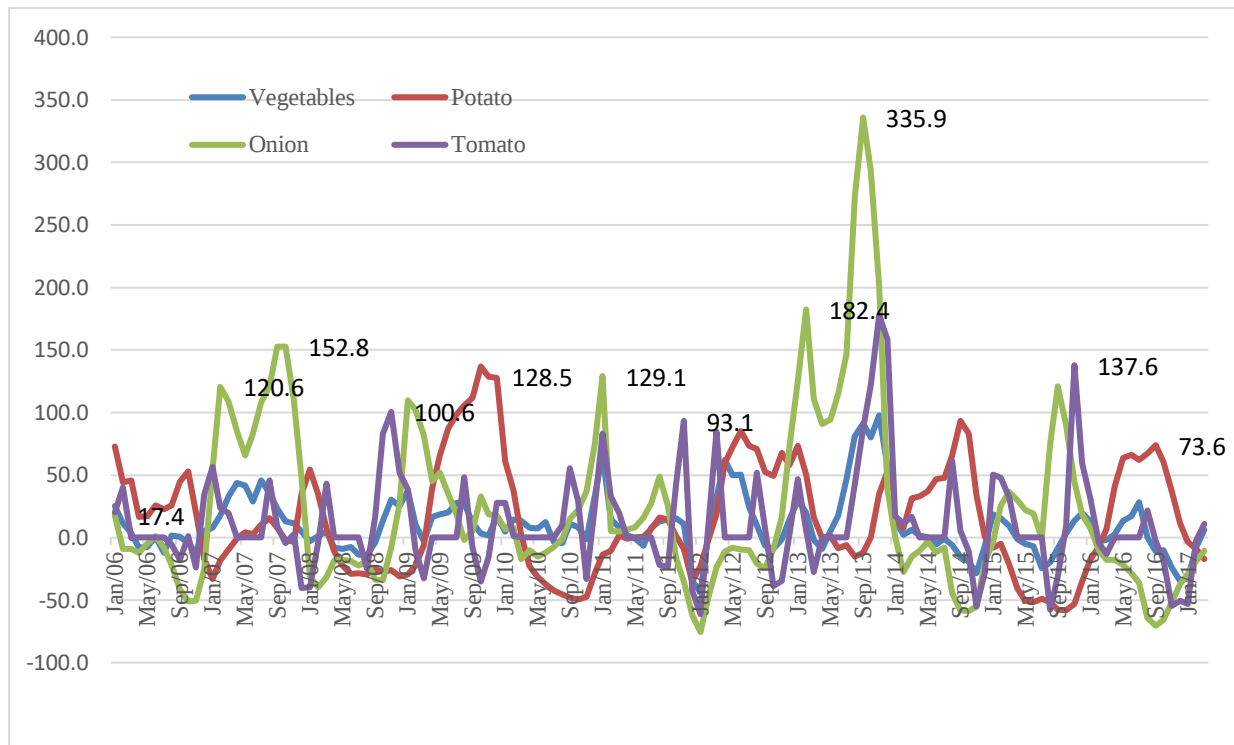
Source: OEA

1.3.4. Food price inflation in selected vegetables prices

Figure-1.5 depicts that the food price inflation in onion has started in April 2007 at 120% and reached a very significant level at 335% in September 2013. While inflation in tomato also stood at 100% in November 2008 and 177.5% in November 2013 and reached highest at 137.4% in November 2015. Inflation in potatoes was 138.6% in November 2009 and reduced to 84% in June 2012. The overall prices of vegetables are consistently high in the last couple of years. The food price inflation of onion, potato, and vegetable prices is significantly increased and volatile due to seasonal factors, which are commodity specific. The rising prices of vegetables are one of the significant drivers of food price inflation, whose contribution is highest towards rising food price level. The most significant factors of rising food price inflation are the increasing prices of vegetables and fruits and their inflation level over the year. The high average disaggregated inflation in fruits and vegetables is displayed in Table 1.1. It is essential to know the disaggregated component of food price inflation while

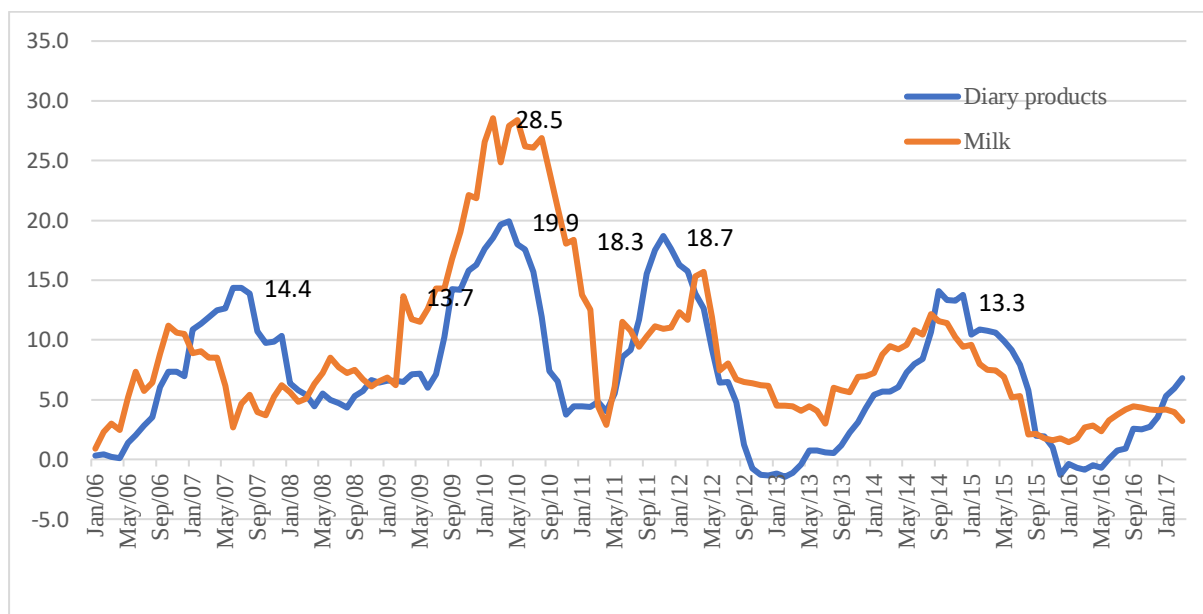
investigating food price inflation in aggregate. It will provide us with an idea of which commodities have a trend and pattern and gauge the inflationary trend in contributing food price inflation. By looking at the classification of food price inflation, we conclude that the increase in these food items at the disaggregated level pushes the food price inflation and promotes aggregate inflation.

Figure-1.5: Behaviour of selected vegetables prices in India (%)



Source: OEA

Figure-1.6: Behaviour of milk and its products prices in India (%)



Source: OEA

1.3.5. Food price inflation in milk and its associate products

The inflation in milk and its products (dairy products) are represented in Figure 1.6. The figures show that inflation in milk also has an inflationary trend in promoting food price inflation. The high level of inflation was observed in November 2006 and later on decreased to 2.7 and further increased to 28.5% in February 2010. Moreover, inflation in milk declined substantially to 2.9% in April 2011. However, the inflation in milk was experienced high due to a surge in demand for protein-rich food products during 2009-2011. Regarding dairy products, inflation in this sector also followed similarly.

In sum, from the above discussion, it is observed that the inflation of food items is significantly increasing over the last couple of years. However, fruits and vegetables, eggs, meat and fish, and milk are the primary reasons of high food price inflation. Another reason behind the rise in food price inflation is changing dietary habits of the people from cereal-based products to high protein and vitamin-based food items, which surges the demand for these food products, thereby increasing the price of protein and vitamin-rich food items. The

overall prices of vegetables are consistently high over the last couple of years in India. The food price inflation of onion, potato, and vegetable prices is significantly high and volatile due to seasonal factors that are commodity specific. The rising prices of vegetables and fruits are among the major drivers of food price inflation, whose contribution is highest towards rising food price level. Therefore, it is essential to know the behavior of disaggregated food items while investigating food price inflation in aggregate. By looking at the classification of food price inflation, we conclude that the increase in these food items at the disaggregated level pushes food price inflation to a significant level and promotes aggregate inflation. Moreover, the high inflation in disaggregated food prices brings an initial signal in the significance of disaggregated food in high food price inflation and aggregate inflation. Hence, it is necessary to correctly analyze the trend and patterns of these disaggregate food items and aggregate level, which would be able to identify the inflationary trend of specific commodities that contribute to food price inflation in India over the period.

Table 1.1. Year-wise food price inflation rate in India (%) (According to 2004-05 base year)

Name of the commodities	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Average
All commodities	6.01	4.91	8.66	2.39	9.57	9.48	7.55	6.32	3.85	-2.72	1.97	5.27
Food articles	8.61	9.43	7.22	12.64	17.92	9.19	8.48	13.28	6.56	4.10	5.83	9.39
Food grains (Cereals and Pulses)	13.77	9.01	9.23	13.54	8.91	2.73	11.26	12.02	4.83	5.84	11.99	9.38
Cereals	9.60	10.09	10.98	12.50	7.85	3.88	9.52	15.32	5.70	0.04	6.82	8.39
Rice	3.22	10.07	14.20	13.80	7.63	3.24	8.84	17.76	9.45	-1.13	4.31	8.31
Wheat	20.14	9.86	8.82	10.56	8.12	-1.56	9.62	12.98	1.85	1.76	8.76	8.27
Jowar	14.02	18.23	6.45	7.25	12.06	30.83	1.10	3.28	15.56	-0.14	3.44	10.19
Bajra	10.13	7.37	4.56	20.82	8.69	7.00	17.27	17.99	-1.38	-1.37	19.82	10.08
Maize	7.56	10.19	4.25	11.00	6.95	22.61	14.15	11.95	-3.86	3.44	11.51	9.07
Barley	12.50	5.05	18.51	-1.71	4.86	13.26	13.57	5.40	4.89	2.97	17.97	8.84
Ragi	7.00	14.49	3.97	32.52	2.88	13.03	27.71	37.90	-3.41	0.12	11.24	13.40
Pulses	32.94	5.49	2.57	17.89	13.84	-1.45	18.72	-0.40	1.31	32.84	31.27	14.09
Gram	37.20	6.13	0.82	-0.46	-3.05	20.21	45.96	-8.82	-13.98	31.67	55.27	15.54
Arhar	7.36	17.84	13.93	38.43	16.29	-12.05	3.75	8.38	6.03	44.60	20.88	15.04
Moong	37.66	-2.33	-3.00	37.68	55.07	-13.51	-0.18	15.42	18.61	17.87	-7.62	14.15
Masur	14.37	22.16	28.59	26.77	-5.77	-20.18	12.79	13.44	18.96	29.52	2.41	13.01
Urad	53.84	-4.02	-9.74	32.29	39.48	-10.24	-8.25	1.69	18.97	41.79	39.33	17.74
Fruits & vegetables	2.45	14.83	6.29	9.10	13.65	14.70	4.73	24.09	4.93	2.89	1.66	9.03
Vegetables	0.37	25.41	1.22	15.72	8.66	9.29	15.31	42.96	-4.84	1.08	-0.66	10.41
Potato	30.91	0.61	-11.15	70.21	-21.08	-2.50	48.41	15.47	41.36	-40.25	39.97	15.63
Sweet Potato	34.87	8.97	-6.74	17.60	23.16	12.25	-6.42	49.20	68.18	-32.76	-0.13	15.29
Onion	-17.95	100.75	-20.65	43.03	8.33	13.08	-12.68	167.14	-26.03	39.78	-34.54	23.66
Tapioca	21.79	18.67	14.28	41.58	32.57	14.53	-19.43	84.51	3.97	-29.50	41.22	20.38
Ginger (Fresh)	-37.50	11.39	76.89	19.14	9.09	-21.17	-16.34	155.73	31.93	-32.07	-20.13	16.09
Peas (Green)	4.69	4.41	5.08	6.22	0.78	7.67	3.81	14.43	2.38	11.42	1.49	5.67
Tomato	4.03	9.31	18.85	1.09	9.59	15.33	1.53	51.04	1.40	20.61	-7.58	11.38
Cauliflower	-5.60	2.25	11.43	2.25	11.25	4.31	3.18	6.55	0.09	13.68	2.95	4.76
Brinjal	2.92	12.80	18.58	-8.33	22.22	4.44	19.33	30.82	-15.46	13.40	12.65	10.31
Okra (Lady finger)	11.81	11.82	7.44	3.43	13.85	47.68	11.56	1.77	-2.51	-2.25	-1.45	9.38

Cabbage	-1.39	66.71	-0.51	15.73	23.15	16.07	57.91	31.27	-8.57	23.39	4.07	20.71
Fruits	4.87	6.16	11.84	3.73	18.73	19.39	-0.06	7.05	18.02	4.75	4.68	9.02
Banana	5.83	5.16	8.77	6.58	19.34	3.63	16.43	21.09	18.17	-3.05	8.11	10.01
Mango	2.66	2.79	12.38	-1.98	11.85	8.22	-1.82	-4.30	6.43	4.07	3.98	4.03
Apple	7.44	16.83	-2.00	21.40	3.80	20.45	7.24	2.24	0.33	0.26	4.59	7.51
Orange	2.24	2.00	13.01	9.41	22.39	28.71	7.56	-13.62	10.67	-2.27	5.41	7.77
Cashew nut	7.46	-3.77	4.89	19.53	6.09	35.60	-3.07	7.73	11.13	17.29	12.99	10.53
Coconut (Fresh)	-9.85	3.39	13.13	-6.63	5.06	31.68	-7.60	25.41	38.42	12.62	-20.93	7.70
Papaya	5.05	11.21	25.33	12.40	24.52	15.80	-29.80	20.18	-9.40	1.59	9.21	7.83
Grapes	4.68	3.97	5.65	1.66	5.89	26.96	-2.41	0.95	7.36	4.85	-2.76	5.16
Pineapple	-1.83	25.05	8.54	16.80	22.63	9.70	17.91	14.72	0.21	-1.77	14.01	11.45
Guava	5.19	-5.52	17.09	-23.66	80.83	-1.38	-34.42	41.61	96.25	32.49	7.75	19.66
Lemon	42.46	20.92	4.27	-11.95	6.26	41.85	2.56	-16.46	34.52	-2.40	16.80	12.62
Sapota	-3.18	20.59	1.19	22.94	14.94	25.54	9.73	5.17	3.55	-7.23	5.48	8.97
Milk	6.20	6.08	6.61	14.24	24.75	9.56	9.51	5.03	10.02	4.93	3.27	9.11
Eggs, meat & fish	7.30	5.01	5.30	14.67	31.52	11.53	15.92	13.01	5.02	1.21	5.93	10.58
Eggs	-4.53	21.50	3.26	8.31	21.87	9.50	8.04	7.40	5.47	-1.02	6.33	7.83
Fish-Inland	0.39	-9.23	-0.89	34.04	42.90	22.86	28.48	25.09	6.09	-0.59	10.73	14.53
Fish-Marine	20.65	5.78	11.47	9.55	40.64	11.76	16.46	5.39	4.79	2.38	0.14	11.73
Mutton	12.43	5.68	12.08	20.16	13.87	6.17	9.91	11.20	7.86	8.30	-0.52	9.74
Beef & Buffalo Meat	5.86	4.83	0.55	6.97	43.08	8.63	2.20	1.72	8.67	-11.14	6.53	7.08
Poultry Chicken	-1.47	14.56	-1.81	5.60	24.04	-1.59	7.77	16.56	0.19	2.07	18.81	7.70
Pork	7.31	34.39	2.73	2.81	19.34	10.69	12.46	5.58	13.48	-4.20	11.94	10.59
Condiments & spices	35.81	16.99	4.33	12.87	35.49	10.33	-16.09	12.25	22.65	15.52	7.02	14.29
Food products	4.51	3.24	8.29	11.08	8.00	5.89	7.48	5.02	2.46	0.05	8.71	5.88
Dairy products	3.20	11.88	5.47	9.81	13.41	10.16	6.93	0.76	9.29	6.58	0.87	7.13
Sugar	4.72	-15.95	6.77	46.96	17.93	1.28	9.61	1.76	-0.99	-10.52	22.67	7.66
Edible oils	3.98	13.25	10.34	-7.19	2.36	13.37	9.91	1.03	-1.40	1.67	4.26	4.69

Source: Authors' calculations.

1.4. Objectives of the study

Given the importance of above issues, the core objectives of this study are framed as:

- (i) to analyse the decomposition of relative price variability into two components due to real and inflationary factors in India,
- (ii) to explore the impact of macroeconomic factors on food price inflation and
- (iii) to examine whether monetary policy helps to stabilise food price inflation in India.

1.5. Data and methodology

1.5.1. Data sources

The different time periods have been used to accomplish the purposes of the study across the chapters. We utilized commodity-wise disaggregated WPI and CPI¹ food monthly data on 105 and 114 commodities. However, 564 and 184 disaggregated WPI and CPI non-food commodities are considered in the analysis in chapter 2. The choice of data series has been grounded on the obtainability of uniform and consistent data on the price of commodities over the time. The food price index of the WPI food series has been constructed using the weighted least square of both primary food articles and manufactured food products. However, CPI food series data have been constructed using a weighted least square of 184 commodities. The food price indices and their respective weightages are obtained from the Office of the Economic Adviser (OEA), published by the MCI. However, CPI food and non-food indices and their weightages are retrieved from the Consumer Price Indices Warehouses, MOSPI.

Chapter 3 makes use of monthly time series data on per capita gross domestic products (GDP) (Y), the real exchange rate (EX), money supply (MS), global food price index (GF), per capita net availability of food grain (NFG), agricultural wages (AW) and CPI-industrial worker for food indices as a proxy for food price index (FP) during January 2006-March 2019. The data on per capita GDP, real exchange rate, the money supply is collected from the Reserve Bank of India (RBI), whereas CPI-IW for food indices and agricultural wages are retrieved from the Ministry of Labour Bureau, Government of India. The data on food grain availability and real global food price index is obtained from the DES, Department of Agriculture & Farmers Welfare, and the FAO, respectively.

¹Definitions of CPI and CPI-C are same and used in the study interchangeably.

Chapter 4 utilizes monthly frequency data spanning January 2009 to December 2019. Our variables focus on food price inflation, aggregate inflation, monetary policy, transportation cost, exchange rate, and economic output for the analysis. The data set of consumer price index-industrial workers for food indices, considered as a proxy for food price (FP) and aggregate inflation (AIF) and transportation cost (TNS), is downloaded from the Ministry of Labour Bureau. Whereas data on the real effective exchange rate (REX), real economic output (GDP), and repo rate as a monetary policy (MP) are restored from the RBI. The combined Price Index-combined (FPC), aggregate inflation-combined (AC), and the sectoral level food price indices are obtained from Consumer Price Indices Warehouses, MOSPI. The data on all the variables for monetary policy transmission channels are retrieved from the RBI. We use CPI-IW because Bicchal & Durai (2019) and Goyal (2015) established that CPI-IW and CPI-C give alike results. All the variables are seasonally adjusted using CENSUS X13 and converted into the natural logarithm except treasury bill, the repo rate, and bank credit. The detailed analysis about the data measurement, the selection of data period, and its sources are provided in data sections in respective chapters.

1.5.2. Econometric methods

The present study employed the techniques propounded by Clements and Nguyen (1981, 1982) to find the decomposition of relative price variability of food items into an element due to real and inflationary factors in India. This methodology can categorize each share of a commodity that contributes to a higher variation of relative price changes and can show the relative share of individual commodity to relative price changes. It also finds out to what extent relative price variability is created by real and inflationary factors using OLS method.

To explore the influence of macroeconomic factors on food price inflation, we have employed various techniques to attain this goal. Generally, macroeconomic variables are non-stationary, which generates spurious results. To avoid spurious and invalid results, we have checked the integration properties of all the variables. We must check the time series properties to confirm that none of the series follow the I (2) process while using ARDL technique. Further, after confirming that none of the series are following the I (2) process, we have applied the ARDL approach to find the long-run association among the variables. Later, the Granger causality test was applied to find the causal relationship between the macroeconomic factors and food price inflation in the short-and long-run.

Later, we deal with whether contractionary monetary policy lessens food price inflation. We have applied ADF and PP tests to verify the data properties of the series. Generally, macroeconomic variables, particularly policy-related variables, suffer the problem of structural breaks. We have utilized the Zivot-Andrews (ZA) unit root test to detect structural breaks in these series by Zivot and Andrews (1992), which account for breaks associated with the sample data set. Most of the macroeconomic variables are non-stationary in nature which generates spurious results. Hence there is the existence of unit root. Applying structural breaks has its own merits as, first, it averts the results from the biased unit root. Second, it is able to identify the possible breaks. Third, it also detects the single crucial breaks out of multiple breaks present in the analysis data series. We apply quantile regression (QR) when series violates the assumption of the classical linear regression model. This study utilizes the quantile regression (QR) technique developed by Koenker and Bassett (1978) to investigate the impact of independent variables on dependent variables at different quantiles of the conditional distribution of predicted variables. Further, based on the break dates, we have estimated the equation by allowing break dates on the right-hand side of the equation using dummy variables. The application of quantile regression (QR) is an extension of the OLS method.

1.6. Organization of the thesis

This thesis has five chapters. Chapter 1 delivers an introduction regarding the background of the study. Section 1.1 debates the background of the study and deliberates research problems associated with it and reflects the significance of the study. Section 1.2 has outlines of topics, inspiration, and research query of the thesis. Section 1.3 discourses the trend and patterns of food price inflation aggregate and disaggregated term. Section 1.4 mentions the considered research objectives of the thesis. Section 1.5 explains the data measurement and its sources of the thesis and discusses econometric techniques utilized to fill the research goal.

Chapter 2 investigates the decomposition of relative price variability into two elements owing to real and inflationary factors. Both monthly and annualized data were used to obtain the change in prices of food commodities. Section 2.1 of the chapter delivers the introduction regarding the background of the study and the literature gap associated with this issue. Section 2.2 explains the review of previous related studies of the relationship between relative price variability and food price inflation and explains the demand and supply-side factors of food price inflation. Section 2.3 represents the data measurement and its sources

and estimation techniques used to describe the relationship. Section 2.4 provides study results. It delivers the empirical analysis undertaken to prove the objectives of the study. It includes the association between food price inflation and the distribution of relative price variability. It represents the share of disaggregated food and non-food commodities and its decomposition analysis. It also included the robustness analysis using CPI food and non-food data and compares WPI and CPI results. Section 2.5 brings the summary and policy implications of the study.

Chapter 3 examines the impact of macroeconomic factors on food price inflation. Section 3.1 of this chapter delivers the introduction regarding food price inflation issues, their importance of the study, and the literature gap associated with it. Section 3.2 represents the literature review regarding the specific macroeconomic factor and food price inflation. Section 3.3 provides the data extraction sources and econometric techniques used in the study. Section 3.4 explains the study analysis and its empirical analysis carried out to full fill the research objectives. Section 3.5 concludes with a summary and its policy suggestions.

Chapter 4 inspects whether contractionary monetary policy reduces food price inflation. Section 4.1 provides the background of monetary policy and food price inflation and its significant contribution to the literature. Section 4.2 discusses the literature regarding previous studies on the effect of monetary policy on inflation and food price inflation. Further, the study also expresses the past research concerning the response of food price inflation from the effectiveness of monetary policy shocks through different channels. Section 4.3 offers the data sources of considered variables and the econometric techniques used in the study to carry forward the said objective. Section 4.4 delivers empirical analysis on the role of monetary policy in stabilizing food price inflation and includes other variables in the analysis. Additionally, it analyses the nexus among these variables with the inflation targeting framework and lags of the monetary policy. Section 4.5 includes the theoretical underpinning of transmission of monetary policy through different channels. This section also explains the behavior of food price inflation and non-food and aggregate inflation with response to the monetary policy shocks. Further, it also considers how sectoral food price inflation responds by following the contractionary monetary policy through various mechanisms. Section 4.6 conveys the conclusions and policy conversations regarding the topic.

Chapter 5 offers a general summary of the entire issues and key findings of the thesis. Section 5.1 provides the overall summary of the thesis. Section 5.2 delivers key findings derived from the core objectives. Section 5.3 includes some critical policy conversations drawn based on empirical results. Moreover, Section 5.4 concludes with the boundaries of the research. Finally, section 5.5 ended with directions to undertake future research.

Food Price Inflation and Relative Price Variability in India: Evidence from Decomposition Analysis

2.1. Introduction

Over the past few decades, a rapid increase in food price inflation has created serious concern among the government authorities and policymakers across the world. It hampers the welfare of the country by increasing the infant and child mortality of the nation. Notably, the world has experienced food price inflation shocks during 2007-08, 2010-11, and 2013 due to certain reasons. Walsh (2011) argued that food price inflation is more explosive and higher than non-food price inflation in lower-income countries. In addition, food price inflation is more persistent over non-food price inflation and is largely transmitted to non-food price inflation in many countries. One of the major problems in inflation targeting is high inflation pressure, which originated from food prices. In fact, food price inflation is not only creating a problem for general inflation but also creates difficulties in the forecasting of the inflation targeting process (Soskic, 2015). Food price inflation plays a significant role in the inflation dynamics and policy point of view of the central banks, particularly for inflation-targeting countries. The rising importance of food price inflation has contributed a larger segment of food outlay to aggregate household spending and the highest weights in CPI and WPI basket. Thus, rise in food price inflation may lead to a surge in aggregate inflation.

However, the impact of food prices on inflation varies across countries because, it depends on economic development, the contribution of food in the aggregate CPI basket, and the level of income of the country. Therefore, the rise in food prices may adversely affect poor consumers in developing countries, especially India, where most consumers spend their larger portion of income on food products. Therefore, it created a serious concern among government authorities and policymakers to reduce high food price inflation. One of the major key macroeconomic challenges that have been faced by India is to control food price inflation pressures. The rising food price inflation is considered as one of the key contributors to the increase in overall WPI inflation in India (Anand et al., 2014). The weightage of food comprises nearly 40% and 25% in India's CPI and WPI, respectively. The average WPI food price inflation was recorded at 8%, whereas non-food price inflation was observed at 4% during January 2006-March 2017 (Office of Economic Advisor, (2017)). We here noted that food price inflation was higher than non-food price inflation in India.

The high and persistent food price inflation rate was observed in India for disaggregated food items over the period 2006-2017. The inflation in primary food articles has started increasing in 2006 and peaked at 21.85 % in May 2010 and finally reached 19.69% in December 2013. Similarly, the inflation rate of manufactured food products was significantly high at 10.43% and 19.30% in July 2008 and March 2010, respectively, and again reached 12.60% in June 2016. However, the inflation rate of overall WPI commodities has increased at a lower rate as compared to primary food articles and manufactured food products during the study period except November 2011, which has been shown in Figure 1.1 of chapter 1. The primary reason behind the high inflation rate (10.9%) of all commodities in May 2010 was due to high food price inflation. Furthermore, from Table 2.1, the average food price inflation was 7.57%, whereas the growth rate of WPI inflation was 5.3% (based on 2004-05 prices) which is lower than the average food price inflation from January 2006 to March 2017. On average, inflation in primary food articles has been recorded the highest (9.21%) than the manufactured food product (5.95%). It suggests that the impact of primary food articles price build-up was broad-based. Overall, the inflation rate of primary food articles and manufactured food products is higher than the WPI for all commodities. Most of the commodities from the primary food articles group have been experiencing a high inflation rate against manufactured food products. The average inflation rate across different food items varies from 4.70% to 22.70%. The inflation rate was lowest (4.70%) for edible oil and highest for onion (22.70%). Onion has experienced the highest food price inflation of 22.70 % from the primary food article group, followed by black pepper (22.60%), tapioca (21.70%), cabbage (19.66%), and guava (18.84%), and so on. Whereas the highest inflation rate (14.13%) was found for groundnut oil cake followed by rice bran extraction (13.29%) and so on, from the manufactured food products group. The reasons for rising food price inflation might be due to global food prices and oil prices, minimum support price (MSP), agricultural wages, high per capita income, low growth of food production, and changing the dietary patterns of food products, which led to increasing demand for food products. The surge in these food items at the disaggregated level pushes food prices to a significant level and eventually promotes aggregate inflation. Moreover, the high inflation in disaggregated food prices delivers an initial signal in the significance of disaggregated food in high food price inflation and aggregate inflation. Thus, it is imperative to see the reasons behind the fluctuation of relative prices of food items at disaggregated level. The variability in the relative price of food items plays a very central character in the demand and supply of food items. Therefore, the central

bank should consider food price inflation while targeting overall inflation for the country at large.

Table 2.1. Average inflation rate of food articles and food products (January 2006 –March 2017)

Commodity name	Inflation rate (%)	Commodity name	Inflation rate (%)
All commodities	5.3	Egg	7.68
Food inflation	7.57	Fish-inland	14.34
Primary food articles	9.21	Fish-marine	11.46
Food grains	9.26	Mutton	9.49
Cereals	8.33	Beef & buffalo meat	7.06
Rice	8.22	Poultry chicken	7.83
Wheat	8.25	Pork	10.43
Pulses	13.78	Condiments and spices	13.83
Gram	16.23	Black pepper	22.6
Arhar	13.88	Other food articles	8.92
Moong	13.19	Tea	9.92
Masur	12.18	Coffee	9.47
Urad	16.85	Manufactured food products	5.95
Fruits and vegetables	8.77	Dairy products	7.09
Vegetables	9.92	Ghee	8.42
Potato	15.09	Butter	7.97
Onion	22.7	Wheat Flour (atta)	7.59
Ginger (fresh)	15.3	Gram Powder (besan)	8.75
Tapioca	21.7	Sooji (rawa)	8.5
Brinjal	9.68	Sugar, khandsari & gur	7.47
Okra (lady finger)	9.33	Sugar	7.96
Cabbage	19.66	Gur	8.53
Fruits	8.95	Groundnut oil	7.91
Banana	10.02	Cotton seed oil	7.67
Cashew nut	10.81	Mustard & rapeseed oil	6.25
Pineapple	11.4	Edible oil	4.7
Guava	18.84	Oil cakes	9.54
Lemon	11.3	Cotton seed oil cake	8.35
Sapota	8.77	Rice bran extraction	13.29
Milk	8.99	Groundnut oil cake	14.13
Egg, meat and fish	10.42	Gola (cattle feed)	10.03

Source: Authors' calculations

The relative price variability changes may be due to both inflationary factors (supply-side) and real factors (demand-side). However, there has been a long debate on the influence of inflation on the relative price variability in the literature, which can be associated with market behavior. The relative price of a commodity refers to the ratio between the price of one

commodity and a weighted average of other commodities within the group. The relative price changes are measured as the variance of the rate of change in individual commodities across all other commodities. The change in the price of commodities depends on the variation in relative prices. If the price of the commodities rises then consumer shift their consumption toward cheaper food items by substitution effect which lead to an increase in demand for cheaper food products thereby price rises through demand-side effects. On the other hand, from the supply-side point of view, continuous demand for certain food items leads to a decrease in the supply of the commodities, hence a rise in prices. The theory of inflation and relative price variability is based on the menu cost approach and rational expectation model. Inflation has an adverse effect on the real sector of the economy through its relative price variability¹. Under the menu cost model, when a higher level of inflation prevails, changes in prices become more scattered. Hence, larger variability in relative price changes (Sheshinski and Weiss, 1977). Ball and Mankiw (1995) argued that large shocks to a few commodities have a disproportionate effect on aggregate inflation due to the price adjustment by the firms. Hence, the distribution of relative price changes promotes aggregate inflation. It suggests that fluctuations in the price level are positively associated with the skewness of relative price changes and vice versa. The measures of supply shocks, namely, relative prices of food and energy, are responsible for the innovation of aggregate inflation. To this line, Fischer (1981) also argued that food and energy shocks are the major determinants of higher relative price variability in the United States during the post-1956 period. It contradicts the classical monetarist who believed that relative price changes arise due to real factors but not due to inflation. Hence, inflation occurs due to changes in the money supply. Further, Ukoha (2007) suggests that high inflation will increase the relative price variability among the agriculture commodities, in turn, inefficiency and misallocation of resources in agriculture. The fluctuation in relative price reduces the welfare of the economy in the general and agricultural sector in particular. Under the rational expectation model, a rise in unexpected demand, which creates inflation, will tend to rise in relative prices (Barro, 1976; Lucas, 1973). According to them, unexpected inflation widens relative prices. Therefore, policymakers should reduce the inflation rate for better decisions. However, along with inflationary factors (supply-side) like changes in technology, resource availability, and additional factors of supply, variability in relative price is also originated from real factors, namely, real income,

¹The previous studies concluded positive nexus between relative price variability and inflation (e.g., Parks, 1978; Parslay, 1996; Debelle & Lament, 1997; Fernandez Valdovinos & Gerling, 2011; Rather et al. 2014). But, a few studies found the negative nexus between these two (see, Reinsdorf, 1994; Fielding & Mizen, 2000).

family composition, and various extra factors of demand (Parks, 1978; Rather., et al.2014). The change (increase) in income stimulates consumer demand, resulting in relatively proportional changes in prices.

There has been a growing importance of decomposition of relative price changes over the period as inflation affects real sectors through the relative price changes. Suppose relative price changes occur due to real factors that lead to an efficient distribution of resources because these forces arise from market forces of the economy. On the other hand, if variability in relative prices changes arises due to inflation, it decreases the economic welfare benefits in the economy by an inefficient allocation of resources and agricultural sectors in particular. Therefore, it is essential to know at which magnitude relative price changes is determined by inflationary (supply-side) and real factors (demand-side) in the variability in relative price changes. This will provide useful insights for the policymakers to implement policy decisions regarding the responsible commodities of higher variability in relative price and forecast inflation accurately. The quantifying relative importance of both demand and supply-side factors would give an idea of specific policy suggestions regarding demand and supply to tame the high relative price of the food basket and protect the consumer from food insecurity. This study can also offer some policy initiatives relating to disaggregated commodities on how changes in the relative price of a particular commodity can affect the economy's stability, followed by the welfare of the people to a larger extent.

The study makes various significant input to the literature in several ways: First, numerous studies have conducted to understand, causes and cures of food price inflation in India (Bhattacharya et al., 2014; Gokarn, 2010; Gulati and Saini, 2013; Rajan, 2014; Huria and Pathania, 2018) and different researchers have given their different conclusions regarding trace the reasons for higher food price². The common features of their studies have mainly restricted to only the nature of food price inflation, and most of the studies are mainly confined to supply-side factors. However, the relative implications of demand and supply-side factors towards the variability of the relative price of food items have not been considered in their studies. Therefore, our study tries to fulfil the literature gap in the existing

²They are: *supply shocks*, drought and low growth of food production (Chand, 2010), the decline in the production and hoarding of onion (Sharma et al. 2011), inadequate access to the public distribution system (PDS) of food grains (Mitra and Josling, 2009), and global oil prices and exchange rate depreciation (Mohanty, 2014) and *demand shocks*, increase in rural wages (Rajan, 2014), rise in per capita income (Sasmal, 2015), rise in demand for high-value food items (Bandara, 2013), increase in MSP (Raghav and Kulkarni, 2005).

literature. Second, the study also identifies each of the commodity price changes and specifies their percentage share, which contributes to the variability of the relative price of the food items. It also examines to what extent the variability of the relative price of food is caused due to real factors (demand-side) and inflationary factors (supply-side). Third, a little study has identified the commodities which led to the variability of the relative price changes in the food basket by using different data period and methodology. However, we have covered a larger number of commodities at a disaggregated level, longer time period, and Clements and Nguyen (1981, 1982) methodology for decomposition analysis in our study. Fourth, for robust check, we used CPI disaggregated food commodities. Although, there are few studies that have investigated the decomposition of relative price variability for the aggregate price level, namely Clements and Nguyen (1981, 1982) for Australia, Ram (1990) for the U.S, and Rather et al. (2014) for India. However, none of the studies have explored the allocation of the relative price variability of food items in the case of India. Fifth, this study also reflects on verifying to what extent non-food commodities are accountable and find out the relative contribution of real and inflationary factors in the variability of relative prices of food items taking both WPI and CPI non-food commodities. Finally, as far as we are aware, current research have an earliest attempt to investigate the decomposition of relative price variability into two elements due to real factors and inflationary factors. Therefore, this study accomplishes a gap in the existing literature.

