DYNAMICS OF FOOD PRICES IN MAJOR CITIES OF PAKISTAN

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ABSTRACT

This research studies the dynamics of food prices for fifteen commodities in fourteen major cities of Pakistan. The dynamics of food prices are evaluated by estimating the components of inflation such as the frequency of price change, the duration of price change, the average size of price change, the direction (increase or decrease) of price change, the synchronization of price change and also by assessing the volatility of food prices. The results illuminates that the frequency of price change is high in big metropolitan cities for most of the commodities and there is a synchronized price change across cities especially in tea and tomato prices. Moreover, the volatility results shows that the prices of beef, chicken, egg, sugar and all vegetables are highly volatile as compare to other food commodities.

Furthermore, the research also explains the factors of food prices in Pakistan. The findings exhibit that there is a negative and significant impact of real effective exchange rate on wheat prices in long run. Similarly, real interest rate inversely affects wheat and rice prices while has direct impact on tea prices. There is a positive and significant impact of international crude oil prices and international food prices on most of the food commodities. Moreover, the study explains that in long run, the increase in local production significantly reduce the prices of food commodities. It is also attributed that government policy of adjusting (increasing) wheat support prices also has a positive and significant impact on wheat prices.

PREFACE

High and volatile food prices are great matter of concern as high growth rate in food prices directly impact the welfare of consumers, while, volatility harms both producers as well as consumers. Unlike inflated food prices, volatility measures the risk factor associated with the production and supply of food commodities. Increase in volatility, raise the uncertainty and can creates production shortage. It is important to identify the dynamics of food prices and the factors behind the changes in food prices to help the policy makers in designing such policies to control the high food prices as well as to stabilize them.

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LIST OF ABBREVIATIONS

IFPRI	International Food Policy Research Institute
CPI	Consumer Price Index
ADB	Asian Development Bank
RIR	Real Interest Rate
REER	Real Effective Exchange Rate
IP	Input Price
SP	Support Price (Wheat)
TLP	Total Local Production
PC	Political Condition
ARCH	Autoregressive Conditional Heteroscedasticity
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
IGARCH	Integrated Generalized Autoregressive Conditional Heteroscedasticity
ARDL Model	Autoregressive Distributed Lag Model

INTRODUCTION

With globalization, countries of the world integrated economically, and interdependency of developed as well as developing nations, on various commodities, have increased. It is evident that during the past two decades, the commodity prices exhibited upsurge and volatile behaviour globally. International food prices were almost doubled in the year 2007-08; which is evident by the Food and Agriculture Organization Index - the food price increased up to 27 per cent. It is observed that there was a massive increase in the prices of some important food commodities, for instance, the prices of rice and wheat were raised by 76 and 121 per cent, respectively. Further, dairy products prices and maize prices were also went up by 90 per cent and 80 per cent in a respective manner. Headey in 2014 termed this massive upsurge in food prices as "International Food Crisis". The crisis has affected about 49 developing countries.

Like other developing countries Pakistan was also affected by international food price crisis. In 2008-09, food inflation broke the record of last 23 years as it inflated to 23.13 percent compared to 17.65 per cent in 2007. Between 2005 and 2008, wheat price was upraised by 106 percent; whereas, the variation in price of other staple food commodities was remained in the range of 20 to 120 per cent. Beside high global food prices there were also some domestic reasons behind the inflated wheat price for instance, regional smuggling and hoarding of wheat was one of the reason. To combat hoarding and smuggling of wheat, Pakistan Government had elevated wheat procurement price. According to Ministry of Finance 2008-09; due to this act the local wheat price was increased more than the international price of wheat. These elevated wheat prices also accelerated the prices of vegetables, meat, oil and milk [Awan, et.al. (2015)]. Further, in 2010 and 2011, Pakistan faced a challenge of heavy floods as well as rains, respectively, which reduced wheat production that further exaggerated not only the price of wheat but also increase the prices of some perishable goods. In 2012 the local food prices were also inflated because of the extraordinary upsurge in the global prices of wheat, soybean and corn. However, in 2014-15 (July-April), there was a decrease in food inflation due to the decline in the prices of several food commodities, particularly the prices of potatoes; wheat, eggs and rice etc. were declined. Further the decline in food inflation was also because of the reduction in oil (fuel) prices. Once again, in 2016, food price inflation shown a rising trend as the prices of, sugar, wheat, pulse (*mash)* and meat, increased by 3.9, 2.6, 8.5 and 1.3 percent, respectively. In the year 2018-19 global food inflation was not increase too much that further decrease the inflationary pressure and Pakistan's food inflation was recorded only 1.8 percent. This reduction in food inflation further reduced the overall inflation in Pakistan [(Economic Survey of Pakistan (2018-19)].

In 2020 Food inflation increased to 10.4 percent due to supply disruption, seasonal change, and increase in transportation cost further more reliance on imported items due to Covid 19 was also one of the reason. In April 2021 food inflation increased to 15.7% due to the massive increase in chicken, tomatoes, eggs, milk, sugar and wheat prices. However, the prices of onion, pulse moong and pulse masoor were reduced. This up and down movement in food prices is an evidence of its volatile nature, thus uncertainty in the food prices. It is worth mentioning here that high food prices and volatility are considered as two important concepts of food price dynamics. On one hand, high growth rate in food prices directly impact the welfare of consumers, while, volatility detriments both producers as well as consumers. Unlike inflated food prices, volatility measures the risk factor associated with the production and supply of food commodities. Increase in volatility, raise the uncertainty and can creates production shortage. Literature identified that there are different factors that cause change in food prices. Economists for instance Abbot *et al.* (2009), Mitchell (2008), Cooke and Robles (2009), Gilbert and Morgan (2010) and Ismail et al (2017), have also explained some of the factors that affect food prices, for instance, low investment in agriculture sector along with low levels of commodity inventory, variations in the oil prices, global money supply, and change in the value of the dollar. Among others, Salman et al (2013); Awan and Imran (2015) highlighted that input prices, money supply, foreign aid, exchange rate and transportation cost played an adverse role in increasing food prices in Pakistan. Realizing the importance of the issue the present research is planned to investigate the individual price dynamics using the micro-data of fifteen major food commodities; Beef, Chicken, Rice, Wheat, Pulse Mash, Pulse Moong, Pulse Masoor, Tomato, Potato, Garlic, Onion, Sugar, Tea, Milk and Eggs. The study also assesses the volatility in their monthly price series for the period of July 2002 to July 2021. Therefore, dynamics of food prices are gauged by estimating not only the components of inflation but also volatility of food prices. Further, it also investigates the key factors of food prices. The foremost objectives of the study are as follows:

- To evaluate the dynamics of food prices at city and commodity level for the time period 2002 to 2021. For this purpose the study analyses the indicators, such as the frequency of price change, the duration of price change, the average size of price change, and the direction (increase or decrease) of price change. The study also observes the synchronization of price change among the said cities of Pakistan.
- To assess the conditional volatility in monthly prices of above food commodities. The food price volatility is assessed by using Autoregressive Conditional Heteroscedasticity (ARCH)/Generalized ARCH (GARCH) and Integrated GARCH (IGARCH) models.
- To observe the impact of various exogenous and endogenous covariates on food prices over the years.

The stylized facts of food prices computed in the research help us in understanding the dynamic features of food prices. Furthermore, the study helps to identify the real sources of changes in food prices that create variation in food prices and also food inflation. The study clears the role of each factor (used in the study) in food price change. The study will help the policy makers to design such policies to control the variation and increase in food prices.

Following introduction in section 1, the paper is organized as follows: section 2 provide a brief literature regarding the issue, section 3 details the conceptual framework of this research, section 4 explains the data sources and factors of food prices, section 5 describes the methodology of each objective, section 6 provides findings and discussion of the research, section 7 gives the conclusion and policy implication.

LITERATURE REVIEW

There is sufficiently large international and national literature exists, regarding the drivers of inflated food prices and its volatile nature. However, this section endeavoured a brief review of the selected research studies. The literature is distributed under two headings, the first one discusses the literature regarding volatility and the second one is about the covariates of exaggerated food prices both internationally and at Pakistan level.

2.1 Literature Based on Food Price Volatility

This section explains a concise review of the research available on food price volatility at national and international level. After the international crisis of food prices in 2007-08 the literature get more extensive. In this respect, in 2007, Jordaan et al determined that the daily prices of soybean and wheat are not volatile, while the daily prices of other crops for instance, white and yellow maize and sunflower are volatile. Similarly in 2011, Apergis and Rezitis analysed the monthly price data of food prices, for the period 1985 to 2007. They concluded that the relative prices of food in Greece are volatile and have greater uncertainty about the prices in future that further have depraved impact on consumers and producers both. Further in 2013, Sukati also worked on the identification of volatility in maize monthly prices for Swaziland. Considering the monthly data from February 1998 to September 2013, it is elaborated that volatility in maize prices was not persistent but strongly affected by market dynamics.

Minot in 2014 determined the volatility in the prices of staple food for the period January 1980 till March 2011. The author asserted that the high volatility in international food prices during 2007 to 2010 didn't accelerate volatility in African prices of staple food. The author also stated that the volatility in tradable food products is smaller than the volatility in non-tradable food products especially for the main cities. Additionally, in 2014 Kelkay and Yohannes found that in Ethiopia during December 2011 to June 2012, volatility in the prices of pea and beans has spill over effects from one time period to another. Balanay (2015) identified that in Philippine, there was a short term time varying volatility in the prices of duck eggs for the period 1990 to 2009. Further, the author recommended that as the market of duck eggs is highly uncertain, there is a need of regular monitoring to cure the market from threats in future. In another study, Kuhe (2019) utilized monthly time series data on Commodity Food Price Index from January 1991 to January 2017 and found that price volatility is quite persistence and mean reverting, indicating that past volatility was important in forecasting future volatility.

Further in Pakistan Zehra and Fatima (2020) assessed the volatility in sixteen food commodities for the monthly data of 2002 to 2016 for fourteen cities. It is asserted that in most of the commodities (for various cities) the volatility is because of the existence of the past variance and residual effects. However, in few commodities (for different cities) the volatility is only due to residual effects. The study also found that there exists heterogeneity among cities with difference in the intensity of volatility.

2.2 Literature Based on Factors Affecting Food Prices

This part of the literature is based on a brief review of the studies that focussed on the main drivers of variation in food prices.