The remaining of the chapter is arranged as tracks. Section 2 offers a short-lived review of the literature of the connected studies. Section 3 provides frameworks of data and quantitative methods. Section 4 offers the empirical consequences and discussion. Lastly, section 6 provides conclusions and policy implications of the study.

2.2. Review of Literature

2.2.1. Inflation and relative price variability

The relationship between inflation and relative price variability is not new, and massive prior researches have investigated the nexus between these two across the world in the literature. However, the literature on the effects of inflation on relative price variability for agricultural commodities is scarce. In particular, developing countries like India, where a large section of people spend larger portion of their income on food, also contributes a leading share to overall inflation in WPI and CPI. The relative price change of food items may hamper the

welfare of the country. For instance, Parks (1978) scrutinized the influence of unanticipated inflation and real income on the variance of relative price changes in the Netherlands and the United States (U.S) during 1921-63 and 1929-75, respectively. His results showed that unanticipated inflation positively impacted the variance of relative price changes. Clements and Nguyen (1981) investigated the effects of inflation on variance in relative price changes in Australia for seven commodity groups during 1959-1978. The results showed that the past inflation in rent is identified as the variation in relative price changes. In contrast, relative price variability is driven by the current inflation in cigarettes, rent, and others. The influence of future inflation on relative price variation for food, cigarettes, etc., and motor vehicles is positive. Clements and Nguyen (1982) examined the association between inflation and relative price in Australia using decomposition analysis over the period 1959-1978. The author found that 76% of the variance of relative prices is determined by real effects. But, 24% is determined by inflationary factors. Further, they also revealed that 43% of overall relative price variability is donated by clothing only. Ram (1990) demonstrated that real factors and inflationary factors are equally responsible for the variability of relative price in the U.S. Akmal (2011) revealed that a non-linear or U-shape relationship is established between relative price variability and inflation in Pakistan. Ghaur et al. (2014) analyzed the impact of unanticipated inflation (supply-side) and real income (demand-side) on relative price variability in Pakistan, covering the period from July 2001–June 2011. Their findings of the study revealed that the supply factors drive relative price variability. However, the demand side factor fails to determine relative price variability. However, Rather et al. (2014) inspected the connection between inflation and relative price variation in India during April 1993-August 2010. Their results revealed that inflation has a positive impact on relative price variability. Further, the authors also found that both real and inflationary factors determine the variability in relative prices. However, a larger variation in relative prices is resulting from real factors. Further, Rather et al. (2014a) found that 52% of relative price variability is because of inflation for 26 commodities in the U.S. Further, they reported inflation affects relative price variability asymmetrically spanning the period, January 2000-January 2013.

However, few studies have focused on the linking between inflation and relative price fluctuation of food items. For instance, Lach and Tsiddon (1992) analyzed the effects of inflation on the dispersion of prices utilizing disaggregated data on 26 foodstuffs in Israel, spanning January 1978- September 1984. The study results found that intra-market relative price variability has resulted from the expected inflation rather than unexpected inflation.

Lapp and Smith (1992) investigated the impact of macroeconomic instability on variance of relative prices of 47 agrarian commodities in the U.S over the period 1962-1987. Their finding revealed that unanticipated inflation was found to be positive with the variation in relative price changes. However, contrary to this, Smith and Lapp (1993) found that the actual inflation positively impacts the relative price variability in agriculture rather than unexpected inflation in the United Kingdom over the period 1956-88. Loy and Weaver (1998) examined the nexus among anticipated, unanticipated inflation and relative agricultural price volatility in Russia during January 1993-December 1995. The results of the study showed that the anticipated inflation rate drove variability in relative prices of food markets. Reziti (2005) studied the nexus amid macroeconomic variables and relative price variability in Greek, spanning the period 1962-1997. The results confirmed that change in relative price variability is positively induced by inflation rate changes and economic activity among 53 agricultural commodities. Ukoha (2007) investigated the effects of inflation on relative price variability among agriculture commodities in Nigeria during 1970-2003. He found a positive and significant outcome among these variables in the short-and long-run. Baek (2010) also argued that change in inflation have a positive impact on relative price variability across U.S. food products.

In addition to this, there is also literature on the causes of the fluctuation in food prices, which drives food prices up. It has established significant research attention in India's case as well. These are supply-side and demand-side factors as follows:

2.2.2. Supply-driven factors

Several studies have focused on factors that are accountable for high food price inflation in India. However, the results are ambiguous, and most of the studies have been confined to supply-side factors only. For example, Chand (2010) pointed out that the escalation in food prices during the study time was mainly due to supply shocks driven by drought in 2009 and the carryover effect of low growth of food production. Nair and Eapen (2012) examined the commodity-wise analysis of food price inflation from January 2008 to July 2010. They found that major reasons for the high food price inflation of 12 significant commodities are domestic supply-side factors and cost escalation in India. Moorthy and Kolhar (2011) also observed that the rise in food price took place due to supply limitations in India's case. World Bank (2010) and Reserve Bank of India (2010) also concluded that supply shocks driven from drought and floods were the important drivers for high food price inflation in India. A micro-level study conducted by Sharma et al. (2011) argued that a reduction in onion

production due to unseasonable rain in major producing states, like Gujarat, Maharashtra, and Karnataka, is the major determinant for the rise in prices of onion during 2009-2011. Besides, they also reported that the hoarding of stock, higher-margin by the retailer, and reduction in minimum export price are also the key reasons for the increase in onion prices. Mitra and Josling (2009) pointed out that food price inflation is driven by inadequate access to the public distribution system (PDS) of food grain by the rural household, and corruption problems create a shortage of food products. Hence, rise in food price inflation. Mitra (2008) showed that the crop failure of rice mainly contributes to food price inflation in India. The author suggested that, like the short-run temporary supply constraints, some long-term factors contribute to food price inflation. Shreedhar et al. (2012) pointed out that the shift in land use towards export-based commercial crops from food crops since the mid-1990s leads to environmental damage resulting in a decline in agricultural productivity. Mohanty (2014) argued that supply-side factors, i.e., increase in the cost of fuel and fertilizers derived from high global oil prices and exchange rate depreciation, are mainly responsible for the existence of food price inflation in India. Lahiri (2012) reported that food price inflation is caused due to hoarding practices of big retailers or intermediaries on perishable commodities, which eventually contributes to food price inflation by creating artificial shortages. Huria and Pathania (2018) examined the role of intermediaries in the hike of food price inflation in India. The study results confirmed that the price wedge positively impacts food price inflation in the short-run and long-run in India.

Apart from the above supply-side factors, there is another branch of supply constraint factor that also key factors for the high food price inflation, i.e., global oil prices. Since India is the largest importer of crude oil, the increase in oil prices leads to a rise in agricultural inputs like fertilizer, modern technology, transport cost used in the farming process, resulting increase in food prices in India. For instance, Baffes (2007) analyzed the impact of crude oil prices on 35 agricultural prices over the period 1960–2005. The results show that there is a positive transmission of oil prices to agricultural commodity prices. It implies that an increase in oil prices affects 35 internationally traded primary commodities by 17%. Mitchell (2008) reported that the production costs rise by 15–20% when energy and transport costs rises by 1% in the major US food commodities. Baffes and Haniotis (2010) found that oil prices are firmly and positively impacted food prices. Nair and Eapen (2012) pointed out that food price inflation was determined by the increase in world oil prices through the development of the

global economy in India. Using NARDL model, Ibrahim (2015) examined the linkages between food prices and oil prices in Malaysia, covering 1970-2012. The empirical analysis reported that an increase in oil prices increases agricultural food prices but not vice versa in the long-run and short-run. Abdlaziz et al. (2016) inspected the influence of oil price shocks on food prices in Indonesia over the period 1995-2014. Using the NARDL model, the study showed that oil price shocks are strongly and positively influenced Indonesia's food prices. Nwoko et al. (2016) revealed that oil prices positively affect food prices in Nigeria in the long-run.

Another factor that contributes to food price inflation is global food price inflation. Robles (2011) indicated that the transmission of international prices has a positive impact on the domestic agricultural market in Asian and Latin American countries. Gulati and Saini (2013) argued that fiscal deficit, higher farm wage, and global food price together contribute 98% variation in food price surge in India over the period 1995- 2012. Further, they also found that domestic food price rises 0.3% when global food price rises by 1% in India. A study by Holtemöller and Mallick (2016) examined the influence of global food prices on aggregate inflation and food price inflation over the period 1996Q2-2013Q2. Using the SVAR model, their results show that global food prices inflationary affected food price inflation in India. Huria and Pathania (2018) also found that global food price inflation increases food price inflation in India. However, Rajmal and Mishra (2009) pointed out a limited transmission of prices from international food to domestic food prices in India. Similarly, Baltzer (2013) stated that international prices positively impacted domestic prices in the case of Brazil and South Africa. However, price transmission is very limited in China and India.

2.2.3. Demand-driven factors

Even though supply-side factors are measured as very significant elements of food price inflation in India, at the same time we cannot ignore the factors of food price inflation which is caused by demand-driven. A large body of studies empirically investigates the causes of food price inflation for both developed and developing economies. One of the vital causes for rising food price inflation is increasing biofuel production to reduce the consumption of fossil fuels. For example, Mitchell (2008) examined the reasons for rapid surge in prices of internationally traded food items during January 2002-June 2008 in the U.S. and European Union countries. The results found two-thirds of the growth in the food grain and oilseeds because of using these two in the biofuel production process.

Further, the study also found that an increase in energy prices, fertilizer and chemicals, decline of the dollar, speculative activities, and export bans are also led to higher food prices. However, Baffes and Haniotis (2010) investigated the impact of three controversial key factors: speculation, surge in demand for food by emerging economies, and biofuels' demand in the recent commodity boom during 2006-2008. The study found that biofuels have a marginal influence on food prices, while the financialization of commodities has partially responsible for the 2007/08 commodity spike. However, they could not establish any relationship between the increase in the demand for food items and the recent commodity price boom. Gilbert (2010) established that demand for grains and oilseeds as biofuel feedstocks are the major determinants of the food price surge. However, the author found a marginal and direct impact in this regard.

The Indian economy is the fastest-growing economy since globalization. Having a high growth of population and rapid increase in the middle-class family is considered as the main source of food price inflation in India. Another source of food price inflation is high-income growth. For instance, Krugman (2008) argued the increase in per capita income directly impacts shifting dietary habits of people towards a high-value product like meat, eggs, and milk which promotes the demand for food grain, resulting in a rise in food price inflation. Kumar et al. (2010) reported that declining the availability of cereals, pulses, and oilseeds led to an expansion in demand for food items, resulting surge in food prices. Carrasco and Mukhopadhyay (2012) documented that the relationship between per capita income and food prices is positive. In contrast, an inverse association exists between agricultural production and food prices in 3 South Asian countries. Mishra and Roy (2012) found that higher per capita income and population growth were the main drivers of food price inflation. Joiya and Shahzad (2013) demonstrated that rising income positively contributes to food price inflation in Pakistan. Sasmal (2015) explored the reasons food price inflation in India during 1971-2012. Using the Johansen co-integration and Granger causality test, the results found that per capita income upsurges food price inflation in India. However, this study could not establish any association between the money supply and food price inflation.

Further, there has been increasing demand for food commodities by the massive public spending of the government on numerous welfare benefit schemes such as rural public works, food security, subsidies, and pensions. The amount of share spent on these expenditures is less productive in nature, which is resulting in an increase in demand considerably without adding much input to supply. Therefore, it eventually creates a discrepancy between the

demand and supply of food products. Mishra and Roy (2012) examined the commodity-wise analysis of the major contributor to the increase in food price inflation in India from July 1988 to May 2011. They found that widening the gap between demand and supply is one of the important roots which add to food price inflation. Bhattacharya and Sen Gupta (2017) stated that excess demand over supply largely contributes to food price inflation in India.

In a recent scenario, escalation in demand for protein-based high-value food products leads to food price inflation. For example, Bandara (2013) argued that due to rapid economic growth, globalization, and lack of availability of adequate supply and variety of food products led to a surge in demand for vitamin and protein-based high-value food products, for instance, milk, fruits and vegetables, egg, meat, and fish, etc. The study also found that supply-side and institutional factors like unseasonal rain and failure of PDS are primary sources of food price inflation in India. However, the author concluded that cereal prices do not increase food price inflation due to the pass-through of global cereal prices. Agrawal and Kumarasamy (2012) examined the drivers of food price inflation in India during 1967-2007. Using the ARDL approach, the results found that a 1% growth in per capita income upsurges the demand for fruits, vegetables, milk, edible oils by 55-65%. However, it reduces the demand for cereals and pulses by 0.05 and 0.20, respectively.

Similarly, Gokarn (2010) also pointed out that an increase in per capita income has led to a surge in demand for protein-based food items, which are the major reasons for food price inflation in India. Mohanty (2011) reported the changing dietary pattern of demand for protein-based food products from the calorie-rich cereals among the rural and urban population, resulting in an increase in food prices. Gulati and Saini (2013) pointed out that there has been a changing dimension of the people's dietary habits from consumption of high calories food items to low calories or protein and vitamin-rich food items, leading to an increase in demand for those food items, resulting in a rise in food price inflation. Rajan (2014) revealed that food price inflation is raised due to a higher level of income and change in income distribution; thus, a shift in the dietary habit from cereal-rich products to high-value protein-rich food products. Utilizing annual data during 1980–1981 to 2013–2014, Gopakumar and Pandit (2017) argued that the surge in real income, money supply and relative prices have a substantial impact on protein inflation in India. On the contrary, a study by Nair and Eapen (2012) argued on the widespread view that there was no evidence of a secular shift in the patterns of food consumption towards a high value of agricultural outcomes, for instance fruits and vegetables, egg, meat, and fish except milk.

Another important factor is cost escalation, which has also induced to surge in food prices. One of the major public work programs is the National Rural Employment Guarantee (NREG) which promotes the real daily agricultural wage rates by 5.3% (Berg et al. 2012). In this line, Gulati et al. (2014) investigated the factors of rising rural wages in India in a panel of 16 major states during 1990–1991 to 2011–2012³. Their results showed that pull and push factors have a positive impact on rural wages. However, the impact of pull factors is stronger than the push factor of Mahatma Gandhi National Rural Employment Guarantee scheme (MGNREGA) on raising farm wages. Rakshit (2011) and Rajan (2014) indicated that an increase in rural wage via welfare oriented-schemes like MNGREGS increase the bargaining and purchasing power of money. Therefore, it increases the demand for food items, followed by an increase in food price inflation. However, Goyal and Baikar (2015) showed that the rapid increase in MGNREGA wages when it merged with inflation boosts agricultural wages rather than the implementation of MGNREGA across India. Bhattacharya and Sen Gupta (2018) examined the driving forces of food price inflation in India during 2006-2013. The analysis showed that agricultural wage inflation had driven the food price inflation after the implementation of MNGREGS. Further, the results revealed that fuel prices also positively affect food price inflation. A most recent study by Huria and Pathania (2018) documented agricultural wages are positively influenced food price inflation in India.

Additionally, wide range of studies has also identified the fiscal deficit as one of the prominent contributors to food price inflation, followed by rural wages and global prices in India (Gulati and Saini, 2013). A recent study by Bhattacharya and Sen Gupta (2017) stated that food price inflation is determined by the fiscal deficit and agricultural wages. An increase in MSP is also considered a major factor of food price inflation. Raghav and Kulkarni (2005) highlighted that the level of MSP for rice and wheat is positively correlated with WPI as well as consumer price index-agricultural labour (CPI-AL) in India. Similarly, Mishra and Roy (2012) said that a rise in MSP creates inflationary pressures in the economy. Sonna et al. (2014) revealed that food price inflation is positively impacted by the real rural farm wages, MSP, and agricultural inputs in the long run in India during 1999-00: Q1-2012-13: Q4. Their short-run results indicated that real rural farm wages, MSP, and agricultural inputs are strongly responsible for the surge in food prices. Finally, Bhattacharya and Sen Gupta (2017) also stated that the MSP contributes the food price inflation in India.

³They have considered three pull factors such as the growth of aggregate GDP, construction-GDP and agri-GDP, whereas MGNREGA is considered as a push factor.

From the above literature review, we figure out that numerous studies have conducted by focusing on factors accountable for high food price inflation in India and across the world. The basic idea of these studies is mainly constrained to only the nature of food price inflation, and also most of the studies are mainly confined to supply-side factors. However, the relative importance of demand and supply-side factors towards the variability of relative prices has not been considered into account. Hence, it is essential to inspect to what extent relative price variability is caused due to real (demand-side) and inflationary (supply-side) factors. To best my knowledge, none of the studies has investigated the allocation of relative price variability for the basket into two elements due to real factors and inflationary factors. Therefore, this study aims to inspect the decomposition of relative price variability in India.

2.3. Data and Estimation Techniques

2.3.1. Data

The present paper makes use of monthly data on 105 commodities prices, which represents 23% of WPI in India. There are 112 numbers of commodities that are included both in primary food articles and manufactured food products (2004-05 base year)⁴. Basically, WPI and CPI are used as a measure of inflation in India. WPI is used the average selling price by domestic producers and retails of goods, whereas CPI uses used average price from the consumer point of view. The weights assigned to food articles on CPI data are higher than the WPI food baskets. Therefore, the CPI data capture the hike in food prices more accurately in recent periods. However, due to a lack of historically comparable data on the all-India CPI commodity-wise food items over the period, we have used the WPI disaggregated data during January 2005-March 2017. Moreover, the data on CPI disaggregated food items are less compared to WPI. WPI has more food items for a more extended period and a widely used price index of inflation in India. Further, to check robustness on CPI disaggregated data, we have used the available data during January 2014-February 2020⁵. To verify to what extent non-food commodities are accountable in the relative price variations of food items, we

⁴Due to unavailability of data for certain commodities under the category of primary food articles, we have dropped seven more commodity prices such as apple, cauliflower, mango, tomato, green (peas), litchi, and grapes.

⁵There are 114 commodities under the CPI food basket based on the 2011-12 base year. We have dropped the eight commodities out of it due to inconsistent and missing data series for some of the commodities. These commodities are jackfruits, singara, mango, kharbooza, pears/nashpati, berries, leechi and chips.

included WPI and CPI non-food commodities in the analysis⁶. The selection of data period has been considered on the basis of the availability of uniform and consistent data on the price of commodities over the period of time. We have also constructed an index for food price inflation using the weighted least square of both primary food articles and manufactured food products using WPI indices. The food price indices and their respective weights are obtained from the Office of the Economic Adviser, published by the MCI. However, CPI food and non-food indices and their weights are retrieved from Consumer Price Indices Warehouses, MOSPI.

2.3.2. Methodology

In order to decompose the relative price variability into two elements, i.e., due to real factors and inflationary factors, we have used the technique developed by Clements and Nguyen (1981, 1982). The essence of the present technique is to identify which commodity share has higher relative price variability of food baskets. It also helps to figure out the relative influence of individuals of the commodity on variability of relative price and able to identify in which magnitudes it is affected by inflationary factors as well as real factors.

The study has used the ordinary least square method in order to estimate the α and β for 105 commodities using the equation $(\pi_{it} - \pi_t) = \alpha_i + \beta_i \pi_i + \varepsilon_t$.

2.3.2.1. Measurement of relative price variability

Suppose, π_{it} is the rate of change in price of i th commodity which is defined as:

$$\pi_{it} = \ln \left(\frac{p_{it}}{p_{it-1}} \right) \quad (2.1)$$

Where p_{it} is the i th commodity in period t and $\ln$ is natural logarithm. The food price inflation can be interpreted as:

$$\pi_t = \sum_{i=1}^n \omega_i \pi_{it} \quad (2.2)$$

Where ω_i refers to weight of i th commodity. The relative price changes can be expressed as:

⁶The 564 number of WPI non-food commodities are considered in the analysis, whereas CPI non-food commodities consist of 184.

$$\lambda_t = \sum_{i=1}^n \omega_i (\pi_{it} - \pi_t)^2 \quad (2.3)$$

When, prices of all the commodities are proportional, then $\pi_{it} = \pi_t$ and $\lambda_t = 0$. The relative price variation of food item i with food price inflation can be denoted as:

$$\omega_i (\pi_{it} - \pi_t) = \alpha_i + \beta_i \pi_t + \varepsilon_t \quad (2.4)$$

Where α_i and β_i are commodity-wise coefficients and ε_t is the random error term with $E(\varepsilon_t) = 0$; α_i/ω_i is the autonomous trend in the relative price of commodity i , reflecting real change in the economy and β_i/ω_i is the elasticity of the relative price of commodity i w.r.t. inflation. If we substitute Equation (2.4) into (2.3), it gives us measurement of relative price variability as:

$$\lambda_t = \sum_{i=1}^n \omega_i \left[\left(\frac{\alpha_i}{\omega_i} \right) + \left(\frac{\beta_i}{\omega_i} \right) \pi_t \right]^2 \quad (2.5)$$

Where ε_t is random error term set identical to its expected value.

2.3.2.2 Decomposition of relative price variability of food items

The share of product i in λ_t for time t is:

$$\theta_{it} = \omega_i \frac{\left[\left(\frac{\alpha_i}{\omega_i} \right) + \left(\frac{\beta_i}{\omega_i} \right) \pi_t \right]^2}{\lambda_t} \quad (2.6)$$

Where θ_{it} is non-negative and its summation is equal to one. Thus, the effect of real changes and inflationary changes on the variability of relative price of i th item are shown in α_i and β_i in Equation (2.4), respectively. Hence, real and inflationary element of θ_{it} are expressed as:

$$\theta_{it}^R = \frac{\left(\frac{\alpha_i^2}{\omega_i} \right)}{\lambda_t} \quad (2.7)$$

$$\text{and } \theta_{it}^I = \frac{\left(\frac{\beta_i^2}{\omega_i} \right)}{\lambda_t} \pi_t^2 \quad (2.8)$$

Both θ_{it}^I and θ_{it}^R are non-negative, and interaction element due to both real and inflationary

$$\text{factor can be represented as: } \theta_{it}^{RI} = 2\alpha_i \frac{\left(\frac{\beta_i}{\omega_i} \right)}{\lambda_t} \pi_t \quad (2.9)$$

which can be either positive or negative. The total share of real changes in λ_t can be

interpreted

$$\text{as: } \lambda_t^R = \sum_{i=1}^n \frac{\left(\frac{\alpha_i^2}{\omega_i}\right)}{\lambda_t} = \sum_{i=1}^n \theta_{it}^R \quad (2.10)$$

and the share of due to inflationary factors in λ_t is:

$$\lambda_t^I = \sum_{i=1}^n \frac{\left(\frac{\beta_i^2}{\omega_i}\right)}{\lambda_t} \pi_t^2 = \sum_{i=1}^n \theta_{it}^I \quad (2.11)$$

and interaction component of both real and inflationary share in λ_t is:

$$\theta_{it}^{RI} = \sum_{i=1}^n 2\alpha_i \frac{\left(\frac{\beta_i}{\omega_i}\right)}{\lambda_t} \pi_t = \sum_{i=1}^n \theta_{it}^{RI} \quad (2.12)$$

Hence,

$$\lambda_t^R + \lambda_t^I + \lambda_t^{IR} = 1 \quad (2.13)$$

The average share of real, inflation and interaction component in relative price variability over the period can be defined correspondingly as:

$$\bar{\lambda}^R = \frac{1}{T} \sum_{t=1}^T \lambda_t^R; \bar{\lambda}^I = \frac{1}{T} \sum_{t=1}^T \lambda_t^I \text{ and } \bar{\lambda}^{RI} = \frac{1}{T} \sum_{t=1}^T \lambda_t^{RI} \quad (2.14)$$

where T is the time. The average share of i th product in relative price variability is interpreted as:

$$\bar{\theta}_i = \frac{1}{T} \sum_{t=1}^T \theta_{it} \quad (2.15)$$

Similarly, the contribution of the average share of real, inflationary, and interaction component of i th commodity to relative price changes, respectively, are defined as follows:

$$\bar{\theta}_i^R = \frac{1}{T} \sum_{t=1}^T \theta_{it}^R; \bar{\theta}_i^I = \frac{1}{T} \sum_{t=1}^T \theta_{it}^I; \text{ and}$$

$$\bar{\theta}_i^{RI} = \frac{1}{T} \sum_{t=1}^T \theta_{it}^{RI} \quad (2.16)$$

2.4. Empirical findings and discussion

2.4.1. Preliminary analysis

2.4.1.1. Food price inflation and distribution of relative price variability

We have used annualized monthly data on food items for India in order to analyze the trend and pattern of relative price variability. The mean, variance, and skewness of the cross-sectional distribution of relative price variability in each period have been calculated presented in Table 2.2 The results depict that an average value of skewness is positive, which indicates that persistent positive skewness in the distribution of price variability is present in India. In other words, the aspect of asymmetries in the price adjustment is appeared due to downward rigidity in prices or differential adjustment lags.

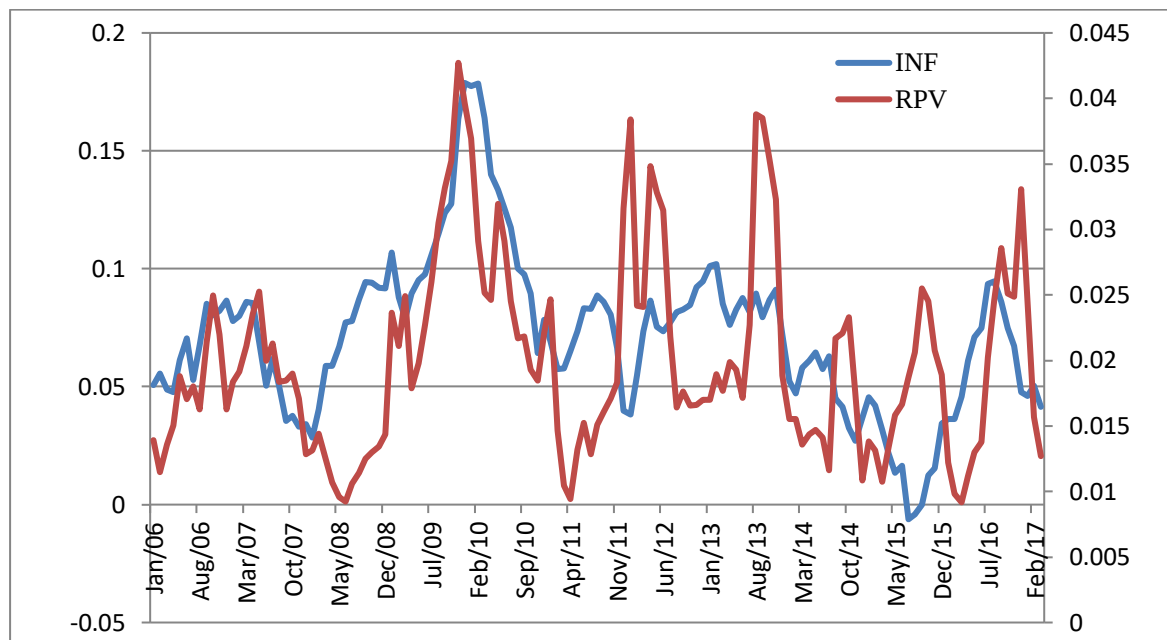
Table 2.2. Descriptive statistics

Variables	Mean	Median	Stand. Dev	Skewness	Minimum	Maximum
Inflation	0.072	0.074	0.034	0.650	-0.006	0.179
Variance	0.020	0.018	0.007	0.936	0.009	0.043
Skewness	0.112	0.299	1.430	0.526	-4.167	3.445

Source: Authors' calculations.

Additionally, we have also represented the graph of food price inflation and relative price variability in order to understand the association between the variables, which is shown in Figure 2.2. It is observed that the high relative price variability when food price inflation is high. The inflation encourages variation in relative price variability. The results of disaggregated food items also exposed that variation in very few commodities creates a high fluctuation in the whole relative price variability.

Figure 2.1. The association between food price inflation and relative price variability



Source: Authors' calculations.

2.4.2. Proportion of sectoral-food prices in relative price variability

We use regression coefficients of α_i and β_i from Equation 2.15, in order to find out the average share of i th commodity price ($\bar{\theta}_i$) in relative price variability. The sector-wise contribution to relative price variability is stated in Table 2.3. The first column represents the components of the food basket, which consists of both the primary food articles and manufactured food products. The second column shows the percentage share of primary food articles and manufactured food products for determining the variation in relative price changes. It depicts that primary food articles have the highest share (82%) compared to manufactured food products (18%). The 82% of variation in the relative price changes is identified from primary food articles, whereas 18% of variation in the relative price changes is contributed by manufactured food products. It implies that the commodities from primary food articles are mainly responsible for determining the variation in relative price changes. Again, the third and fourth column of Table 2.3 indicates that 53% of the variability of relative price in primary food articles is derived from real factors, and the remaining 47% comes from inflationary factors⁷. However, the variability of relative price in manufactured

⁷The shares of real and inflationary components are adjusted for the interaction component: therefore,

food products is mainly explained by inflation (70%), and the rest (30%) is due to real factors. The portion of real factors to relative price variability is higher than the inflationary factors in the primary food articles, while the share of inflationary factors is higher against real factors under manufactured food products. Therefore, we can say that a rise in the relative price variability of primary food articles occurs due to real factors, and the relative prices of manufactured food products occurs due to inflationary factors for India. In other words, these results indicate that variability in relative prices in India arises due to both real and inflationary factors. These results contradict previous studies claiming that relative price variability of food items occurs due to inflationary factors known as supply-side factors.

Table 2.3. Sector-wise contribution to relative price variability of food items

Food price inflation	$(s\bar{\theta}_i)$	$(\bar{\theta}_i^R)$	$(\bar{\theta}_i^I)$
Primary food articles	82	53	47
Manufactured food products	18	30	70
Total	100	-	-

Note: $s\bar{\theta}_i$ is the summation of average proportions of prices $(\bar{\theta}_i)$ in each sector, $\bar{\theta}_i^R$ denotes shares of real factors in relative price variability, and $\bar{\theta}_i^I$ denotes shares of inflationary factors in relative price variability. Source: Authors' calculations

2.4.3. Shares of disaggregated food items and its decomposition

The shares of a particular commodity in the total variability in relative price are reported in Table 2.4. One interesting result of this study is that only 25 among 105 commodities are predominately contributing 93% of the variation in relative price changes in the food basket. We have reported the commodities whose share has equal to 1% or above. The highest shares of commodities that contribute to larger relative price variability are identified, mainly vegetables. The price of cabbage alone contributes 24% of the variability in relative price, followed by brinjal (19%), onion (12%), potato (9%), milk (5%), vanaspati (3%), fish inland (2%) and fish marine (2%) and so on. It implies that few commodity prices determine the higher relative price of food items in the basket. They are fruits and vegetables and milk, and fish prices accomplish a leading role in the variability of relative prices. The increase in the variability of the relative price of food items is due to changing dietary patterns of food

$$\bar{\theta}_i^R = \bar{\theta}_i^R / (\bar{\theta}_i^R + \bar{\theta}_i^I) \text{ and } \bar{\theta}_i^I = \bar{\theta}_i^I / (\bar{\theta}_i^R + \bar{\theta}_i^I)$$

products from cereals-based food to high-value products. Further, from Table 2.4, columns 3 and 4 are decomposed into two components, i.e., real and inflationary factors for each commodity. The result indicates that 41% of the relative price variability of cabbage is because of real factors and the residual 59% by inflationary factors. Similarly, for brinjal, 42% of the variation in relative price changes is attributed by real factors, whereas 58% of the variation in relative price changes is originated from inflationary factors. Whereas, in the case of gram, 99% of its share due to real factors, and 1% due to inflationary factors. Similarly, for fish-inland, 92% of its share is caused by real factors, and the residual 8% is caused by inflationary factors.

Table 2.4. Shares of commodity prices and its decomposition results

Commodities	$(\bar{\theta}_i)$	$(\bar{\theta}_i^R)$	$(\bar{\theta}_i^I)$
Gram	1	99	1
Fish-inland	2	92	8
Tapioca	1	84	16
Fish-marine	2	67	33
Mutton	1	56	44
Chillies (dry)	1	56	44
Milk	5	50	50
Potato	9	46	54
Wheat	1	44	56
Onion	12	42	58
Rice	1	42	58
Brinjal	19	42	58
Cabbage	24	41	59
Wheat flour (atta)	1	38	62
Coconut (fresh)	1	36	64
Powder milk	1	34	66
Molasses	1	28	72
Poultry chicken	1	28	72
Maida	1	23	77
Mustard& rapeseed oil	1	20	80
Soyabean oil	1	19	81
Biscuit / cookies	1	10	90
Palm oil	1	6	94
Sunflower oil	1	3	97
Vanaspati	3	1	99

Source: Authors' calculations.

However, 99% of the variability in relative price of vanaspati is from inflationary factors and 1% from real factors. Overall, the commodities having the highest share contribute to greater fluctuation in relative price changes by both demand and supply-side factors. In particular, relative price variability in food items is mainly contributed by vegetable prices, which are

determined by both real and inflationary factors. However, inflationary factor contributes larger share in the variability in the food prices. Whereas, the commodities contributing lesser variation in relative price changes are determined by inflationary factors except few commodities like gram, fish, and tropica, they are mostly generated from the manufactured food products.

To determine which commodity price has a significant impact on variability in relative price, we have presented the shares of decomposed commodities results in Table 2.5. The figure given in column 2 of Table 2.5 shows that 25 commodities jointly contribute 93% of the variability in relative prices. Among them, 15 commodities are under the primary food articles and 10 commodities under manufactured food products, which have a significant share in the variability in relative prices. Under the primary food articles, 15 commodity prices together contribute 81% of the variation in relative prices. Whereas, under manufactured food products, 10 commodity prices contribute only 12% of the variation in relative prices. The major variation in relative price changes arises mainly due to vegetable prices and milk under primary food articles that contribute 69% of the variation in relative prices. Again, we also found that a large number of commodity prices from primary food articles have a significant share in variability in relative prices, which is consistent with Table 2.3 results.

The column 3 and 4 from Table 2.5 represents the percentages of food prices due to real and inflationary factor, respectively. The both real and inflationary factors denote the major variability in relative prices. However, inflationary factor contributes relatively larger share in the variability in cabbage, brinjal, onion, potato, and milk under the primary food articles. In particular, larger fluctuation in relative prices is due to real factors for fish-inland, fish-marine, gram, and tapioca. However, the fluctuations in relative prices are due to inflationary factors for vanaspati, powder milk, maida, biscuit /cookies, palm oil, mustard & rapeseed oil, soyabean oil, and sunflower oil in manufactured food products. Therefore, it is clear from the above results that the larger variation in relative prices is due to both real and inflationary factors. However, inflationary factor contributes relatively larger proportion of the variability in relative prices. However, all the food items under the category of manufactured food products are due to inflationary factors. Few items under the category of primary food articles are due to real factors.