In this regard Schimmelpfennig and Khan (2006) underlined the relative significance of monetary and some supply side factors of inflated prices in Pakistan. They explained a stylized model of inflation that contains some monetary factors like money supply, credit to the private sector, exchange rate, further as a supply side factor wheat support price was included for Pakistan for period January 1998 to June 2005. The model was assessed on monthly basis. It is identified that role of monetary factors in current inflation is very prominent by affecting inflation with one year lag. However, the variation in support price of wheat has only short term impact on inflation. While, support price of wheat is handled by monetary policy then over medium term it also affect inflation. Another study of Frankel (2006) analyzed US data for the period 1950-2005. The research determined an inverse relationship between real interest rate and commodity and mineral prices. It is explained that the increase in interest rate lower the desire to hold commodity inventories and accelerate the supply of storable commodities which further reduce the prices. Loening et al (2009) analysed the impact of external, monetary and agricultural sector on cereal inflation in Ethopia for the period January 1999 to November 2008. The main finding of the research is that there was significant impact of lagged growth of money supply on cereal inflation in short run while, insignificant in long run. However, there is an existence of significant impact of external sector (world food prices in terms of local currency) and gap in agricultural output on cereal prices in the long run. The research highlighted that drought has impermanent impact on cereal prices, while international fertilizer and energy price inflation have no impact on cereal prices. Ahsan et al (2011) analysed that per capita income, agriculture output, agricultural subsidies, money supply, and world food prices are the key determinants of food prices in Pakistan. An important conclusion of the paper is that the most significant variable which affects food prices in the long run as well as in the short run is money supply. While international food prices are affecting food prices only in the long run, that increases the domestic price in a country. It is also concluded that subsidies help in reducing food prices in the long run but the impact of subsidy is very small. Another study of Joiya and Shahzad (2013) identified the determinants of high food prices in Pakistan. The time series data for the period 1972-73 to 2009-10 has been used. The results indicated that both in short run and in long run GDP, food export, food import and total credit to agriculture sector have significant impact on food prices. GDP and food export have been a contributor towards high food prices while food imports and credit to agriculture sector reduced the food prices. Further, an extensive research work has been done by IFPRI for examining instability in food prices and its effect on food safety, security and policy. The book was edited by Matthias Kalkuhl, Joachim von Braun, and Maximo Torero (2016). One of the most related chapter, of the study investigated the main drivers of food price spikes and volatility for wheat, maize, and soybeans. The analysis has indicated that exogenous shocks as well as the linkages between food, energy, and financial markets play a significant role in explaining food price volatility and price spikes.

Furthermore, Nwoko et al (2016) studied not only the long run and short run linkages among oil price and food price volatility but also examined the causal relationship between them. The study analysed the yearly data of food price volatility index and crude oil for the period 2000 to 2013. The research revealed a long run relationship among food price volatility and oil price. Similarly the study identified a positive and significant short term linkage among food price volatility and oil price. However, it is found that there was a unidirectional causality from oil prices to volatility in food prices.

Moreover, in 2017 Ismail, et al. investigated the monthly data from April 1983 to April 2013 of rice, wheat, tea, beef, lamb poultry, sunflower oil, rape seed oil soybean oil, sugar, cotton, urea and crude oil prices for Pakistan. The authors examined the factors that influenced the volatility of selected food and agricultural commodities. The research identified that poultry and beef prices are affected by interest rate, while price of wheat are affected by exchange rate; however, rice and sugar prices are influenced by urea prices further the volatility in wheat prices is affected by volatility in crude oil prices. However, Sekhar et al. (2017) in IFPRI research papers categorised the food commodities into high and low volatility groups further, the study also identified the drivers of food inflation in India by analysing the annual data of commodity prices and other variables for the period January 2005 to July 2015. It is concluded that most of the vegetables, fruits and pulse Moong are categorized in to high volatility group while, Rice, meat, fish egg, milk and pulse Masoor are fall in low volatility group. Further, the study revealed that both the supply as well as demand side factors are key drivers of food inflation in India. However, the prices of edible oil and Cereal seemed to be principally determined by supply side factors for instance minimum support prices, wage rates and production. While, the prices of milk, eggs, fish, meat vegetables and fruits seemed to be influenced mainly by demand side factors. Though, the impacts of demand and supply side factors seemed to be almost same for pulses.

Norazman et al (2018) after the analyses of monthly data from 1991 to 2013 for Malaysia found that real effective exchange rate (decrease in real effective exchange rate) and international food commodity prices are the primary factors to accelerate food prices in Malaysia. Additionally the study also reported that oil prices directly contributed to surge food price inflation in the long term and may have indirect impact on Malaysian food prices via its effect on international food commodity prices. While Labour costs appeared to have minimum effect on food price inflation in short term as well as in long term.

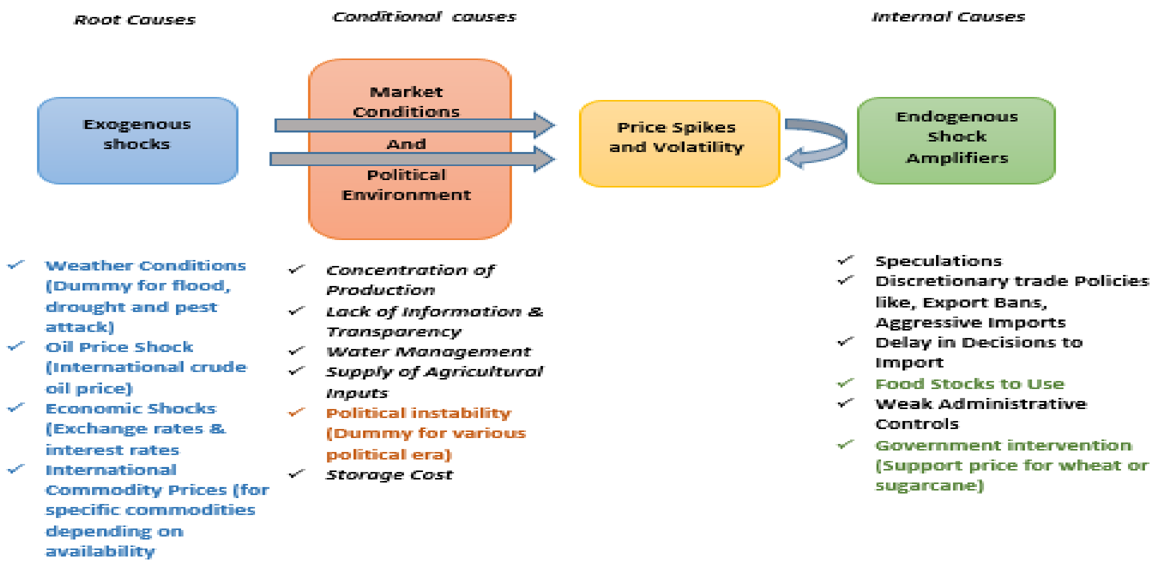
Additionally, for Iran Radmehr et al (2020) examined the short and long term influence of oil prices (petroleum prices) and exchange rate (value of Iranian currency per US dollar) on food prices. Authors analysed the monthly prices data of ten food commodities for the time period March 1995 to February 2018. It was revealed that in both short term and long term food prices increased due to an upsurge in energy prices. While, in long run the appreciation in the US dollar with respect to Iranian Rial exerted a positive and significant influence on food prices.

The review exhibits that in the literature there is a gap regarding the identification of dynamics of food prices at city level. The cities are different by means of physical structure and population that makes the difference in demand and supply for staple food. The proposed study will lengthen the literature by identifying the dynamics of food prices at commodity-city level and by investigating the main drivers of food prices for the given period. The conceptual framework of the study is given below.

CONCEPTUAL FRAMEWORK

To determine the main drivers of food prices the study adopts the concept proposed by Tadasse et al in 2016 with little modification.

Figure 1: Conceptual Framework of the Research



Source: Tadesse et al. (2016)

According to the framework given in Figure 1 the determinants of food prices are divided in to three groups: 1. exogenous shocks, 2. Market Conditions and Political Environment and 3. Endogenous shocks. It is explained that exogenous factors are the root cause of price fluctuation. These include extreme weather shocks (heavy rains and floods), economic shock (change in interest rate and exchange rate), international commodity price shock and oil price shock. It is expected that these exogenous shocks are responsible to generate variability in food prices while; the extent of their influences or the saturation of their effect on native economy is partly rest on the market conditions and political situation of the certain country. Hence, the second group of factors associated to political and market conditions that can reduce or aggravate exogenous shocks. Majority of these factors like lack of transparency in water management and commodity markets are time invariant and quite hard to measure; consequently these factors are not taking into account in the empirical analysis in this research.

Factors include in the third group are endogenous shock. They are unrestricted trade policies, speculative activities determined by price expectations, weak administrative control etc. Some other country specific endogenous factors, like role of middle man, hoarding etc. are also important factors. These factors amplify the effect of other factors present in the first and second group. However, similar to the second group of factors, most of the endogenous factors are qualitative in nature and hence difficult to include in the modelling of framework.

The present study although emphases mainly on exogenous shocks as they may be the foremost root cause that stimulates the emergence of the other factors. However, some country related political, economic and other endogenous factors are also included in the empirical analysis. Detailed description of the factors impacting the prices of various commodities included in this research is described in the next section. Each factor, that influence the prices of specific commodities are selected after careful and thorough review of international and national literature.

DATA SOURCES AND FACTORS

This section provides the data sources and describes the main factors that affect food prices[1] included in the research

4.1 Data Sources

The study employed monthly data of food prices for fifteen food commodities[2] from CPI basket, namely; beef, chicken, pulses (mash, moong, masoor), rice (IRI), wheat, tomatoes, potatoes, onions, garlic, milk, eggs, sugar and tea, for 14 large cities of Pakistan. Cities included in this analysis are Bahawalpur, Faisalabad, Hyderabad, Islamabad, Karachi, Khuzdar, Lahore, Multan, Peshawar, Quetta, Rawalpindi, Sargodha, Sialkot and Sukkur. Monthly data is gathered from July 2002 to July 2021, from various issues of Monthly Statistical Bulletin published by the Pakistan Bureau of Statistics. In this way, total of about 48,090 observations are included in this study. Further, the monthly data of real effective exchange rate, interest rate, international crude oil prices[3], and international prices of food commodities (tomato, beef, chicken, milk, wheat, rice, sugar and tea) in Rupees is collected from IMF and State bank of Pakistan for the period July 2002 to April 2021. The yearly data of total production of food commodities (except garlic and tea) and wheat support price is collected from Ministry of Agriculture Pakistan and PBS respectively. Further the dummy variable is used for political Era.