Table 2.5. Shares of decomposed commodities

Commodities	$(\bar{\theta}_i)$	$(\bar{\theta}_i^R)$	$(\bar{\theta}_i^I)$
Primary food articles			
Cabbage	24	41	59
Brinjal	19	42	58
Onion	12	42	58
Potato	9	46	54
Milk	5	50	50
Fish-inland	2	92	08
Fish-marine	2	67	33
Rice	1	42	58
Wheat	1	44	56
Gram	1	99	01
Tapioca	1	84	16
Coconut (fresh)	1	36	64
Mutton	1	56	44
Poultry chicken	1	28	72
Chillies (dry)	1	56	44
Manufactured food products			
Vanaspati	3	1	99
Powder milk	1	34	66
Maida	1	23	77
Wheat flour (atta)	1	38	62
Biscuit / cookies	1	10	90
Molasses	1	28	72
Palm oil	1	6	94
Mustard & rapeseed oil	1	20	80
Soyabean oil	1	19	81
Sunflower oil	1	3	97

Source: Authors' calculations.

2.4.4. Shares of sub-sector prices and its decomposition

The shares of major sub-category decomposed commodities are stated in Table 2.6. The outcomes display that 8 commodities whose shares are more than or equal to 2% together contribute 95% of the variation in relative price changes. However, out of them, fruits & vegetables alone offer 67% of overall relative price changes which is produced by both real and inflationary factors. But inflationary factor contributes relatively larger share in the variability in relative prices. From Table 2.6, it also revealed that 43% of relative price variability is attributed by real factors, and the residual 57% is by inflationary factors. For edible oils, which contribute 8% of variability in relative prices is mostly initiated from inflationary factors (88%). For condiments & spices and eggs, meat & fish, the changes in relative price variability originated from real factors which are 89% and 66%, respectively.

Table 2.6: Shares of major sub-category decomposed commodities

Commodities	$(\bar{\theta}_i)$	$(\bar{\theta}_i^R)$	$(\bar{\theta}_i^I)$
Condiments & spices	1	89	11
Eggs, meat & fish	5	66	34
Food grains (cereals + pulses)	3	57	43
Milk	6	52	48
Other food products	2	44	56
Fruits & vegetables	67	43	57
Dairy products	1	41	59
Grain mill products	2	33	67
Canning, preserving & processing of food	1	19	81
Bakery products	2	15	85
Edible oils	8	12	88
Sugar, khandsari & gur	1	10	90
Tea & coffee processing	1	1	99

Source: Authors' calculations.

2.4.5. Shares of commodity prices and its decomposition analysis using WPI non-food

Further, we also considered WPI non-food analysis to check to what extent non-food commodities are accountable for the variability of relative price changes of food items. The outcomes are reported in Table 2.7. Total 46 commodities out of 564 have been identified, which contributed 50% of changes in the relative prices of food items whose share is 1% or more. We have presented the results of non-food items on the basis of the average share of the commodities whose share is 2% or more. The results show that among the 564 commodities, 10 commodities have been identified, which contributes 23% of the variations in relative price changes in food items. Most of the identified commodities responsible for the changes in the relative prices are triggered by agricultural inputs like power and fuel. These are sugarcane, coking coal, non-coking coal, high-speed diesel, urea, HRC, motor vehicles. These are the inputs used as major inputs of the agricultural sector directly and indirectly in the production and transportation of output/produce. An increase in the price of these fuels and other major inputs of the agricultural sector, like agricultural machinery, pesticides, and equipment, would increase the cost of production of food items. Thus, increase in variability in the relative price of food stuff.

We also investigate the relative contribution of real factors and inflationary factors in the variability of relative prices of food items. Interestingly, for cotton shirts, 0% of the variation in relative prices of food items is because of real factors. However, entire 100% is for inflationary factors. For urea, 10% of the variation is occurred by the real factors and the outstanding 90% by the inflationary factors. For sugarcane, 60% of the variability in relative price changes is determined by real factors and 40% by inflationary factors. For high-speed diesel, 52% of the variability is initiated by real factors and 48% by inflationary factors. Additional 36 commodities are responsible for the 32% variation in relative prices whose average share is equal to one.

From the above analysis, it is clear that an increase in non-food price inflation has contributed to higher relative price variability in food items as it implies upward pressure on input prices. Few non-food commodities lead to larger variability in food items, and most of them are from power and fuel. These are agricultural inputs that are identified in the inflation of food items.

Table 2.7 Shares of commodity prices and its decomposition analysis using WPI non-food data

Commodities	$(\bar{\theta}_i)$	$(\bar{\theta}_i^R)$	$(\bar{\theta}_i^I)$
Sugarcane	2	60	40
Coking Coal	2	67	33
Non-Coking Coal	2	36	64
High Speed Diesel	3	52	48
Cotton Shirts	3	0	100
Urea	2	10	90
Grey Cement	2	31	69
HRC(Steel)	2	14	86
Gold & Gold Ornaments	2	80	20
Motor Vehicles	3	9	91

Source: Authors' calculations

2.4.6. Robustness check using CPI food items

We use CPI disaggregated data to check the robustness of the study. Because the high weights have been given to the CPI basket of the food commodities than the WPI food basket, i.e., it accounts for nearly 39.8% weights of aggregate CPI inflation. In contrast, the WPI food basket accounts for 24.6% weights of the aggregate WPI basket. Therefore, to check the robustness of the data, we have analyzed the data from the CPI food basket. The

results are displayed in Table 2.8. We have divided the entire Table 2.8 into two sub-parts, namely, panel A and panel B, on the basis of the average share of the commodities equal to or greater than 1. Panel A consists of the commodities whose share is 2% or more, whereas commodities share equal to 1% or more are included in panel B. It shows that 22 commodities have been identified among the 106 commodities, which contribute 94% of the variation in relative price changes. The results of panel, A show that 9 commodities are together contributing 83% of the variability in relative prices. However, among them, only one commodity, namely, tomato, determines 45% of the relative price changes followed by potato (10%), onion (9%), cauliflower (7%), peas (vegetables) (3%), cabbage (3%), brinjal (2%), parwal/patal, kundru (2%) and milk (2%). It is also revealed that, in the case of tomato, 39% of relative price variability is attributed by real factors, and the surplus 61% is attributed by inflation factors. For potatoes, 36% of the variation in relative price changes is because of real factors, and 64% of the variation is due to inflationary factors. For cauliflower, 36% of relative price variability is determined by real factors, and 64% is by inflationary factors. However, in the case of onion, 25% of fluctuation in relative prices is decided by real factors, and 75% by inflationary factors.

Based on the above results, the conclusions emerge from the panel: A that most of the responsible commodities in the fluctuations of the relative prices is identified as vegetables. The relative price variability of all the commodities is largely determined by inflationary factors and shared as highest against real factors. Therefore, we can conclude that the majority of the identified commodities in variability in relative prices in panel A are largely determined by inflationary factors, and there are very a smaller number of commodities that creates larger variability in the relative price of the food basket in an aggregate term.

It stated that 13 commodities had been identified as 1% shares that contribute 10% of the relative price changes is depicted in panel B. Most of the commodities are identified as vegetable items from panel B. It indicates that vegetables are considered an essential source of commodities where variation in relative price takes place. The relative price variability in vegetable items is largely derived from inflationary factors. For palak/other leafy vegetables, 36% of the relative price variability is determined by real effects, and 64% is determined by inflationary effects. For lady's finger, 44% of the variability in relative price is created through real factors, and 56% through inflationary factors and so on. Further, in the case of

rice-PDS, rice - other sources, wheat/atta – other sources, and refined oil are also determined by inflationary factors, i.e., 95%, 85%, 64%, and 77%, respectively. However, in the case of fish prawn and goat meat/mutton, 67% and 61% of the variation in relative price changes is due to real factors, and 33% and 39% are due to inflationary factors.

Table 2.8: Shares of commodity prices and its decomposition analysis using CPI food data

Commodities	$(\bar{\theta}_i)$	$(\bar{\theta}_i^R)$	$(\bar{\theta}_i^I)$
Panel A:			
Parwal/patal, kundru	2	52	48
Brinjal	2	30	70
Milk: liquid (litre)	2	45	55
Cabbage	3	36	64
Peas (Vegetables)	3	33	67
Cauliflower	7	36	64
Onion	9	25	75
Potato	10	36	64
Tomato	45	39	61
Panel B:			
Rice – PDS	1	5	95
Rice – other sources	1	15	85
Wheat/ atta – other sources	1	36	64
Goat meat/mutton	1	61	39
Fish, prawn	1	67	33
Mustard oil	1	23	77
Refined oil [sunflower, soyabean, saffola, etc.]	1	23	77
Radish	1	36	64
Carrot	1	27	73
Garlic (gm)	1	45	55
Palak/other leafy vegetables	1	36	64
Green chillies	1	44	56
lady's finger	1	44	56

Source: Authors' calculations.

Thus, the relative price changes of fish and mutton are largely initiated by real factors. We can conclude that more than 50% of the variations are originated by the inflationary factors (supply-side factors) for most of the commodities, and the majority of them are identified as vegetable items. These are mostly depending on supply-side factors like a monsoon, extreme weather conditions. Therefore, change in this factor contributes a larger relative price

variability. Whereas, we found that variability of relative prices in fish prawn and goat meat/mutton are due to real factors. Because there has been a significant shift in consumption patterns/ dietary habits of the people from cereal-based products to protein rich items, for instance milk, fish, meat, and eggs, the rise in demand for these products may put upward pressure on relative prices. It might be the reason for the larger relative price variability in protein-rich food products. Since food contributes significant weight (nearly 40%) to the CPI basket, it implies that any increase in food prices would surge the CPI inflation.

2.4.7. Shares of commodity prices and its decomposition analysis using CPI non-food

Further, we also considered analysis of CPI non-food commodities to check whether non-food commodities are responsible for the higher relative price variability of food items. The results are displayed in Table 2.9. Overall, 46 commodities of 184 have been identified, which contribute 84% of the variation in relative price variability in food items whose share is equal to or greater than 1%. We have presented the results of non-food items on the basis of the average share of the commodities whose share is 2% or more. Among the 184 commodities, 14 commodities have been identified, contributing 56% of variation in food items. From the results, it is shown that only one commodity, house rent; garage rent has been contributed 16% variation of relative price variability followed by medicine [non-institutional] (6%), petrol for vehicle (5%), electricity (std. unit) 4% and so on. It is also observed that 42% variation in house rent; garage rent is originated from real factors, and rest 58% is from inflationary factors. A36% of the fluctuations in relative prices of medicine is formed by real factors and 64% determined by inflationary factors. For petrol for a vehicle, 33% variability in relative prices are owing to real effects, and the residual 67% is for inflationary effects. Additional 32 commodities have responsible for 32% of the variation in relative prices whose average share is equal to one.

Overall, it is concluded that apart from food items, non-food items are also responsible for variability in relative price changes of food items. Among 14 identified commodities, 5 commodities are from power and fuel. These are petrol for vehicle, electricity, LPG, kerosene PDS (litre), firewood and chips, petrol for vehicle and bus/tram fare, etc. These are the basic agricultural inputs involved in the process of food production and transportation of food items which eventually included in the price of food items. Hence, increase in variation in relative price in food items. Further, an increase in bus fare due to a hike in diesel and petrol

prices is responsible for the variability in relative price changes of food items. We here found a pass-through of fuel prices to variation in the relative price of food commodities. The result is similar to Bhattacharya and Sen Gupta (2018) in India, who found that fuel inflation moderately affects food price inflation. However, Huria and Pathania (2018) found that fuel inflation increases food grain inflation in India. Finally, an increase in non-food price inflation increases food price inflation via rising cost of production of agricultural sector inputs & fertilizer, and other machinery and equipment used in the production process. Thus, hike in variability in relative price changes of food prices.

Table 2.9: Shares of commodity prices and its decomposition analysis using CPI non-food data

Commodities	$(\bar{\theta}_i)$	$(\bar{\theta}_i^R)$	$(\bar{\theta}_i^I)$
Cooked meals purchased (no.)	3	39	61
Cooked snacks purchased	2	34	66
House rent; garage rent	16	42	58
Electricity (std. unit)	4	14	86
LPG [excl. conveyance]	3	45	55
Kerosene “PDS (litre)	2	82	18
Firewood and chips	3	31	69
Medicine [non-institutional]	6	36	64
Petrol for vehicle	5	33	67
Bus/tram fare	2	33	67
Air fare [normal]: economy class [adult]	2	29	71
Telephone charges: mobile	3	24	76
tuition and other fees [school; college; etc.]	3	52	48
gold	2	39	61

Source: Authors' calculations.

2.4.8. Comparison between WPI and CPI results

Firstly, only 25 commodities contribute 93% of the relative price variability among 105 commodities from WPI data. Among them, cabbage alone provides 24% of the variability in relative price changes, followed by brinjal (19%), onion (12%), and so on. However, from the CPI data, it is observed that 22 commodities have been identified among the 106 commodities, which contribute 94% of the variation in relative price. Among them, one commodity only, namely, tomato, which determines 45% of the fluctuation in relative prices

followed by potato (10%), onion (9%), cauliflower (7%), peas (vegetables) (3%), cabbage (3%), brinjal (2%), parwal/patal, kundru (2%) and milk (2%).

Secondly, WPI and CPI data revealed that the commodities having the highest shares contribute to the higher fluctuations in relative price changes by both demand and supply-side factors. Thirdly, in particular, changes in relative price variability mainly provided by vegetable prices which are determined by both real and inflationary factors but magnitude is larger for inflationary factors for both the results. However, the variability in relative price changes in all the commodities are largely determined by inflationary factors and shared as highest against real factors except fish (prawn), parwal and goat meat/mutton from CPI results. Fourthly, both the CPI and WPI non-food items are responsible for the relative price variability of food items. From the above analysis, we can conclude that the majority of identified commodities in relative price variability (mainly vegetables) are largely determined by inflationary factors from CPI results, whereas changes in relative price variability are mainly determined by both real and inflationary factors from the WPI results. However, inflationary factor has nearly 60% share in the relative price variability. Overall, the results obtained from both the data set exhibits similar results. However, it varies with magnitudes.

2.5. Concluding remarks and policy suggestions

This chapter 2 has empirically explored the decomposition of relative price variability in the case of India employing monthly frequency on 105 commodities prices, spanning the period January 2005-March 2017. This study broadly focuses on three important issues: (a) Identifying the individual and sub-category commodities whose contribution is higher towards the variability in relative price, (b) Allocation of relative price variability into two elements owing to inflationary and real factors. For that, we have used the methodology developed by Clements and Nguyen (1981, 1982) and (c) Checking the robustness of CPI food disaggregated data to comparison with WPI disaggregated food data. We have also taken into account WPI and CPI non-food commodities to verify to what extent non-food commodities are accountable in the variability of relative price changes of food items.

Based on the empirical results, we found the interesting point is that 25 out of 105 commodity prices are predominately contributing 93% of relative price variability in the food basket where their share is equal to 1% or above. The results of the sectoral empirical investigation showed that prices of primary food articles and manufactured food products

contribute 82% and 18% of the variability in relative price, respectively. Further, the results of decomposition analysis indicate that 53% of the variability in the relative price of primary food articles is due to real factors, and the outstanding 47% is through inflationary factors. Whereas 30% of the variability in the relative price of manufactured food products is due to real factors, and the rest 70% is due to inflationary factors. Overall, the commodity having the highest share largely contributes to variability in relative price by both demand and supply-side factors. These results contradict the previous studies, which says that relative price variability in food basket is mainly because of inflationary factors are known as supply-side factors. In particular, relative price variability mainly contributed by vegetable prices which are determined by both real and inflationary factors. However, inflationary factor contributes relatively larger share in the variability in relative prices. The 24% relative price variability of the overall food item is attributed from cabbage only. The essential conclusions emerge from the analysis that few commodity prices have an enormous contribution to variability of relative price. The majority of commodities under primary food articles have a higher contribution to relative price variability, whereas commodity prices under manufactured food products have the least contribution to it. The variability in relative prices of commodities under primary food articles seems to be originated due to real factors, and commodity prices under manufactured food products are due to inflationary factors. We also included analysis of WPI non-food items to check to what extent non-food commodities are accountable for the relative price variability of food items. Most of the identified commodities responsible for the variability in relative price changes are basically from agricultural inputs like power and fuel. These are the inputs used as major inputs of the agricultural sector directly and indirectly in the process of production and transportation of output/produce.

Finally, the study also checked the robustness of results using CPI food items. The results also confirmed that inflationary factors largely determine the majority of the identified commodities in relative price variability. It indicates that vegetables are considered an important source of commodities where relative price variability takes place. Moreover, this study was also taken into account CPI non-food commodities to verify to what extent non-food commodities are accountable for the variability of relative prices of CPI food items. The results concluded that non-food items are also responsible for the variability of relative prices of food items. These are the basic agricultural inputs involved in the process of food production and transportation of food items which eventually are included in the price of food

items. We found transmission of fuel inflation to variability in relative price changes of food items in India.

From both the WPI and CPI results, we found similar conclusions among them. We conclude that the percentage share of variation in relative price changes is similar for both the data set. The majority of the commodities in fluctuations of food basket are identified as vegetables in both the data set. In particular, variability in relative prices is mainly contributed by vegetable prices which are determined by both real and inflationary factors. However, share of inflationary factors seems to be more than 50% of the relative price changes. While the relative price variability in all these commodities is largely determined by inflationary factors using CPI data. Overall, the results obtained from both the data sets depicts similar to each other. However, it varies with magnitudes.

Based on the empirical conclusions, we can draw the subsequent policy implications. First, our results concluded that both the supply and demand-side factors are responsible for larger relative price variability, and robustness check results revealed that variability in relative price is mainly owing to inflationary factors (supply-side). Therefore, the government and policymakers should take necessary policy measures for both the supply and demand-side. Second, to meet the supply-side response, we need to increase agricultural productivity growth. Therefore, the government should encourage massive FDI inflows in the agriculture sector. It also helps in technology transfer which subsequently boosts farm production and productivity via adopting new technology. Further, investments in infrastructural activities through FDI can also enhance the rural infrastructure, which creates a positive platform for rural farmers to sell their agricultural products in the market. Third, various institutional reforms such as allocating different crop insurance schemes and providing rural credit facilities via rural banking and small-scale cooperative societies should be taken by the government. Other policy reforms like widening the irrigation facilities of agricultural land, issue of soil health cards for effective use of fertilizer, and using high yield variety (HYV) seeds should be implemented effectively in their production process, which eventually increases agricultural productivity. A balance should be maintained between the increase in agricultural wages and productivity growth, which reduces the high prices. Then, a sustainable and stable food price level can be established in the economy. Fourth, to meet the demand-side response, monetary policy can control food price inflation through moderating consumption demand. The contractionary monetary policy measures might help curb food price inflation by reducing the money supply and credit facilities, which eventually curtail the

aggregate demand. Thus, it leads to low food price inflation. Moreover, the government should also consider the policy measures of producer welfare point of view because still half of the population livelihood depends on food production in rural areas. Since food donates significant weights (nearly 40%) and major contributors to aggregate inflation, the central bank can target and tame the aggregate inflation by moderating the demand for non-food items, which is interest-sensitive. An increase in interest rate does not affect the consumption expenditure of food and necessary items. Hence, demand for food items remains unchanged to change in interest rates (Kapoor and Ravi, 2009). Our study also found that the rise in non-food price inflation also accounted for the variability of relative price changes of food items via increasing production of agricultural sector inputs used in the production process. Thus, increase in variability in the relative price of food items. Further, we also found that few commodities are responsible for the variability of relative price variability. Food items contribute significantly headline inflation. Therefore, the suitable policy decisions should be taken by the central bank by focusing on commodity-wise disaggregated inflation points of view while targeting headline inflation in order to maintain stability in price and growth of the economy. Further, if variability in relative price of both the identified food and non-food items can be checked by implementing appropriate policy stance, then food price inflation can be eliminated as a whole term.

3.1. Introduction

The main purpose of monetary policy in any economy is to maintain price stability. However, high food price inflation affects not only macroeconomic stability but also small farmers and poor consumers of the developing country, where poor people spend their larger portion of their food consumption. Agricultural commodity price volatility negatively impacts all societies by creating macroeconomic instability; specifically, it affects the impoverished that devote a massive percentage of their earnings on food and fuel (Zhang et al. 2010). Therefore, high food price inflation has become a significant concern among researchers and policymakers in determining responsible factors to surge food price inflation. The high food price inflation has been experienced in the recent period due to increasing demand for biofuels in many developed countries, increasing demand for various diets among newly prosperous populations as compared to the production of such foodstuff, rise in minimum support prices, rapid regional economic growth, increasing the cost of fertilizers and other inputs, rising oil prices, etc.

Agriculture is very competitive in producing homogenous goods, given its vulnerability and high dependence on monsoon. It also contributes 17 % of gross domestic product and employs more than 50% of the population. However, the share of the agricultural sector to GDP has been diminishing substantially since 2014, and the growth of agriculture is likely to increase by 2.1% in 2018-19 (Kapoor, 2018). Therefore, attention should be given to the agricultural sector as well as the behavior of prices of agriculture, especially for developing countries like India, where the majority of the population depends on agriculture. The persistent and high food price inflation over the period has gained more extensive attention in India by researchers and policymakers as food price inflation has been the major contributor behind the increase in overall Wholesale Price Index (WPI) inflation in India (Anand et al., 2014). Further, agricultural price is susceptible to relative changes in input prices, supply factors, etc.

Theoretically, the reasons for rising food prices are basically due to two factors in the literature, i.e., real and monetary shocks. These are explained by structuralist and monetarist approaches, respectively. According to structuralists, the money supply is sluggish, and the real factors such as supply-side shocks are accountable for an upsurge in food and relative prices. The surge in these prices is ultimately confirmed through the rise in money supply. Hence, inflation occurs in the prices of commodities. However, monetarists argued that inflation is driven by the autonomous increase in money supply via generating aggregate demand, which increases the relative price of commodities. Hence, a surge in inflation is a result of rise in money supply, it is not necessarily because of response to accommodate by real shocks.

However, developing countries like India are not exceptional from higher food prices and macro-economic instability. Since the 1991 economic reforms, the Indian economy has maintained a single-digit economic growth rate and moderate inflation. However, in recent years, one of the major problems that the Indian economy is facing is higher food price inflation. The WPI food price inflation was documented 10.20% during January 2008-July 2010 (Nair & Eapen, 2012). Further, CPI-IW for food was experienced at 8.05% during 2006-2019 while recorded at 13%, especially in 2013. However, the growth rate of gross food grain production was 2.66% during this period. The demand for food commodities rises at a higher rate due to the high economic growth rate (7-9%) per annum. In contrast, the annual growth of agriculture is relatively low (1.5%) compared to the service sector and GDP growth (Sasmal, 2015). The total investment in agriculture has been reduced from 2.43% to 1.28% during 1979-80 to 2007-08 period (Mani et al. 2011). The expenditure on subsidies, maintenance of existing projects, the relatively lower allocation of resources for irrigation, poor infrastructure and research, absence of adequate credit facilities in rural areas are the drivers of slow growth in public investment in agriculture (Sivagnanam and Murugan, 2016). Given this high food price inflation, researchers and policymakers have raised severe concern about reducing the food price inflation because most of the population spend half of the income on food expenditure, and food containing a larger share in the CPI basket. Therefore, it is necessary to find the causes and suitable majors to reduce food price inflation.

The present study contributes to food price inflation literature in several ways. First, a wide range of studies has investigated the principal factors of food price inflation for India. The various demand and supply-side factors, namely, per capita income, growth of money supply, changing patterns of dietary habits of the consumer, high agricultural wages, speculations,

and low growth of agricultural productions, are accountable for high food price inflation. However, the results are ambiguous and vary considerably across countries due to different data periods and econometric methodologies applied in their studies. Second, the change in macroeconomic factors may have a substantial influence on food price inflation. For instance, if the money supply positively impacts food prices, the consumer suffers from welfare loss. If it negatively impacts food prices, the producer suffers from welfare loss. However, this relationship of macroeconomic factors has not been empirically analyzed significantly with respect to food price inflation in India. Third, various researches have explored the impact of macroeconomic factors on food price inflation across the world. For example, (Kargbo (2000) for Eastern and Southern Africa; Kargbo (2005) for West Africa; Reziti (2005) for Greece; Kargbo (2007) for South Africa; Yu (2014) for China and Sasmal (2015) for India. Nevertheless, few studies have empirically studied the effect of macroeconomic factors on food price inflation by incorporating other control variables like net availability of food grain into account. To the best of my knowledge, there is no study existing in the context of India. Fourth, most of the studies have taken WPI food indices, food items from only primary food articles or some of the indices of selected food items as a measure of food price inflation. However, the present study has used the CPI-IW. Fifth, numerous studies have concluded that food price inflation is triggered by supply-side factors (see Chand, 2010; Nair and Eapen, 2012; Holtemoller and Mallick, 2016, etc.). However, in order to examine the rise in food price inflation, we have included both demand and supply-side factors in our study. Six, the present study also considered that food price inflation is not only influenced by domestic factors but also by global factors. More specifically, changes in global food prices and the exchange rate might influence food price inflation positively and significantly. However, the influence of these external factors on food price inflation does not explain to what extent food price inflation is driven by domestic supply-side factors. For this purpose, we have included food grain the availability as a control variable in the model. Therefore, the goal of the current search is to evaluate the long-run and short-run impact of macroeconomic factors on food price inflation and also verify the causal relationship aspect of these variables in the case of India over the period January 2006- March 2019.

The remaining of the episode is structured as surveys. Section 2 follows the review of literature on the linking between macroeconomic variables and food price inflation. Section 3 deals with data and techniques. Section 4 discourses the results of the study. Section 5 provides concluding remarks and policy inferences.

3. 2. Review of Literature

Since this chapter aims to examine the impact of macroeconomic factors on food price inflation, this section provides an assessment of the literature to establish the empirical basis of the link between macroeconomic factors and food price inflation.

3.2.1. Money supply and food price inflation

A surge in the money supply positively affects the food price inflation through both the demand and supply channels. First, it positively affects market credit facility by generating aggregate demand followed by changes in relative prices across commodities which push the food prices up. Second, it negatively affects the creation of investment by providing credit to the producer, which increases the supply and puts the commodity price down. Numerous studies have investigated the influence of money supply on food price inflation across the world. For example, Mellor and Dar (1968) examined the movement of food grains prices in India from 1949-50 to 1963-64. The authors found that the expansion of the money supply largely determines upward pressure on food grains price. Barnett et al. (1983) examined the nexus between money supply and agricultural prices in the U.S using monthly data during 1970-1978. The empirical results show that the money supply positively affects food price inflation and agricultural commodity prices. Bessler (1984) analyzed the nexus among relative prices of the agricultural sector, industrial sector, and money supply in Brazil during 1964-81. His finding from the Granger causality test demonstrated a prevalence of unidirectional causal nexus from money supply to agricultural prices. But bidirectional causality is found between industrial prices and money supply.

Bhujangarao (1987) examined the important determinants of food grain prices in India over the period 1961-1983. He showed that money supply to GDP ratio and stocks of food grains to public distribution positively contribute to the expansion of food grain prices. Devadoss and Meyers (1987) investigated how relative prices of farm output (agricultural sector) change over non-farm output prices (manufacturing sector) due to money supply shocks in the United States across the period January 1960-December 1985. Using VAR techniques, the study revealed that relative prices of farm output respond faster due to money supply shocks than the non-farm output. Further, they also found that the money supply shocks have a direct and non-neutral effect on the relative price of the agricultural sector.

Saghaian et al. (2002) examined the linkages of monetary effects on the overshooting of agricultural prices in New Zealand. The author found that a 1% rise in money supply boosts agricultural and industrial prices by 0.43% and 0.77%, respectively. Further, the results show that the recovery of agricultural prices is quicker than industrial prices due to money supply shocks in the short-run, while neutrality of money could not find in the long-run. Reziti (2005) investigated the impact of macroeconomic variables on relative price variability among 53 agricultural products in Greece over the period 1962-1997. His findings indicated a strong positive affiliation between macroeconomic variables and relative price variability. Another study by Kargbo (2007) inspected the influence of macroeconomic factors on food prices in South Africa during the period 1957-2004. Using the VECM test, the study found that there is a significant and persistent effect of money supply on agricultural prices and farm input prices. Asfaha and Jooste (2007) investigated the impact of monetary changes on relative prices of agricultural sector in South Africa. The result shows that the money supply promotes agricultural prices. Similarly, Gil et al. (2009) revealed that the agricultural prices and input prices are positively impacted by the money supply in Tunisia during 1967-2002. But agricultural variables have no significant effect on the money supply. Further, using quarterly series from 2006 to 2016, Bhattacharya and Jain (2020) examined whether monetary policy stabilizes food price inflation in emerging and developed countries. Their findings concluded that monetary policy induces food price inflation in these countries. It suggests that it increases food price inflation via the rising cost of capital and eventually increases the production charges in labour-intensive food sectors.

However, using monthly data during the period 2003-2012, Yu (2014) examined the impression of monetary policy on food prices in the long-run for the 7 food items in China. The results show that prices of major food products have a negative relation with monetary policy expansion except for wheat and rice. Further, the author found that the influence of demand on food price is lesser than the supply. The study by Kargbo (2000) found mixed results in Eastern and Southern Africa. The results show that a growth in money supply tends to increase real food prices significantly in the case of Kenya, Sudan, and Tanzania. However, the money supply decreases real food prices in the case of Malawi and Zambia. Similarly, Kargbo (2005) revealed that the rise in money supply is negatively associated with food price inflation in Cote d'Ivoire and Senegal, while it is positively affected in Nigeria in the group of West African countries over the period 1960-1998. In contrast to this, Sasmal (2015) found an absence of the long-run association between money supply and food price

inflation in India during 1971-2012. Awokuse (2005) analyzed the nexus between macroeconomic policies and agricultural prices in the U.S during January 1975–December 2000. The author found that the money supply does not affect agricultural prices in the short-run. Ziotis and Papadas (2011) examined the connection between money supply and retail food prices in Greece from January 1970 to December 1990. The money supply plays a neutral character in increasing retail food prices.

3.2.2. Exchange rate and food price inflation

The depreciation of the real exchange rate upsurges the food price inflation via increasing the import of petroleum products, fertilizer, and other finished products relating to agricultural commodities, which are very expensive in nature. In other words, depreciation of the exchange rate directly affects the agricultural sectors via changing the prices of tradable and non-tradable goods resulting an escalation of agricultural prices in favour of the farmer. Conversely, the appreciation of the exchange rate makes the import cheaper and export dearer, which increases the demand for the import of agricultural commodities. Therefore, a decrease in domestic food prices and the resulting decline in food price inflation. For example, Chambers and Just (1981) investigated the effect of an exchange rate on wheat, corn, and soybean prices of the U.S markets. The findings of their research revealed that fluctuation in exchange rate significantly influences agricultural commodity prices in the long-run. However, its influence was smaller in the short-run. Using vector autoregressive (VAR) modelling, Taylor and Spriggs (1989) examined the effect of macro-economic monetary variables on agricultural prices in Canada. The authors show that the exchange rate has a greater influence on the volatility of agricultural prices in Canada. Hyder and Shah (2004) examined the influence of the exchange rate movement on food prices in Pakistan during January 1988-September 2003. The study revealed that domestic price inflation is moderately affected by exchange rate movements mainly since the higher share of wheat, sugarcane, cotton, and energy in WPI and CPI baskets. Awokuse (2005), employing an alternative vector autoregression (VAR) type model, the study found that the exchange rate increases agricultural prices. However, no effect was found between money supply and agricultural prices. Mitchell (2008) exhibited that the depreciation of the exchange rate is positively affected food prices by 20% in the United States. Baek and Koo (2010) inspected the primary reasons of affecting food price inflation in the U.S during January 1989-January 2008. Their results revealed that agricultural commodity prices and exchange rate are considered as two significant contributors in affecting the behavior of food price inflation in

the short-run and long-run. Nazlioglu and Soytaş (2012) confirmed that the weak dollar is positively related to agricultural prices. The most recent study by Iddrisua and Alagidede (2019) stated that food price inflation is positively impacted by the exchange rate in South Africa from January 2002-November 2018.

In contrast to this, using monthly data during January 1974-December 2002, Cho et al. (2005) confirmed that the exchange rate and inflation rate are negatively impacted relative agricultural prices. Mushtaq et al. (2011) indicated that the real exchange rate reduces the wheat price in Pakistan in the long-run. Awan and Imran (2015) surveyed the effect of food price inflation on Pakistan's economy. The results revealed that the exchange rate is negatively and significantly impacted food price inflation in the long-run. However, it is positive and insignificant in the short-run. However, Sasmal (2015) found no substantial association is established between exchange rate and food price inflation in India during 1971-2012.

3.2.3. Per capita income and food price inflation

Per capita income positively impacts food price inflation via increasing purchasing power of the money in the hands of the people, which leads to a surge in demand for food items ensuing in an upsurge in food prices. Further, the increase in income due to high economic growth leads to changes in the dietary habits of the people by shifting demand from cereals-based food to protein-based products, thereby increasing in demand for these proteins and vitamin-based products like milk, fish, and meat resulting in food price inflation. Carrasco and Mukhopadhyay (2012) argued that income is positively affected food prices in three South Asian economies, namely, Bangladesh, India, and Sri Lanka, over the period 1995-2009. However, the decline in agricultural production increases food prices up, and magnitudes are varying across countries. Krugman (2008) argued the rise in income has a direct impact on shifting dietary habits of people towards a high-value product like meat, eggs, and milk which promotes the demand for food grain, resulting in a rise in food price inflation. Wolf (2008) claimed a sharp surge in demand for protein-rich food items like meat and related animal feeds from cereal-based food items due to the rise in India and China's economic growth. Gokarn (2010) also argued that growth in demand for protein-rich food due to per capita income is a major driving force of food price inflation in India. Joiya and Shahzad (2013) analyzed the causes of high food prices in Pakistan, covering the period

1972-73 to 2009-10. By employing the ARDL model, their results documented that a rise in income leads to a surge in food price inflation. Bandara (2013) pointed out that an increase in income resulting from the rapid economic growth led to a surge in demand for vitamin and high protein food products, for illustration milk and non-vegetarian stuff sets. Using the cointegration and causality test, Sasmal (2015) found that food price inflation is positively caused by per capita income in India. Awan and Imran (2015) examined the domination of food price inflation on Pakistan's economy. The results revealed that per capita income positively and substantially promotes food price inflation in the long-run. Most recently, Makun (2021) demonstrated that per capita GDP promotes food inflation in Fiji.

In contrast, a study by Kargbo (2000) revealed mixed evidence in the case of Eastern and Southern African countries. His results indicated that food price inflation is positively associated with per capita income in Kenya, South Africa, and Zambia, whereas an adverse effect was found between the variables in the case of Ethiopia and Malawi. Similarly, Kargbo (2005) confirmed an increase in income promotes food price inflation in Nigeria and Senegal. However, a positive relationship was originated between them in Cote d'Ivoire. Agrawal and Kumarasamy (2012) documented food price inflation rose with the response to increases in per capita income in India. They also suggested that a one percent spiral in income upsurges the demand for fruits, vegetables, milk, and edible oil by 0.55–0.65 % and animal products by 0.38 %. However, it reduces the demand for cereals and pulses by 0.05 % and 0.20 %, respectively. Gilbert (2010) investigated the causes to understand high food prices in the U.S over the period 1970-2008. The Granger causality analysis directed that the rise in demand, growth of money supply, and exchange rate are the major causes of explaining price movements.