4.2 Main Factors of Food Prices with Empirical Evidence

International Prices of Food Commodities

Fluctuations in international prices of food commodities employ direct as well as indirect impact on domestic prices of food commodities via international trade and also through amendment in domestic policies. Ahsan et al (2011) identified that international commodity prices affect the domestic commodity prices even if the commodity is not tradable. ADB (2008) highlighted that increases in world food prices pressurize the domestic market in the absence of imports, which cause domestic food prices to rise. Import of food commodities at higher international prices, can generate imported inflation. Therefore, the study includes the international food prices in the analyses. The correlation graphs between international and domestic food commodity prices are presented in Figure A-1 (Appendix).

[1] Description of price spells of fifteen commodities in fourteen cities is given in Box A-2 (Appendix)
[2] Selection criteria of Food Commodities and their units are given in Box A-1 and Table A-1 (Appendix)
[3] Brent Crude Oil $/(Barrel)/159L

Real Interest Rate

After international commodity prices, interest rate is another important variable that affect food prices. Frankel (2006), Calvo (2008), and Roache (2010) had found that agricultural commodity prices are affected by a small change in interest rates. Literature identified that interest rate affect food prices in two ways positively as well as negatively. As it is the cost of borrowing, a farmer pay on loan, the high interest rate discourage agricultural investment that increased the food prices. While on the other hand, interest rate is used as a policy tool to rising general price level. Ismail et al (2017) identified both positive and negative impact of interest rate on some food commodities.

Real Effective Exchange Rate

Exchange rate also has a leading role in the transmission of international goods prices to native market (Landerretche et al., 2007; Abbot et al., 2009; Zerom and Nakamura 2010). There are two ways in which exchange rate affect the food prices 1) As the currency depreciated it upsurges the prices of inputs or raw material for instance seeds, pesticides and fertilizers etc. and also increase the prices of final food commodities that are imported like pulses etc. 2) Depreciation in exchange rate also accelerated the import price of crude oil that further raise the transportation cost of agricultural commodities and finally cause an inflationary pressure on food prices. Therefore, depreciation in exchange rate causes to accelerate food prices. Further, depreciation in exchange rate or decline in REER (depreciation in the value of Rupees) is an indication that country's exports become cheap and imports become expensive, in other words the country gains its trade competitiveness that also cause inflationary pressure (Rathburn et al 2021).

Crude Oil Prices (Input Prices)

Oil price shock may influence the native food prices by several ways in food supply chain. For instance it not only affects the production of the commodity by increasing the cost of production but also influence the processing and local as well as international distribution of the commodity. It amplifies the retail price and farm gate price, as it is used to transport the commodity from the producers to buyers. It is enlightened from the literature that increase in agricultural input prices, namely fertilizer and crude oil increases the expenditures of producers, which ultimately raises the prices of agricultural outputs Herrmann (2009), Baffes (2007) and Ghani et al (2018) have found significant effect of crude oil or diesel on agricultural commodities.

Government Intervention – Support Prices

Government interventions also play a vital role to support the prices of important food commodities. Minimum Support Price incentivizes farmers to cultivate adequate crop to fulfil the local production target. It is fixed by the government at which the crop (commodity) is procured from the growers. Due to minimum support price farmers are able to get good price for their forthcoming crops to spend in the production of agricultural commodities. Hence, it is worth mentioning here that the support price of commodity is one of the most important determinant which is considered as an endogenous shock amplifier. Khan and Qasim, (1996) Sherani, Schimmelpfennig and Khan (2006) stated that wheat support price increased the inflation in Pakistan. In the model for wheat the study includes wheat support prices as a proxy of government intervention.

Political Conditions

Tadaess et al (2016) explained that various government policies, for instance, discretionary trade policies; export bans, aggressive imports, delay in decision to imports etc. have direct impact on variability in food prices. It is considered that political condition is an endogenous variable that amplify the spikes in food prices. The study includes political Era in the analyses as proxy of political condition. It is assumed that every government applies different food policies to control food inflation in their period.

RESEARCH METHODOLOGY

This section explains the different methodological approaches that are adopted for accomplishing the objectives of the study.

5.1 The Pattern of Price Adjustment over the Time

The first objective of this study is to evaluate the dynamics of food price at city and commodity level over the time period under study. The pattern of price change of each product is evaluated on the basis of various indicators. For instance, the duration of price spells, the frequency of price change, the direction of price change, the average size of price change and the degree of synchronization of price change. The methodology of each of these indicators is described below.

Price Duration and the Frequency of Price Changes

In this study, firstly, frequency of price change and duration of spells for each commodity is calculated at city level. Both these indicators are considered important in explaining the price dynamics. According to Baumgartner et al (2005) and Woodford et al. (2009) inflation has positive impact on the likelihood of price change at the commodity level. In the same Lach and Tsiddon (1992) found relatively smaller spells of commodity prices during the high inflation episodes.

Prices are considered as flexible (rigid) if they exhibit high (low) frequency of price change and thus have a smaller (longer) duration of fixed prices. This behavior (rigidity or flexibility) can be characterized by employing two interrelated methodological approaches. The first is the "Frequency Approach" and the second is the "Duration Approach". The Frequency Approach first computes the frequency of price changes and then derives an implied duration of the spells. Whereas, the Duration Approach measures the duration of price spell (the number of months in which a price remains unchanged) directly and then derives an implied frequency of price changes as the inverse of duration. Prices are considered as rigid if they show a low frequency of price change and hence a longer duration.

The frequency approach utilizes the entire possible information available in the dataset. For instance, it incorporates all the uncensored and censored spells[4] in the computation. However, both the duration and frequency approach exhibit the similar results for all the uncensored spells of the dataset.

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[4] An incomplete series or spell witnessed in a specific price trajectory is called censored spell. Spells could be noticed as truncated either on both sides of spells called as doubled censored spell or on right or left side of spell called right censored or left censored spell respectively.

The average frequency of price changes (F) are calculated as the number of non-zero price change observation as a fraction of all price observation of the selected sample. For instance, in the context of current study, the frequency of price change for a specific food product "j" sold at a particular city "k" over time period "T" would be calculated as:

$$F_{jk} = \frac{\sum_{t=2}^{T} X_{jkt}}{T_{jk}-1}$$

Where, T_{jk} is the total number of monthly price observations P_{jk} over the sample period and X_{jkt} is the binary variable indicating the price change in t.

$$X_{jkt} = \begin{cases} 1 \ if P_{jkt} \neq P_{jkt-1} \\ 0 \ otherwise \end{cases} ..$$

The aggregated frequency of price change at the product level would then be calculated by averaging over all the cities "k" for the same product category "j".

$$F_j = \frac{\sum_{k=1}^{14} F_{jk}}{\bar{K}}$$

Given the frequency of data available, we assume that price change once within a given month. The implied average and median duration of a price spell can be derived using the aggregated frequency of price change at the product level. The implied duration of price spells could be calculated as the inverse of the frequency of price changes:

$$D_j = \frac{1}{F_j}$$

According to the Duration Approach, the duration of price spells is directly computed from the price trajectories in the data. In contrast to the frequency approach, the duration approach directly deals with the issue of censoring of price spells which has a considerable influence on the result. However, if the sample does not have the censored price spells, the two approaches give the same results.

The price spell of the particular product –city (j, k) is the observed episode of the fixed price $P_{j,k,t} = P_{j,k,t-1}$, so that the end of this price spell occurs when there is a price change $P_{j,k,t} \neq P_{j,k,t-1}$. The duration of this price spell is then defined by the time interval between the two calendar dates cd ($P_{j,k,t}$) – cd ($P_{j,k,t-1}$)limiting this price spell. The length of the trajectory of this product –city is the size of the time interval that the price of this product – outlet $P_{j,k}$ was observed, i-e,

$$TL_{J,K} = cd\ (P_{j,k,t}) - cd\ (P_{j,k,t-1})$$

The computation starts by calculating the average duration of the price spell of each trajectory of each product – city (j,k) by:

$$ADT_{J,K} = \frac{TL_{J,K}}{NS_{J,K}}$$

Where, $TL_{J,K}$ is the length of the trajectory and $NS_{J,K}$ is the number of spells contained in the trajectory.

The second step is to compute the average duration of the product j by taking the simple average of the durations of the trajectories of the product- city $ADT_{J,K}$ across all cities for the same product j as follows:

$$ADC_J = \frac{\sum_{k=1}^{\bar{k}} ADT_{J,K}}{\bar{K}}$$

The direct approach entails two main advantages over the frequency approach. First, every single change in the price of product – city (j,k) is taken into account. Second, it is possible to obtain the entire distribution of price duration.

The Direction of Price Change

The total frequency of price changes is simply the sum of two components: Frequency of price increases and the frequency of price decreases. Analyzing each of these components separately is useful, particularly when they may display offsetting movements in response to aggregate shocks.

The frequency of price increase for a specific food product "j" sold at a particular city "k" over time period "T" would be calculated as:

$$F_{jk}^{\uparrow} = \frac{\sum_{t=2}^{T} X_{jkt}^{\uparrow}}{T_{jk}-1}$$

Where, T_{jk} is the total number of monthly price observations P_{jk} over the sample period and $X_{jkt}^{\uparrow}$ is the binary variable indicating the price increase in t.

$$X_{jkt}^{\uparrow} = \begin{cases} 1 \; if P_{jkt} > P_{jkt-1} \\ 0 \; otherwise \end{cases} ..$$

The average of the monthly frequency of price decreases would be computed analogously as:

$$F_{jk}^{\downarrow} = \frac{\sum_{t=2}^{T} X_{jkt}^{\downarrow}}{T_{jk}-1}$$

Where, $X_{jkt}^{\uparrow}$ is the binary variable indicating the price decrease in t.

$$X_{jkt}^{\downarrow} = \begin{cases} 1 \; if P_{jkt} < P_{jkt-1} \\ 0 \; otherwise \end{cases} ..$$

The aggregated frequency of price increases (decreases) at the product level would then be calculated by averaging over all the cities "k" for the same product category "j".

$$F_j^{\uparrow(\downarrow)} = \frac{\sum_{k=1}^{14} F_k}{\bar{K}}$$

The Average Size of Price Change

An alternative indicator of price setting behavior is the size of price change (increase or decrease). As already explained, the frequency measures is indicative of the extensive margin (how often price changes), whereas, size of price change captures the intensive margin behind inflation (Klenow and Malin, 2010).

The average size of price increase or decrease at the product-city level would be calculated by the following formulas respectively:

$$\bar{\partial}_{jk}^{\uparrow} = \frac{\sum_{t=2}^{T} X_{jkt}^{\uparrow}(lnP_{jkt} - lnP_{jkt-1})}{\sum_{t=2}^{T} X_{jkt}^{\uparrow}}$$

$$\bar{\partial}_{jk}^{\downarrow} = \frac{\sum_{t=2}^{T} X_{jkt}^{\downarrow}(lnP_{jkt-1} - lnP_{jkt})}{\sum_{t=2}^{T} X_{jkt}^{\downarrow}}$$

5.2 Degree of Synchronization across Cities

The synchronization of price changes across cities would be computed by the approach proposed by Fisher and Konieczny (2000) known as "Synchronization Ratio". The synchronization ratio is based on the monthly frequency of price changes.