3.2.4. Global food price and food price inflation

The increase in the global food price can influence the domestic price of commodity via international trade mechanism. When there is a rise in global food price, producer increases export to the global market, resulting in a decrease in supply in the home market tracked by a hike in prices. On the other hand, when the import takes place from the global market during the global food price hike, increasing domestic substitute food items is followed by a surge in price in the domestic market. The extent of global food price transmission on the local supply or price hike in the domestic market depends on which extent or magnitudes commodity trade

takes place. Further, an increase in prices from the global to domestic market can be transmitted based on the level of the agricultural sector's integration with the worldwide market. Robles (2011) indicated that the transmission of international prices has a positive impact on the domestic agricultural market in Asian and Latin American Countries. Gulati and Saini (2013) revealed that the global food price index is positively impacted food price inflation in India. Similarly, Baltzer (2014) states that international prices induced domestic prices in Brazil and South Africa. However, the price transmission is very limited in China and India. Lee and Park (2013) investigated the transmission of global food price inflation on national food price inflation in 72 countries, spanning 2000-2011. Their findings confirmed that the lagged values of global food price inflation positively impacted food price inflation rates in all regions. Selliah et al. (2015) have analyzed global food price transmission to internal food price in Sri Lanka during the 2003M1-2013M12 period. This implies that an increase in global food prices increases domestic food prices in both the short and long run. Bhattacharya and Sen Gupta (2017) examined the drivers of food price inflation in India during 2006–2013. Their results found that global prices positively impacted food price inflation. Holtemöller and Mallick (2016) examined the influence of global food price on aggregate and food price inflation from 1996Q2 to 2013Q2. Using the SVAR model, their results show that global food price has an inflationary tendency on food price inflation in India. Huria and Pathania (2018) also found that global food price hike increases food price inflation in India. However, Rajmal and Mishra (2009) pointed out that there is a limited transmission of prices from international food prices to native prices in India.

3.2.5. Agricultural wage and food price inflation

One of the major public work programs is the National Rural Employment Guarantee (NREG) which promotes the real daily agricultural wage rates. An increase in rural wages can induce food prices via an escalation in the cost of production. On the other hand, it raises food prices via high purchasing power resulting a hike in wage rate which boost the demand. Bhattacharya and Sen Gupta (2017) investigated the reasons for driving food prices up in India. The results showed that a rise in agricultural wages increases food price inflation in India. Gulati and Saini (2013) revealed that domestic farm wages are positively associated with food price inflation in India. Bhattacharya and Sen Gupta (2018) examined the drivers of food price inflation through 2006 to 2013. The results of the SVECM showed that

agricultural wage inflation drove the food price inflation after the implementation of MNGREGS in India. Goyal and Baikar (2015) showed that the rapid increase in MGNREGA wages when it merged with inflation boosts agricultural wages rather than the implementation of MGNREGA across India.

From the above literature review, it is observed that food price inflation has been contributed by both demand and supply-side factors. Many studies have investigated the impact of macroeconomic factors on food price inflation across the globe. However, only a few studies have been directed which empirically examined the influence of macroeconomic factors on food price inflation by incorporating net food grain availability and agricultural wages in a multivariate framework. So far as we know, there is no study available in the case of India in this regard employing monthly data over the period January 2006- March 2019. Hence, our study attempts to fill this gap.

3.3. Data Extraction and Econometric Techniques

3.3.1 Data

The current research applies monthly time series data on per capita GDP (Y), real exchange rate (EX), money supply (MS), Global food price index (GF), per capita net availability of food grain (NFG), agricultural wages (AW) and CPI-industrial worker for food indices as a proxy for food price index (FP) during January 2006-March 2019. The data on per capita GDP, real exchange rate, money supply is retrieved from the Reserve Bank of India (RBI). In contrast, CPI-industrial workers for food indices and agricultural wages are retrieved from the Ministry of Labour Bureau., Government of India. The data on availability of food grain and real global food price index is obtained from the DES, Department of Agriculture & Farmers Welfare, and the FAO, respectively. Since monthly data on food grain availability is not available in the case of India, therefore we have used the linear interpolation method to get the monthly data for this variable. The range of data period has been considered on the basis of the accessibility of uniform and consistent monthly data over a time. Generally, we use high-frequency data while working on macroeconomic variables to detect the true effect of the variables. Further, data on food price inflation is volatile in nature; measuring the impact of macroeconomic factors on food price inflation using high-frequency data, namely, weekly and monthly, provides accurate estimates rather than using annual series. Since data on a targeted variable, food price inflation is not available on a weekly basis for a longer period in the case of India. Therefore, we have used monthly data for this purpose.

The real exchange rate (EX) is measured as real effective exchange rate, which is trade based weighted average value of Indian currency against 36- bilateral currency weights; Per capita income (Y) is measured as a per capita gross domestic product for India; Money supply (MS) is measured as broad money (M₃); global food prices (GF) are measured as a real global food price index, and Agricultural wages (AW) is measured as average daily wage rates from agricultural occupations; per capita net availability of food grain (NFG) is measured as Gross Production plus net imports plus stocks. Finally, food price inflation (FP) is measured as a CPI-IW food index. Food price inflation was experienced in India from 2006 onwards. However, the CPI-Combined series is used and also available from 2014 onwards as a measure of the official inflation rate. To get a longer frequency of data on food price inflation series, we have used CPI-IW as a proxy for food price inflation measure. We select to use CPI-IW because Bicchal & Durai (2019) and Goyal (2015) established that CPI-IW and CPI-C have alike properties. CPI-IW is available for a more extended period. All the variables are seasonally adjusted using CENSUS X13 and converted into the natural logarithm form.

3.3.2. Econometric Techniques

3.3.2.1. Unit root tests

One should necessarily check the properties of all the variables before commencing any econometric techniques as it gives spurious and invalid results. Given that the ARDL technique requires checking the integration properties of the selected variables to confirm that none of the series should follow I (2) process, which seems to be invalid and unsuitable for applying the ARDL approach. Therefore, study applies ADF and PP tests to look over the integration properties of the variables.

3.3.2.2. ARDL bounds testing approach to cointegration

We utilize the ARDL technique to cointegration propounded by Pesaran and Shin (1999) and Pesaran et al. (2001) to examine the long-run and short-run association between macroeconomic factors and food price inflation in India. This method is superior to other traditional approaches of Johansen and Juselius (1990) and Johansen (1991) cointegration on the following grounds. First, it is one of the most popular and flexible methods and can be applied for both I (1) or I (0) or both the order. Second, as noted by Pesaran and Shin (1999),

ARDL estimators give the true parameters, and coefficients are super consistent compared to other long-run estimates, especially for small sample size. Third, it also helps to eradicate the problem of the endogeneity that appears in the model. Fourth, it is even able to evaluate both short-run and long-run estimates simultaneously. The UECM of the ARDL model can be characterized as ways:

$$\begin{aligned}
\Delta \ln FP_t = & \alpha_0 + \alpha_F \ln FP_{t-1} + \alpha_Y \ln Y_{t-1} + \alpha_M \ln MS_{t-1} + \alpha_E \ln EX_{t-1} + \alpha_G \ln GF_{t-1} \\
& + \alpha_{NF} \ln NFG_{t-1} + \alpha_A \ln AW_{t-1} + \sum_{a=1}^h \beta_a \Delta \ln FP_{t-a} + \sum_{b=0}^i \beta_b \Delta \ln Y_{t-b} \\
& + \sum_{c=0}^j \beta_c \Delta \ln MS_{t-c} + \sum_{d=0}^k \beta_d \Delta \ln EX_{t-d} + \sum_{e=0}^l \beta_e \Delta \ln GF_{t-e} \\
& + \sum_{f=0}^m \beta_f \Delta \ln NFG_{t-f} + \sum_{g=0}^n \beta_g \Delta \ln AW_{t-g} + \mu_{1t}
\end{aligned} \tag{3.1}$$

$$\begin{aligned}
\Delta \ln Y_t = & \alpha_0 + \alpha_Y \ln Y_{t-1} + \alpha_F \ln FP_{t-1} + \alpha_M \ln MS_{t-1} + \alpha_E \ln EX_{t-1} + \alpha_G \ln GF_{t-1} \\
& + \alpha_{NF} \ln NFG_{t-1} + \alpha_A \ln AW_{t-1} + \sum_{a=1}^h \beta_a \Delta \ln Y_{t-a} + \sum_{b=0}^i \beta_b \Delta \ln FP_{t-b} \\
& + \sum_{c=0}^j \beta_c \Delta \ln MS_{t-c} + \sum_{d=0}^k \beta_d \Delta \ln EX_{t-d} + \sum_{e=0}^l \beta_e \Delta \ln GF_{t-e} \\
& + \sum_{f=0}^m \beta_f \Delta \ln NFG_{t-f} + \sum_{g=0}^n \beta_g \Delta \ln WA_{t-g} + \mu_{2t}
\end{aligned} \tag{3.2}$$

$$\begin{aligned}
\Delta \ln MS_t = & \alpha_0 + \alpha_M \ln MS_{t-1} + \alpha_F \ln FP_{t-1} + \alpha_Y \ln Y_{t-1} + \alpha_E \ln EX_{t-1} + \alpha_G \ln GF_{t-1} \\
& + \alpha_{NF} \ln NFG_{t-1} + \alpha_A \ln AW_{t-1} + \sum_{a=1}^h \beta_a \Delta \ln MS_{t-a} + \sum_{b=0}^i \beta_b \Delta \ln FP_{t-b} \\
& + \sum_{c=0}^j \beta_c \Delta \ln Y_{t-c} + \sum_{d=0}^k \beta_d \Delta \ln EX_{t-d} + \sum_{e=0}^l \beta_e \Delta \ln GF_{t-e} \\
& + \sum_{f=0}^m \beta_f \Delta \ln NFG_{t-f} + \sum_{g=0}^n \beta_g \Delta \ln AW_{t-g} + \mu_{3t}
\end{aligned} \tag{3.3}$$

$$\begin{aligned}
\Delta \ln EX_t = & \alpha_0 + \alpha_E \ln EX_{t-1} + \alpha_F \ln FP_{t-1} + \alpha_Y \ln Y_{t-1} + \alpha_M \ln MS_{t-1} + \alpha_G \ln GF_{t-1} \\
& + \alpha_{NF} \ln NFG_{t-1} + \alpha_A \ln AW_{t-1} + \sum_{a=1}^h \beta_a \Delta \ln EX_{t-a} + \sum_{b=0}^i \beta_b \Delta \ln FP_{t-b} \\
& + \sum_{c=0}^j \beta_c \Delta \ln Y_{t-c} + \sum_{d=0}^k \beta_d \Delta \ln MS_{t-d} + \sum_{e=0}^l \beta_e \Delta \ln GF_{t-e} + \sum_{f=0}^m \beta_f \Delta \ln NFG_{t-f} \\
& + \sum_{g=0}^n \beta_g \Delta \ln AW_{t-g} + \mu_{4t}
\end{aligned} \tag{3.4}$$

$$\begin{aligned}
\Delta \ln GF_t = & \alpha_0 + \alpha_G \ln GF_{t-1} + \alpha_F \ln FP_{t-1} + \alpha_Y \ln Y_{t-1} + \alpha_M \ln MS_{t-1} + \alpha_E \ln EX_{t-1} \\
& + \alpha_{NF} \ln NFG_{t-1} + \alpha_A \ln AW_{t-1} + \sum_{a=1}^h \beta_a \Delta \ln GF_{t-a} + \sum_{b=0}^i \beta_b \Delta \ln FP_{t-b} \\
& + \sum_{c=0}^j \beta_c \Delta \ln Y_{t-c} + \sum_{d=0}^k \beta_d \Delta \ln MS_{t-d} + \sum_{e=0}^l \beta_e \Delta \ln EX_{t-e} \\
& + \sum_{f=0}^m \beta_f \Delta \ln NFG_{t-f} + \sum_{g=0}^n \beta_g \Delta \ln AW_{t-g} + \mu_{5t}
\end{aligned} \tag{3.5}$$

$$\begin{aligned}
\Delta \ln NFG_t = & \alpha_0 + \alpha_{NF} \ln NFG_{t-1} + \alpha_F \ln FP_{t-1} + \alpha_Y \ln Y_{t-1} + \alpha_M \ln MS_{t-1} + \alpha_E \ln EX_{t-1} \\
& + \alpha_G \ln GF_{t-1} + \alpha_A \ln AW_{t-1} + \sum_{a=1}^h \beta_a \Delta \ln NFG_{t-a} + \sum_{b=0}^i \beta_b \Delta \ln FP_{t-b} \\
& + \sum_{c=0}^j \beta_c \Delta \ln Y_{t-c} + \sum_{d=0}^k \beta_d \Delta \ln MS_{t-d} + \sum_{e=0}^l \beta_e \Delta \ln EX_{t-e} \\
& + \sum_{f=0}^m \beta_f \Delta \ln GF_{t-f} + \sum_{g=0}^n \beta_g \Delta \ln AW_{t-g} + \mu_{6t}
\end{aligned} \tag{3.6}$$

$$\begin{aligned}
\Delta \ln AW_t = & \alpha_0 + \alpha_A \ln AW_{t-1} + \alpha_F \ln FP_{t-1} + \alpha_Y \ln Y_{t-1} + \alpha_M \ln MS_{t-1} + \alpha_E \ln EX_{t-1} \\
& + \alpha_G \ln GF_{t-1} + \alpha_{NF} \ln NFG_{t-1} + \sum_{a=1}^h \beta_a \Delta \ln AW_{t-a} + \sum_{b=0}^i \beta_b \Delta \ln FP_{t-b} \\
& + \sum_{c=0}^j \beta_c \Delta \ln Y_{t-c} + \sum_{d=0}^k \beta_d \Delta \ln MS_{t-d} + \sum_{e=0}^l \beta_e \Delta \ln EX_{t-e} \\
& + \sum_{f=0}^m \beta_f \Delta \ln GF_{t-f} + \sum_{g=0}^n \beta_g \Delta \ln NFG_{t-g} + \mu_{7t}
\end{aligned} \tag{3.7}$$

Where, Δ denotes first difference operator; μ_t is the residual; α_0 is the constant term; $\alpha_F, \alpha_Y, \alpha_M, \alpha_E, \alpha_G, \alpha_{NF}$ and α_A are the long-run coefficients; $\beta_a, \beta_b, \beta_c, \beta_d, \beta_e, \beta_f$ and β_g are the short-run coefficients.

The optimal lag selection has been made based on the Akaike Information Criteria (AIC). The primary footstep in the ARDL method is to evaluate the Equations (3.1-3.7) by ordinary least squares (OLS). The long-run association is determined founded on the F test or Wald test for the coefficient of the lagged variables. The null hypothesis of no long-run association, $H_0: \alpha_F = \alpha_Y = \alpha_M = \alpha_E = \alpha_G = \alpha_{NF} = \alpha_A = 0$ contrary to the alternative hypothesis; $H_1: \alpha_F \neq \alpha_Y \neq \alpha_M \neq \alpha_E \neq \alpha_G \neq \alpha_{NF} \neq \alpha_A = 0$ referred to the equation follows as (FP/Y, MS, EX, GF, NFG, AW). According to Pesaran et al. (2001), the null hypothesis of no long-run association can be rejected when F -statistics is larger than the UCB. It suggests an evidence of long-run association among the variables. Similarly, when F -statistics is smaller than LCB, then we cannot reject the null hypothesis, which suggests that no long-run association among the variables. The long-run relationship is said to be inconclusive if the F -statistics value falls within the lower and upper bound values. The LCB can apply if regressors are $I(0)$, and UCB can apply if regressors are $I(1)$.

3.3.2.3. Granger causality test

After identifying the long-run association among the variables, our further phase is to apply the vector correction model to examine the directions of causal nexus among the variables in the short-run and long-run. The model of VECM can be written as follows.

$$\begin{aligned}
\begin{bmatrix} \Delta \ln FP_t \\ \Delta \ln Y_t \\ \Delta \ln MS_t \\ \Delta \ln EX_t \\ \Delta \ln GF_t \\ \Delta \ln NFG_t \\ \Delta \ln AW_t \end{bmatrix} &= \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \\ \alpha_6 \\ \alpha_7 \end{bmatrix} + \begin{bmatrix} \beta_{11,1} & \beta_{12,1} & \beta_{13,1} & \beta_{14,1} & \beta_{15,1} & \beta_{16,1} & \beta_{17,1} \\ \beta_{21,1} & \beta_{22,1} & \beta_{23,1} & \beta_{24,1} & \beta_{25,1} & \beta_{26,1} & \beta_{27,1} \\ \beta_{31,1} & \beta_{32,1} & \beta_{33,1} & \beta_{34,1} & \beta_{35,1} & \beta_{36,1} & \beta_{37,1} \\ \beta_{41,1} & \beta_{42,1} & \beta_{43,1} & \beta_{44,1} & \beta_{45,1} & \beta_{46,1} & \beta_{47,1} \\ \beta_{51,1} & \beta_{52,1} & \beta_{53,1} & \beta_{54,1} & \beta_{55,1} & \beta_{56,1} & \beta_{57,1} \\ \beta_{61,1} & \beta_{62,1} & \beta_{63,1} & \beta_{64,1} & \beta_{65,1} & \beta_{66,1} & \beta_{67,1} \\ \beta_{71,1} & \beta_{72,1} & \beta_{73,1} & \beta_{74,1} & \beta_{75,1} & \beta_{76,1} & \beta_{77,1} \end{bmatrix} \times \begin{bmatrix} \Delta \ln FP_{t-1} \\ \Delta \ln Y_{t-1} \\ \Delta \ln MS_{t-1} \\ \Delta \ln EX_{t-1} \\ \Delta \ln GF_{t-1} \\ \Delta \ln NFG_{t-1} \\ \Delta \ln AW_{t-1} \end{bmatrix} \\
&+ \dots + \begin{bmatrix} \beta_{11,n} & \beta_{12,n} & \beta_{13,n} & \beta_{14,n} & \beta_{15,n} & \beta_{16,n} & \beta_{17,n} \\ \beta_{21,n} & \beta_{22,n} & \beta_{23,n} & \beta_{24,n} & \beta_{25,n} & \beta_{26,n} & \beta_{27,n} \\ \beta_{31,n} & \beta_{32,n} & \beta_{33,n} & \beta_{34,n} & \beta_{35,n} & \beta_{36,n} & \beta_{37,n} \\ \beta_{41,n} & \beta_{42,n} & \beta_{43,n} & \beta_{44,n} & \beta_{45,n} & \beta_{46,n} & \beta_{47,n} \\ \beta_{51,n} & \beta_{52,n} & \beta_{53,n} & \beta_{54,n} & \beta_{55,n} & \beta_{56,n} & \beta_{57,n} \\ \beta_{61,n} & \beta_{62,n} & \beta_{63,n} & \beta_{64,n} & \beta_{65,n} & \beta_{66,n} & \beta_{67,n} \\ \beta_{71,n} & \beta_{72,n} & \beta_{73,n} & \beta_{74,n} & \beta_{75,n} & \beta_{76,n} & \beta_{77,n} \end{bmatrix} \times \begin{bmatrix} \Delta \ln FP_{t-1} \\ \Delta \ln Y_{t-1} \\ \Delta \ln MS_{t-1} \\ \Delta \ln EX_{t-1} \\ \Delta \ln GF_{t-1} \\ \Delta \ln NFG_{t-1} \\ \Delta \ln AW_{t-1} \end{bmatrix} \\
&+ \begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \gamma_3 \\ \gamma_4 \\ \gamma_5 \\ \gamma_6 \\ \gamma_7 \end{bmatrix} \times (ECM_{t-1}) + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \\ \varepsilon_5 \\ \varepsilon_6 \\ \varepsilon_7 \end{bmatrix} \tag{3.8}
\end{aligned}$$

Where Δ is the difference operator; ECM_{t-1} is the lagged error correction term, which is derived from the long-run cointegration relationship; $\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}, \varepsilon_{4t}, \varepsilon_{5t}, \varepsilon_{6t}$ and ε_{7t} are the random errors; $\gamma_1, \gamma_2, \gamma_3, \gamma_4, \gamma_5, \gamma_6$ and γ_7 are the speed of adjustments. The long-run relationship among the variables specifies an evidence of Granger-causality minimum one way, which is derived by F -statistics and lagged ECM. The short-run causal relationship is signified by F -statistics on the predictor variables, whereas the long-run causality is characterized by t -statistics on the coefficient of the lagged ECM.

3.4. Analysis of empirical results

3.4.1. Preliminary analysis

A preliminary analysis is conducted using commonly used descriptive statistics. We also reported the summary of descriptive statistics of all the considered variables in Table 3.1. The outcomes revealed that the average food price index and the real exchange rate is 5.375% and 4.687% during the study period. However, the average money supply and real global food price indexes are 11.185% and 4.619%. The availability of food grain and agricultural wages is 5.130% and 6.931% whereas, per capita income is 0.445% which is lower than other

variables across the sample period. The outcomes of the correlation matrix are represented in Table 3.2. The correlation analysis revealed that per capita income, money supply, real exchange rate, real global food price index, availability of food grain, and agricultural wages are positively associated with food price inflation. For instance, food price inflation is highly correlated with per capita income, money supply, real exchange rate, availability of food grain, and agricultural wages. It suggests that macroeconomic factors might be promoting food price inflation in India. Similarly, per capita income is positively correlated with money supply, exchange rate, and availability of food grain and agricultural wages. Further, there is a high positive correlation between agricultural wages and availability of food grain.

Table 3.1. Descriptive Statistics

	FP	Y	MS	EX	GF	NFG	AW
Mean	5.375	0.445	11.185	4.687	4.619	5.130	6.931
Median	5.424	0.489	11.266	4.698	4.614	5.137	7.055
Maximum	5.770	0.590	11.927	4.804	4.862	5.194	7.615
Minimum	4.771	0.130	10.149	4.571	4.346	5.043	6.043
Std. Dev.	0.321	0.120	0.511	0.057	0.121	0.047	0.535
Skewness	-0.420	-1.232	-0.389	-0.149	-0.128	-0.061	-0.321
Kurtosis	1.789	3.953	1.962	2.116	2.558	1.430	1.567

Source: Authors' estimations

Table 3.2. Results of correlation matrix

	FP	Y	MS	EX	GF	NFG	AW
FP	1						
Y	0.183	1					
MS	0.994	0.135	1				
EX	0.639	0.228	0.656	1			
GF	0.129	-0.470	0.140	0.170	1		
NFG	0.909	0.119	0.907	0.515	0.080	1	
AW	0.993	0.178	0.989	0.625	0.107	0.936	1

Notes: Results are calculated using natural logarithms data. Source: Authors' estimations

3.4.2. Results of unit root tests

To avoid the problem of spurious and invalid outcomes of all the non-stationary data, we have checked the integration properties of all the variables and approve that all the series exhibits either I (0) and I (1) or mixed order. Therefore, the ADF and PP unit root tests are used to check the order of integrations of the variables. Table 3.3 reported consequences of unit root tests. It indicates that food price inflation (FP), per capita income (Y), money supply

(MS), real exchange rate (EX), real global food price index (GF), availability of food grain (FG), and agricultural wages (AW) are integrated of order I (1).

Table 3.3. Unit root test outcomes

Variables	ADF		PP	
	At Level	First difference	At Level	First difference
FP	-0.163	-9.152***	-0.010	-8.907***
	(0.993)	(0.000)	(0.995)	(0.000)
Y	-2.579	-12.422 ***	-2.715	-12.422***
	(0.290)	(0.000)	(0.232)	(0.000)
MS	-2.097	-15.691***	-2.236	-15.996***
	(0.543)	(0.000)	(0.465)	(0.000)
EX	-2.528	-10.756***	-2.528	-10.643***
	(0.314)	(0.000)	(0.314)	(0.000)
GF	-3.271	-8.476***	-2.738	-8.648***
	(0.075)	(0.000)	(0.222)	(0.000)
NFG	-2.704	-2.223***	-2.268	-3.303 ***
	(0.236)	(0.025)	(0.448)	(0.001)
AW	-0.516	-17.154***	-0.789	-17.781***
	(0.981)	(0.000)	(0.963)	(0.000)

Notes: *, ** and *** indicate the rejection of null hypothesis of unit root at the 10%, 5% and 1% significance levels, respectively. Source: Authors' estimations

3.4.3. Results of ARDL cointegration tests

The above unit root test results show that all variables follow the same order of integration, i.e., I (1). Hence, we apply the ARDL technique to check the long-run relationship among the variables using Equations (3.1) to (3.7) during January 2006-March 2019. Here, the optimal lag length is 2, according to VAR lag order selection criteria. The outcomes of the ARDL model are presented in Table 3.4. The result shows that calculated F-statistics (4.155) is larger than UCB at the 5% level of significance when food price inflation is a predicted variable (FP/Y, MS, EX, GF, NFG, WA). It specifies that a long-run association is confirmed among food price inflation (FP) and per capita income (Y), money supply (MS), real exchange rate (EX)), global food prices (GF), availability of food grain (NFG), and agricultural wages (WA). Likewise, calculated F-statistics (11.043) is also larger than UCB when per capita income is considered a predicted variable and integrated order (1). Therefore, UCB is applied to establish a long-run association among the variables. Likewise, calculated F- statistics (10.239) is also larger than UCB when money supply (MS) is considered as a predicted variable. Similarly, estimated F-statistics (3.335) is also larger than UCB at the 10% level of significance when global food price (GF) is considered as a predicted variable. However, calculated F-statistics is lower than UCB when exchange rate (EX), availability of

food grain (NFG) and agricultural wages (AW) serve as predicted variables. It suggests no such long-run association among the variables when exchange rate, availability of food grain and agricultural wages are the predicted variables.

Table 3.4. ARDL bounds testing approach results

Bound testing approach to cointegration		
Estimated Model	Optimal lag length	F Statistics
$FP = f(Y, MS, EX, GF, NFG, AW)$	(2, 0, 0, 1, 0, 0, 0)	4.155**
$Y = f(FP, MS, EX, GF, NFG, AW)$	(2, 2, 0, 1, 1, 0, 0)	11.043***
$MS = f(FP, Y, EX, GF, NFG, AW)$	(2, 0, 0, 1, 0, 0, 0)	10.239***
$EX = f(FP, Y, MS, GF, NFG, AW)$	(2, 0, 0, 1, 0, 0, 1)	3.015
$GF = f(FP, Y, MS, EX, NFG, AW)$	(2, 0, 2, 0, 0, 0, 0)	3.335
$NFG = f(FP, Y, MS, EX, GF, AW)$	(2, 2, 0, 0, 0, 0, 0)	2.611
$AW = f(FP, Y, MS, EX, GF, NFG)$	(2, 0, 0, 0, 0, 0, 0)	2.418
<i>Critical Values</i>		
Significance level	Lower bound I (0)	Upper bound I (1)
10%	2.12	3.23
5%	2.45	3.61
1%	3.15	4.43

Notes: *, ** and *** specify the 10%, 5% and 1% significance levels, respectively. Source: Authors' estimations

3.4.4. Results of long-run and short-run estimates

The cointegration test outcomes based on the ARDL model revealed the long-run equilibrium relationship among the variables. However, these results do not explain the cause-and-effect association between the food price inflation and macroeconomic factors, namely, per capita income, money supply, exchange rate, global food prices, availability of food grains, and agricultural wages. Hence, we have investigated the influence of macroeconomic factors on food price inflation in this part. It is better to check the long-run influence of macroeconomic factors on food price inflation, given that the cointegration relationship is confirmed among the variables when food price inflation is considered as the dependent variable. The results of the long-run analysis are reported in Table 3.5 in panel-I. The long-run results illustrate that per capita income positively and significantly impacted food price inflation. It implies that a 1% hike in income induces food price inflation by 0.14%. The rise in per capita income resulting from high economic growth increases the purchasing power of the money in the hands of the people, which leads to a surge in demand for food items resulting in an increase in food prices. The results of our study are similar to Carrasco and Mukhopadhyay (2012) in three South Asian economies; Agrawal and Kumarasamy (2012) in India; Joiya and Shahzad

(2013) in Pakistan. However, our result is inconsistent with Kargbo (2000), who revealed negative relation between the variables in the case of Ethiopia and Malawi; Kargbo (2005) in Cote d'Ivoire.

Similarly, a 1% rise in money supply promotes food price inflation by 0.36%. It infers that the surge in money supply puts upward pressure on food price inflation and is significant at the 1% level of significance. The money supply is positively affecting food price inflation by generating aggregate demand in the market, which pushes the food prices up. This finding is consistent with Kargbo (2000) for Kenya, Sudan, and Tanzania among the Eastern and Southern African countries and contradictory with Sasmal (2015), who did not find any long-run connection between money supply and food price inflation in India and Yu (2014) for China who confirmed that monetary policy expansion is negatively influenced seven major food products in the long-run. Similarly, a rise in the real exchange rate has a downward pressure on food price inflation. It indicates that a one percent surge in the real exchange rate will have a negative impact on food price inflation by 0.30%. The real exchange rate reduces food prices in the long run. The appreciation of the exchange rate makes the import cheaper and export dearer, which increased the demand for the import of agricultural commodities. Therefore, an increase in imports at a more affordable rate decreases food prices in the domestic market, resulting in a decline in food price inflation. The outcome is consistent with Cho et al. (2005) and is inconsistent with Iddrisua and Alagidede (2019) in South Africa; Durevall et al. (2013) in Ethiopia.

Further, the availability of food grain is negatively affecting food price inflation. In other words, there is an opposite affiliation between availability of food grains and food price inflation in India. It suggests that a 1% increase in availability of food grains reduces food price inflation by 0.69%. The rise in the supply of net food availability in the domestic market by increasing food production can reduce food price inflation. Therefore, the government should increase domestic food production and reduce the exports of commodities. Further, agricultural production is seasonal, and it's positively correlated to the month of food harvest. The stock of food grain during harvest season can avoid the off seasonal food price inflation. Increasing the stock of food items by establishing a larger cold storage system and strengthen and widening the existing warehouses can also help to control food price inflation in India. This result is similar to Kargbo (2005) in Cote d'Ivoire and Nigeria; Carrasco and Mukhopadhyay (2012) in three South Asian economies. Furthermore, our results revealed that food price inflation rose with the response to upsurges in global food

prices. It suggests that a 1% surge in global food price upsurges food price inflation by 0.13%. All the countries across the world have connected to each other due to globalization and the financial integration of the global market. In fact, the economic conditions in India have also transformed substantially after the 1991 reforms. Therefore, change in economic conditions of domestic and global markets may affect the domestic market price through international trade. The increase in food prices in the global market can be transmitted to the domestic market based on the magnitude of the agricultural sector's incorporation with the global market. From our analysis, we conclude that the global food price plays a very substantial role in promoting food price inflation in the domestic market in India. Because the rise in global food prices attracts the producer to increase their exports to the global market, thereby decreasing supply in the home market, which led to a surge in prices of food items. This result is consistent with Selliah et al. (2015) for Sri Lanka, Holtemöller and Mallick (2016) for India, Huria and Pathania (2018) for India. However, Rajmal and Mishra (2009) and Baltzer (2013) pointed out a limited transmission of prices from international food prices to local prices in India. The extent of transmission of global food price on price hike in the domestic market depends on at which magnitudes commodity's international trade takes place.

Finally, the results of our study also found that agricultural wages positively and substantially impacted food price inflation. It infers that a 1% surge in agricultural wages boosts the food price inflation by 0.31% in the long-run. The rise in wage rate via welfare oriented-schemes like MNGREGS increases the bargaining and purchasing power of money, resulting in a rise in demand for food items followed by a surge in food price inflation. The increase in the agricultural wage rate should be substituted with food price inflation by increasing productivity. Hence, a surge in demand for food originated by the growth of the agricultural wage rate can be substituted by raising the productivity of each worker. A similar result is found by Bhattacharya and Sen Gupta (2018) for India.

After having discussed on long-run results, we shall move in to discuss with reference to the short-run. The consequences of the short-run analysis are reported in Table 3.5 in panel-II. The short-run analysis indicates that a rise in income and money supply are positively related to food price inflation in the short-run as the coefficients of these variables are statistically significant. Similarly, food price inflation rises with the rise in global food prices. Further, the real exchange rate positively influenced food price inflation in the short-run. However, the conclusion on the exchange rate variable cannot be drawn as the coefficient is not significant.

Moreover, agricultural wages are positively influencing food price inflation. It implies that an increase in agricultural wages raises food price inflation in the short-run. The outcome is reliable with Huria and Pathania (2018) for India. However, availability of food grain is negatively and significantly impacted food price inflation. It suggests that a one percentage rise in the availability of food grain decreases food price inflation by 0.11% in the short-run. This verdict is alikeas Kargbo (2005) in Cote d'Ivoire and Senegal among West African countries. Finally, the results also documented lagged food price inflation has an influential impact on present food price inflation. It suggests that 1% increases in lagged food price upsurge food price inflation by 0.36% in the short-run.

Table 3.5. Results of the long-run and short-run analysis

Variables	Coefficient	t-statistics	P-value
<i>Panel-I: Long-run results</i>			
Constant	3.527**	2.012	0.046
<i>Y</i>	0.143***	2.835	0.005
<i>MS</i>	0.363***	4.853	0.000
<i>EX</i>	-0.309***	-2.501	0.013
<i>GF</i>	0.131***	2.686	0.008
<i>NFG</i>	-0.694**	-2.179	0.030
<i>AW</i>	0.31***	3.744	0.000
R squared	0.998		
<i>Panel-II: short- run results</i>			
<i>CPI(-1)</i>	0.361***	4.723	0.000
<i>Y</i>	0.023***	2.546	0.011
<i>MS</i>	0.059***	3.392	0.000
<i>EX</i>	0.026	0.55	0.582
<i>GF</i>	0.021***	2.788	0.006
<i>NFG</i>	-0.113**	-2.164	0.032
<i>AW</i>	0.051***	3.088	0.002
ECT(-1)	-0.168***	-4.886	0.000
<i>Diagnostic Tests</i>			
Breusch-Godfrey test	1.313 (0.272)		
ARCH LM test	0.053(0.818)		
Durbin–Watson	1.94		
Ramsey RESET	0.111 (0.911)		
CUSUM	Stable		
CUSUMSQ	Stable		

Notes: *, ** and *** show the similar indication as Table 3.4. Source: Authors' estimations

The sign of lagged ECT is negative and significant at the 1% level, which implies that short-run deviation from food prices can be restored towards the long-run equilibrium with the speed of adjustment of 16.8%. The model has satisfied all the diagnostic tests, such as this model is free from autoregressive conditional heteroscedasticity, the functional form of the model is well specified, which is represented by the Ramsey RESET coefficient.

3.4.5. Results of VECM Granger causality test

After identifying the long-run association between macroeconomic factors and food price inflation, we have employed the Granger causality test to examine the directions of causal nexus among the variables in the short-run and long-run. The Granger causality results are represented in Table 3.6. The results of the short-run causality are attained from the F-statistics of lagged independent variables, while the outcomes of long-run causation are originated from the negative and significant coefficients of t-statistics of lagged ECM. The consequences are reported in Table 3.6 and show that a short-run bidirectional causality is confirmed between per capita income, exchange rate, and food price inflation at a 1% level. This finding is the opposite of Sasmal (2015), who proved a unidirectional causality from per capita income to food price inflation in India. Similarly, a bidirectional causality is existed between availability of food grain and food price inflation in the short-run. It implies that a surge in the food grain availability diminishes food price inflation by increasing the domestic food grain production in the one hand. On the other hand, an increase in food price inflation also leads to a rise in food grain availability by rising demand for food products. Further, a unidirectional causality is confirmed from global food prices to food price inflation. It advocates that a rise in global price attracts exporters to increase their supply of food items to the global market to get high profit which eventually decreases the domestic market supply, resulting in a price increase. However, no causal relationship is running from money supply and agricultural wages to food price inflation in the short-run.