Perfect synchronization of price changes occurs when either price changes simultaneously in all the cities of the country or price remains unchanged in all the cities. Hence in this case, the proportion of price changes at time t is either equal to 1 or to 0. If the average frequency of price changes for product category j is equal to F_j, it means, in the case of perfect synchronization that price changes in all the cities simultaneously in F_j percent of cases. Using the probability of price changes, it is then possible to compute the theoretical value of standard deviation of the proportion of price changes over time in case of perfect synchronization, which is equal to as follows:

$$SD_j^{max} = \sqrt{F_j\,(1 - F_j)}$$

This theoretical value is an upper limit for the standard deviation of the proportion of price changes. Similarly, in the case of perfect staggering, a constant proportion F_j cities, reported a price change each month and the standard deviation of the proportion of price changes over time is equal to 0. The observed standard deviation of price changes for product category j is given by:

$$SD_j = \sqrt{\frac{1}{T-1}\sum_{t=2}^{T}(F_{jt} - F_j)^2}$$

Where, T is the number of months for which prices are observed.

The synchronization ratio of product classification j is defined as the ratio of observed standard deviation to the theoretical maximum standard deviation of price changes.

$$SR_J = \frac{SD_J}{SD_j^{max}}$$

The synchronization ratio would be equal to 1, in the case of perfect synchronization. While, in the case of perfect staggering (complete absence of synchronization) it would be equal to zero.

5.3 Volatility Assessment in Food Prices

To accomplish the second objective of this research, two methods are used. One is standard deviation and second is ARCH/GARCH and IGARCH Models.

Standard Deviation

In this method, the standard deviation of log return prices (growth rates) is measured to identify the periods of high and low volatility for each food commodity. The categorization is based on the median value of standard deviation for the years. The years in which the standard deviation is above or equal to the median value are called high volatile periods represented by “1” while, the years in which standard deviation value is below the median value are called low volatile periods represented by “0”. Further, the method also helps to identify the commodities with high and low volatility. The categorization is based on the median value of standard deviation for the commodities. Over the period (July 2002- July 2021) the commodities with standard deviation more than or equal to the median value are referred as highly volatile commodities and are represented by “1”. While, others are less volatile and are represented by “0”. The method assumes constant variance of error terms.

ARCH/ GARCH Model

On the bases of literature, to assess the volatility in food prices for Pakistan, this paper has also employed ARCH/ GARCH models. To model the time series data it is supposed that the residual has constant variance (homoscedasticity). But actually the variance of residual is not constant and heteroskedastisity arise in various time series data. This pointed out that the assumption of homoskedasticity in the residual variance is not valid. Engle (1982) presented the Autoregressive Conditional Heteroskedasticity (ARCH) Models, used to analyse the time series data with the presence of heteroskedasticity.

The equation for ARCH (p) model to determine the variance is given below:

$$\delta_t^2 = \gamma + \sum_{m=1}^{p} \alpha_m \ \varepsilon_{t-m}^2 \qquad 1$$

Where

δ^2_t is the error term’s conditional variance

ε^2_{t-m} is squared error term of preceding period

α_ms are ARCH parameters

In this model the error terms are considered to have a distinctive size or variance and the variance of the present error term is depend on the squares of the preceding error terms. While, the GARCH model which was introduced by Bollerslev (1986), is the extension of ARCH model, introduced by

Engle in 1982. The methodology proposed a method to estimate uncertainty if the uncertainty is serially correlated. The GARCH Model principally generalizes ARCH model into an autoregressive moving average model. Equation for GARCH model is shown below.

$$\delta_t^2 = \gamma + \sum_{m=1}^{p} \alpha_m \ \varepsilon_{t-m}^2 + \sum_{n=1}^{q} \beta_n \ \delta_{t-n}^2 \qquad 2$$

δ^2_{t-n} variances of the previous time period

β_ns GARCH parameters

$0<\alpha_m<1$, $0<\beta_n<1$, and $\alpha_m + \beta_n<1$ to fulfil GARCH conditions

The basic difference in ARCH and GARCH model is that in ARCH model, conditional variance of error term at time period t is totally based on the squared error term of the preceding time period. While, in GARCH model, the conditional variance of error term at time period t is based on both the squared error term of the earlier time period like in ARCH (p) model, and also on the conditional variance in the earlier time period. Hence, the model is termed to GARCH (p, q) model where, p are the lagged terms of the squared error terms and q are the lagged terms of conditional variances.

In GARCH model, α exhibits the impact of random deviations in the preceding period on δ_t^2, and β illuminates the impact of past variance on current variance. If the value of ARCH error parameter (α) is significant then, it is assumed that market actions significantly affect current variance. However, significant GARCH coefficient (β), points out that shocks to conditional variance depend on the presence of previous variances and it take long time to die out. Referring that, the volatility is persistent.

This study begins with the estimation of conditional volatility by using ARCH (1) and GARCH (1, 1) models. The ARCH (1) and GARCH (1, 1) conditions showing through equations 3 and 4 respectively, are appropriate as they display a parsimonious illustration of conditional variance that adequately fits for most of the high frequency time series data (Bollerslev (1987) as well as Engle (1993).

$$\delta_t^2 = \gamma + \alpha \ \varepsilon_{(t-1)}^2 \qquad 3$$

$$\delta_t^2 = \gamma + \alpha\varepsilon_{(t-1)}^2 + \beta\delta_{(t-1)}^2 \qquad 4$$

Integrated GARCH (p, q) Model

The IGARCH (p, q) model is a wider form of GARCH (p, q) model. This model has a property of "persistent variance" where the present information is remain essential for the estimate of the conditional variances in all prospects. The study uses IGARCH (1,1) model in the cases where the sum of ARCH and GARCH parameters is equal to 1.

The necessary condition for I GARCH (p, q) model is

α (1) + β (1) = 1

IGARCH (1, 1) is defined by the following equation:

$$\delta_t^2 = \gamma + \alpha\, \varepsilon_{(t-1)}^2 + \beta\delta_{(t-1)}^2 \qquad 5$$

Where $\alpha + \beta = 1$

By employing ARCH (1)/GARCH (1,1) and IGARCH (1,1) models, the study generates volatility series for the prices of each commodity for all cities. The validity to apply ARCH/GARCH and IGARCH model for the assessment of volatility is verified by ARCH-LM test. The test is used to identify the presence of heteroscedasticity in the price series of each food commodity for every city. The null hypothesis for ARCH-LM test is no ARCH effect, showing that the residuals are Homoscedastic demonstrating that volatility remains same over the period of time [Alemu, et al. (2007)]. The p-value less than 0.05 recommended the rejection of null hypothesis of no ARCH effect and accepting the alternative hypothesis of the existence of ARCH effect in the residual series. This rejection of null hypothesis permits this study to use GARCH (1,1) and IGARCH (1,1) models.

5.4 Factors Affecting Food Prices

The third objective of this research is the identification of the factors of food price change that is accomplished by the following model.

Autoregressive Distributed Lag (ARDL) Model

The empirical time series model that shows the association among the food prices of food commodities and their associated factors is as follows:

$$LP_t = \beta_0 + \beta_1 LREER_t + \beta_2 LRIR_t + \beta_3 LOP_t + \beta_3 LIP_t + \beta_3 LPD_t + \beta_3 LSP_t + \varepsilon_t \qquad 6$$

Where, LP_t is the log of price series of a particular food commodity at time t. LREER, LRIR, LOP, LIP, LPD and LSP are the log of real effective exchange rate, log of real interest rate, log of input prices (crude oil prices), log of international prices, log of production and log of support prices respectively. The above independent variables are almost same (data is not available otherwise) for each commodity. The study uses ARDL bound test by Pesaran, (2001). The model identifies the long run and short run association among the covariates and prices of each commodity. There are different cointegration approaches for instance, Engle-Granger (1987), Johansen and Juselius (1990) and Johansen (1991). ARDL is the most suitable model as it is applicable for the series with different integrating orders e.g. I (0) or I (1) (Pesaran et al. 2001) unlike other models. ARDL Model separately, for each commodity price is shown by the following equation.

$$\Delta LP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i}\Delta LP_{t-i} + \sum_{i=0}^{p} \alpha_{2i}\Delta LREER_{t-i} + \sum_{i=0}^{p} \alpha_{3i}\Delta LRIR_{t-i} + \sum_{i=0}^{p} \alpha_{4i}\Delta LOP_{t-i} + \sum_{i=0}^{p} \alpha_{5i}\Delta LIP_{t-i} + \sum_{i=0}^{p} \alpha_{6i}\Delta LPD_{t-i} + \sum_{i=0}^{p} \alpha_{7i}\Delta LSP_{t-i} + \alpha_8 LP_{t-1} + \alpha_9 LREER_{t-1} + \alpha_{10} LRIR_{t-1} + \alpha_{11} LOP_{t-1} + \alpha_{12} LIP_{t-1} + \alpha_{13} LPD_{t-1} + \alpha_{14} LSP_{t-1} + \varepsilon_t \qquad 7$$

Where, Δ and i represents the difference operator and lag length respectively. The long run relationship between the covariates (variables) is identified by the F-test of the joint significance of the coefficient of lagged variables. The null hypothesis of the model is α_8=α_9=α_{10} = α_{11}=α_{12}=α_{13} =α_{14}= 0, showing the absence of long run relationship.

In this test the variables are cointegrated, if F-statistic (calculated) is greater than the upper critical bound (UCB), While if it is less than the lower critical bound (LCB), then the series are not cointegrated. The cointegration decision would be inconclusive if the F-statistic (calculated) is between the UCB and the LCB. These critical bounds are given by Pesaran (1997). To estimate the short run association the following equation presents the error correction model separately for each commodity prices.

$$\Delta LP_t = \gamma_0 + \sum_{i=0}^{p} \gamma_{1i} \Delta LREER_{t-i} + \sum_{i=0}^{p} \gamma_{2i} \Delta LRIR_{t-i} + \sum_{i=0}^{p} \gamma_{3i} \Delta LOP_{t-i} + \sum_{i=0}^{p} \gamma_{4i} \Delta LIP_{t-i} + \sum_{i=0}^{p} \gamma_{5i} \Delta LPD_{t-i} + \sum_{i=0}^{p} \gamma_{6i} \Delta LSP_{t-i} + \phi ECT_{t-1} + \varepsilon_t \quad 8$$

The negative and significant value of the coefficient of ECT_{t-1}(ϕ) explains that the dependent variable would monotonically converge to long-run equilibrium as a result of change in their determinants.

FINDINGDS AND DISCUSSION

This section details the estimation results of the objectives covered in this research.

6.1 Result of Duration and Frequency of Price Change

Table 1 below presents the average frequency of price change and the corresponding implied duration derived from frequency approach for fifteen food products. Price rigidity computed by frequency of price change and implied duration reveals considerable variation among food products. Green bars in the table help us in visualizing and analyzing the results more easily. On average, 66.8 percent of prices changed every month during the period under study, implied the mean duration of 1.9 months of price spell.

Commodities like tomatoes, onions, potato, garlic, chicken and eggs proved to have the most flexible prices. Prices of refined sugar also shows frequent changes with the implied duration of just 1.2 months of price spell. Averaged at city level, the price of tomatoes changed most frequently (94.7%) thus implied a shorter duration of about 1 month (or even less) of price spell. Similarly, frequency of price change of farm chicken and eggs are 94.3 and 91.5 percent respectively.

Wheat flour and pulses shows relatively moderate price adjustments with implied mean duration of 1.4 to 1.6 months spells respectively.

In contrast, there exists range of other goods as well that proves relatively less flexible price behavior. Among these, the most evident food categories are fresh milk, tea, beef and rice. These commodities exhibit low frequency of price change with a mean implied duration of more than three months of price spell.

Table 1: Frequency and Implied Duration of Price Change

Commodities	Frequency (%)	Implied Duration (months)
Milk Fresh	23.5	4.3
Tea	26.7	3.7
Beef	30.8	3.3
Rice	32.5	3.1
Pulse Masoor	61.4	1.6
Pulse Mash washed	64.7	1.5
Pulse Moong Washed	67.4	1.5
Wheat flour	69.5	1.4
Garlic	83.4	1.2
Potatoes	85.0	1.2
Sugar refined	85.1	1.2
Onion	91.4	1.1
Egg Farm	91.5	1.1
Chicken Farm	94.3	1.1
Tomatoes	94.7	1.1
Total	66.8	1.9

Source: Author's Calculation

Analyzing at city level, almost similar frequency of price change is observed for all food products. Most evident fact shown in Table 2 is that in Khuzdar city price of almost all the food products under consideration changed less frequently than rest of all other cities. It is also noticed that prices of most of the commodities change more frequently in big metropolitan cities than the rest of the cities. For instance, Fresh milk that shows the least events of price change on average, reveals relatively higher frequency of price change in Islamabad, Rawalpindi, Karachi, Peshawar, Multan and Lahore. Similarly, beef shows high frequency of price change in Peshawar, Islamabad, Rawalpindi, Karachi, Multan and Lahore.

The above analysis proves that there are range of food commodities that are characterized by flexible price while several others show moderate durations of price spell. Several other studies like, Bils and Klenow (2004), Aucremanne and Dhyne (2004) provide the similar results about the existence of highly heterogonous price setting behavior among various products.

As mentioned above, the duration of price spell can also be computed directly by the Duration Approach. In the next section, we analyze the price behavior of each product by Duration Approach that also helps us in validating the above results.

Table 2: Frequency of Price Change by City

Frequency of Price change by City (%)															
Cities	Beef	Chicken	Egg	Garlic	Milk	Onion	Potatoes	Pulse Mash	Pulse Masoor	Pulse Moong	Rice	Sugar	Tea	Tomatoes	Wheat flour
Bahawalpur	25.8	95.2	90.4	79.0	20.5	87.3	73.4	60.3	50.7	59.8	19.2	77.3	27.1	93.0	86.9
Faisalabad	26.2	97.4	93.9	86.5	17.9	96.1	93.0	65.9	73.8	72.1	34.1	88.6	27.1	95.6	80.8
Hyderabad	27.5	96.1	93.9	88.6	21.8	93.4	83.4	72.9	72.1	80.3	35.8	82.5	25.3	96.9	79.5
Islamabad	43.7	98.7	97.4	82.1	35.8	96.1	94.8	55.5	54.1	63.8	24.0	87.8	29.7	98.3	76.0
Karachi	39.3	96.5	94.3	90.0	31.9	95.2	86.9	81.7	79.5	79.5	52.0	92.6	24.5	97.8	63.3
Khuzdar	22.7	78.6	78.6	76.4	14.4	86.0	74.2	55.5	54.1	49.8	34.9	75.5	21.8	86.5	48.5
Lahore	29.7	98.7	98.3	83.0	26.6	98.7	95.2	63.3	59.4	62.9	21.8	89.5	26.6	98.7	71.2
Multan	30.1	96.5	92.1	84.7	30.6	91.7	84.7	59.4	55.5	74.2	41.9	84.3	26.6	95.6	85.6
Peshawar	45.4	98.3	93.9	91.7	31.0	94.8	86.9	89.5	83.8	90.8	55.5	90.0	29.7	96.9	63.8
Quetta	25.3	94.8	88.6	82.1	17.0	85.6	82.1	86.5	72.9	86.9	31.4	88.2	26.2	94.8	42.8
Rawalpindi	43.7	98.3	96.5	79.5	35.8	96.5	92.1	63.8	58.1	66.8	26.6	93.9	30.6	98.7	79.0
Sargodha	26.6	92.1	90.8	79.9	19.7	90.4	83.0	57.2	49.3	58.5	35.4	79.9	25.8	90.0	72.5
Sialkot	24.5	96.5	86.0	82.1	13.1	83.8	87.8	47.2	46.3	46.7	16.2	77.7	25.3	91.3	72.5
Sukkur	20.1	83.0	86.0	82.1	12.7	84.3	72.5	47.6	50.2	51.5	25.8	83.0	27.1	91.3	50.2

Source: Author's Calculation

Further, Table 3 shows the estimated duration of price spells from duration approach, averaged at city level.

Table 3: Duration of Price Change

Duration of Price Change (%)	
Tomatoes	1.06
Chicken	1.07
Egg	1.10
Onion	1.10
Sugar	1.18
Potatoes	1.19
Garlic	1.20
Wheat flour	1.51
Pulse Moong	1.54
Pulse Mash	1.60
Pulse Masoor	1.69
Rice	3.45
Beef	3.46
Tea	3.77
Milk Fresh	4.80
Total	1.98

Source: Author's Calculation

Table 3 is made visualize for the reader by inserting red bars in each rows. Table 3 reveals that an average duration of price spells is 1.9 months from both the frequency approach as well as from duration approach. On comparing the results of duration approach and frequency approach, analogous pattern is found across food products. The duration of tomato prices is about 1.1 month from both approaches, which is the shortest duration found in the sample thus proves the most flexible price behavior among all the commodities in the sample. Similar to the results of frequency approach, vegetable, farm eggs and farm chicken show the flexible price behavior.

On average, fresh milk reveals the longest duration of 4.8 months of price spells. However, analyzing at city level, substantial heterogeneity in prices of fresh milk among cities exist. Table 4 reveals that the duration of price spell for milk is as low as 2.76 months in capital city Islamabad and as high as 7.9 months in Sialkot, which is famous for the milk production in Pakistan. Overall, it is observed that price changes more frequently in large cities like Islamabad, Rawalpindi, Karachi, Peshawar, Multan and Lahore, while it changes less frequently in cities like Sialkot, Sukkur and Khuzdar.

Similarly, rice, beef and tea also shows longer duration of price spells on average. However, similar to fresh milk, rice and beef shows greater heterogeneity of price duration among cities. In main cities of Punjab like, Sialkot, Bahawalpur, Lahore, Islamabad and Rawalpindi, duration of price spell is large to moderate. This shows that as Punjab is the main region of rice cultivation in Pakistan, price are relatively stable in the cities of Punjab.

Although frequency of price change and duration of price spells are important indicators in assessing the dynamics of price change across commodities and regions, however, to understand the economic impact of price change at macro level, extensive and intensive margin of inflation are even more important concepts. In this respect, frequency of price increase and decrease defines the extensive margin of inflation, while, magnitude of these increase and decrease in prices defines the intensive margin of inflation, are thus calculated in the next sections.

Table 4: Duration of Price Change by City

Duration of Price change by City (month)															
Cities	Beef	Chicken Farm	Egg Farm	Garlic	Milk Fresh	Onion	Potatoes	lse Mash wash	Pulse Masoor	e Moong Was	Rice	Sugar refined	Tea	Tomatoes	Wheat flour
Bahawalpur	3.95	1.06	1.11	1.27	4.77	1.15	1.36	1.66	1.97	1.67	5.09	1.30	3.63	1.08	1.15
Faisalabad	3.75	1.03	1.07	1.16	5.59	1.04	1.08	1.52	1.36	1.39	2.97	1.13	3.69	1.05	1.24
Hyderabad	3.63	1.04	1.07	1.13	4.67	1.07	1.20	1.37	1.39	1.24	2.76	1.21	3.95	1.03	1.26
Islamabad	2.29	1.01	1.03	1.22	2.76	1.04	1.06	1.80	1.85	1.57	4.16	1.14	3.37	1.02	1.32
Karachi	2.57	1.04	1.06	1.11	3.18	1.05	1.15	1.22	1.26	1.26	1.92	1.08	4.09	1.02	1.58
Khuzdar	4.32	1.27	1.27	1.31	6.74	1.16	1.35	1.80	1.85	2.01	2.90	1.32	4.58	1.16	2.06
Lahore	3.37	1.01	1.02	1.21	3.75	1.01	1.05	1.58	1.68	1.59	4.49	1.12	3.75	1.01	1.40
Multan	3.32	1.04	1.09	1.18	3.32	1.09	1.18	1.68	1.79	1.35	2.41	1.19	3.75	1.05	1.17
Peshawar	2.20	1.02	1.07	1.09	3.18	1.06	1.15	1.12	1.20	1.10	1.79	1.11	3.37	1.03	1.57
Quetta	4.02	1.06	1.13	1.22	5.87	1.17	1.21	1.16	1.37	1.15	3.23	1.13	3.82	1.06	2.34
Rawalpindi	2.29	1.02	1.04	1.26	2.83	1.04	1.09	1.57	1.72	1.50	3.69	1.07	3.27	1.01	1.27
Sargodha	3.69	1.09	1.10	1.25	4.98	1.11	1.21	1.73	2.01	1.71	2.83	1.25	3.88	1.11	1.38
Sialkot	4.09	1.04	1.16	1.22	7.90	1.19	1.14	2.14	2.18	2.14	6.19	1.29	3.95	1.10	1.38
Sukkur	4.98	1.21	1.16	1.22	7.63	1.19	1.38	2.10	1.99	1.94	3.88	1.21	3.69	1.10	1.99

Source: Author's Calculation

6.2 Result of the Direction of Price Change

Table 5 shows the average frequency of increase and decrease of prices. Yellow bars in both columns reveal that most of the commodities display an increase in prices followed by decrease and thus both frequencies of price increase and decrease are higher. While, other commodities exhibit higher frequency of price increase with seldom decrease in prices. Overall, price increase is found more often than price decrease for the sampled food commodities. Table 5 shows that an average frequency of price increase is 38.2 percent compared to 28.6 percent of price decrease.
The highest frequency of price increase is recorded for farm egg which is followed by farm chicken and potatoes. Whereas, lowest frequency of price increase is found for tea and fresh milk. Highest frequency of price decrease is found for tomatoes, which is followed by onion and farm chicken. Rare events of price decreased is recorded for fresh milk and beef.
On average it is found that although price increase is usually more widespread, however, price decrease is also not very uncommon phenomena for most of the food products.