There is an existence of a bidirectional causal relationship between global food prices and per capita income. However, no causality runs from the money supply, exchange rate, availability of food grain, and agricultural wages to per capita income. A short-run unidirectional causality is established from food price inflation, exchange rate, global food prices, and

availability of food grain to the money supply. A bidirectional causality exists between agricultural wages and money supply in the short-run. Further, unidirectional causality is running from per capita income, the exchange rate, to global food prices.

Table 3.6. Results of VECM Granger causality test based on ARDL

Direction of Causality								
Short-run								Long-run
F-statistics (prob)								[t-Statistics]
Dependent Variable	$\Delta \ln FP$	$\Delta \ln Y$	$\Delta \ln MS$	$\Delta \ln EX$	$\Delta \ln GF$	$\Delta \ln NFG$	$\Delta \ln AW$	$ECM_T(-1)$
$\Delta \ln FP$		12.987*** (0.000)	0.337 (0.562)	25.481*** (0.000)	3.583* (0.060)	3.272* (0.070)	1.748 (0.188)	0.124 [0.353]
$\Delta \ln Y$	11.232*** (0.000)		0.902 (0.343)	1.603 (0.204)	2.807* (0.063)	0.438 (0.509)	1.182 (0.278)	2.85E-15 [3.637]
$\Delta \ln MS$	21.511*** (0.000)	0.195 (0.659)		24.566*** (0.000)	14.172*** (0.000)	9.510** (0.002)	2.942* (0.088)	-2.23E-15*** [-3.478]
$\Delta \ln EX$	14.696*** (0.000)	0.292 (0.589)	1.204 (0.302)		0.092 (0.761)	1.670 (0.198)	1.843 (0.162)	3.80E-15 [4.511]
$\Delta \ln GF$	1.926 (0.1673)	28.554*** (0.000)	0.316 (0.574)	4.444** (0.036)		0.545 (0.461)	1.847 (0.176)	-2.52E-15 *** [-2.967]
$\Delta \ln NFG$	17.869*** (0.000)	16.223*** (0.000)	6.564*** (0.011)	9.512*** (0.002)	11.371*** (0.001)		0.073 (0.786)	-7.07E-16*** [-2.467]
$\Delta \ln AW$	16.200*** (0.000)	35.767*** (0.000)	8.100*** (0.005)	5.073** (0.025)	3.852** (0.051)	29.711*** (0.000)		-1.42E-15 [1.135]

Notes: *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. Source: Authors' estimations.

A unidirectional causal relationship exists from per capita income, money supply, exchange rate, and global food prices to availability of food grain in the short run. Moreover, short-run unidirectional causality is confirmed from food price inflation, per capita income, exchange rate, and global food prices to agricultural wages.

Moving to the long-run causality, the coefficients are negative and statistically significant for all the variables of Equation (3.8), where money supply, global food prices, and availability of food grain are the dependent variables. Therefore, results indicate a bidirectional causality among the money supply, global food prices, and availability of food grain production in the long-run.

3.5. Concluding remarks and policy implications

The main aim of this chapter was to examine the impact of macroeconomic factors on food price inflation in India from January 2006-March 2019. In order to consider the dynamics of the short-run and the long-run analysis and directions of causality among the variables, current research applied the ARDL method and Granger causality test in our study. The results of the ARDL model have shown signal of the long-run connection between macroeconomic factors and food price inflation. The coefficients of the long-run result show that per capita income, money supply, global food price, and agricultural wages are positively and significantly impacted food price inflation in India in both the long-run and short-run. However, availability of food grain is negatively impacted food price inflation. It implies that an increase in food availability reduces food price inflation in the short-and long-run. Further, the real exchange rate is positively affecting food price inflation. However, it is insignificant in the short-run.

The Granger causality estimates show that a short-run bidirectional causality is confirmed among per capita income, exchange rate, availability of food grain, and food price inflation. Further, there is evidence of unidirectional causality running from global food prices to food price inflation. However, no causal relationship is running from money supply and agricultural wages to food price inflation in the short-run. The long-run results revealed a there is a presence of bidirectional causality among the money supply, global food prices, and availability of food grain in the long-run.

There is an existence of a bidirectional causal nexus between global food prices and per capita income. However, no causality is running from the money supply, exchange rate, availability of food grain, and agricultural wages to per capita income. A short-run unidirectional causality is established from food price inflation, exchange rate, global food prices, and availability of food grain to the money supply. A bidirectional causality exists between agricultural wages and money supply in the short-run. Further, unidirectional causality is running from per capita income, the exchange rate, to global food prices. A unidirectional causal relationship is existing from per capita income, money supply, exchange rate, and global food prices to availability of food grain in short run. Moreover, short-run one-way causality is confirmed from food price inflation, per capita income, exchange rate, and global food prices to agricultural wages.

Given these results, the paper makes an essential contribution to the macroeconomic factors and food price inflation in India. The significant policy suggestion that arises from the analysis is that the money supply positively impacts food price inflation. It indicates that growth in money supply promotes food price inflation in the long-run, which affects the welfare of the poor consumer as the majority of the people depend on agriculture. It also positively affects market credit facilities by generating aggregate demand followed by changes in relative prices across commodities which push the food prices up. Therefore, the government should adopt effective policy measures to protect the consumers from the higher food prices like the public distribution system, policies for food security, and reducing the money supply via adopting a contractionary monetary policy which eventually reduces food price inflation by reducing demand for food items. Further, the increase in global food price inflation triggers food price inflation by international trade channels. However, the influence of global food price inflation on food price inflation can be moderated by introducing a flexible tariff structure. Hence, the government should introduce stable and liberal trade policies that reduce food price inflation without compromising farmers' remuneration values.

Moreover, our results also revealed that an increase in net availability of food grain reduces food price inflation in the short and long run. Therefore, the government should take necessary steps in favour of an increase in domestic food production. The high yielding variety (HYV) seeds, easily accessible credit facilities should be available to the farmer, which can increase the domestic agricultural food production, thereby reducing the import of agricultural goods through the exchange rate and their adverse impact on food price inflation. The stock of food grain during harvest season can avoid off-seasonal food price inflation.

Increasing the stock of food items by establishing an extensive cold storage system and strengthening large warehouses can control food price inflation in India. Furthermore, the rise in agricultural wages boosts food price inflation. The increase in the agricultural wage rate should be substituted with food price inflation by increasing labour productivity. Hence, the increase in demand originated by a hike in agricultural wage rate can be substituted by raising each worker's productivity.

From the causality analysis results, we find that per capita income causes food price inflation both in the short-run. In this respect, we can say that there is a substantial sectoral imbalance among the sectors. The demand for commodities is increasing at a higher rate due to high economic growth, whereas the growth of agriculture is quite low as compared to the service sector and GDP growth. The government should be more focused on the agricultural sector and its growth and productivity by allocating massive funds in the irrigation, agricultural research, and innovation of modern technology and its adaptation in agriculture. Therefore, balanced and sustainable growth and stability can be achieved for a developing country like India. The real exchange rate and food price inflation Granger causes to each other. The depreciation of the real exchange rate promotes the food price inflation via expanding the import of petroleum products, fertilizer, and other finished products relating to agricultural commodities, which are very expensive in nature. The increasing import of these products promotes food price inflation by raising domestic prices. Hence, to reduce the food price inflation, government should increase the domestic agricultural production to meet our demand for food items rather than importing from other countries.

**Does Monetary Policy Stabilize Food Price Inflation in India?
Evidence from Quantile Regression Analysis**

4.1. Introduction

In the recent period, there has been a rising trend of food price in developed and developing economies, which has gained immense attention by the policymakers as it laid pressures on aggregate inflation (Anand et al., 2015; Walsh, 2011; Cecchetti and Moessner, 2008; Patnaik, 2019). This rising food price inflation not only affects headline inflation but also creates uncertainty, leading to rising inflation expectations and hinders public confidence in the central bank in middle-and lower-income countries (Anand et al., 2014; Šoškić, 2015; Pourroy et al., 2016). Most importantly, it also creates problems in forecasting the aggregate inflation and attending inflation targets in inflation-targeting countries (Gómez et al., 2012). The producer faces difficulties in decisions of investment activities due to rising inflation uncertainty about future prices. On the other hand, the food prices adversely impact health and welfare activities by increasing infant and child mortality and undernourishment in developing nations (Lee et al., 2013). Because, food contributes considerable weight in CPI basket and most of the people spend their more extensive portion of income on food in developing nations (Cecchetti, Moessner, 2008; Holtemoller and Mallick, 2016). The surge in food prices makes the poor divert the fund from food to non-food, resulting in a deterioration of health followed by welfare loss.

Further, some of the earlier studies pointed out that high food price inflation is determined by shocks from supply-side factors (Moorthy and Kolhar, 2011; Šoškić, 2015). Some of these factors are drought and low growth of food production (Chand, 2010), the decline in the production and hoarding of onion (Sharma et al. 2011), inadequate access to the public distribution system (PDS) of food grains (Mitra and Josling, 2009). In contrast, others have argued that demand-side factors are responsible for rising food price inflation. These are income (Pourroy et al., 2016; and Sasmal, 2015; Šoškić, 2015), increase in rural wages (Rajan, 2014, Bhattacharya and Gupta, 2017), rise in demand for high-value food stuffs (Bandara, 2013), increase in MSP is responsible to promotes food price inflation. Ignoring high food price may affect the non-food price inflation and aggregate inflation through its

second-round effects. Therefore, it should be matter of concern for central authority to reduce the food price by taking appropriate policy measures.

If so, then what is the optimum policy measure for the central authority to adopt in the inflation targeting framework and the extent of success of monetary policy to achieve the optimal welfare maximization of the economy? There is an ongoing debate on two sets of theoretical frameworks for selecting the optimal inflation policy measures, i.e., core and headline inflation. Whether monetary authority is to choose core or headline inflation for adopting inflation targeting when high food price is the main element of inflation in the country. The previous research confirmed that targeting core inflation is the optimal policy measure of inflation that maximizes welfare benefits and macroeconomic stability of the economy when the financial market is complete (Aoki, 2001). While, targeting core inflation by the central bank should not be an appropriate choice in the prevalence of financial frictions. The central banks of inflation targeting countries should target the flexible headline inflation targeting to maximize superior welfare benefits over core inflation (Anand and Prasad, 2010). Further, targeting headline inflation is the appropriate policy for emerging economies, where the proportion of spending on food on aggregate expenditure is higher, and most of the people do not have access to credit facilities (Anand and Prasad, 2010; Catao and Chang, 2015; Anand et al., 2015). However, the above literature has explained the significance of selecting the optimal policy to influence food price inflation and concluded that aggregate inflation targeting is an optimal policy measure for developing countries. It maximizes welfare benefits as food contributes higher weights to CPI baskets.

However, India is not exceptional from food price inflation, where average CPI food price inflation has crossed double-digit nearly 12% in 2012 and 2013. The highest inflation was recorded at 15.6% in November 2013. Further, it started increasing in 2015 and continued till the end of 2016. Overall, the average inflation during that period exceeded 6%. However, average food price inflation during January 2012-September 2020 was high for meat and fish, eggs, milk, vegetable, pulses at 7.95%, 6.24%, 6.35%, 8.84%, and 6.43%, respectively. Further, the average WPI food price inflation was recorded at 8%, whereas non-food price inflation was 4% during January 2006- March 2017 (Office of Economic Advisor, 2017). Food contributes higher weight to CPI headline inflation, and the proportion of food is more significant in the total aggregate household spending. India's food price inflation contributes nearly 43% of the aggregate consumption basket of CPI (Holtemoller and Mallick, 2016). But in advanced economies, the share of food contributes around 15% of the aggregate basket

(Alper et al., 2016; Cecchetti, Moessner, 2008). India is being ranked with the highest number of poor people, over 170 million, which accounts for nearly one-fourth of global poverty in 2015, and 4 extreme poor out of 5 live in India, among the South Asia region (World Bank, 2018). The association between monetary policy and food price inflation is rare for India. Most studies are done to trace food price inflation, whether it originated from demand and supply-side shocks. However, very few studies are conducted on these nexuses. Here the question that arises is whether upward movement of food prices originated from various shocks is stabilized by adopting a contractionary monetary policy in India.

Based on the following background, rising food prices increase not only macroeconomic uncertainty but also retard the welfare of the poor at large. Therefore, examining the influence of monetary policy on food price inflation is crucial issue for India. It helps the governments and policymakers to implements various policy measures concerning food price inflation. Maintaining stability in food price inflation provides many welfare benefits for developing countries like India. Hence, the question that arises is whether the upward movement of food prices originated from various shocks is stabilized by monetary policy in India. Despite several economic and social welfare implications of food price inflation, the impact of monetary policy on food price inflation has been ignored. Several kinds of literatures have emphasized the behavior of aggregate inflation and other macroeconomic variables by following monetary policy shocks. But unfortunately, few researchers are empirically analyzing whether monetary policy shocks stabilize food price inflation. (Frankel, 2008 for United States; Akram, 2009 for United states; Moorthy and Kolhar, 2011 for India; Scrimgeour, 2014 for United States; Hammoudeh et al., 2015 United states; Anand et al., 2014 for India; Holtemoller and Mallick, 2016 for India; Iddrisu and Alagidede, 2020 for South Africa; Bhattacharya and Jain, 2020 for advanced and emerging economies). These are studies that attempt in the case of India (Moorthy and Kolhar, 2011; Anand et al., 2015; Holtemoller and Mallick, 2016). None of the above studies have attempt to verify the efficiency of monetary policy on food price inflation through various channels. Regarding the effectiveness of various monetary policy channels, this is the first study that emphasizes the role of monetary policy in stabilizing food, non-food and aggregate inflation and sectoral food price inflation in India.

Furthermore, most of the earlier researches have applied the VAR technique to understand the nexus between monetary policy and food price inflation. Some researchers have argued that the increase in food price inflation is promoted through supply-side effects (Šoškić,

2015; Moorthy and Kolhar, 2011; Alper et al., 2016). The rise in food price generates volatility in food price, resulting in the presence of tail dynamics in food price distribution. But these tail dynamics can't be explained by a mean-based approach through the VAR model. These tail dynamics of food price may put an inflationary impact on aggregate inflation, which creates difficulties in attaining inflation targets of the central authority. Therefore, we have applied a quantile regression approach to achieve our study objectives. The importance of monetary policy in stabilizing food price inflation in different stages of food price inflation distribution can be described by a quantile regression approach. Further, the VAR and OLS methods are based on the assumption of conditional mean and symmetric properties but macroeconomic policy is based on asymmetric properties. Thus, the application of these techniques gives biased results. Finally, the existence of volatility creates larger outliers in the distribution; applying VAR and OLS method provides biased estimates as it is highly affected by the outliers. Hence, quantile regression gives better estimates as it considers heterogeneity in the error term (Yang et al., 2015; Benoit and Poel, 2017; Iddrisu and Alagidede, 2020). With the existence of limited research, investigating the nexus between these variables adds to the critical policy stance. It tries to fill this literature gap using quantile regression analysis on monthly data during January 2009-December 2019.

The study outcome demonstrated that contractionary monetary policy is negatively and significantly influenced food price inflation across quantiles. In contrast, the exchange rate and transportation cost have positively affected it. It suggests food price inflation and headline inflation reduce following contractionary monetary policy in the developing economy. However, exchange rate and transportation cost significantly promote food price inflation in lower and middle, and whole quantiles. The study also shows that contractionary monetary policy stabilizes food price inflation during the inflation-targeting regimes. Further, the outcome of this study revealed that the monetary policy transmission through exchange rate and asset price channels enhances food price inflation across the quantiles. Whereas, bank credit and interest rate channels reduce food price inflation in lower and median quantiles. The overall consequences of the study established that the effectiveness of monetary policy transmission through different mechanisms is heterogeneous across quantiles in varying levels of sectoral food prices.

This study delivers significant input to the empirical studies in the following ways: Firstly, we investigate whether an increase in food price inflation can be stabilized by monetary policy response and other control variables in India. We also discuss whether the monetary

policy reduces food price inflation in India after implementing inflation-targeting framework. Secondly, most of the studies have carried out using the VAR model. However, we have analyzed the significance of monetary policy on food price inflation employing a quantile regression model. It helps to understand the effects of independent variables on dependent variables at different quantiles of the dependent variable's conditional distribution. Thirdly, we also inspect the usefulness of the monetary policy on food, non-food, and aggregate inflation through various channels. To do so, we can identify the channels from which monetary policy transmits to food price inflation. Since empirical aspects of research on the linkages between monetary policy and food price inflation are scarce in India, our study offers a significant explanation of these relationships. Fourth, maintaining stability in prices through monetary policy depends on the pricing decisions of different sectors. However, stability in inflation via monetary policy at the sectoral level varies from aggregate inflation owing to degrees of price stickiness, sector-specific factors, and different channels of monetary policies. One of the crucial objectives of the monetary authority is stabilizing relative prices of different commodities around their optimal value (Aoki, 2001). This is important for central bank authority to recognize how sectoral food price inflation behaves in response to policy action. This is the way through which we could inspect the efficiency of monetary policy at the sectoral level. Thus, our study considers the relative importance of various channels of monetary policy on food price inflation at the sectoral level. Therefore, we demonstrate how sectoral food price inflation behaves in response to policy action through different channels. Finally, most of the reviews on these relationships are emphasized for the developed economies, especially for the U.S economy. However, we have investigated the importance of monetary policy on food price inflation in India, where majority of the individuals spend their larger expenditure on food items, and food contributes a larger share in aggregate household spending. To our information, present research that analytically considered the relative importance of monetary policy on food price inflation and at the sectoral level in India through various channels for the first time. With the existence of limited research, investigating the nexus between these variables adds to the critical policy stance.

The remaining of the segment is planned as tracks: Segment 2 appraisals previous studies. Segment 3 concentrates on data and method employed to carry forward the aim. Segment 4 confers empirical outcomes and analysis. Segment 5 presents robustness checks, while Segment 6 deals with concluding remarks and policy suggestions.

4.2. Literature Review

This segment analyses the assessment of previous studies on the importance of monetary policy on stabilizing food price inflation. It essentially discusses whether monetary policy authority of inflation targeting countries ought to target core or headline inflation as a measure of inflation targeting, which can maximize the country's higher welfare benefit. What is the optimal inflation measures core vs. aggregate inflation for targeting inflation by the monetary authority when food price shocks determine aggregate inflation? Some researchers argued that core inflation (by eliminating two volatile components from aggregate inflation (i.e., food and fuel)) is the suitable measure of inflation because food and fuel shocks are volatile and temporary, which is determined by supply shocks and non-monetary by nature. Its fluctuation makes much difference in the aggregate inflation rate. Therefore, food and fuel should not be involved in inflation measures while targeting inflation by the monetary authority (Wynne, 2008; Mishkin, 2007; 2008). Utilizing a New Keynesian model, Aoki (2001) examined the connection between relative-price changes and inflationary instability and select suitable goal measures for the monetary authority within the condition of particular sectors supply shocks. They reported that targeting optimal measures of inflation in the sticky-price sector brings superior welfare- maximizing benefits and macroeconomic stability when the financial market is complete. Thus, stabilizing core inflation characterized by inflation in the sticky-price sector is an optimal monetary policy measure rather than aggregate inflation. Gregorio (2012) also advocated that food contributes a larger weight in the consumer basket, and the larger fluctuation in food price may lead to transmission of food to non-food price inflation. Stabilizing food prices by the central bank according to structural characteristics of the country causes many welfare implications. Therefore, after regulating the spreading effects of food to non-food, targeting core inflation is a better indicator for monetary policy than headline inflation when food price inflation is temporary. Using the alternative Taylor rules with a New Keynesian model, Kara (2017) stated that food and energy prices are involved in the U.S economy's monetary policy decisions despite food contribute lesser weightage assigned to aggregate inflation.

However, some of the previous studies have stated that stabilizing headline inflation is considered as an optimal choice that leads to maximum welfare benefit of the country. Soto (2003) supported stabilizing targeting aggregate inflation is the best choice of monetary policy authority which maximizes greater welfare benefits when a larger proportion of food is non-tradable. This is because the contribution of food in aggregate consumption spending is

higher. Anand and Prasad (2010) developed a model welfare maximization of different inflation targeting indices considering incomplete financial market framework and choose optimal inflation targeting indices with superior welfare benefits. To doing so, they have established a realistic two-sector two-good new-Keynesian model for emerging and developed countries in their analysis to select the optimal price index to target inflation. They concluded that targeting core inflation by the central bank should not be an appropriate choice in the presence of financial frictions. The inflation targeting countries should target the flexible headline inflation targeting as it permits monetary policy to maximize welfare benefits than core inflation and optimal choice for policy point of view. The demand of consumers due to lack of financial services may cause less sensitive to the change in interest rate. Furthermore, the results are appropriate for emerging economies, where the proportion of spending on food in aggregate spending is high, price elasticity of demand is low for the food sector, and most of the people do not have access to credit facilities. Anand et al. (2015) established a theoretical impression where he stated that targeting headline inflation by the central bank gives maximum welfare benefits in contrast to core inflation, provided there is a persistence of financial frictions. He propounded a model in an open economy framework for developing countries with incomplete financial markets. In this connection, he argued that the food sector includes a large section of people, where they disburse a relatively substantial portion of their earnings on household consumption spending, and prices are too flexible. The workers from the food sector have no access to credit facilities to borrowing or savings; in fact, their demand depends on daily earnings (real wages). The lack of access to credit availability by the farmers (food sector) leads to demand insensitive to the interest rate. Therefore, the relative price of commodities in the flexible price sector affects aggregate supply and also influences aggregate demand through real wages. Catao and Chang (2015), employing DSGE approach in an open economy framework, they reported that targeting consumer price index brings welfare-maximizing benefits over producer price index when a positive shock to the global food price index, given that international risk sharing is perfect (optimal policy holds higher weightage to domestic price stability) and the export price elasticity of home country should not be less. Further, the authors revealed that the targeting expected consumer price index provides larger welfare benefits than the normal consumer price index. Finally, they concluded that targeting the producer price index gives larger welfare benefits, provided international risk sharing is incomplete. Stabilizing producer price index is an ideal strategy over consumer price index depending on circumstances that depend on complete risk sharing. Pourroy et al. (2016) how monetary policy authority of inflation

targeting country should react to high inflation driven by world food price shocks in developing countries. The authors result indicated that the choice of selecting the best monetary policy decision depends on level of income. They recommend that targeting headline inflation is the best choice of optimal monetary policy decisions for low-and middle-income countries. Because expenditure on food contributes a higher segment in total consumption expenditure and mostly depends on the domestic food sector (a greater proportion of food are non-tradable). Therefore, fluctuations in food prices make substantial differences in headline inflation. However, the best choice of selecting monetary policy decision is non-food price inflation targeting for high-income nations because the proportion of the food sector in core inflation is low. Ginn and Pourroy (2019) analyzed whether combined effects of both fiscal and monetary policies target the inflation generated by food price shocks which are welfare improving in middle-income countries. The outcomes of the study revealed that collective responsibility of both fiscal and monetary policies through targeted food price subsidies enhance the greater aggregate welfare benefits with the existence of credit-constrained households and with their higher expenditure on food. Further, they suggested that such consumer subsidies ease the price and consumption of credit-constrained households and decrease the need for monetary policy reaction on subsidized food price targeting over aggregate inflation targeting.

4.2.1. Monetary policy and aggregate inflation

The theoretical support behind the optimal measures of inflation targeting may differ based on the optimal monetary policy of the country, which enables to attend larger welfare benefits. The bundle of studies exists on an empirical basis that discusses the nexus between monetary policy and aggregate inflation. But few of the selected literature exist that discusses relationship between monetary policy and aggregate inflation. Kapur and Behera (2012) examined the monetary policy transmission in India in a small macro model by applying quarterly data April-June 1996 to January-March 2011. Their results indicated an increase in monetary policy actions significantly impacted the non-agricultural growth sector and non-food manufactured sector inflation with lag 2nd and 5th quarters, respectively. By employing SVAR models of 1996-97:1 to 2011-12:1, Khundrakpam and Jain (2012) estimated the effects of different channels of monetary policy transmissions on economic growth and inflation in India. Out of the four channels of monetary policy, the credit channel and asset price channel have a substantial impact in stabilizing inflation in India. However, the

exchange rate channel is insignificant on it. Applying the structural VAR model, Mallick and Sousa (2013) pointed out that contractionary monetary policy is negatively and significantly impacted output and inflation in BRICS countries during 1990: Q1–2012: Q1. Sengupta (2014) examined the changing transmission of monetary policy channels in India from April 1993 to March 2012. The study divided the entire data period into two different periods as pre-and-post LAF period with the implementation of Liquidity adjustment facilities (LAF) in 2000. Using Vector Auto Regression techniques, the author revealed that the monetary policy stabilizes inflation through bank lending rate and interest rate channel. In contrast, asset price and exchange rate channels were weak in the pre-LAF period. However, all the monetary policy transmission channels were vital in stabilizing inflation except bank lending rate channels in the post-LAF period in India. In contrast, some studies have concluded that monetary policy impacts inflation positively. Anzuini et al., (2010) examined the power of monetary policy on aggregate commodity prices in the United States during January 1970-September 2009. Their findings reported that contradictory monetary policy promotes commodity price index in the U.S. However, Mallick (2015) demonstrated that the impact of monetary shocks on inflation is minimal. However, the exchange rate positively influences inflation in India.

4.2.2. Monetary policy and food price inflation

Several studies investigated the connection between monetary policy and aggregate inflation. However, few studies intend to recognize the influence of policy responses on food price inflation across the world. Approaching to food price inflation literature, studies on the effectiveness of the monetary policy on food price inflation are scarce. Few studies are undertaken to understand the nexus between monetary policy and food price inflation across the world. Frankel (2008) examined the behavior of monetary policy on real commodity prices in the U.S, spanning 1950-2005. The findings of the study demonstrated that a surge in short-term real interest rates reduces aggregate commodity prices and, in case 23, disaggregated agricultural commodity prices. Further, his outcomes were analyzed for some chosen emerging and advanced countries using aggregate commodity prices. The author found the likewise results for these selected countries. But, the impact of monetary policy on aggregate commodity prices was positive in Mexico. Akram (2009) explored the nexus between real interest rate, the dollar, and commodity prices in the United States during 1990 Q1-2007 Q4. Using a structural VAR model, the study revealed a surge in the interest rate

and exchange rate, leading to a decline in both food and oil prices. Anand et al. (2014) investigated the character of monetary policy on food price inflation applying the Bayesian technique, spanning 1996 Q1-2013 Q4 in India. Their outcomes demonstrated that contractionary monetary policy reduces food price inflation. Scrimgeour (2015) demonstrated the response of commodity price with relation to changes in monetary policy in the U.S. The author confirmed that a 1% rise in interest rate tends to a 0.6% immediate fall in commodity price. Additionally, the study also considered the other group of commodities in the analysis including metal prices, oil, and agricultural commodities. His results indicated that the response of metal price in relation to interest rate changes is higher than agricultural commodities. Hammoudeh et al. (2015) analyzed the response of aggregate commodity prices and different sub-group of commodity prices such as a non-fuel commodity, food prices, beverage, agricultural raw materials, metals, and fuel (energy) when monetary policy changes in the United States during 1957: Q1- 2008: Q3. Using SVAR techniques, the results revealed that the contractionary monetary policy is negatively and significantly impact aggregate commodity prices with lags. However, in the disaggregate ground, contractionary monetary policy significantly increases food price inflation. Holtemoller and Mallick (2016) examined the impact on food price inflation when monetary policy changes in India using the SVAR model. The results revealed that monetary policy tightening reduces food price inflation by raising interest rates. A surge in interest rate spurs the cost of capital, followed by a reduction in aggregate demand, resulting in a decline in food price inflation. Ginn and Pourroy (2020) revealed that the central bank positively responds to food price inflation to maintain stability in Chile. However, it further reduces policy rates deliberately in spite of high food price inflation. Because the second-round effect of food price shock drives non-food price inflation despite monetary policy reaction. Finally, their conclusion suggested that targeting headline inflation is an optimal monetary policy indicator as its welfare benefit is superior.

Bhattacharya and Jain (2020) investigated whether the monetary policy helps to maintain stability in food price inflation in advanced and emerging economies using quarterly data for 2006: Q1-2016: Q2. The panel VAR results indicated that unexpected monetary tightening positively and significantly impacts food price inflation via the production cost channel. It suggests that monetary tightening destabilizes the food and overall inflation. The relative importance of monetary policy channels via production cost and aggregate demand channel

upsurges food price inflation. Iddrisu and Alagidede (2020) investigated the nexus between monetary policy and food price inflation in South Africa, utilizing month data from January 2002-November 2018. By employing a quantile regression approach, their outcomes confirmed that contractionary monetary policy encourages food price inflation, and its impact is significant across the quantiles in South Africa. They also concluded that transportation cost and exchange rate positively impacted food price inflation in 50th, 25th, and 50th quantiles, respectively. A most recent study by Kumar and Dash (2020) studied the impact of time-varying monetary policy on aggregate inflation and disaggregate inflation in India using monthly data during February 1997- February 2017. The study outcomes revealed that the transmission of contractionary monetary policy on inflation is largely transmitted through credit and asset price channels. Further, considering disaggregated data, the author concluded that monetary policy actions are efficiently reducing manufacturing sector inflation than the agricultural sector.

Several studies accounted for the influence of monetary policy in stabilizing aggregate inflation at a global level. However, limited studies are carried out on the effects of monetary policy in reducing food price inflation. Most of the studies are in the case of developed countries, especially the U.S. There is hardly any study that discusses the case of India. Therefore, our study attempts to demonstrate the impact of monetary policy in stabilizing food price inflation in India using quantile regression analysis during January 2009-December 2019. Further, the effectiveness of various mechanisms of monetary policy on food price inflation is scarce. However, no studies have investigated on the influence of monetary policy on food price inflation and non-food price inflation through different channels of monetary policy. To our information, present research is considered as first study that empirically considered the relative importance of various channels of monetary policy to food price inflation and at the sectoral level in the case of India.

4.3. Data and Econometric Techniques

4.3.1. Data sources

This study utilizes monthly frequency data spanning, January 2009 to December 2019. The focus of our variables comprises food price inflation, aggregate inflation, policy rate, transport cost, exchange rate, and economic output for the analysis. The preference of the mentioned variables is based on the following literatures (Akram, 2009; Bhattacharya and

Jain, 2019; Iddrisu and Alagidede, 2020; and Kumar and Dash, 2020). The consumer price index-industrial workers for food indices, considered as a proxy for food price (FP), and aggregate inflation (AIF) and transportation cost (TNS), is downloaded from the Ministry of Labour Bureau, Government of India. Whereas the real effective exchange rate (REX), repo rate as a monetary policy (MP) and real economic output (GDP) are obtained from the RBI online database. The data on combined price index-combined (FPC), aggregate inflation-combined (AC), and the sectoral level food price indices¹ are obtained from MOSPI. The monthly frequency data are used from January 2011 to July 2020 for the CPI-C food and non-food series. Non-food price inflation (NF) data is calculated by taking a weighted average of inflation excluding food. We used short-term 91 days treasury bill (percent) as a proxy of interest rate channel (IR), total bank credit to commercial sectors (percent) as a proxy of bank credit channel (BC), the exchange rate of Indian rupees with respect to the dollar as an exchange rate channel (EX) and a monthly average of Bombay Stock Exchange S&P (BSE S & P 100) as an asset price channel (AP) to measure the different channels of monetary policy transmission. The data on all the variables for channels of monetary policy transmissions are retrieved from the RBI online database. Monthly data on GDP is not available in the case of India. Therefore, we have applied the linear interpolation method to get the monthly data for this variable. We use CPI-IW because Bicchal & Durai (2019) and Goyal (2015) established that CPI-IW and CPI-C give likewise results. All the variables related to food indices are seasonally adjusted using CENSUS X13. All the variables are converted into the natural logarithm except treasury bill, the repo rate, and bank credit.

4.3.2. *Econometric Techniques*

4.3.2.1. *Unit root tests*

The main motive for conducting this research is to analyze the impact of monetary policy on food price inflation in India. To do so, we have applied a unit root tests to check the order of integration of the nominated variables. Here, we have applied ADF and PP tests to verify the data properties of the variables.

¹Sectoral level food price index consists of cereals and its associate products (CER), meat and fish (MF), eggs (EGG), milk and its associate products (ML), oils and fats (OF), fruits (FRU), vegetables (VEG), pulses and its associate products, (PUL) sugar and confectionery (SU), and spices (SPI).

4.3.2.2. *Structural break test*

Generally, macroeconomic variables, particularly policy-related variables, suffer the problem of structural breaks because changes in policy and its significance vary with respect to the current scenario (both economic policies and non-economic conditions such as political situations) of the country. Further, macroeconomic variables are nonstationary in nature, and applying econometric techniques with nonstationary data provides biased and spurious results. Therefore, we have utilized the Zivot and Andrews test (1992) unit root test, which avoids the biased nature of nonstationary data and accounts for breaks associated with the sample data series. In contrast, the ADF and PP tests do not include structural break properties in their data series. We can discard the null hypothesis when calculated t-statistics are greater than critical values and vice versa. We found that we can reject the null hypothesis for monetary policy variable since it is significant at a 10% significance level. However, it cannot be rejected for all other variables as it is insignificant across the three significant levels. The benefits of applying unit root tests that consider structural breaks into the accounts are: i) It averts the data from biased properties of nonstationary, ii) it enables to identify likely structural break. It considers only one significant break among the series.