Table 5: Direction of Price Change (%)

Commodities	Increase (%)	Decrease (%)
Milk Fresh	20.62	2.87
Beef	27.51	3.24
Tea	18.34	8.33
Rice	21.12	11.35
Wheat flour	45.29	24.17
Pulse Mash	35.09	26.33
Pulse Masoor	38.02	26.70
Pulse Moong	37.71	29.69
Potatoes	47.10	37.90
Garlic	45.32	38.08
Egg Farm	53.18	38.30
Sugar refined	45.60	39.46
Chicken farm	47.63	46.69
Onion	44.70	46.72
Tomatoes	45.54	49.13
Total	38.18	28.60

Source: Author's Calculation

Table 6 shows direction of price change by city. Darker shade of green in the table represents the high frequency of price change and the gradual lightening tone shows the decreasing frequency. A quick glance of table 6 corroborates the findings of table 5 at city level.
For beef, overall frequency of price increase is although low relative to most of other food products, however, city wise comparison in table 6 reveals the reverse case for large cities. For

instance, Peshawar, Islamabad, Rawalpindi, Karachi, Lahore and Multan shows high frequency of price increase. Whereas, incidence of price decrease happened seldom in all cities.

A similar pattern of price increase is observed for milk. It is shown that frequency of price increase is higher in large cities like Islamabad, Rawalpindi, Multan, Peshawar, Karachi and Lahore respectively, compared to other cities.

Unlike above, rice and tea shows similar frequency of price increase across cities. Common pattern observed in these four commodities is that the difference between frequency of price increase and decrease is larger compared to most of other food commodities like commodities included in vegetable group and chicken, egg and sugar.

In commodities like chicken, egg, tomato, onion, garlic, potato and sugar, frequency of price increase and decrease is almost similar, which shows that price increase is usually followed by price decrease. These results pointed towards the existence of some temporary shocks like weather conditions, speculation, pest attacks, production shock etc.

Although, direction of price change is an important phenomenon in explaining the overall price change behaviour, however, size or magnitude of price change is also important. Hence, in the next section of this study we estimate and analyze the magnitude of price change.

Table 6: Direction of Price Change by City

Frequency of Price Increase & Decrease by City (%)																
Cities	Increase/Decrease	Beef	Chicken	Egg	Garlic	Milk	Onion	Potatoes	Pulse Mash	Pulse Masoor	Pulse Moong	Rice	Sugar	Tea	Tomatoes	Wheat flour
Bahawalpur	Increase	22.7	46.7	52.4	46.3	20.1	44.5	41.0	36.2	27.9	30.6	13.5	43.2	18.3	45.0	54.6
	Decrease	3.1	48.5	38.0	32.8	0.4	42.8	32.3	24.0	22.7	29.3	5.7	34.1	8.7	48.0	32.3
Faisalabad	Increase	24.0	48.5	55.0	43.7	15.7	48.0	51.5	41.0	40.6	40.2	23.6	50.2	18.3	47.6	53.3
	Decrease	2.2	48.9	38.9	42.8	2.2	48.0	41.5	24.9	33.2	31.9	10.5	38.4	8.7	48.0	27.5
Hyderabad	Increase	25.8	48.0	53.7	47.2	18.3	45.4	47.6	45.0	42.8	42.8	22.3	41.5	17.5	49.8	48.9
	Decrease	1.7	48.0	40.2	41.5	3.5	48.0	35.8	27.9	29.3	37.6	13.5	41.0	7.9	47.2	30.6
Islamabad	Increase	39.7	49.8	57.6	46.3	32.8	44.1	52.4	35.8	33.6	37.6	17.5	49.3	20.5	46.3	49.8
	Decrease	3.9	48.9	39.7	35.8	3.1	52.0	42.4	19.7	20.5	26.2	6.6	38.4	9.2	52.0	26.2
Karachi	Increase	34.9	48.9	52.8	47.6	25.3	46.7	48.0	50.2	39.7	42.4	36.2	51.1	16.6	48.9	41.5
	Decrease	4.4	47.6	41.5	42.4	6.6	48.5	38.9	31.4	39.7	37.1	15.7	41.5	7.9	48.9	21.8
Khuzdar	Increase	17.9	41.5	41.9	42.4	11.4	42.4	38.9	30.1	30.1	29.7	22.3	38.4	14.4	39.3	31.0
	Decrease	4.8	37.1	36.7	34.1	3.1	43.7	35.4	25.3	24.0	20.1	12.7	37.1	7.4	47.2	17.5
Lahore	Increase	27.5	48.9	56.8	44.5	23.1	51.1	51.1	37.1	32.3	38.0	14.8	45.9	18.8	45.9	53.3
	Decrease	2.2	49.8	41.5	38.4	3.5	47.6	44.1	26.2	27.1	24.9	7.0	43.7	7.9	52.8	17.9
Multan	Increase	27.5	50.2	55.9	49.8	28.4	47.2	51.1	33.2	32.3	38.0	24.9	46.3	18.8	46.7	54.6
	Decrease	2.6	46.3	36.2	34.9	2.2	44.5	33.6	26.2	23.1	36.2	17.0	38.0	7.9	48.9	31.0
Peshawar	Increase	41.0	48.0	54.6	48.0	28.4	44.1	48.0	49.3	46.3	49.3	34.1	46.7	20.1	41.5	38.4
	Decrease	4.4	50.2	39.3	43.7	2.6	50.7	38.9	40.2	37.6	41.5	21.4	43.2	9.6	55.5	25.3
Quetta	Increase	22.3	48.5	50.7	45.9	14.4	40.2	45.9	46.7	44.1	48.0	18.3	45.4	18.3	47.6	25.8
	Decrease	3.1	46.3	38.0	36.2	2.6	45.4	36.2	39.7	28.8	38.9	13.1	42.8	7.9	47.2	17.0
Rawalpindi	Increase	38.4	48.5	57.2	45.9	31.9	45.9	52.0	40.2	34.9	41.0	19.2	51.1	21.4	45.4	51.5
	Decrease	5.2	49.8	39.3	33.6	3.9	50.7	40.2	23.6	23.1	25.8	7.4	42.8	9.2	53.3	27.5
Sargodha	Increase	24.5	47.6	53.3	38.9	16.6	43.7	42.8	31.9	27.5	32.3	22.7	41.5	17.9	43.2	46.3
	Decrease	21.8	44.5	37.6	41.0	3.1	46.7	40.2	25.3	21.8	26.2	12.7	38.4	7.9	46.7	26.2
Sialkot	Increase	21.4	48.0	50.7	45.0	10.0	42.4	48.0	27.9	29.7	28.4	9.2	42.4	17.5	43.7	50.2
	Decrease	3.1	48.5	35.4	37.1	3.1	41.5	39.7	19.2	16.6	18.3	7.0	35.4	7.9	47.6	22.3
Sukkur	Increase	17.5	43.7	52.0	43.2	12.2	40.2	41.0	27.5	29.3	29.7	17.0	45.4	18.3	46.7	34.9
	Decrease	2.6	39.3	34.1	38.9	0.4	44.1	31.4	20.1	21.0	21.8	8.7	37.6	8.7	44.5	15.3

Source: Author's Calculation

6.3 Results of Average Size of Price Change

Table 7 below shows the average size of price increase and decrease. Bar graph inserted in the table works as a quick visualizing tool, which shows that average size of price increase is 11 percent compared to 11.36 percent of price decrease. It is revealed that average size of price increase and decrease both emerged sizeable for most of the perishable food products. Although, for some food products, size of price decrease is greater than price increase but for the other products magnitude of increase is higher.

Table 7: Size of Price Change

Commodities	Increase (%)	Decrease (%)
Pulse Masoor	5.25	4.56
Pulse Mash	5.74	5.06
Sugar refined	5.86	5.09
Wheat flour	4.73	5.18
Pulse Moong	6.24	5.28
Milk Fresh	5.51	7.18
Rice	8.18	7.97
Tea	6.72	8.81
Beef	5.23	11.68
Garlic	11.94	12.09
Chicken Farm	13.02	12.27
Egg Farm	11.60	14.19
Potatoes	15.95	18.12
Onion	21.94	19.80
Tomatoes	37.12	33.11
Total	11.00	11.36

Source: Author's Calculation

Table 7 clearly envisaged that price of tomatoes record highest magnitude of price change, which is followed by onion. During the period under study, the lowest price of Rs. 4.5 was recorded for Sargodha city in May 2004 and highest price of Rs. 212 is recorded for Islamabad in November 2019. These huge ups and downs are recorded in the prices of tomatoes because of the production and supply shocks. Although, milk and beef commodities record seldom events of price decrease but table 7 shows that the magnitude of these decrease in prices is relatively high.

For analyzing in more detail, Table 8 below shows the magnitude of price increase and decrease at city and commodity level. Red bars in the diagram show the magnitude of price decrease compared to the blue bars that shows the magnitude of price increase. Graph reveals that prices increase and decrease with same magnitude in almost all the cities for most of the commodities except for milk, rice and tomato.

Price of milk decreased with higher magnitude only in some particular cities, like, Faisalabad, Hyderabad, Sialkot and Peshawar. Similarly, magnitude of price decrease of rice is higher in Karachi and Rawalpindi. In case of tomato, highest magnitude of price increase is recorded for Sargodha, which is followed by Khuzdar and Bahawalpur.

In all cities, although the smallest size of price increase and decrease are recorded for pulses over the whole period under study but frequency of price increase is recorded high for all three pulses included in this study. This shows small but frequent increase in prices of pulses in all cities. It is worth mentioning here that most of the demand of pulses are fulfilled through import in Pakistan as pulses are cultivated as only catch crop, hence, production is not sufficient to meet total demand of pulses in the country (Ullah et. al. 2020). Intensive and extensive margin of inflation for pulses shows the transmission of international prices into the domestic market.

As far as wheat flour is concerned, the size of price decrease is relatively higher than size of price increase in almost all cities of Pakistan. However, the events of price increase are higher for wheat than events of price decrease, which suggest the increasing trend of price over the period under study.

Table 8: Magnitude of Price Increase and Decrease by City (%)

Size of Price Increase & Decrease by City (%)																
Cities	rease/Decrea	Beef	Chicken	Egg	Garlic	Milk	Onion	Potatoes	Pulse Mash	Pulse Masoor	Pulse Moong	Rice	Sugar	Tea	Tomatoes	Wheat flour
Bahawalpur	Increase	5.53	13.46	12.32	12.26	4.28	22.93	18.88	6.53	6.06	8.06	9.49	5.51	5.62	41.49	5.21
	Decrease	-9.22	-12.10	-15.13	-14.40	-3.39	-22.52	-21.81	-6.56	-4.76	-5.96	-8.25	-5.05	-6.20	-37.54	-6.17
Faisalabad	Increase	5.19	13.38	10.95	13.83	7.96	21.36	19.10	4.80	5.48	6.57	6.70	4.64	5.97	34.02	4.16
	Decrease	-8.53	-12.39	-13.68	-12.37	-20.02	-20.04	-21.85	-4.78	-4.80	-5.88	-7.82	-4.37	-6.94	-32.32	-5.02
Hyderabad	Increase	4.14	12.29	11.58	11.53	6.24	23.52	15.45	5.10	4.18	4.83	7.06	6.71	8.23	37.76	4.98
	Decrease	-6.65	-11.33	-13.58	-11.43	-10.92	-21.03	-18.93	-5.29	-3.80	-3.51	-6.10	-5.15	-12.06	-38.45	-5.14
Islamabad	Increase	3.11	12.62	9.89	8.61	3.04	16.95	10.96	4.36	5.65	4.53	5.45	8.20	6.35	28.35	3.77
	Decrease	-5.91	-11.84	-12.57	-9.00	-5.93	-13.22	-12.30	-3.73	-6.12	-3.57	-3.22	-8.81	-8.87	-23.87	-3.82
Karachi	Increase	3.97	13.72	12.14	11.12	4.23	20.10	11.01	4.67	5.23	5.39	9.95	5.64	8.53	37.08	4.01
	Decrease	-8.80	-13.04	-13.61	-10.57	-4.59	-18.17	-12.08	-4.75	-3.47	-4.04	-18.23	-5.29	-11.79	-35.56	-3.74
Khuzdar	Increase	6.62	9.77	14.30	13.84	7.97	27.27	16.77	8.52	7.50	8.36	8.07	6.35	7.45	42.10	6.18
	Decrease	-5.19	-9.43	-14.35	-15.62	-5.25	-25.58	-16.71	-7.37	-6.84	-8.36	-7.99	-4.79	-7.87	-33.91	-6.36
Lahore	Increase	3.63	15.70	11.15	10.85	4.04	18.84	16.34	4.51	4.60	5.11	7.39	4.76	5.74	34.40	3.44
	Decrease	-2.34	-14.50	-13.59	-10.52	-3.79	-18.90	-17.91	-3.56	-3.25	-4.89	-4.90	-3.47	-7.49	-28.51	-5.43
Multan	Increase	4.28	12.23	11.69	11.67	2.86	21.99	17.94	5.81	5.04	7.04	8.15	5.33	6.02	38.22	4.07
	Decrease	-5.00	-12.15	-16.09	-14.11	-2.17	-21.98	-25.88	-4.30	-4.22	-5.36	-6.94	-4.73	-8.16	-35.20	-4.46
Peshawar	Increase	2.68	12.79	10.21	11.19	3.58	19.87	12.09	4.65	4.05	6.24	4.60	6.97	8.46	38.53	5.39
	Decrease	-3.72	-11.32	-12.33	-10.37	-8.04	-15.91	-13.13	-3.70	-3.31	-5.38	-3.22	-5.97	-12.60	-27.19	-5.02
Quetta	Increase	5.33	10.82	9.24	12.34	6.54	19.83	13.61	6.63	4.55	5.38	7.92	5.31	5.91	33.50	6.40
	Decrease	-5.21	-10.35	-10.17	-12.88	-6.09	-16.14	-15.35	-5.99	-4.49	-4.61	-4.63	-4.04	-7.55	-32.21	-4.79
Rawalpindi	Increase	3.38	14.41	12.05	9.37	3.21	21.80	12.94	4.30	3.91	5.06	10.64	4.49	5.45	32.73	4.21
	Decrease	-4.39	-12.99	-15.73	-10.39	-4.96	-18.46	-15.22	-3.72	-3.21	-4.84	-17.43	-3.82	-7.37	-26.40	-4.70
Sargodha	Increase	8.78	14.54	13.23	15.28	5.77	26.11	23.06	5.92	5.83	6.66	8.62	5.60	6.03	43.55	4.44
	Decrease	-5.17	-14.60	-16.84	-12.62	-6.87	-23.19	-22.33	-4.23	-4.23	-5.23	-9.38	-4.28	-7.51	-38.47	-4.69
Sialkot	Increase	10.83	13.80	11.55	11.17	11.05	23.09	20.00	6.30	5.48	6.42	11.96	5.58	6.10	38.39	4.32
	Decrease	-4.29	-12.68	-14.64	-11.42	-11.63	-21.85	-22.43	-5.47	-6.09	-6.00	-6.61	-4.78	-7.34	-33.80	-5.96
Sukkur	Increase	5.68	12.80	12.12	14.12	6.33	23.52	15.14	8.32	6.01	7.67	8.50	6.97	8.20	39.52	5.58
	Decrease	-3.83	-13.11	-16.38	-13.62	-6.90	-20.15	-17.78	-7.41	-5.28	-6.31	-6.85	-6.67	-11.62	-40.15	-7.19

Source: Author's Calculation

6.4 Results of Degree of Synchronization across Cities

Table 9 shows a broad spectrum of synchronization across cities ranges from partial staggered to partial synchronized pricing behavior. On average, the synchronization ratio of food products among cities is 0.53. Whereas, computed synchronization of each product across cities ranges between 43 to about 80 percent. The prominent category that shows the highest degree of synchronization in price change is tea.

Table 9: Synchronization of Prices among Cities

Beef	0.43
Pulse Masoor	0.45
Milk Fresh	0.46
Rice	0.46
Pulse Moong Washed	0.46
Pulse Mash washed	0.46
Garlic	0.48
Wheat flour	0.50
Potatoes	0.51
Egg Farm	0.57
Onion	0.57
Sugar refined	0.59
Chicken Farm	0.60
Tomatoes	0.64
Tea	0.79
Total	0.53

Source: Author's Calculation

The degree of synchronization for tea is 80 percent, which is highest among all the sampled food commodities. This is probably because most of the demand of tea in country is fulfilled through import as Pakistan is 3rd largest importer of tea. It is considered that the price of the tea mainly depends on international tea price, hence its price change simultaneously in all cities.

Synchronization ratio for tomatoes is relatively higher, which shows that the impact of tomatoes' shortage and delay in its import from neighboring countries, impact simultaneously in all cities of the country. Similarly, prices of farm chicken, refined sugar, onion and farm egg are also found relatively well synchronized.

Remaining commodities shown in table 9, however, are found to be quasi synchronized ranges between 51 to 43 percent. It is observed that although the price list of food items are released by government to maintain the harmonized system, however, these results prove the implementation problems and proper check and balance of prevailing prices across cities.

6.5 Results of Volatility Assessment

Standard Deviation Results

The periods of high and low volatility for each commodity are presented in Table A-3 (Appendix). It is illustrated from the table that during the period of accelerated global food prices that is 2002-2008; in Pakistan the food prices of beef, chicken, egg, tomato and sugar were highly volatile in most of the years as compare to other commodities. Further, year 2008-09 remain highly volatile for egg, milk, onion, tomato, potato, Pulse Mash, Pulse Masoor, rice, wheat and tea. As in 2008-09 food inflation broke the record of previous 23 years and reached to 23.13 percent. Moreover, in the next year almost all food commodities remain volatile except tomato and tea. It is evident from the results that during the years 2014-2015 and 2015-16 the volatility in most of the food commodities were low as there was a decline in the fuel prices in 2014-15. Additionally in 2020, due to Covid 19, all the food commodities except onion were highly volatile. Moreover, Table A-4 (Appendix) explained that the price of the commodities for instance; beef, chicken, egg, sugar and all vegetables are highly volatile over the given period. While commodities like milk, tea and rice, wheat and all the three pulses are comparatively less volatile over the period.

ARCH/ GARCH Model Results

This section provides the estimation results of ARCH/ GARCH and IGARCH models. Before estimating ARCH/ GARCH and IGARCH models, preliminary test of unit root and ARCH-LM tests have been applied. For Unit Root, Augmented Dickey Fuller (ADF) test is applied on the log return[5] price series of each food commodity for the respective city. Unit root results[6] revealed that the log return price series of all food commodities are stationary at level for each city.

Results of ARCH Lagrange Multiplier (LM) Test

ARCH-LM test is performed to identify the existence of short run time varying volatility in the log return prices of food commodities for each city. It is analysed from Table A-5 (Appendix), that for most of the cities, ARCH effect is present in the log return price series of all food commodities except in Khuzdar, Quetta and sukkur (for beef), Islamabad (for chicken), Khuzdar (for milk), Bahawalpur (for Garlic) Lahore and Sialkot (for Onion), Karachi and Multan for (Potato), Bahawalpur and Sukkur for (tomato) Khuzdar and Lahore (for pulse mash), Bahawalpur, Karachi, Lahore and Multan for (Pulse Masoor), Bahawalpur, Hyderabad and Sialkot for (pulse moong), Sargodha for (wheat), Khuzdar and Sialkot for (rice IRI) and Peshawar for (tea and sugar).

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[5] *Log Return* = $ln \frac{p_t}{p_{t-1}}$ *where,* p_t is the monthly price for period t and p_{t-1} is the monthly price for period t-1

[6] Results are shown in Table A-2 (Appendix)

However, it is found that ARCH effect is present in the log return prices of egg in all cities of Pakistan. Finally, on the bases of ARCH-LM test, the study has identified log return price series having ARCH effect. The test endorses the application of ARCH (1)/GARCH (1,1) and IGARCH (1,1) methodology for assessing the volatility in the price series of selected food commodities.