4.3.2.3. *Quantile regression approach*

We have employed a quantile regression model to explore the influence of predictor variables on predicted variable at various quantiles of the conditional distribution of predicted variable. The quantile regression approach was primarily coined by Koenker and Bassett (1978). The benefits of the quantile regression approach are as ways: (1) it is an extension of the OLS method. In quantile regression analysis, the conditional quantile function of predicted variables can be estimated by minimizing the weighted absolute deviations. Whereas the least squares minimise the sum of the squared residuals. (2) It does not restrict to calculate the mean of the dependent variables rather it can be used as an effect of independent variables on predicted variables at various points of the conditional distribution of dependent variables. Whereas, OLS estimates conditional mean distribution. (3) OLS estimates are biased and misleading in heterogeneous and skewed distribution as it does not include. But, quantile regression gives accurate and unbiased estimators. Because it accounts for entire samples into the model and assigns different weights to different quantiles, and computes the impact of independent variables at different quantiles of (heterogeneous structure of the different levels

of food price inflation) conditional distribution of the dependent variable. (4) It is efficient as it is assumed to be a non-normality error. (5) The conditional distribution of the predicted variable is splitted into several quantiles, where the 50th quantile denotes the median (Hübler 2017). The symmetric and asymmetric weights are used to find the median value (quantile=50th) and other quantiles (quantile= 10th, 20th ..., 90th). However, OLS results consider average values of the conditional distribution. Therefore, given the set of predictor variables X_{it} (monetary policy, exchange rate, economic output, transportation cost), conditional distributions of dependent variables (food price inflation, aggregate inflation, and sectoral food price) are denoted as τ th quantile. The quantile regression analyses whether monetary policy reacts heterogeneously in various quantiles of the conditional distribution of food prices. The following quantile regression equation can be expressed as:

$$Y_t = \beta'_{\tau} X_t + u_{\tau t} \quad (4.1)$$

The τ -th quantile of the conditional distribution of Y_t given X_t is,

$$Q_{\tau}\left(\frac{FP_t}{X_t}\right) = \beta'_{\tau} X_t \quad (4.2)$$

Where, Y_t is the predicted variable, X_t is the vector of predictor variables, β_{τ} is the τ quantile coefficient value, $u_{\tau t}$ is the error terms. $Q_{\tau}\left(\frac{FP_t}{X_t}\right)$ is the τ th conditional quantile of Y given the explanatory variable X . FP is the natural logarithms of food, non-food, aggregate inflation, and sectoral food price inflation in period t , and X_t symbolizes vector of four predictor variables, namely monetary policy, exchange rate, economic output, and transportation cost, respectively. We find the estimated coefficient of quantile regression of β_{τ} by minimising the following functions at given Q_{τ} .

$$\begin{aligned}
Q_\tau(\beta_\tau) &= \min_{\beta} \sum_{t=1}^T [|FP_t - \beta'_\tau X_t|] \\
&= \min_{\beta} \left[\sum_{\ln FP_t \geq \beta X_t} \tau |FP_t - \beta'_\tau X_t| + \sum_{\ln FP_t < X_t} (1 - \tau) |FP_t \right. \\
&\quad \left. - \beta'_\tau X_t| \right]
\end{aligned} \tag{4.3}$$

The coefficients of the different quantiles refer to the marginal effects of the predictor variables on food price inflation at a specific quantile of food price inflation.

Further, a single structural break was identified for all the variables and also significant for monetary policy variable at a 10% level. The identified break period and monetary policy variable might have some effect on the food price inflation. Therefore, to see the effects of monetary policy and other independent variables on food price in different quantiles, we have designed quantile regression analysis using dummy variables on the right-hand side of equations. We presented the value of dummy variables as 1 in identified break period and 0 otherwise for all the variables and estimated the model along with the baseline model.

4.4. Empirical outcomes

4.4.1. Descriptive statistics

The descriptive statistics of variables are represented in Table 4.1. The average food price index, repo rate, and real exchange rate are 5.53% and 6.68%, and 4.70%, respectively. However, the average real economic output and transportation cost during the study period is 11.25% and 5.39%. The kurtosis is positive for all the variables across the model and stood highest for the exchange rate and transportation cost. The repo rate has experienced the highest volatility, followed by food prices and transportation costs and so on. Further, we also see from the Table that skewness is negative for all the variables except economic output.

Table 4.1. Descriptive statistics

	FP	MP	REX	GDP	TRC	AIN
Mean	5.533	6.685	4.705	11.255	5.397	5.458
Median	5.613	6.500	4.716	11.247	5.470	5.517
Maximum	5.855	8.500	4.804	11.568	5.641	5.799
Minimum	5.049	4.750	4.571	10.944	5.003	4.997
Std. Dev.	0.219	1.096	0.053	0.180	0.193	0.218
Skewness	-0.570	-0.114	-0.473	0.059	-0.686	-0.460
Kurtosis	2.038	1.969	2.555	1.809	2.244	2.075

Notes: Results are calculated using natural logarithms data. Source: Authors' estimations

4.4.2. Results of unit root tests

An essential step of all the time series data is to check stationary properties whether the series is stationary or not. For this purpose, we have used ADF and PP tests. Table 4.2 depicts the unit root tests results. The unit root test outcomes demonstration that all series are non-stationary at level except GDP and converted to stationary after first difference.

Table 4.2. Outcomes of unit root tests

Variables	ADF		PP	
	At Level	First difference	At Level	First difference
FP	-2.582	-7.723***	-2.188	--6.384***
	(0.289)	(0.000)	(0.491)	(0.000)
MP	-1.842	-5.427***	-1.128	-10.870***
	(0.678)	(0.000)	(0.919)	(0.000)
REX	-2.480	-10.029***	-2.573	--9.960***
	(0.337)	(0.000)	(0.293)	(0.000)
GDP	-3.831*	-3.024***	-2.201	-3.166**
	(0.017)	(0.000)	(0.484)	(0.024)
TRC	-0.6440	-9.745***	-0.756	-9.709***
	(0.974)	(0.000)	(0.966)	(0.000)
AIN	-2.255	-7.022***	-2.216	-9.439***
	(0.454)	(0.025)	(0.476)	(0.001)

Notes: *, **, and *** indicate the rejection of null hypothesis of unit root at the 10%, 5%, and 1% significance levels, respectively.

4.4.3. Outcomes of structural breaks unit root test

At more often, macroeconomic factors, notably policy-related variables, suffer problem of structural breaks because changes in policy and its significance vary with respect to the current scenario of the country. Many policy decision changes take place with the changes in economic policies and large economic shocks and political situations over the sample period. The changes in the policy decision may have some critical implications for important macroeconomic variables. The ADF and PP tests does not account for the structural break. Therefore, we have utilized the Zivot-Andrews unit root test by Zivot and Andrews (1992), which accounts for breaks associated with the sample data set. Table 4.3 denotes the outcomes of the unit root test with a structural break. Since calculated smallest t-statistics of all variables are lower than the critical values across the significance levels, we can't reject the null hypothesis of no unit root. It suggests that there is a prevalence of unit root. However, for monetary policy variable, minimum t-statistics is larger than critical values at a 10% significance level. Therefore, we can reject the null hypothesis. It indicates that there is evidence of a unit root test with a structural break for monetary policy variable. The 6th column of Table 4.3 provides the structural break dates.

Table 4.3. Outcomes of Zivot-Andrews unit root test – includes both trend and intercept

Variables	t-statistics	critical values			break date
		1%	5%	10%	
FP	-4.751	-5.57	-5.08	-4.82	Apr-13
MP	-4.955*	-5.57	-5.08	-4.82	May-11
REX	-3.951	-5.57	-5.08	-4.82	Aug-11
GDP	-4.656	-5.57	-5.08	-4.82	Feb-14
TRC	-4.280	-5.57	-5.08	-4.82	Aug-14

Note: * denotes significance at 10% level.

4.4.4. Results of quantile regression without structural breaks

Here, we discuss the impression of monetary policy on food price inflation and aggregate inflation in India by incorporating other variables into the model. The results of quantile regression without considering structural break are represented in Table 4.4. This study shows that contractionary monetary policy is negatively and significantly impacted food price inflation across the quantiles. It indicated that by implementing contractionary monetary policy decisions, the central bank stabilize the food price inflation. The central bank reduces food price inflation by increasing interest rate. The increase in interest rate resulting from

contractionary monetary policy increases storage cost, which promotes suppliers to reduce stocks of the commodities. Thus, enhancing the supply of commodities led to a decline in prices of food items. The food price reduces by -0.029% and -0.039% when the monetary policy rate increases by 1% in the 10th and 50th quantile. But, it decreases by -0.041 % and -0.055% when the policy rate increases by 1% in the 80th and 90th quantiles. It suggests that the role of a contractionary monetary policy resulting from the rising interest rate in stabilizing food prices is moderate and relatively less prevalent in higher quantiles. This result is contradicting Bhattacharya and Jain (2020) for developed and developing countries; Iddrisu and Alagidede (2020) for South Africa, who found that contradictory monetary policy positively influences food price inflation. However, Akram (2009) for the U.S, Frankel (2008) for the U.S, Scrimgeour (2015) for the U.S, and Anand et al. (2014) for India reported that contradictory monetary policy reduces food price inflation.

Table 4.4. Quantile regression outcomes without structural breaks

Variable	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th
FP = f (MP, REX, GDP, TRC)									
Constant	1.490	1.606	2.008	1.948	1.936	1.101	1.427	1.111	1.641
	0.220	0.082	0.007***	0.008***	0.014	0.240	0.196	0.600	0.719
MP	-0.029***	-0.040***	-0.040***	-0.039***	-0.039***	-0.037***	-0.039***	-0.041***	-0.055***
	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010
REX	0.298***	0.355***	0.362***	0.386***	0.344***	0.337***	0.338***	0.182	0.212
	0.000	0.000	0.000	0.000	0.000	0.002	0.008	0.168	0.500
GDP	-0.474***	-0.545***	-0.611***	-0.624	-0.589***	-0.453***	-0.509***	-0.402	-0.480
	0.017	0.001	0.000	0.000	0.000	0.007	0.010	0.235	0.514
TRC	1.506***	1.600***	1.658***	1.676***	1.642***	1.519***	1.578***	1.556***	1.615***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006
Pseudo R ²	0.870	0.871	0.874	0.869	0.857	0.841	0.816	0.787	0.771
Adjusted R ²	0.865	0.867	0.870	0.864	0.852	0.836	0.811	0.781	0.764
AIF = f (MP, REX, GDP, TRC)									
Constant	-1.802	-2.290	-2.317	-2.210	-2.208	-2.507	-2.337	-1.802	-2.861
	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.154
MP	-0.010*	-0.010***	-0.012***	-0.014***	-0.015***	-0.014***	-0.016***	-0.019***	-0.021***
	0.089	0.010	0.002	0.000	0.000	0.000	0.000	0.000	0.005
REX	0.220***	0.248***	0.251***	0.203***	0.166***	0.152***	0.160***	0.136***	0.118***
	0.000	0.000	0.002	0.006	0.000	0.000	0.000	0.000	0.000
GDP	0.063	0.122	0.118	0.130	0.154**	0.206***	0.176**	0.102	0.252
	0.659	0.208	0.192	0.126	0.059	0.009	0.021	0.390	0.366
TRC	1.030***	0.975***	0.988***	0.991***	0.975***	0.932***	0.959***	1.041***	0.945***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pseudo R ²	0.915	0.920	0.921	0.919	0.916	0.912	0.905	0.896	0.892
Adjusted R ²	0.912	0.918	0.919	0.917	0.913	0.909	0.902	0.893	0.889

Notes: ** and *** infer the significance levels at the 5% and 1%, respectively.

In the case of exchange rate, we found that a 1% surge in exchange rate promotes food price inflation by 0.29%, 0.38%, and 0.34% in 10th, 40th and 70th quantiles. The influence of the exchange rate on food price inflation is positive and significant at a 1% significance level in the lower and middle of quantiles. However, its impact is positive but insignificant in higher quantiles (80th and 90th). The influence of the exchange rate on food price inflation is prominent over the quantiles. The exchange rate plays a major character in driving food price inflation in India. There are two main channels that drive food price inflation are: the import of food commodities from other countries and the use of intermediate goods and modern technology in the production process. Cereals, edible oils, and petroleum products are the primary food items that India imports from other countries. The expanding the cost of importing petroleum products, fertilizer, and other finished products relating to agricultural commodities. In other words, depreciation of the exchange rate directly affects the agricultural sectors via changing the prices of tradable and non-tradable goods resulting a hike in the agricultural prices in favor of the farmer. India is the largest importer of fertilizers and pesticides from abroad. The increase in prices of these products may add the cost of production to the domestic country, resulting a price rise. Further, with the view of rising high growth rate and income of the middle-class family, demand for processed foods also keeps rising. India imported processed fruit, vegetables, and fruit juices valued at more than \$80 million in 2010. The production of these processed foods needs high quality and modern technology and equipment. The import of these machinery from abroad increases the cost of production of food processing companies, ensuing a price acceleration of food stuffs ultimately. This result is consistent with Iddrisu and Alagidede (2020) for South Africa. In contrast to this, Cho et al. (2005) confirmed that change in the exchange rate is negatively influencing relative agricultural prices. However, Sasmal (2015) found no significant association between the exchange rate and food price inflation in India during 1971-2012. In the case of economic output, the study finds that the impact of economic output is negatively impacted food price inflation and also significant across the quantiles except higher quantiles. The increase in economic output helps to reduce food price inflation in India.

With respect to transportation cost, we show that the transportation cost is positively and significantly influenced food price inflation in entire quantiles. A 1% increase in transportation cost enhances food price inflation by 1.64% and 1.62% in median (50th) and higher quantiles (90th). It suggests that an increase in transportation cost increases food price inflation and also consistent over the quantiles. The transportation cost includes the

intermediate cost which merged in the process of distribution of food commodities to the ultimate consumers in the domestic country. The increase in fuel prices would increase the cost of production of food items. Thus, there is an expansion in the prices. India is the largest importer of crude oil energy after the US and China. The demand for crude oil price increases to meet the demand for energy and other requirements. Therefore, the rise in oil prices positively affects the domestic food prices indirectly through import prices, production cost, use of agricultural technology, and transportation cost, which results in a surge in food prices. In contrast to this, food price inflation also resulted from the rising oil prices. The rise in oil prices from the other countries promotes domestic inflation via lower income, lower output resulting in high domestic prices and vice versa. There has been a rise in demand for biofuel energy as it is used as a substitute for crude oil prices to reduce the adverse effects of high oil prices. The rising demand for biofuel energy increases the food price inflation in the domestic countries as it is produced from agrarian products, for example maize, rapeseed oil, and the other grains and edible oils. The rise in demand for maize, rapeseed oil and edible oils reduces the supply availability in the market resulting a rise in prices of food products. In recent days, biofuel energy added with diesel energy is used as a fuel for the mode of transport. Using biofuel energy in the transport sector plays a major role in promoting food price inflation indirectly. Finally, we can conclude that rising crude oil prices and biofuel energy are plays a substantial role in promoting India's food price inflation. Further, delivering stocks from food manufacturing canters and agricultural farms to market places and ultimate consumers also increases price of food products by providing wages to drivers. The charges associated with it may vary based on the distance and infrastructural connectivity from the farm to the market. India's infrastructural network is not good as enough and still under construction with respect to the road. Some food production centre areas do not have proper transportation facilities as they are situated far away from the city. The low infrastructural network may include higher transportation costs to the food prices. Thus, transportation cost plays a substantial role in promoting food price inflation and highly prevalent in India. On the other hand, good transportation facilities and easy access to the markets and cities significantly reduce the distribution costs of the food commodities. The fuel consumption in the process of transportation boosts the cost of processing, manufacturing, and transporting resulting in an increase in price of food commodities. The direct energy costs and transportation costs reported around 8 percent of retail food costs in 2005 (Henderson, 2008). The increase in petrol prices stimulates transportation costs, which creates inflationary pressures on India's food price inflation (Rao, 2020). Fuel prices are

significantly influencing food prices and volatility as it increases the transportation cost in the United States (Volpe, 2013). The transportation cost contributed 30 % of the price of fruits and vegetables, whereas about 45 % of food is wasted (Singh, 2011).

To understand the impact of these independent variables on aggregate inflation in India, we have shown the results of quantile regression in the lower part of Table 4.4. From the results, it is clear that implementing a tight monetary policy stabilizes the aggregate inflation in India. The rise in interest rate declines the circulation of money supply in the economy. The reduction in money supply makes lending expensive. Thus, investment reduces and followed by demand, resulting in a decrease in inflation. A 1% surge in policy rate reduces food price inflation by -0.015% and -0.021% in 50th and 90th quantiles. However, the influence is significant across the quantiles. The results of this study are in line with Khundrakpam and Jain (2012) for India; Mallick and Sousa (2013) pointed out that contractionary monetary policy is negatively and significantly impacted inflation in BRICS. Further, we also found that the exchange rate depreciation surges aggregate inflation. It states that a 1% variation in the exchange rate induces aggregate inflation to 0.248%, 0.251 % and 0.166% in 20th, 30th, and 50th quantiles, respectively. However, the magnitude of the impact is declining in 0.136% and 0.118% in higher quantiles (80th and 90th).

Regarding economic output, the results of our study revealed that increase in economic output increases aggregate inflation across quantiles. The economic output positively influences aggregate inflation in the 50th, 60th, and 70th quantiles. However, its impact is insignificant in lower and higher quantiles. A 1% surge in economic output promotes aggregate inflation by 0.15%, 0.21%, and 0.18% in the middle of the quantiles (50th, 60th and 70th). As India is known as fastest growing economies, the growth is rising in an upward trend. Therefore, increases in economic output led to a boost in demand, increasing the price of goods and services that push the price up. Furthermore, the study also demonstrated that transportation cost positively and significantly impacted aggregate inflation, and its influence is prominent across the quantiles. It indicated that the transportation cost substantially contributes to the promotion of aggregate inflation across the quantiles by rising fuel prices and adding other intermediate costs such as transportation, packaging and security which put upward pressures on prices.

4.4.5. Outcomes of quantile regression with structural breaks

We have considered two conditions in our analysis based on the existence of structural breaks of the independent variable. Firstly, we presented our study where results do not include structural breaks and quantile regression results without a break are described in Table 4.4. Secondly, our outcomes reported in Table 4.5 are included a structural break into the analysis. It is to know whether structural breaks have a substantial influence on the dependent variables or not. For this purpose, we have included dummies of each independent variable in the right side of the equation. The dummy takes the value 1 in the specified break period and takes 0 otherwise in the right side of the equation. The study found statistically insignificant results of independent variables on food prices across the quantiles when we include breaks in our research. It indicates that there is no impact of independent variables on food price within our study period. However, monetary policy positively influences food price inflation in higher quantiles (70th, 80th and 90th) quantiles. The impact of transportation cost on food price inflation is positive in the lower quantile, and the output has a negative effect in higher quantiles. Overall, including structural breaks does not reflect any significant improvements in food price inflation in our model. Therefore, we fix our analysis without breaks.

Table 4.5. Quantile regression outcomes with structural breaks

Variable	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th
FP = f (MP, REX, GDP, TRC)									
Constant	0.825	1.424	1.949	1.673	1.887	1.096	1.521	1.454	1.689
	0.625	0.188	0.007	0.030**	0.021**	0.264	0.164	0.499	0.723
MP	-0.030***	-0.039***	-0.037***	-0.036***	-0.038***	-0.035***	-0.039***	-0.042***	-0.056***
	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.013
REX	0.355***	0.396***	0.357***	0.397***	0.347***	0.325***	0.364***	0.181	0.234
	0.001	0.000	0.000	0.000	0.000	0.003	0.005	0.192	0.557
GDP	-0.402	-0.544***	-0.595***	-0.587***	-0.582***	-0.446***	-0.535***	-0.450	-0.501
	0.110	0.002	0.000	0.000	0.000	0.011	0.007	0.196	0.537
TRC	1.429***	1.593***	1.637***	1.635***	1.633***	1.514***	1.593***	1.594***	1.631***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010
DMP	0.005	-0.002	-0.016	-0.024	-0.027	-0.036	-0.043***	-0.037***	-0.056***
	0.712	0.930	0.432	0.290	0.244	0.115	0.049	0.051	0.085
DREX	0.015	0.012	-0.004	-0.013	-0.014	-0.023	-0.029	-0.019	-0.028
	0.322	0.539	0.858	0.567	0.557	0.332	0.198	0.369	0.415
DGDP	0.018	0.003	-0.019	-0.025	-0.032	-0.037	-0.043***	-0.066***	-0.070***
	0.410	0.879	0.338	0.264	0.175	0.111	0.041	0.004	0.017
DTRC	0.050***	0.030	0.010	0.002	-0.003	-0.004	-0.014	-0.028	-0.036
	0.019	0.124	0.617	0.946	0.914	0.847	0.506	0.233	0.315
Pseudo R ²	0.871	0.872	0.876	0.871	0.860	0.844	0.821	0.792	0.777
Adjusted R ²	0.863	0.864	0.868	0.863	0.851	0.834	0.809	0.779	0.762

Note: ** and *** advocates the similar note as Table 4.4

4.4.6. Quantile regression outcomes with lags

Monetary policy changes react to inflation after two to five quarters lags (Kapur and Behera, 2012). In order to check how food price inflation responds resulting from contractionary monetary policy, we have included twelve-month lags of monetary policy. The outcome of the analysis is represented in Table 4.6. The results show that contractionary monetary policy has a positive and substantial influence on food price inflation across all the quantiles. It suggests that contractionary monetary policy destabilizes the food price inflation in India after 12 lags. The rise in food price inflation is resulting from contractionary monetary policy. This is in line with the theoretical background of rising food price inflation by implementing contractionary monetary policy. The increase in interest rate raises the cost of capital by non-food sector producing firms as they are capital intensive producers, resulting in an increase in the cost of production followed by a rise in price of non-food commodities by the firms. The non-food sector firm substitutes labour instead of capital to reduce the capital cost that pushes wages upward. Since food-producing firms depend highly on labour, rising wages by both the food and non-food sectors tends to increase labour cost, followed by the cost of production in the food sector, thereby increasing food price. The outcome of this study gives a likewise results with (Iddrisu and Alagidede, 2020; Bhattacharya and Jain, 2020). Additionally, the exchange rate, economic output, and transportation cost positively impact food prices across the quantiles. It suggests that the exchange rate, economic output, and transportation cost destabilizes food price inflation in India.

Table 4.6. Quantile regression results with 12 lags

Variable	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th
FP = f (MP, REX, GDP, TRC)									
Constant	-6.006	-5.554	-5.494	-5.368	-5.021	-5.190	-5.154	-5.339	-4.669
	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
MP (-12)	0.022***	0.025***	0.031***	0.032***	0.033***	0.044***	0.042***	0.042***	0.044***
	0.001	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000
REX	0.359***	0.438***	0.583***	0.558***	0.684***	0.706***	0.759***	0.754***	0.787***
	0.044	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GDP	0.724***	0.573***	0.451***	0.476***	0.332***	0.365***	0.328***	0.363***	0.234***
	0.000	0.002	0.037	0.006	0.058	0.011	0.004	0.000	0.017
TRC	0.280**	0.442**	0.553**	0.498***	0.625***	0.557***	0.586***	0.553***	0.669***
	0.070	0.026	0.022	0.007	0.001	0.000	0.000	0.000	0.000
Pseudo R ²	0.849	0.853	0.853	0.844	0.832	0.820	0.806	0.788	0.775
Adjusted R ²	0.844	0.847	0.848	0.838	0.826	0.814	0.800	0.780	0.768

Note: ***, ** and * specify significance level at 1%, 5% and 10% respectively.

4.4.7. Quantile regression outcomes after implementation of inflation targeting framework

To verify the impact of contractionary monetary policy on food price inflation after implementing the inflation targeting outline, we have applied a different set of data for the analysis. The choice of introducing a different data based on the inflation targeting framework as it officially introduced on August 2016. Here, our selection of dissimilar sets of data is from August 2016-December 2019. The study results are explained in Table 4.7. It indicates that contractionary monetary policy negatively impacts food price inflation with the presence of an inflation-targeting framework. It suggests that the role of monetary policy helps in stabilising food prices significantly over the quantiles even after implementing the inflation-targeting era. The exchange rate has a negative impression on food price inflation. However, it is insignificant across the quantiles. Moreover, economic output plays a significant role in promoting food price inflation in lower quantiles but insignificant higher quantiles.

Table 4.7. Quantile regression results after implementing inflation-targeting framework

Variable	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th
FP = f (MP, REX, GDP, TRC)									
Constant	0.758	-0.387	0.028	1.152	2.847	4.468	4.219	4.406	6.856
	0.617	0.812	0.987	0.525	0.174	0.040**	0.047**	0.023**	0.001**
MP	-0.052***	-0.038*	-0.045**	-0.048***	-0.058***	-0.061***	-0.055***	-0.062***	-0.076***
	0.006	0.094	0.025	0.012	0.002	0.002	0.004	0.000	0.000
REX	-0.176	-0.183	-0.194	-0.277	-0.112	-0.241	-0.301	-0.297	-0.055
	0.268	0.315	0.308	0.186	0.565	0.321	0.343	0.327	0.854
GDP	1.099***	1.278***	1.174***	1.069***	0.471	0.316	0.481	0.494	-0.161
	0.002	0.001	0.005	0.013	0.236	0.470	0.323	0.279	0.707
TRC	-1.159	-1.332	-1.174	-1.084	-0.290	-0.146	-0.396	-0.452	0.266
	0.027**	0.019***	0.059**	0.083*	0.548	0.783	0.511	0.417	0.625
Pseudo R ²	0.534	0.520	0.492	0.463	0.453	0.481	0.529	0.592	0.650
Adjusted R ²	0.490	0.475	0.445	0.413	0.402	0.433	0.486	0.554	0.617

Note: Similar as Table 4.6

4.5. Effectiveness of monetary policy transmissions through various channels

4.5.1. Different channels of monetary policy

We start our analysis with different channels through which monetary policy transmits to inflation in India. Here, we have taken different proxy for different channels of monetary policy transmission and see how monetary policy pass through its effects on inflation through different channels. The variations and significance of monetary policy show the relative importance of different channels on inflation in India. In this section, we discuss four vital mechanisms of monetary policies. These are interest rate channels, bank credit channel, exchange rate channel, and asset price channel.

4.5.1.1. Interest rate channels

It is known as a standard transmission (Keynesian IS-LM) of monetary policy mechanism. The main objective of tightening monetary policy is to lessen the supply of money by increasing the short-term nominal interest rate. The high interest rate makes lending more costly. Since price rigidity prevails in the short-run, a surge in nominal interest shoots up the real interest rate. This increase in real interest rate raises the cost of borrowing, which enlarge the investors cost of capital. Then, a deterioration in investment increases saving and is followed by consumption declines and this decreases in aggregate demand. When demand is lower than the supply, prices drop down, resulting in a reduction of inflation.

4.5.1.2. Bank credit channels

To execute the contractionary monetary policy, the central bank regulates the money supply by increasing the interest rate. With the surge in the interest rate, the bank pays higher interest on household deposits and worsens the balance sheets of the banks. It became expensive for the bank to refinance for new lending activities, which causes to decline in bank lending. As the interest rate rises, the risk associated with the previous loan also rises. Therefore, banks stop providing the new loan that puts downward pressure on the supply of credit. The decline in bank credit hurts the consumption and investment for households and investors as well. Thus, a fall in aggregate demand and gradually inflation fall.

4.5.1.3. Asset price channels

The asset price channels of monetary policy transmission affect inflation through equity prices and housing. The aim of tight monetary policy is to diminish the existing liquid in the market, decreasing the money supply. There will be lower demand for equities in the market when the money supply reduces. According to Keynesian, when there is a surge in interest rate, the value of the bond rises compared to the equities, which tend to a decline in equity prices. This decline in Tobin's q (that is, market value is lower than the replacement value of capital) causes a decrease in investment by the firms. The deterioration in equity prices tends to reduction in the worth of the security and borrowing capacity. The declining capacity to borrow deteriorates credit growth in the economy, which causes a fall in investment activities and aggregate demand, ensuring a decrease in inflation. Additionally, an increase in interest rate makes finance to housing costlier. Thereby, decreasing demand in housing finance leads to a fall in real estate price followed by consumption declines, and demand shrinks leading to a decrease in inflation.

4.5.1.4. Exchange rate channels

The transmission of monetary policy via exchange rate channels subject to the reaction of the exchange rate to monetary policy shocks and the extent of countries openness with the rest of the world. The increase in interest rate encourages investment in home currency rather than international currencies. The capital inflow of currencies due to increase in internal interest rates leads to an appreciation of the internal currency. As a result, demand for domestically produced goods declines as an appreciation of the currency makes exports costlier and import cheaper, followed by a cut in aggregate demand. A result of decline in demand leads to reduction in inflation.

4.5.2. Robust analysis

As the fact is already established by Bicchal & Durai (2019) and Goyal (2015) that CPI-IW and CPI-C give alike results. We have used CPI-C to check the robust of CPI-IW outcomes. The consequences of robustness from CPI-IW and CPI-C are reported in Table 4.8 and 4.9. From Table 4.8, it is depicted that monetary policy through exchange rate and asset price channels are positively impacted food price inflation across the quantiles. However, the bank credit channel is negatively impacted food price inflation across the quantile. In contrast, the

interest rate channel is negatively impacted in lower quantiles. However, coefficients are insignificant in higher quantiles. It suggests that monetary policy destabilizes food price inflation across the quantiles through exchange rate and asset price channels. However, bank credit and interest rate channels stabilize food price inflation across quantiles and lower quantiles. Further, Table 4.9 reports the outcomes of CPI-C. The quantile regression consequences show that exchange rate and asset price channels are positively and significantly influenced food price inflation across the quantiles. It suggests that monetary policy transmission through exchange rate and asset price channels promotes food prices rather than stabilizes food price inflation. Generally, India's rupee depreciates concerning dollar, depreciation led to an increase in food price inflation by importing intermediate goods such as petroleum products, fertilizers and modern technology in the production process, leading to rise in cost of production, resulting in an increase in prices of food commodities. This study is in line with Hnatkovska et al. (2016); Iddrisu and Alagidede (2020).

However, bank credit and interest rate channels are negatively impacted food price inflation in lower and middle quantiles, but it is insignificant in the higher quantiles. It indicates that the food price stability can be achieved by adopting contractionary monetary policy through bank credit and interest rate channels in India in the short and medium-term. A similar outcome was found by Frankel (2008) for the U.S, who pointed that a surge in interest rate stabilizes food price inflation by an increase in the supply of commodities via increasing storage cost. The study shows that the results of CPI-C emerge likewise estimates as shown in CPI-IW. Therefore, we move our estimation of the efficiency of monetary policy on non-food and aggregate inflation data using CPI-C data in the next section.

Robust analysis

Table 4.8. Quantile regression results 2011 to 2020 using CPI-IW

Variable	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th
FP = f (EX, BC, AP, IR)									
Constant	1.384***	1.422***	1.509***	1.515***	1.650***	1.603***	1.547***	1.361***	1.481***
	0.000	0.000	0.000	0.0000	0.000	0.000	0.000	0.000	0.000
EX	0.656***	0.676***	0.651***	0.638***	0.624***	0.636***	0.658***	0.696***	0.681***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0000
BC	-0.005***	-0.005***	-0.0059***	-0.007***	-0.007***	-0.008***	-0.007***	-0.006***	-0.006***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.025
AP	0.181***	0.168***	0.171***	0.177***	0.169***	0.167***	0.163***	0.166***	0.161***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IR	-0.010***	-0.009***	-0.008***	-0.006***	-0.004	-0.0012	0.0002	-0.0013	-0.0021
	0.000	0.000	0.000	0.016	0.126	0.635	0.929	0.565	0.638
Pseudo R ²	0.867	0.875	0.871	0.863	0.853	0.842	0.833	0.827	0.828
Adjusted R ²	0.862	0.870	0.866	0.858	0.848	0.836	0.827	0.821	0.822

Note: Similar as reflected in Table 4.6

Table 4.9. Quantile regression results using CPI-C

Variable	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th
FPC = f (EX, BC, AP, IR)									
Constant	0.988***	1.017***	1.158***	0.997***	1.032***	1.029***	0.787***	0.493***	0.343***
	0.000	0.000	0.000	0.000	0.000	0.002	0.025	0.377	0.552
EX	0.595***	0.665***	0.640***	0.625***	0.602***	0.615***	0.666***	0.685***	0.665***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BC	-0.005***	-0.0046***	-0.0055***	-0.0056***	-0.0064***	-0.0064***	-0.0049***	-0.004	-0.003
	0.000	0.000	0.000	0.001	0.000	0.002	0.02	0.2122	0.2484
AP	0.163***	0.129***	0.126***	0.151***	0.158***	0.151***	0.153***	0.175***	0.200***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IR	-0.010***	-0.011***	-0.0101***	-0.0082***	-0.0060**	-0.0041	-0.0036***	-0.0016***	-0.0006***
	0.003	0	0	0.004	0.042	0.139	0.09	0.434	0.721
Pseudo R ²	0.856	0.86	0.854	0.845	0.835	0.825	0.813	0.803	0.806
Adjusted R ²	0.851	0.855	0.849	0.839	0.829	0.818	0.806	0.796	0.799

Note: Asmentioned in Table 4.6.

Table 4.10. Quantile regression results (non-food and aggregate inflation-CPI-C)

Variable	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th
NF = f (EX, BC, AP, IR)									
Constant	0.119***	0.283***	0.368***	0.371***	0.457***	0.502***	0.589***	0.640***	0.665***
	0.669	0.203	0.085	0.041	0.01	0.002	0	0	0
EX	0.732***	0.707***	0.650***	0.583***	0.561***	0.557***	0.531***	0.573***	0.588***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BC	0.0007	0.0014	0.0014	0.0015*	0.0017**	0.0011	0.0006	0.0008	0.0006
	0.572	0.142	0.15	0.088	0.046	0.172	0.441	0.359	0.52
AP	0.186***	0.184***	0.201***	0.231***	0.234***	0.231***	0.233***	0.209***	0.201***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IR	-0.0089	-0.015***	-0.014***	-0.013***	-0.015***	-0.014***	-0.013***	-0.014***	-0.014***
	0.11	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000
Pseudo R ²	0.882	0.882	0.881	0.884	0.888	0.889	0.887	0.878	0.871
Adjusted R ²	0.877	0.877	0.877	0.88	0.884	0.885	0.883	0.874	0.866
AC = f (EX, BC, AP, IR)									
Constant	0.301**	0.299*	0.566***	0.541***	0.532***	0.578***	0.717***	0.652***	0.538**
	0.032	0.064	0.004	0.006	0.007	0.000	0.000	0.001	0.023
EX	0.716***	0.717***	0.614***	0.622***	0.592***	0.607***	0.592***	0.606***	0.635***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BC	-0.0004	-0.0009	-0.0014*	-0.0016*	-0.0019**	-0.0021**	-0.0023**	-0.002	-0.0017
	0.46	0.254	0.078	0.067	0.035	0.034	0.046	0.235	0.369
AP	0.178***	0.178***	0.199***	0.198***	0.212***	0.200***	0.194***	0.195***	0.193***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IR	-0.010*	-0.009*	-0.0120**	-0.0107**	-0.0088**	-0.0087**	-0.0107***	-0.0101***	-0.008
	0.013	0.016	0.0221	0.0228	0.0593	0.0212	0.0008	0.0006	0.0002
Pseudo R ²	0.898	0.902	0.901	0.899	0.897	0.895	0.886	0.881	0.882
Adjusted R ²	0.895	0.898	0.898	0.896	0.893	0.888	0.882	0.877	0.878

Note: As shown in Table 4.6

4.5.3. Quantile regression results with various channels of monetary policy

In the previous section, we have investigated whether the contractionary monetary policy helps in stabilizing food price inflation through different channels in India. In this section, we discuss the effectiveness of monetary policy on different inflation levels through various channels. It means the influence of monetary policy on non-food and aggregate prices through interest rate, exchange rate, asset price, and bank credit channels. The results of the study are reported in Table 4.10. We have divided the entire results into two panels: Panel A shows monetary policy impact on non-food price inflation; and Panel B depicts the impact on aggregate inflation.

Panel A, we have analyzed the effectiveness of contractionary monetary policy through different mechanisms on non-food price inflation. The influence of monetary policy through exchange rate and asset price are positively impacted non-food price inflation across quantiles. But the monetary policy did not respond through the bank credit channel as its coefficients are positive and insignificant to non-food price inflation except 40th and 50th quantiles. It recommends that exchange rate, asset price, and bank credit channels do not transmit to reduce non-food price inflation; rather, it increases it. However, the interest rate channel is negatively influencing non-food price inflation. It indicates that monetary policy reduces non-food price inflation through interest rate channels. In other words, monetary policy variables pass-through to non-food commodities via the interest rate to stabilize food price inflation. Panel B: the results show that exchange rate and asset price channels do not help to stabilize the aggregate inflation resulting from contractionary monetary policy; rather, it increases aggregate inflation across quantiles. However, monetary policy transmission takes place to aggregate inflation through the bank credit and interest rate channels in lower and middle quantiles, and all the quantiles, respectively. It indicates that these two mechanisms of monetary policy help to stabilize aggregate inflation in India. The likewise results were found by Chen et al. (2017) and Gozgor (2014), who have found that monetary policy mechanisms transmit through bank credit channels for emerging countries.

4.5.4. Results of quantile regression with different sectors of food items

In the present segment, we deal the effectiveness of the contractionary monetary policy through different channels on sectoral disaggregated food price inflation. Here, we have included the ten sectoral disaggregate items. These are cereals and its associate, meat and

fish, eggs, milk and its associate, oils and fats, fruits, vegetables, pulses and its associates, sugar and confectionery, and spices. This analysis can determine how sectoral food price inflation responds from the response of contractionary monetary policy through asset price, exchange rate, bank credit, and interest rate channels. The results are depicted in Table 4.11. Maintaining stability in prices via monetary policy changes relies on its potential to influence the relative price of disaggregate variables. The monetary policy will be found to be ineffective in regulating the entire economy if all disaggregated prices vary in equal proportion by following interest rate changes. Thus, it is significant to realize the response of different monetary policy channels on disaggregated commodities' prices. The pass-through effects of monetary policy through several channels may have several impacts on various disaggregated sectors' prices. We can able to understand which sectors continue to maintain price stability and which sector not. This analysis enables us to recognize the influence of monetary policy transmission via different channels on a disaggregated sectoral level that may have significant implications for the policymakers.

The study outcome demonstrated that monetary policy transmission through exchange rate and asset price channels positively impacts all the prices of food sectors across quantiles. It suggests that the role of the asset price and the exchange rate do not help to stabilize the food price inflation in India; rather, it increases. The exchange rate of the rupee depreciates with respect to dollar; depreciation led to increasing in food price inflation through the import of petroleum products, fertilizers, and modern technology used in the production process. The monetary policy transmission through interest rate channels reduces food price inflation in meat and fish, eggs, spices, and pulses in all the quantiles. Whereas, for the milk and oil and fats sectors, interest rate channels of monetary policy help to control the inflation in median and higher quantiles. The price of cereals and its products sector, milk, pulses, and its products, and spices responds negatively through increasing bank credit channels. It indicates that the monetary policy via bank credit channels stabilizes the cereals, pulses and their products, milk, and spices across the quantiles. However, monetary policy transmission through bank credit channels is heterogeneous across quantiles for oil and fats, fruits, vegetables, and sugar sectors.

Although the coefficients are negative, their magnitudes are negligible in stabilizing inflation in these sectors. Further, the sectors associated more with agriculture like fruits and

vegetables exhibited heterogeneous (both positive and negative) coefficients to the monetary policy shocks. Because food price inflation is mostly driven by supply-side shocks in India. Again, the existence of cost channels in the economy may weaken the effectiveness of monetary policy shocks. An adoption of monetary policy by raising interest rate raises the cost of production, leading to an increase in commodities prices as cost is included in the price of the food items, resulting an increase in price (Baumeister et al. 2013). In this connection, Holtemoller and Mallick (2016) also argued that food price inflation drives aggregate inflation in India through cost-push channels. Although monetary policy shocks help in reducing food price inflation in India, it still exists that supply shocks mostly cause food price inflation. Thus, sectoral food price inflation is least affected by monetary policy shocks. These results are supported by Ginn and Pourroy, (2019) in middle-income economies, Bhattacharya and Jain, (2020) for developed and developing economies; Iddrisu and Alagidede (2020) in South Africa, Kumar and Dash (2020) for India who reported that monetary policy transmissions do not stabilises food price inflation.

Table 4.11. Quantile regression results with sectoral disaggregated food items

Variable	25 th	50 th	75 th	25 th	50 th	75 th	25 th	50 th	75 th	25 th	50 th	75 th
	CER = f (EX, BC, AP, IR)			MF = f (EX, BC, AP, IR)			EGG = f (EX, BC, AP, IR)			SPI = f (EX, BC, AP, IR)		
Constant	0.848*** 0.000	0.974*** 0.0000	1.171*** 0.0000	-0.3712 0.2769	0.0244 0.9452	0.0183 0.9538	0.550*** 0.0146	0.4493** 0.0381	0.6186 0.0122	1.124*** 0.0000	1.585*** 0.0000	2.272*** 0.0000
EX	0.474*** 0.000	0.524*** 0.0000	0.617*** 0.0000	0.778*** 0.0000	0.768*** 0.0000	0.798*** 0.0000	0.756*** 0.0000	0.761*** 0.0000	0.779*** 0.0000	0.578*** 0.0000	0.488*** 0.0000	0.477*** 0.0000
BC	-0.004*** 0.000	-0.003*** 0.000	-0.004*** 0.000	-0.0001 0.961	-0.0023 0.114	-0.0021 0.219	-0.0004 0.748	-0.0004 0.758	0.0001 0.941	-0.005*** 0.000	-0.004*** 0.000	-0.002*** 0.032
AP	0.2277*** 0.0000	0.1892*** 0.0000	0.1287*** 0.0000	0.2357*** 0.0000	0.2039*** 0.0000	0.1921*** 0.0000	0.1337*** 0.0000	0.1410*** 0.0000	0.1136*** 0.0000	0.1659*** 0.0000	0.1610*** 0.0000	0.0940*** 0.002
IR	-0.0018 0.6020	0.0015 0.7064	-0.0013 0.5229	-0.0184* 0.0677	-0.021*** 0.0087	-0.021*** 0.0004	-0.0141** 0.0004	-0.009*** 0.0017	-0.007*** 0.0016	-0.022*** 0.0000	-0.027*** 0.0000	-0.031*** 0.0000
Pseudo R ²	0.8768	0.8361	0.8057	0.8643	0.8473	0.8186	0.8060	0.7775	0.7199	0.8496	0.8344	0.7839
Adjusted R ²	0.8723	0.8301	0.7986	0.8593	0.8418	0.8120	0.7990	0.7694	0.7098	0.8441	0.8284	0.7761

Note: Same as listed in Table 4.6

Table 4.11. Quantile regression results with sectoral disaggregated food items continued...

Variable	25 th	50 th	75 th	25 th	50 th	75 th	25 th	50 th	75 th
	ML = f (EX, BC, AP, IR)			OF = f (EX, BC, AP, IR)			FRU = f (EX, BC, AP, IR)		
Constant	0.4848*** 0.0004	0.5325*** 0.0000	0.5179*** 0.0069	1.6271*** 0.0000	2.0495*** 0.0000	2.4154*** 0.0000	0.1598 0.5327	0.3383 0.3214	0.2735 0.5884
EX	0.5981*** 0.0000	0.5791*** 0.0000	0.5943*** 0.0000	0.6365*** 0.0000	0.5774*** 0.0000	0.4859*** 0.0000	0.4844*** 0.0000	0.3453*** 0.0000	0.4512*** 0.0000
BC	-0.0060*** 0.0000	-0.0058*** 0.0000	-0.0045*** 0.0000	-0.0026 0.0111	-0.0015 0.1302	-0.0005 0.6800	-0.0069*** 0.0000	-0.0063*** 0.0000	-0.0030 0.2194
AP	0.2159*** 0.0000	0.2213*** 0.0000	0.2188*** 0.0000	0.0572* 0.0783	0.0448*** 0.0138	0.0508*** 0.0016	0.2974*** 0.0000	0.3432*** 0.0000	0.3062*** 0.0000
IR	-0.0025 0.2443	-0.0043* 0.0922	-0.0083*** 0.0026	-0.0068 0.2259	-0.0155*** 0.0004	-0.0210*** 0.0000	0.0075** 0.0386	0.0070 0.2320	-0.0002 0.9687
Pseudo R ²	0.9155	0.9045	0.8793	0.8101	0.7849	0.7443	0.8272	0.7901	0.7340
Adjusted R ²	0.9124	0.9010	0.8749	0.8032	0.7770	0.7350	0.8209	0.7825	0.7243
	VEG = f (EX, BC, AP, IR)			PUL = f (EX, BC, AP, IR)			SU = f (EX, BC, AP, IR)		
Constant	-0.4411 0.6040	0.9521 0.3637	-1.0828 0.6752	3.5328*** 0.0000	3.9325*** 0.0000	6.0081*** 0.0000	2.9988*** 0.0000	3.4150*** 0.0000	3.6818*** 0.0000
EX	0.9710*** 0.0001	0.7131*** 0.0053	0.9117*** 0.0045	0.3649*** 0.0000	0.3695*** 0.0000	0.6858*** 0.0123	0.2635** 0.0202	0.1809 0.1109	-0.0379 0.8520
BC	-0.0035 0.5284	-0.0161** 0.0213	-0.0059 0.6838	-0.0173*** 0.0000	-0.0195*** 0.0000	-0.0251*** 0.0000	-0.0021 0.5666	-0.0067*** 0.0187	-0.0085*** 0.0021
AP	0.1377 0.1255	0.1235 0.1797	0.2406 0.1883	0.0046 0.9009	-0.0356 0.3174	-0.3686** 0.0554	0.0696** 0.0566	0.0682 0.1013	0.1413*** 0.0021
IR	0.0065 0.7298	0.0104 0.6068	0.0290** 0.0571	-0.0165*** 0.0000	-0.0176*** 0.0000	-0.0531** 0.0303	-0.0074** 0.0535	-0.0055 0.2458	0.0008 0.9378
Pseudo R ²	0.5379	0.4423	0.3392	0.6893	0.6130	0.4995	0.4153	0.4646	0.3874
Adjusted R ²	0.5211	0.4221	0.3152	0.6780	0.5989	0.4813	0.3940	0.4451	0.3652

Note: Identical as denoted in Table 4.6

4.6. Conclusions and policy conversations

The first and foremost ideas of monetary policy are to maintain price stability and maximize the output of the economy. However, a surge in food price has gained more considerable concern for the policymakers as it put upward pressure on aggregate inflation dynamics for all the nations. It also becomes significant for inflation targeting countries with middle and lower-income levels. Because food prices create difficulties in attending inflation targets and welfare benefits of the developing countries, where most individuals spend their more enormous expenditure on the food items, and level of poverty is high for these countries. The present chapter has inspected the role of monetary policy shocks on food price inflation in India. The contractionary monetary policy is negatively and significantly impacting food price inflation using the monthly frequency data spanning January 2009-December 2019. We have used quantile regression analysis to understand the behaviour of predictor variables on food and aggregate inflation in different quantiles of the dependent variable's conditional distribution. The results of this analysis illustrate that contractionary monetary policy is negatively influencing food price inflation. Whereas, the exchange rate and transportation cost are positively promoting food price inflation. The study conclusions advocate that a monetary policy stabilises the food and headline inflation in the developing economy like India, where consumption of food items contributes larger share to the aggregate household spending. The study also suggests that the exchange rate and transportation cost play a substantial role in promoting food price inflation in lower and middle quantiles and the whole quantiles, respectively.

Further, to understand how food price inflation reacts to change in monetary policy lags, we estimated a model including 12-month lags. The results revealed that food price inflation rises by following 12 months of lags of contractionary monetary policy. Food price inflation increases with lags of contractionary monetary policy through the cost of production channels in the economy. Moreover, our study also considers whether contractionary monetary policy stabilizes food price inflation after implementing the inflation targeting agenda. The findings of study concluded that food price inflation reduces resulting from a contractionary monetary policy with the inflation targeting framework.

The study also intended to peruse the success of monetary policy surprises through various channels such as interest rate, bank credit, asset price and exchange rate channels on the food,

non-food and aggregate inflation. The outcome of our study revealed that the monetary policy transmission through exchange rate and asset price channels enhances food price inflation across the quantiles, but bank credit and interest rate channels reduce food price inflation in lower and median quantiles. Again, exchange rate, asset price, and bank credit channels do not communicate to reduce non-food price inflation; instead, it increases across quantiles. However, the interest rate channel is negatively influencing non-food price inflation in all the quantiles. Regarding aggregate inflation, the exchange rate and asset price channels do not stabilize the aggregate inflation resulting from contractionary monetary policy across quantiles. However, monetary policy transmits to aggregate inflation through the bank credit and interest rate channels in lower and middle quantiles, and all the quantiles, respectively. Furthermore, to check robust analysis, this study also estimated the model using consumer food prices-combined-food (CPI-C) with consumer food prices-industrial workers-food (CPI-IW) data. The result of the investigation found that CPI-C gives similar results as CPI-IW.

Finally, we also incorporated the effectiveness of contractionary monetary policy through different channels on sectoral disaggregate food price inflation. The conclusions of the study demonstrated that the effectiveness of monetary policy transmission through different mechanisms is heterogeneous across quantiles for all the sectoral prices. The role of asset price and the exchange rate does not support in stabilizing food price inflation in all the sectors in India. The monetary policy transmission through interest rate channels decreases the food price inflation in meat and fish, eggs, spices and pulses, milk and oil and fats sectors. However, the influence is different across the quantiles. Price stability in cereals and its products, milk, pulses and its products, and spices sectors can be achieved via bank credit channels across the quintiles. Nevertheless, monetary policy transmission through bank credit channels is heterogeneous across quantiles for oil and fats, fruits, vegetables, and sugar sectors. However, a handful of studies emphasize the association between monetary policy and food price inflation. Most of the studies regarding these variables are mostly confined to the United States and other developed countries. The study results validate the break in the literature relating to emerging countries.

Based on the above findings, the present study provides following policy suggestions: (i) The contractionary monetary policy stabilizes food price inflation. The monetary authority should continue to follow the contractionary monetary policy for a substantial period. (ii) The study

also found that the effectiveness of monetary policy tightening to stabilize sectoral food price inflation for some commodities. However, the effect is shallow in reducing inflation to a significant level. The monetary policy also generates heterogeneous results across quantiles for fruits and vegetables. Supply-side shocks mostly determine the reasons behind the minimal effects of monetary policy on food price inflation. The lower impact of monetary policy might be due to the presence of cost channels in the economy. Therefore, inflation targeting authority should also consider food price inflation in aggregate and at different sectors of food items while taking a proper policy stance while taking a proper policy stance. The government should also emphasize supply-side food price inflation measures like increasing the production of net food grain availability and applying modern agricultural equipment to increase production. The response of inflation at the sectoral level may be different than the aggregate level. Therefore, aggregate inflation may not be a suitable measure with pricing decisions at the firm level. (iii) We find that the exchange rate promotes food price inflation, and India is one of the top importers of fertilizer, modern technology, and other intermediate equipment. Therefore, the government should adopt flexible trade policies like reducing imports for both the unprocessed and processed food items that could reduce the domestic country's food prices. (iv) The appropriate policy measures should be taken with respect to minimize the transport cost facilities by establishing an agricultural farm in a good connectivity area. The development of infrastructural connectivity nearby food manufacturing companies will reduce the food price by reducing distance and travel costs. Further, setting up the local infrastructure facilities for storing perishable food items can be created to minimize wastage and transportation costs of food products, followed by food prices. Using biofuel energy as fuel for transport purposes may reduce the cost of transport instead of petrol or diesel, resulting in a decrease in food prices.

5.1. Summary

Maintaining price stability and maximizing sustainable growth of output is the prime objective of every economy. However, as we know, very high inflation or very low inflation retards the output growth of an economy and other macroeconomic variables. Thus, accomplishing price stability is one of the prerequisite conditions in achieving sustainable development of an economy. Therefore, the central bank must look into the instability in prices in the short-run. According to the quantity theory of money, inflation and the growth rate of money are proportionate to each other in the long-run, which suggests that as the growth rate of money increases, inflation also increases in a positive direction. However, supply-side factors are primarily determined by the fluctuation in prices in the short-run. Therefore, the monetary authority needs to know about inflation's impact on the growth or other economic variables and its different effects (positive and negative) across the countries.

However, rising food price inflation creates macroeconomic instability and hampers the welfare benefits of the people. The main reason behind the increase in inflation is a rise in food price inflation. The rising food price inflation also increases aggregate inflation because food expenditure constitutes larger weights in the aggregate inflation and most people spend their more extensive portion of the income on food items. It not only raises aggregate inflation but also creates difficulties in achieving inflation targets in inflation-targeting countries with low- and middle-income countries. Furthermore, high food price inflation creates problems in forecasting the accuracy of the aggregate inflation. On the other hand, food prices adversely impact the health and welfare of the country by increasing infant and child mortality and undernourishment in developing nations. Given the importance of food price inflation, it becomes a concern for researchers and policymakers to find the responsible factors that push food prices up. Some of the essential sources that drive food prices up in an upward direction are : increasing demand for biofuels in many developed countries, increasing demand for various diets among newly prosperous populations, rise in minimum support prices, rapid regional economic growth, increasing the cost of fertilizers and other inputs, rising oil prices, etc.

However, India is not an exception from the problem of high food price inflation, where the majority of the population pays their larger part of their income on food. Therefore, rising food price inflation may put several problems for the economy. Some of the studies have found that high food price inflation exists due to supply-side factors, and others have argued in favor of demand-side factors. However, results are mixed in nature. The relative price variability of the food items plays a central character in the demand and supply of food items. An immense shock to a few commodities has a disproportionate effect on aggregate inflation due to its price adjustment. Hence, the distribution of relative price changes promotes aggregate inflation. Further, to maintain stability in prices to a certain level, monetary policy targeting was introduced by government of India. By following the above significant importance of high food price inflation in the economy's stability and welfare, the present study attempted to examine three vital issues concerning food price inflation.

Here are the three core purposes of the thesis: Firstly, the study tries to determine the relative significance of real and inflationary factors in the variation in relative price variability of food price inflation using decomposition analysis. This study also identifies the commodities whose contribution is more significant in the relative price variability of food and non-food prices. Moreover, the study analyses the association pattern by establishing the nexus between food price inflation and relative price variability. Second objective has analyzed the influence of macro-economic factors on food price inflation, and the causal nexus among the variables in both the short-and long-run. Third objective has inspected whether high food price inflation originated from different shocks can be stabilized by following contractionary monetary policy shocks? All of these objectives are examined for India.

In chapter 2, the study has identified each of the commodities in the food basket, which contributes to the larger variability of relative prices in food prices. Further, using decomposition analysis, the study allocates relative price variability into an element due to real factors (demand-side) and inflationary factors (supply-side). This study proceeded to determine the relative significance of real and inflationary factors in the variance of the relative price changes. To fulfill the objective, the study applied the methodology suggested by Clements and Nguyen (1981, 1982). It tells about at which magnitude real and inflationary factors determine the relative price variability. Moreover, the study also discusses the patterns of the relationship between food price inflation and relative price variability. Additionally, to

determine whether non-food commodities are accountable for the variance of relative price changes of food items, we have identified each of the commodities in the non-food baskets, and their proportion of contribution in the relative prices of food prices. We also decompose the relative price variability of food prices due to real and inflationary effects. We have used both the WPI and CPI food and non-food data to find out the robustness check of both the estimates.

In chapter 3, we have discussed the impact of macroeconomic factors on food price inflation. To fulfil our objective, we have applied the ARDL approach to cointegration by Pesaran and Shin (1999) and Pesaran et al. (2001) to establish the long-run association between the macroeconomic factors and food price inflation. Further, to assess the short-and long-run impact among these variables, we have applied ARDL approach using short-and long-run analysis. The Granger causality technique was employed to find the causal nexus among the macroeconomic factors on food price inflation in the short-and long-run.

In chapter 4, we have dealt with whether contractionary monetary policy is able to reduce food price inflation. We have applied the Zivot-Andrews unit root test to recognize structural breaks in these series by Zivot and Andrews (1992), which account for breaks associated with the sample data set. Further, study utilised the quantile regression technique offered by Koenker and Bassett (1978) to investigate the impact of independent variables on dependent variable at different quantiles of conditional distribution of predicted variables. More technically, the marginal impact of monetary policy, real exchange rate, transportation cost, and economic output on food price inflation and aggregate inflation is examined. Based on the break dates, we have estimated the model by allowing break dates in the right-hand side of the equation using dummy variables. The study also considers monetary policy's influence on food price inflation after implementing an inflation-targeting framework and 12 lags of monetary policy. Furthermore, the study also demonstrates whether food, non-food and aggregate inflation can be stabilized by following contractionary monetary policy through different channels, exchange rates, interest rates, asset prices, and bank credit channels. Moreover, the study investigates whether the effective spread of monetary policy mechanism can help to reduce food price inflation in ten different sectors of food commodities such as cereals and its associates, meat and fish, eggs, milk and its associates, oils and fats, fruits, vegetables, pulses and its associates, sugar and confectionery, and spices.

5.2. Key findings

From the results of Chapter 2, we found the exciting point that 25 out of 105 commodity prices in India are predominately contributing 93% of relative price variability in food baskets where their share is equal to 1% or above. The sector-wise outcomes showed that prices of primary food articles and manufactured food products contribute 82% and 18% of the relative price variability, respectively. Further, the decomposition analysis results indicate that 53% of the variability in the relative prices of primary food articles is accredited to real factors, and the rest 47% through inflationary factors. Whereas 30% of the relative price variability of manufactured food products is originated through real factors, the rest 70% by inflationary factors. Overall, the commodity having the highest share largely contributes to variability in relative price by both demand and supply-side factors. These results contradict previous studies, which say that relative price variability in food basket is mainly because of inflationary factors known as supply-oriented effects. In case of disaggregated food items, the 24% relative price variability of the overall food item is attributed from cabbage only. For cabbage, 41% of the relative price variation is determined by real effects, and 59% is by inflationary effects. In particular, fluctuation in relative price variability is mainly encouraged through vegetable prices determined by both real and inflationary factors. However, inflationary factor contributes relatively larger proportion in the variability in relative prices.

The essential conclusions emerge from the analysis show that few commodity prices have an immense contribution to variability of relative price. The majority of commodities under primary food articles have a higher contribution to relative price variability, whereas commodity prices under manufactured food products have the least contribution. The variability of relative prices of commodities under primary food articles originates from real factors, and commodity prices under manufactured food products are due to inflationary factors. We identified that WPI non-food items also play a notable role in the relative price variability of food items. The results show that among the 564 commodities, ten commodities have been identified, which contributes 23% of the variability in relative prices of food items whose share is 1% or larger. Most of the identified commodities are basically from agricultural inputs like power and fuel.

Furthermore, the study also checked the robustness analysis using CPI food and non-food items. It shows that 22 commodities have been identified among the 106 commodities,

contributing 94% of the variation in relative price changes. The results also confirmed that the majority of the identified food commodities in the relative price variability is largely initiated by inflationary factors. It indicates that vegetables are considered an important source of commodities where relative price variability takes place. However, among the 184 commodities, 14 non-food commodities have been identified, contributing 56% of the relative price changes in food items. Here, we also found similar results as WPI non-food items that primary agricultural inputs contribute a significant variation in the relative price changes of food prices. Our results confirmed that a rise in fuel price contributes to larger variation in relative price changes of food items in India.

From results of both the WPI and CPI, we found similar conclusions among them. We conclude that the percentage share of variation in relative price changes is identical for both the data sets. The majority of the commodities in food basket fluctuations are identified as vegetables in both the data sets. In particular, variability in relative prices is mainly contributed by vegetable prices determined by both real and inflationary factors. However, inflationary factor contributes relatively larger proportion (nearly 60%) in the variability in relative prices from the WPI results. While the relative price variability in all these commodities is largely determined by inflationary factors using CPI data. Overall, the results obtained from both the data sets exhibit similar results. However, it varies with magnitudes.

From chapter 3, results revealed a long-run connection among the macroeconomic factors and food price inflation. The long-run estimates show that per capita income, money supply, global food price, and agricultural wages positively and substantially impacted India's food price inflation in the long-run and short-run. However, the net availability of food grain negatively influenced food price inflation. It implies that a surge in per capita income, money supply, global food price, and agricultural wages promotes food price inflation. But, increase in food availability reduces food price inflation in the short and long-run. Further, the real exchange rate is positively affecting food price inflation. However, it is insignificant in the short-run. The Granger causality estimates show that a short-run bidirectional causality is confirmed among per capita income, exchange rate, per capita net availability of food grain, and food price inflation. Further, unidirectional causality is confirmed from global food prices to food price inflation. However, no causal relationship is existing from money supply and agricultural wages to food price inflation in the short-run. The long-run outcomes

discovered a bidirectional causal nexus among the money supply, global food prices, and net availability of food grain.

From chapter 4 results, it is observed that the impact of tight monetary policy is negatively influencing food price inflation. The consequence of the exchange rate and transportation cost is positive on food price inflation. The conclusions of this study advocate that a monetary policy change stabilizes the food and headline inflation in the developing economy like India, where consumption of food items contributes larger share in the aggregate household spending. The study also suggests that the exchange rate and transportation cost play a substantial role in promoting food price inflation in lower and middle, and whole quantiles, respectively. The results revealed that food price inflation rises by following 12 months of lags of contractionary monetary policy. Food price inflation increases following lags of contractionary monetary policy through the cost of production channels in the economy. Moreover, our study also considers whether contractionary monetary policy stabilizes food price inflation after implementing the inflation targeting agenda. The findings of the study concluded that food price inflation reduces resulting from the contractionary monetary policy after introducing inflation targeting framework in the country.

Further, our study outcomes revealed that the monetary policy transmission through exchange rate and asset price channels enhances food price inflation across the quantiles. In contrast, bank credit and interest rate channels reduce food price inflation in lower and median quantiles. Again, exchange rate, asset price, and bank credit channels do not communicate to reduce non-food price inflation; instead, it increases it across quantiles. However, the interest rate channel is negatively influencing non-food price inflation in all the quantiles. Regarding aggregate inflation, the exchange rate and asset price channels do not help to stabilize the aggregate inflation resulting from contractionary monetary policy across quantiles. However, monetary policy transmits to aggregate inflation through the bank credit and interest rate channels in lower and middle quantiles, and all the quantiles, respectively. The result of the analysis found that CPI-C gives similar results as CPI-IW. Finally, the study outcomes demonstrated that the effectiveness of monetary policy transmission through different mechanisms is heterogeneous across quantiles for all the sectoral prices.

The role of asset price and the exchange rate does not support stabilizing food price inflation in all the sectors in India. The monetary policy transmission through interest rate channels decreases the food price inflation in meat and fish, eggs, spices and pulses, milk and oil and fats sectors. However, the influence is different across the quantiles. But, price stability in cereals and their products, milk, pulses and their products, and spices sectors can be achieved via bank credit channels across the quintiles. Nevertheless, monetary policy transmission through bank credit channels is heterogeneous across quantiles for oil and fats, fruits, vegetables, and sugar sectors.

5.3. Policy conversations

From the empirical findings, we can draw the following policy inferences:

From chapter 2 (objective 1), our results concluded that both the supply and demand-side factors are responsible for higher relative price variability, and robustness check results revealed that variability in relative price is mainly due to inflationary factors (supply-side). Therefore, essential policy measures should be taken by the government and policy makers for both the supply and demand-side.

Supply-side measures:

- ❖ To meet the supply-side response, we need to increase the growth of agricultural production and productivity. Various institutional reforms in the country such as the allocation of different crop insurance schemes and availing rural credit facilities via rural banking and small-scale cooperative societies should be taken by the government. Other policy reforms like widening the agricultural land area under irrigation, issuing soil health cards for effective use of fertilizer, and making use of high yield variety (HYV) seeds should be implemented effectively in their processes of production, which eventually would increase agricultural productivity.

Demand-side measures:

- ❖ To meet the demand-side responses, the monetary policy can control food price inflation through moderating consumption demand. The contractionary monetary policy measures might help to curb the problem of food price inflation via reducing the money supply and credit facilities which eventually curtail the aggregate demand. Thus, it helps to reduce food price inflation.

- ❖ Our study found that both food and non-food items are accounted for the variability of relative price changes of food items. Food contributes larger weights in headline inflation. The suitable policy decisions should be taken by the central bank by focusing on commodity-wise disaggregated inflation points of view while targeting headline inflation in order to maintain stability in price and growth of the economy.
- ❖ The effective policy suggestions should be taken by the government with respect to the identified food and non-food commodities, which account for higher variability in the relative price of food commodities. Further, if variability in relative of both the identified food and non-food items can be checked by implementing appropriate policy stance, then food price inflation can be eliminated as a whole term.

From chapter 3 (objective 2), we suggest following policy suggestions.

- ❖ The global food price inflation triggers food price inflation by international trade channels. Hence, the government should introduce stable and liberal trade policies that reduce food price inflation without compromising farmers' remuneration values of their produce.
- ❖ Our result also revealed that a rise in net availability of food grain reduces food price inflation in both the short and long-run. Therefore, necessary steps should be taken by the government in favor of an increase in domestic food production. The easily accessible credit facilities should be available to the farmer to invest the fund in their production activities, followed by the rise in the domestic agricultural food production. The increase in the stock of food grain during harvest season can avoid off seasonal food price inflation. The increase in the stock of food items by establishing an extensive cold storage system and strengthening large warehouses can control food price inflation in India.
- ❖ The rise in agricultural wages boosts food price inflation. The increase in the agricultural wage rate should be substituted with food price inflation by increasing labour productivity. Hence, the increase in demand originated by a hike in agricultural wage rate can be substituted by raising the productivity of each worker.
- ❖ The per capita income promotes food price inflation in the short-and long-run. In this respect, we can conclude that there is a vast sectoral imbalance among the sectors. The demand for commodities is increasing at a higher rate due to increased economic growth, whereas the growth of agriculture is quite low compared to the service sector and GDP growth. The government should be more focused on the agricultural industry and its growth and productivity by allocating massive funds in the irrigation, agricultural

research, provisions of credit to small farmers, tractors, pesticides, modern machinery and innovation of modern technology and its adaptation in agriculture which led to increase in productivity of agricultural sector. Therefore, balanced and sustainable growth and stability can be achieved for a developing country like India.

- ❖ The real exchange rate and food price inflation Granger causes to each other. The exchange rate depreciation spurs food price inflation via expanding the import of petroleum products, fertilizer, and other finished products relating to agricultural commodities, which are very expensive. The increasing import of these products and other food products promotes food price inflation by raising domestic prices. Hence, to reduce the food price inflation, the government should increase the domestic agricultural production to meet our demand for food items rather than importing from other countries.

From chapter 4 (objective 3), we provide following policy conversation and suggestions:

- ❖ As contractionary monetary policy stabilizes food price inflation; the monetary authority should continue to follow the contractionary monetary policy for a substantial period.
- ❖ The study also found that the effectiveness of monetary policy tightening stabilizes sectoral food price inflation for some commodities. Therefore, inflation targeting authority should also consider food price inflation and different sectors of food price inflation resulting from the contractionary monetary policy while taking a proper policy stance.
- ❖ The government should adopt flexible trade policies like reducing imports for both the unprocessed and processed food items that could reduce the food prices in the domestic country. The exchange rate positively impacted food prices. Therefore, the government should adopt necessary policy measures through the contractionary monetary policy. The increase in interest rate attracts foreign investors via developing corporate support and creates guidelines for the export sector.
- ❖ The appropriate policy measures should be taken to reduce transport cost facilities by establishing an agricultural farm in a suitable connectivity area. The development of infrastructural connectivity nearby food manufacturing companies will reduce the cost of transport by reducing distance and travel costs. Further, local infrastructure facilities for the storage of perishable food items can be created to minimize wastage and transportation costs of food products. Using biofuel energy as fuel for transport purposes may reduce the cost of transport instead of petrol or diesel, resulting in a decrease in food prices.

5.4. Boundaries of the research

The borders of the present researches are limited to demand and supply-side analysis to know the determinants of food price inflation. However, other factors like institutional factors and restrictive trade policies such as corruption, trade policy intervention, hoarding of food commodities influence food price inflation. Due to the monthly data unavailability of respective variables for the consistent period, we have not included them in this study. The inclusion of time-varying analysis in this study may have provided the efficiency and improvement of monetary policy transmission over time. However, we have not considered it due to the short data period. Further, the decomposing relative price variability with different food price inflation regimes for a longer time may provide valuable insights to the literature. However, decomposing relative price variability with different food price inflation regimes does not make much difference in a short period.

5.5. Directions for future research

First, future research can be conducted on food price inflation and relative price variability with different inflation regimes by using other methods like Bai-Perron structural break analysis. The decomposing relative price variability with different inflation regimes provides insightful light to the existing food price inflation literature. Second, food subsidy policy along with monetary policy can help to stabilize food price inflation and maximize the welfare benefits of developing countries in the presence of financially constrained households. Providing subsidies to food price diminishes food price inflation. Therefore, the monetary policy should not be too strict as they target subsidised food prices. Therefore, the future study can be directed with the synchronization of both fiscal policy and monetary policy in the stabilization of food prices. Further, a method of time-varying analysis can be included to investigate the behavior of food price inflation following contractionary monetary policy. Third, the panel study can be conducted by taking a group of inflation-targeting and non-targeting countries in the analysis and it may compare the monetary policy's effectiveness on food price inflation with non-targeting countries. Future exercise can be undertaken on the influence of different monetary policy channels on disaggregate individual food commodities for India. Finally, a careful analysis can be done by incorporating impact of specific supply-side factors on food price inflation in India along with demand-side factors.

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<http://labourbureau.gov.in/>

<https://www.rbi.org.in/>

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An Empirical Analysis of Asymmetry and Threshold Effect of Intergovernmental Grants in India: A Panel Data Analysis

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Abstract

The present study empirically examines the effect of intergovernmental grants on the expenditure of state government in India. Using a panel data set during 1980–1981 to 2009–2010, the flypaper effect was found in the case of total and revenue expenditure and also an evidence of an asymmetric effect to change (increase or decrease) in grant variable for entire sample period. Again, to understand the flypaper and asymmetry effect in the pre- and post-reform period, this study uses the data from 1980–1981 to 1989–1990 as a pre-reform period and 1991–1992 to 2009–2010 as a post-reform period. The results of the panel regression model and two-stage least squares (2SLS) method show that there is an absence of flypaper effect except capital expenditure in the pre-reform period, whereas there exists an evidence of flypaper effect except capital expenditure in the post-reform period. Similarly, the responses of all the expenditure accounts are found to be asymmetric except capital expenditure. Further, in order to find the non-linear effect, this study employs Hansen (1999) threshold regression model to measure the threshold effect of intergovernmental grants on total expenditure of state government. The threshold regression results indicate that lower-income state grants have a stronger flypaper effect than middle- and higher-income states.

Keywords

Intergovernmental grants, flypaper and asymmetry effect, threshold effect, two-stage least squares

Introduction

A federal structure of government involves two levels of government: a set of self-governing lower level governments under a single central higher level of government. An intergovernmental grant plays a very significant role as a policy instrument in a federal structure. The need for intergovernmental grant arises

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due to certain economic problem that warrants intergovernmental transfers of resources from the centre to states and the local government: (a) fiscal imbalances between different levels and the same level of governments; and (b) due to unmet need of the lower level of government.

The main objective is to resolve and reduce the fiscal imbalances between different levels of governments; maintain the horizontal fiscal imbalances across the same level of governments; and ensure the competitive equality among all levels of governments. A very important issue in the whole idea of intergovernmental transfer is to have a mechanism to effectively deliver this transfer which fulfils the said objectives. If there is an ad hoc single criterion for the distribution and transfer of resources, such as size of population, per capita income, it will further add to problems of disparities as only some states will be benefited from transfers. Therefore, it is very evident to have a systematic and effective design for intergovernmental transfers.

The intergovernmental transfers in India are being implemented through three major channels, namely, the Finance Commission, Planning Commission and Centrally Sponsored Schemes in terms of grants, loan and tax sharing. As an important instrument of an intergovernmental transfer, the study aims at examining the effect of intergovernmental grants on the behaviour of expenditure of state government in India which is explained through flypaper effect.

The number of empirical studies have been undertaken which argued that expenditure stimulus from unconditional grants are higher than that of an equivalent increase in income. This concept is known as 'flypaper effect'. However, results from empirical studies contradict to theoretical framework which explains expenditure stimulus from unconditional grants which have equivalent effect on state government spending with an equivalent increase in disposable income (Bradford & Oates, 1971). It indicates that a unit increase in grants and in an individual or a community's income have identical effects on the spending of state government. The flypaper effect has been explained by 'money sticks where it hits'.

The present study contributes to the public finance literature in several ways: First, numerous studies have examined the effect of intergovernmental grants on the state government expenditure across the globe. However, few of them have been conducted in the case of India. Second, some have investigated the impact of decrease in intergovernmental grants on state government spending across the world as well as in the case of India. However, empirical results are ambiguous. Third, no study has so far empirically explored the threshold/non-linear effect of the per capita grant on public expenditure in the Indian context. The non-linear nature of this relationship is very important in determining an effective policy in addressing issues of intergovernmental grants and its influence on state government spending. The empirical response of government spending to change in grants and non-linear effect of grants on government spending over the Indian data give a supplementary insight of existing studies of flypaper effect which would give some new directions to economists and policymakers.

The remainder of this article is organized as follows: the second section explains the review of literature and the third section describes the data and economic methodology which are employed in this study. The fourth section presents the empirical results and analysis. The fifth section presents the summary and policy conclusions.

Review of Literature

Flypaper effect refers to the phenomenon in which expenditure stimulus from unconditional grants are higher than that of an equivalent increase in income. If the collective disposable income of the people increases, the local citizens would like to spend less on local public goods and services than the amount

of additional grants which local government receives from the central government. Thus, money tends to be utilized for which it has been allocated, that is, 'money sticks where it hits'. This phenomenon is known as a flypaper effect in the public finance literature. This phenomenon contradicts to the theoretical framework propounded by Bradford and Oates (1971) whose theory explains that grants were given to a group of people by collective decision not by any individual.

The basic model used to examine the effect of grants on a community is based on the indifference curve approach and known as a median voter model in the public finance. The median voter model postulates that the government expenditure reflects the median voter demand. Further, the median voter assumed to have the median income of the community. Thus, the government spending should correlate with median income. Moreover, the allocation of grants for public expenditure would be in accordance with the income elasticity of median income. Thus, an increase in grants is expected to have the same effect as an equivalent increase in the disposable income of the community represented by the median voter.

Generally, empirical testing of flypaper effect is observed a conventional aspect as it considers only increase in grants without taking into account cut in grants. However, the asymmetric effect deals with the impact of government expenditure to cut in grants and explains whether the sign and magnitude of the cut in grant is the same as increase in grant. The studies on flypaper and asymmetry effect were tested by Gramlich (1987) who found that when there is a cut in grants, the subnational government increases their own tax revenue in order to maintain their existing level of expenditure which is called as fiscal replacement. This kind of behaviour is known as a basic asymmetric effect. When state government is highly responsive to increase in grants, it is relatively insensitive to cut in grants.

Similarly, there is a study by Heyndels (2001) who examined the impact of unconditional grants on government spending in 308 Flemish municipalities during 1989–1996. The author found that there is an asymmetric reaction of decrease in grants. Levaggi and Zanola (2003) revealed that decrease in grants has an asymmetric effect on the regional healthcare spending in 20 Italian states. On the contrary, Stine (1994) found a very striking asymmetric response: not only expenditure declines but tax revenue also decreases with the decrease in grants in 66 Pennsylvania countries over the period of 1978–1988. Such type of asymmetric response is called as fiscal restraint effect.

However, Gamkhar and Oates (1996) found that there is no asymmetric response of state and local government on increase or decrease in grants of the USA during 1953–1991. However, there are very few studies which have tested response of government expenditure due to change in grants (either increase or decrease) in the case of India. For example, Rajaraman and Vasishtha (2000) examined the flypaper effect for 14 districts in Kerala using local-level data during 1993–1994. Lalvani (2002) investigated the effects of grants on state government spending for 14 Indian states during 1980–1998. The results found that there is a presence of flypaper effect for India.

Further, the results also found asymmetry effect to cut in grants. Similarly, Karnik and Lalvani (2005) documented that there is an existence of flypaper effect and the results of asymmetric response to decrease in grants are mixed in case of Maharashtra during the period of 1993–1998. A recent study by Panda and Nirmala (2013) argued that central transfers not only have stimulatory effect on states government spending but also have disincentives on expenditure of states. Further, their results also confirm the flypaper effect in the Indian case.

From the overall analysis, it is observed that flypaper effect existed for most of the studies for different reasons. These are incorrect definition of grants and specification error (Hines & Thaler, 1995), deadweight loss (Hamilton, 1986) and fiscal illusion (Logan, 1986; Oates, 1979). However, in spite of different drawbacks, the debate on flypaper effect still persists and will remain relevant for the research. The present study aims at to test the effect of intergovernmental grants on state government expenditure in the Indian context for both pre- and post-reform period which is explained by flypaper and asymmetric effect.

Objectives of This Study

Given this theoretical and empirical background, the present study aims to estimate the effect of intergovernmental grants on the state government expenditure of India to understand the presence of flypaper effect. Later, it also tries to attempt an important question: how will the state government respond when there is a cut in grants from the centre? Further, the study examines the non-linear effect of grants on state government expenditure in the case of India.

Data Sources

This present study uses panel data covering 14 major states in India, including Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Punjab, Orissa, Uttar Pradesh, Tamil Nadu and West Bengal over the period from 1980–1981 to 2009–2010. Later, in order to understand the flypaper effect in pre- and post-reform period, the study has divided the entire data period (1980–1981 to 2009–2010) into two periods, namely pre- (1980–1981 to 1990–1991) and post-reform (1991–1992 to 2009–2010). The study excluded the special category states and union territories due to its high dependency on grants and very low capacity to collect their own revenues.

Further, in order to find out the threshold/non-linear effect of grants on the income, the study has also used the data from 1980–1981 to 2009–2010. The considered panel data on total, revenue and capital expenditure, and total grants and state per capita income have been obtained from the Handbook of Statistics on State Government Finance, State Finances: A Study of Budgets and Handbook of Statistics on Indian Economy published by the Reserve Bank of India (RBI) and National Accounts Statistics published by Central Statistical Organisation (CSO).

Measurement of Variables

The study used all variables in per capita terms and transformed into natural logarithm which helped to avoid problems associated with their distributional properties (Kutan, Paramati, Ummalla & Zakari, 2017; Paramati, Ummalla & Apergis, 2016; Paramati, Apergis & Ummalla, 2017). Therefore, the estimated coefficient in regression model can be interpreted as elasticities. The measurement of above variables is as follows:

Total expenditure (PTX): It explains the state government total expenditure and is a sum of expenditures incurred on both capital and revenue accounts.

Revenue expenditure (PRX): It is incurred by the state government in their revenue account.

Capital expenditure (PCX): It explains the expenditure of the state government in their capital accounts.

Total grants (PTG): It explains the amount of total grants from the centre to state government.

State domestic income (PY): It explains income of the state government which is the real net state domestic product in 2004–2005 prices.

Dummy total grants (DTG): It explains the difference between total and lag value of total grants multiplied by dummy variables. $D = 1$ if $[\ln PTG_t - \ln PTG_{t-1}] < 0$, when there is fall in grants, $D = 0$ if $[\ln PTG_t - \ln PTG_{t-1}] \geq 0$, when there is an increase in grants.

Methodology

This study used panel data technique to estimate the model from a panel of 14 major states which will provide a useful insight rather than aggregate time series data. Panel data estimation allows heterogeneity existing among individual units, whereas time series and cross-section data did not allow it and as a result runs the risk of obtaining biased results. It is also capable of identifying and measuring the effects that are not possible in the case of only cross-section and time series data.

Panel Regression Model

A panel regression model is employed using the fixed effects technique to examine the effects of grants on the state government expenditure. The linear panel regression model was estimated including an interaction dummy to capture the asymmetric effects of grants on public spending. To estimate the direct effect of grants on state expenditure, above variables are incorporated in the following panel data regression separately.

$$\ln PTX_{it} = \mu_i + \phi_1 \ln PY_{it} + \phi_2 \ln PTG_t + e_{it} \quad (1)$$

$$\ln PRX_{it} = \mu_i + \phi_1 \ln PY_{it} + \phi_2 \ln PTG_t + e_{it} \quad (2)$$

$$\ln PCX_{it} = \mu_i + \phi_1 \ln PY_{it} + \phi_2 \ln PTG_t + e_{it} \quad (3)$$

where $i = 1, \dots, 14$ corresponding to 14 states and $t = 1, \dots, T$ with T is the total time period used in this study. $\ln PTX_{it}$ is natural logarithm of total expenditure per capita for the state i at time t . $\ln PY_{it}$ is natural logarithm of real NSDP per capita for state i at time t . $\ln PTG_{it}$ is natural logarithm of total grants per capita for state i at time t . $\ln PCX_{it}$ is natural logarithm of capital expenditure for state i at time t . e_{it} denotes disturbances and is assumed to be independent and identically distributed with mean zero and finite variance.

To estimate the asymmetric effect of grants on state expenditure above equations are modified with a dummy variable as follows:

$$\ln PTX_{it} = \mu_i + \phi_1 \ln PY_{it} + \phi_2 \ln PTG_t + \phi_3 D * [\ln PTG_t - \ln PTG_{t-1}] + e_{it} \quad (4)$$

$$\ln PRX_{it} = \mu_i + \phi_1 \ln PY_{it} + \phi_2 \ln PTG_t + \phi_3 D * [\ln PTG_t - \ln PTG_{t-1}] + e_{it} \quad (5)$$

$$\ln PCX_{it} = \mu_i + \phi_1 \ln PY_{it} + \phi_2 \ln PTG_t + \phi_3 D * [\ln PTG_t - \ln PTG_{t-1}] + e_{it} \quad (6)$$

where $D = 1$ if $[\ln PTG_t - \ln PTG_{t-1}] < 0$
 $= 0$ if $[\ln PTG_t - \ln PTG_{t-1}] \geq 0$

The dummy takes the value 1 when there is a fall in the grants. In that case, ϕ_2 is the elasticity of increasing grants, whereas $\phi_2 + \phi_3$ is the coefficient indicating the elasticity of decreasing grants. This variable measures the response of government spending to cut in grants. The null hypothesis of symmetrical response to increase and a decrease in grants is rejected if the coefficient of asymmetry variable is statistically significant. The symmetric hypothesis refers to the response of government spending to decrease in grants is the same to the increase in grants with the same sign and magnitude.

Two-stage Least Squares Model

The previous equations have also been estimated using the two-stage least squares (2SLS) methodology.¹ The 2SLS is an instrumental variable technique. It involves two-stage estimation procedures. In the first stage, the endogenous variables are regressed upon its determinants using least squares method. In the second stage, the equations are estimated by OLS, replacing all endogenous variables with their predicted values from the regressions estimated in the first stage.

Threshold Regression Model

This study has estimated a threshold regression following the methodology of Hansen (1999).² He found that for any given threshold variable, the slope coefficient and the threshold value can be estimated by ordinary least squares method after fixed effect transformations in a panel setup. The optimal threshold value is selected in two steps. First, sorting the distinct values of the threshold variable and eliminating the largest and smallest 5 per cent of the observations. Second, the optimal threshold value is identified as the smallest sum of squared residuals of the following model.

The econometric specification of threshold regression model used in this study is expressed as:

$$\ln PTX_{it} = \mu_i + \theta_1 \ln PY_{it} + \beta_1 PTG_{it} I(Q_{it} \leq \gamma_1) + \beta_2 PTG_{it} I(\gamma_1 < Q_{it} \leq \gamma_2) + \beta_3 PTG_{it} I(\gamma_2 < Q_{it}) + e_{it}, \quad (7)$$

where $I(\cdot)$ is the indicator function, Q_{it} is threshold variable, γ_1 and γ_2 are the threshold values. β_1 captures the effect of grants on expenditure when the threshold variable (Q_{it}) is less than or equal to γ_1 , β_2 captures the effect while the threshold variable (Q_{it}) is between lower threshold value (γ_1) and upper threshold value and β_3 captures the effect threshold variable (Q_{it}) is greater than or equal to γ_2 .

Empirical Analysis

Panel Unit Root Test Results

All variables are pretested for their integration properties using standard panel unit root tests. The present study employed two common unit root tests, namely the Levin, Lin and Chu (2002) and Breitung (2000) and two individual unit root tests, namely Im, Pesaran and Shin (2003) and Fisher Augmented Dickey-Fuller (ADF) (Choi, 2001; Maddala & Wu, 1999). All these tests are based on the null hypothesis of a unit root against the alternative hypothesis of stationary of the series. The panel unit test results are displayed in Table 1. The results indicate that all variables are stationary in their level. However, Levin–Lin–Chu (LLC) test common unit root and Fisher ADF test individual unit failed to reject the null of unit root for net state domestic product (PY). Whereas other two unit root tests rejected the null of unit root in PY. Hence, PY has been treated as a stationary variable.

Panel Regression Results

The results of non-dynamic linear panel regression are presented in Table 2. Model (1) has total expenditure of state government (PTX) as a dependent variable. The coefficient of PTG is (0.787) which is higher than the coefficient of PY (0.466). It suggests that an increase in grants will have a greater significant effect on the state government's total expenditure than that of equivalent increase in income of an individual. In other words, expenditure stimulus from unconditional grants exceeds from that of an equivalent increase in income. Thus, it is concluded that there is a presence of flypaper effect. It is

Table 1. Panel Unit Root Test

Variables	Common Unit Root-LLC	Individual Unit Root-IPS	Individual Unit Root-Fisher ADF	Common Unit Root-Breitung
PTX	-2.5951 (0.00)	-7.4982 (0.00)	-7.2715 (0.00)	-6.5216 (0.00)
PRX	-2.3368 (0.00)	-5.8543 (0.00)	-4.3970 (0.00)	-5.5218 (0.00)
PCX	-2.6139 (0.00)	-8.3259 (0.00)	-8.7208 (0.00)	-6.1935 (0.00)
PY	-0.8746 (0.19)	-3.1725 (0.00)	-0.4312 (0.33)	-2.3251 (0.00)
PTG	-2.2088 (0.01)	-7.3972 (0.00)	-7.2433 (0.00)	-3.8003 (0.00)

Source: Author's own findings.

Note: Figures of the parentheses are *P*-values.

Table 2. Non-dynamic Linear Panel Data Regression Estimates (1980–1981 to 2009–2010)

Parameter	Estimated Coefficients		
	Model 1 (PTX)	Model 2 (PRX)	Model 3 (PCX)
μ_1	-1.1038* (0.42)	-0.748* (0.48)	-4.9673* (0.53)
ϕ_1	0.4666* (0.05)	0.3611* (0.06)	0.8477* (0.06)
ϕ_2	0.7874* (0.02)	0.8697* (0.02)	0.5097* (0.02)
ϕ_3	-0.7899* (0.10)	-0.9123* (0.11)	-0.3844* (0.12)
R^2	0.9085	0.8855	0.8822*
F	10.05 [0.00]	10.91 [0.00]	5.85 [0.00]

Source: Author's own findings.

Notes: Figures in (#) and [#] are standard errors and *p*-values; * denotes significance at 5% level.

probably due to following reason: if the collective disposable income of the people increases, the local citizens would like to spend less on local public goods and services than the amount of additional grants which local government receives from the central government.

The asymmetry variable PDTG has a negative and significant coefficient, which indicates that asymmetric response of expenditure with the decrease in grants. The reasons for asymmetry effect is that when grants are reduced, it does not reduce the expenditure of the total expenditure account, which continues to increase due to fiscal replacement form of asymmetry behaviour; the state government increases their own tax revenue to maintain the present level of expenditure of government. Since asymmetry is present in the model, the response of expenditure with an increase in grant can be captured by ϕ_2 and the response of expenditure to a fall in grant can be measured by $(\phi_2 + \phi_3)$. In the case of total

expenditure, the elasticity of decreasing grant is estimated to be $(0.7874 - 0.7899 = -0.0025)$. Thus, a fall in the grant variable will not affect the total expenditure as the coefficient is too negligible.

Similar to Model (1), flypaper effect is also found in case of Model (2), where revenue expenditure (PRX) as a dependent variable. This suggests that increase in unconditional grants from the centre has a greater stimulatory effect on revenue expenditure than the equivalent increase in income. The negative and significant coefficient of PDTG indicates there is presence of fiscal replacement form of asymmetry effect for revenue expenditure. The elasticity of decreasing grant with respect to revenue expenditure is estimated to be -0.04 . However, in the case of Model (3), there is an absence of flypaper effect, since income variable (PY) is positive and significant; higher than the grant variable (PTG). Similarly, asymmetry effect is also found in the Model (3) when capital expenditure (PCX) as a dependent variable which suggests that when grant falls, it does not reduce the expenditure of capital account.

Since revenue expenditure is a short-term phenomenon and incurred on specific revenue transactions, such as goods and services which contain major items of total expenditure like pension and other items, and all expenses are incurred immediately within the current accounting period. However, capital expenditure is a long-term phenomenon, and it incurs when value of a capital asset is created and expenditure related to capital expenditures are done in a phased manner. In addition, share of revenue expenditure represents the considerable amount of budget to total expenditure. While the share of capital expenditure is quite less as comparison to revenue expenditure. Further, as total expenditure is a combination of both the revenue and capital expenditure, share of revenue expenditure is considerably high to total expenditure. Therefore, the flypaper effect is observed for both revenue and total expenditure, but not in the case of capital expenditure for the entire period.

Two-stage Least Squares Regression Results

The results of 2SLS method have drawn the same conclusion as panel regression results (Table 3). The asymmetry effect is validated for Models (1), (2) and (3), whereas the flypaper effect is found for both total and revenue expenditure except capital expenditure account. The results are found to be robust since the panel least squares and 2SLS provide similar results.

Results of Pre- and Post-reform Periods

Panel Regression Results

As in the previous section, the three models where expenditure (i.e., PTX, PRX and PCX) is regressed on state domestic product (PY), grants (PTG) and dummy (PDTG). In order to understand the flypaper effect in pre- and post-reform period, the study has divided the entire data period (1980–1981 to 2009–2010) into two sub-periods, namely pre-reform (1980–1981 to 1990–1991) and post-reform (1991–1992 to 2009–2010). The results of panel data model for pre- and post-reform period are given in Table 4.

From the above equations, it is found that there is an absence of flypaper effect for Models (1) and (2) in case of the pre-reform period. By contrast, the results confirm the flypaper effect for Model (3) where capital expenditure as a dependent variable. The cut in grants (PDTG) does not reduce the expenditures of both the total and revenue expenditure which continue to increase due to fiscal replacement form of asymmetry. However, the coefficient with respect to PDTG is insignificant in the case of capital expenditure; when grants fall, it does not have any significant effect on the subnational government to maintain the expenditure of the capital account. In other words, response of capital expenditure is symmetrical to fall in grants as the coefficient with respect to dummy variable is not significant. However, in the case of post-reform period, flypaper effect is present for both the models (1) and (2) but not at

Table 3. Non-dynamic Estimates of Two-stage Least Squares regression (2SLS) Results (1980–1981 to 2009–2010)

Parameter	Estimated Coefficient		
	Model 1 (PTX)	Model 2 (PRX)	Model 3 (PCX)
μ_1	−0.2794 (0.46)	0.1923 (0.51)	−4.585* (0.56)
ϕ_1	0.3535* (0.05)	0.2349* (0.06)	0.7893* (0.07)
ϕ_2	0.8436* (0.02)	0.9289* (0.03)	0.5460* (0.03)
ϕ_3	−0.8008* (0.10)	−0.9118* (0.11)	−0.4152* (0.12)
R^2	0.8836	0.8583	0.8760
F	11.00 [0.00]	11.83 [0.00]	5.60 [0.00]

Source: Author's own findings.

Notes: Figures in (#) and [#] are standard errors and *p*-values; * denotes significance at 5% level.

Table 4. Non-dynamic Linear Panel Data Regression Estimates

Parameter	Estimated Coefficient of Pre-reform Period (1980–1981 to 1990–1991)			Estimated Coefficient of Post-reform Period (1991–1992 to 2009–2010)		
	Model 1 (PTX)	Model 2 (PRX)	Model 3 (PCX)	Model 1 (PTX)	Model 2 (PRX)	Model 3 (PCX)
μ_1	−5.421* (1.32)	−8.257* (1.51)	0.189 (1.59)	−0.3751 (0.44)	0.1234 (0.45)	−5.000* (0.64)
ϕ_1	1.019* (0.15)	1.262* (0.17)	0.3449 (0.18)	0.5018* (0.05)	0.4290* (0.05)	0.8023* (0.08)
ϕ_2	0.5485* (0.03)	0.6024* (0.03)	0.4061* (0.03)	0.6061* (0.03)	0.6087* (0.03)	0.5929* (0.04)
ϕ_3	−0.3841* (0.09)	−0.5040* (0.10)	−0.0945 (0.11)	−0.8691* (0.12)	−0.8718* (0.13)	−0.8012* (0.18)
R^2	0.83	0.79	0.51	0.816	0.770	0.799
F	14.3 [0.00]	16.7 [0.00]	18.5 [0.00]	7.22 [0.00]	8.69 [0.00]	4.15 [0.00]

Source: Author's own findings.

Notes: Figures in (#) and [#] are standard errors and *p*-values; * denotes significance at 5% level.

Model (3) where capital expenditure is a dependent variable. The responses of all expenditure are found to be asymmetry with the decrease in grants in the post-reform period. It indicates that expenditure of capital account continues to incur in spite of cut in grants.

The reasons behind the absence of flypaper effect in total and revenue expenditure in the pre-reform period but the present in the post-reform period are: increase in ratio of grants to total, revenue and capital expenditure during 1980–1981 to 1989–1990 is 16, 11 and 21 per cent, respectively. Whereas increase in ratio of grants to total, revenue and capital expenditure during 1991–1992 to 2009–2010 is

11, 10 and 3 per cent, respectively. It is observed that the percentage increase in ratio of grants to total and revenue expenditure in the pre-reform period is lesser than capital expenditure and vice versa. Thus, flypaper effect is absent in the case of total and revenue expenditure in pre-reform period but not in capital expenditure. However, flypaper effect is vindicated in the case of total and revenue expenditure except capital expenditure in the post-reform period. It is concluded that flypaper effect is observed whenever the ratio of grants to expenditure is high and vice versa.

Two-stage Least Squares Results

The above-specified models have estimated using 2SLS method for pre- and post-reform period in order to account for endogeneity in the grant variable. The results of 2SLS regression method for pre- and post-reform period are depicted in Table 5.

Models (1) and (2) give similar results as panel regression model in pre-reform period, that is, there is no flypaper effect on revenue and total expenditure. Thus, an increase in grants does not have a greater stimulatory effect on revenue and total expenditure. Similarly, asymmetry effects are found in both model. However, in the Model (3), flypaper effect is confirmed for capital expenditure. As per the results of panel data regression in pre-reform period, coefficient of PDTG is also insignificant for Model (3), which indicates that when grants fall, it does not have any significant effect on the subnational government to maintain the expenditure of the capital account.

Like panel regression results, the same results are found in case of 2SLS method in the post-reform period. Panel data regression results indicated the presence of the flypaper effect when total and revenue expenditure is used. However, there was no flypaper effect with respect to capital expenditure. Similarly, the asymmetry effect is present in total and revenue expenditure but not in the case of a capital expenditure account.

Panel Threshold Regression Model

The existence of a possible threshold effect in the grants variable is tested using Hansen (1999) methodology. Using data for the entire sample period from 1980–1981 to 2009–2010, this study estimated

Table 5. Non-dynamic Estimates of Two-stage Least Squares Regression (2SLS) Results

Parameter	Estimated Coefficient of Pre-reform Period (1980–1981 to 1990–1991)			Estimated Coefficient of Post-reform Period (1991–1992 to 2009–2010)		
	Model 1 (PTX)	Model 2 (PRX)	Model 3 (PCX)	Model 1 (PTX)	Model 2 (PRX)	Model 3 (PCX)
μ_1	0.2362 0.46	0.8025 0.48	−4.691* 0.68	−3.811* (1.54)	−6.326* (1.72)	1.351 (1.78)
ϕ_1	0.6297* (0.03)	0.6327* (0.04)	0.6131* (0.05)	0.5772* (0.04)	0.6352* (0.04)	0.4270* (0.05)
ϕ_2	0.4290* (0.06)	0.3495* (0.06)	0.7607* (0.09)	0.8365* (0.17)	1.044* (0.19)	0.2130 (0.20)
ϕ_3	−0.8152* (0.12)	−0.8084* (0.13)	−0.7869* (0.18)	−0.3854* (0.09)	−0.5061* (0.10)	−0.0919 (0.11)
R^2	0.782	0.728	0.785	0.810	0.791	0.377
F	7.81 [0.00]	9.49 [0.00]	3.93 [0.00]	11.33 [0.00]	13.87 [0.00]	17.62 [0.00]

Source: Author's own findings

Notes: Figures in (#) and [#] are standard errors and p -values; * denotes significance at 5% level.

a double threshold model with total expenditure (PTX) as the dependent variable. As mentioned earlier, the per capita state domestic product (PY) is taken as threshold variable. Accordingly, states were classified into three: lower-income states which have per capita domestic product below first threshold value; middle-income states which have a per capita income first and second threshold; and finally higher-income states which have a per capita income greater than the second threshold value. The estimations are derived using the code written by Hansen for the statistical software package R.

Test of Threshold Effect Results

The panel threshold regression model warrants a test for the existence of threshold relationship. Therefore, the null hypothesis of one threshold against the alternative hypothesis of two thresholds is tested. The results are shown in Table 6.

The results indicate that there exist two thresholds in the per capita income variable. The F -statistics rejects the null of one threshold against the alternative two thresholds at the 5 per cent level of significance. Figure 1 provides the confidence interval construction in double threshold model.

Panel Threshold Regression Results

The panel threshold model explained in Equation (7) is estimated using per capita state domestic product for state i at time t as the threshold variable. The results are presented in Table 7.

$$\ln PTX_{it} = \mu_i + \theta_1 \ln PY_{it} + \beta_1 PTG_{it} I(Q_{it} \leq \gamma_1) + \beta_2 PTG_{it} I(\gamma_1 < Q_{it} \leq \gamma_2) + \beta_3 PTG_{it} I(\gamma_2 < Q_{it}) + e_{it}$$

Table 7 indicates that the two thresholds identified for logarithm of total income per capita are given as $\gamma_1 = 9.038$ and $\gamma_2 = 10.560$. Accordingly, states have been classified into three, namely the lower-income states that have income (Logarithm) less than 9.038; middle-income states that have income between 9.038 and 10.560; and higher-income states that have income greater than 10.560. The estimates from the threshold regression model indicate the presence of the flypaper effect as the elasticity coefficient with respect to grant variable is significant and higher than the income elasticity for all the three groups

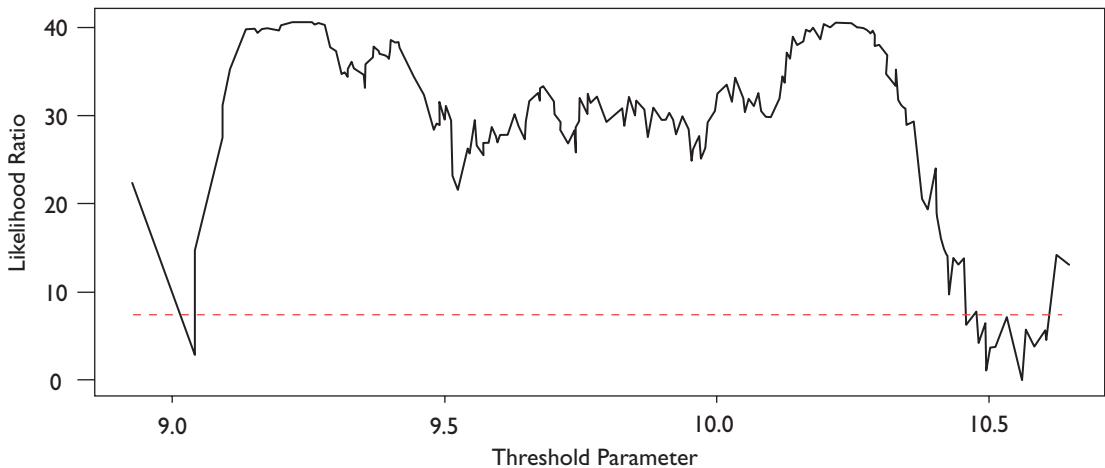


Figure 1. Confidence Interval Construction in Double Threshold Model

Source: Author's own findings.

Table 6. Test for Threshold Effects

<i>Test for Double Threshold</i>	
F-statistics	73.627
p-Value	0.01
(10%, 5%, 1% critical value)	(32.17), (48.08), (71.39)

Source: Author's own findings.

Table 7. Estimates of Panel Threshold Regression Model

Parameter	Estimated Coefficient
ϕ_1	0.728* (0.025)
β_1	0.954* (0.072)
β_2	0.850* (0.065)
β_3	0.806* (0.0638)
γ_1	9.038
γ_2	10.560

Source: Author's own findings.

Notes: Numbers in parentheses are standard errors; *denotes significance at 5% level.

of states. Similarly, the income elasticity is found to be positive and significant. The results also indicate that the flypaper effect is higher for lower-income states, that is, states below the first threshold value. The flypaper effect becomes lesser as the per capita income of states increases.

It is probably due to lower-income states depends more on grants due to very low capacity to collect their own revenues in terms of low tax base and high marginal propensity to consume than the middle- and higher-income states. Therefore, stronger flypaper effect is observed for lower-income states than the middle- and higher-income states. In this regard, Rao and Srivastava (2014) investigated dependence of states on central transfer for Indian states. Their finding indicates that the share of total grants varies the range from 4 to 18 per cent for higher-income states, from 7 to 20 per cent for middle-income states and from 13 to 26 per cent for higher-income states. The coefficient of grants for higher-income states, that is, state that has income above the second threshold, is the least among the three. The estimates of threshold regression provide evidence for threshold effect in the income variable and the lower-income states to exhibit a strong flypaper effect.

Summary and Policy Conclusions

The traditional theories of the public finance literature postulate that grants from the centre and an equivalent increase in disposable income of the citizen have an identical effect on the state government expenditure. Empirical evidence, however, indicates that expenditure of the state government from unconditional grants has greater stimulatory effects than that of an equivalent increase in the income of the individuals which is known as a flypaper effect in the literature. The present study examined the

effect of intergovernmental grants on state government expenditure in the Indian context. The empirical analysis is carried out using panel data collected from 14 states for a period from 1980–1981 to 2009–2010. The integration properties of the variables are tested using conventional panel unit root tests. The estimation was carried out using panel least squares and 2SLS methodology. There is a strong vindication of flypaper effect in total and revenue expenditure except capital expenditure. The response of expenditure is asymmetric to a change (decrease) in grant variables; when grants fall, it does not affect the expenditure it continues to increase. The results are found to be robust as panel least squares, and 2SLS estimates give similar inference regarding the flypaper effect. Again, in order to examine the flypaper effect in pre- and post-reform period, the study was divided the entire data period (1980–1981 to 2009–2010) into two data periods, namely pre-reform (1980–1981 to 1990–1991) and post-reform (1991–1992 to 2009–2010). The results documented that there is an absence of flypaper effect in total expenditure and revenue expenditure in the pre-reform period except capital expenditure. However, in the post-reform period, there is a presence of flypaper effect in total and revenue expenditure but not in capital expenditure. Thus, there is a considerable shift in the relationship between grants and expenditure since the liberalization era.

The responses of all the expenditure accounts are found to be asymmetric in the post-reform period. It implies that when grants are reduced, it does not affect the expenditure of the state government which continues to increase; state governments increase their own tax revenue to maintain the present level of expenditure of government. However, in case of pre-reform period, when grants fall, it does not have any significant effect on the sub-national government to maintain the expenditure with regard to capital account.

Similarly, in order to test the possible threshold effect of per capita grants on per capita state expenditure, a panel threshold regression is employed. The test for threshold effect in the total grants indicates the presence of two thresholds in the per capita state domestic product as threshold variables. The results of threshold regression indicate that the lower-income states' grants have a stronger flypaper effect than middle- and higher-income states as classified by the threshold variable.

From the previous results, we have concluded that the effect of intergovernmental grants has a stimulatory effect on state government expenditure. It appears that additional money tends to remain in the sector into which it is given (i.e., flypaper effect). The results of the present study contradict to the traditional theory of grants and expenditure. Thus, redesigning the intergovernmental transfers and effective allocation of grants to specific purposes by the central government would enhance effectiveness of public expenditure and can be used as a tool to implement welfare schemes. In this regard, Chaudhuri (2001) argued that Orissa has been experiencing persistent deterioration of fiscal balances in revenue expenditure in spite of continuous budgetary support to the inefficient and loss-making PSUs. It is because of growing dependence on central transfers in terms of grants-in-aid and the state's share in central taxes, and fails to generate additional revenue from its own sources. Therefore, the alternative investment of the released funds can be made by diverting fund from budget outflow to social and community services in order to reduce fiscal deficit. Again, the asymmetry behaviour of grant variable indicates that when there is a decrease in grants, state government put more effort to increase their tax revenue in order to maintain the same level of expenditure of the government. It implies that when there is an increase in grants, the effort of tax collection capacity has been reduced by the state government. It is because of either excessive expenditure assignment to state government or inadequate revenue assignment, and the both. The results from the threshold regression indicate that the lower-income states' grants have a stronger flypaper effect than middle- and higher-income states. It is probably due to lower-income states depends more on grants due to very low capacity to collect their own revenues in terms of low tax base. Therefore, there is a need for state government to put more effort to make use of their tax base at fullest.

Directions for Further Research

Further research can be investigated by taking the data from more states. Considering the important role played by *Panchayati Raj Institutions* in the provision of public goods, empirical examination of flypaper effect using data from these institutions would give useful insights for policymakers. Similarly, separate study can be conducted using time series data as the states exhibit considerable heterogeneity on various accounts.

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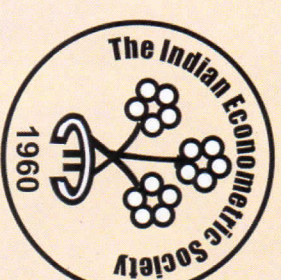
Notes

1. We used 2SLS method for following reasons: The OLS estimates of Equations (4)–(6) may be biased due to the endogenous nature of the grant variable (Gamkhar & Oates, 1996; Stine, 1994). In order to account for this simultaneous equation bias, we have estimated the above equations using the 2SLS method.
2. In order to assess the non-linear effect of per capita grants on per capita state expenditure, this study has estimated a threshold regression following the methodology of Hansen (1999). The non-linear nature of this relationship is very important to understand for determining an effective policy in addressing the issues of intergovernmental grants and its influence on state government spending. The non-linear effect of grants on government spending over the Indian data gives a supplementary insight of the existing studies of flypaper effect and might put some new directions to economists and policy makers.

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