Results of ARCH (1) Model

This section highlights the results of ARCH model, applied on the series which have ARCH effect. Table A-6 (Appendix) explains the results of ARCH (1) model applied on the log return price series of food commodities. It is seen that the ARCH coefficient is significant for all the commodities, showing that the short term time varying volatility in the return prices of all the above commodities is influenced by some external factors, which may cause extra supply in some period whereas a deficient supply in the next period.

Results of GARCH (1,1) Model

After the application of ARCH (1) model the study further assessed the volatility by using GARCH (1,1) model. This model helps to answer whether the existing volatility is only due to some external factors or also due to the existence of previous volatility in the food commodities. For easy analysis the research allocates the food commodities into five groups[7].

Table A-7 (Appendix) divulges the results of Meat group. Significant ARCH and GARCH coefficients for beef, in each city explain, the volatility in log return price series is not only enormously affected by residual effects but also due to the presence of past variance in log return prices. It exhibits that the volatility in beef prices is persistent and takes long time to come to an end. On the other hand, for chicken prices only ARCH parameter is significant for each city though, the GARCH parameter is significant only for Khuzdar, Quetta and Sargodha. Significant ARCH coefficient and insignificant GARCH coefficient explains that, in chicken prices the presence of volatility is only due to the factors that cause changes in its supply and demand while, past variance do not effect current volatility. Cities where, conditions of GARCH model are not fulfilled like, negative GARCH coefficient, ARCH (1)[8] model is considered for volatility assessment.

The findings of Dairy group are demonstrated in Table A-8. The significant ARCH coefficient for both commodities in each city is indicated that volatility is highly influenced by residual effects. That might be the change in input prices (oil prices), seasonal (winter and summer) changes which create volatility in the log return price of egg and milk. As in winter season, the demand for eggs generally rises and so on. However, GARCH coefficient is insignificant for egg prices in

[7] 1. Meat Group (Beef and Chicken), 2. Dairy Group (milk and egg), 3. Vegetable Group (Garlic, Onion, Potato and Tomato), 4. Cereal and Pulses Group (Rice, Wheat, Pulse Mash, Pulse Masoor and Pulse Moong) 5. Other Group (Sugar and Tea)

[8] For Bahawalpur, Karachi, Rawalpindi and Sialkot chicken prices ARCH(1) model is considered

majority of the cities except Quetta, presenting that the volatility in most of the cities is not due to previous volatility. Though, the conditional volatility in milk prices is also due to the presence of previous volatility in majority of the cities except for Islamabad and Sargodha. All those cities where GARCH coefficient is negative the study considers ARCH model, as it is the best to assess conditional volatility. IGARCH model is used in return price series of milk for Peshawar as the sum of both ARCH and GARCH coefficients is equal to 1. IGARCH[9] model fulfils its necessary condition, i.e., $\alpha + \beta = 1$, displaying that shocks have permanent impact on volatility.

The results of vegetable group are reported in Table A-9. It is seen that, in this group ARCH parameter is significant for all commodities in their respective cities. Showing that short term time-varying volatility in prices of vegetables has responsive behaviour towards shocks or residual effects. These shocks might be the change in transportation cost, change in international prices of vegetables or change in weather condition (in 2010 and 2011 rains and floods, particularly in Sindh harm the production of these vegetables). While, past volatility in vegetable prices has no effect on current volatility for majority of the cities. However, the volatility in the log return prices of Garlic (Faisalabad, Hyderabad, Multan, Peshawar, Quetta and Sukkur), in the log return prices of Onion (Rawalpindi and Sukkur), in the log return prices of Tomato (Khuzdar) and in the log return prices of Potato (Bahawalpur); is due to both the existence of residual effects and previous volatility, showing persistent behaviour of volatility for these cities. The ARCH (1) model is considered in cases where the GARCH coefficient is negative. IGARCH (1,1) model is applied for Garlic (Sukkur) and Rawalpindi (Onion),where the summation of both coefficients is equal to or more than 1.

The outcomes of Cereal and Pulses group are presented Table A-10 and A-11 (Appendix). The ARCH parameter is significant for all commodities present in the group for the respective city. It referred that short term time varying volatility in prices of cereal and pulses is affected by residual effects that may affect the crop yield. While, the crop yield is based on different factors like weather conditions input prices etc. In 2017 Ismail, et al. accentuated in their research that urea price has significant impact on rice price while, rupee depreciation influences on wheat prices. It is noticed that volatility is persistent in the return prices of Rice IRI and Wheat in all cities as the past variance significantly affect the present variance. Similarly, in most of the cities the volatility is also persistent for Pulse Mash, Pulse Masoor and Pulse Moong except for Pulse Mash (Quetta, Sialkot and Sukkur), for Pulse Masoor (Islamabad) and for Pulse Moong (Quetta and Sargodha). The results explain that in some cases the condition of GARCH model is violated with negative GARCH coefficient[10], the study assessed the volatility of these commodities by using

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[9] IGARCH Model results for all commodities are shown in Table A-13 (Appendix).

[10] For Pulse Mash (Quetta, Sialkot and Sukkur), For Pulse Masoor (Islamabad)

the ARCH model. Further, in return prices where the sum of ARCH and GARCH coefficient is equal to or more than 1 the study applies the IGARCH model[11].

Table A-12 (Appendix) presents the GARCH results of Sugar and Tea. The results depict that for both commodities, in each city ARCH coefficient is significant, referring that volatility is strongly because of residual effects. For Sugar they might be some political factors-government policies, high input prices specifically fluctuation in crude oil prices that is used in processing. However, the factors that cause fluctuation in the tea prices are might be the international price of tea, exchange rate, oil prices, as Pakistan is the large importer of tea. The results point out that the volatility in sugar prices in all cities is not depend on the existence of previous volatility except for Karachi city. While, the significant GARCH coefficient in every city for tea prices illustrates that volatility is not only due to residual affects but also influenced by the previous variance. ARCH model is suitable for volatility assessment in series, where GARCH coefficient is negative[12].

6.6 Results and Interpretation of Factors Affecting Food Prices

The interpretation of ARDL results are presented in this section. Most of the policy macroeconomic variables like real effective exchange rate, real interest rate and crude oil prices are included in all the models of food commodities. These variables are included in the models thus to capture the intensity of exogenous shocks in determining the prices of important food commodities. Whereas, some other repressors, for instance, international prices of the same commodities and local production of commodities are included in the models depending on the availability of time series data. Other important group of factors, identified by the literature are the political and market conditions. However, most of such factors, for instance, low transparency, political instability etc. are difficult to quantify. Hence, to gauge the impact of political instability, three dummies for political eras are included in the models. Unfortunately, support prices are only announced for the wheat crop by the government of Pakistan each year. Hence, this variable is included in the model for wheat prices only. This variable signifies the role of government in determining the prices of wheat for that year.

Table A-14 in Appendix, shows the group unit root test results. Group unit root test is performed for first difference thus to ensure that all the series are integrated at I(1) or I(0). It has been argued that higher order integrated variables can exhibit spurious regression results in Autoregressive Distributed lag Models (ARDL). Therefore, for examining cointegration of

[11] For Pulse Mash (Faisalabad, Hyderabad, Islamabad and Rawalpindi), for Pulse Masoor (Sargodha), for Rice IRI (Peshawar and Sukkur) and for Wheat (Rawalpindi)

[12] Multan, Rawalpindi, Sargodha and Sukkur for Sugar

Note: Conditional Standard Deviation graphs for all commodities are presented in Figure A-2 (Appendix).

variables by the method of ARDL bound testing, we checked the stationarity of series, as a precondition, suggested by Dickey and Fuller (1979).

The group unit root test for first difference confirmed that the order of integration for each variable of each model is either I(0) or I(1). Given such prerequisites, we perform ARDL bound testing to determine the long run as well as short run impact of various factors on the price of food commodities.

Proceeding further, lag orders for each model are selected on the basis of AIC. According to Pesaran & Shin (1999) precise adjustment of orders of the ARDL model is necessary to remove serial correlation in residual and the endogenous variables issue. Hence, lags' maximum values are decided for each fifteen models of the study on the AIC basis and graphs of lag length are shown in Figure A-3 (Appendix).

Subsequently, the study examined the long-run relationship between log of commodity prices and the likely determinants for each model by the ARDL bound testing method as suggested by Pesaran et al. (2001). Table 1, shows the F-statistics for the ARDL long run form and bounds test along with the corresponding lower bounds, i.e., I (0) and upper bounds, i.e., I (1) at 5 percent level of significance. Results confirm the presence of long run cointegrating association between the variables for most of the models. With log prices of various food commodities for instance; (onion, tomato, potato, beef, chicken egg, milk, wheat, pulse mash, sugar and tea) as dependent variables, the null hypothesis of no level relationship has been rejected as the F-statistics exceed upper bound critical values.

Table 10: ARDL Bound Test Results

Dependent Variables	F-Statistics	Lower bound at 5%	Upper Bound at 5%	k	Remarks
Vegetable Group					
log (Onion price)	8.29	2.56	3.49	4	Present
log (tomato price)	8.10	2.39	3.38	5	Present
log (garlic price)	0.90	2.79	3.67	3	Absent
log (potato price)	8.29	2.56	3.49	4	Present
Meat Group					
log (beef price)	4.54	2.39	3.38	5	Present
log (chicken price)	5.93	2.39	3.38	5	Present
Dairy Group					
log (egg price)	9.99	2.56	3.49	4	Present
log (milk price)	9.79	2.39	3.38	5	Present
Cereal & Pulses Group					
log (wheat price)	9.66	2.27	3.28	6	Present
log (rice price)	2.13	2.39	3.38	5	Absent
log (Pulse moong price)	3.03	2.56	3.49	4	Absent
log (pulse mash price)	3.4	2.56	3.49	4	Present
log (pulse masoor price)	2.32	2.56	3.49	4	Absent
Other Group					
log (sugar price)	3.38	2.39	3.38	5	Present
log (tea price)	14.94	2.56	3.49	4	Present

Source: Author's calculation

The above Table provides evidence of long-run relationship between log prices of onion, tomato, potato, beef, chicken egg, milk, wheat, pulse mash, sugar and tea and their determinants. Hence, Table 11 describes the partial long-term impact of various factors on log prices of these food commodities.

It is shown in table 11 that log of real effective exchange rate significantly influences the log prices of wheat. It is shown that 1 percent point decrease in real effective exchange rate (REER) will increase the wheat prices by 0.64 percentage. Model of log wheat price confirms the negative association of prices with REER, which is supported by literature as well. For instance, it is well documented that exchange rate transmit international good prices to local markets (Zerom and Nakamura 2010; Abbot et al., 2009 and Landerretche et al., 2007). Further Ismail et al (2017) also found the same results for Pakistan.

Further, the study found negative relationship for the prices of wheat and rice, while, positive relationship exists between the price of tea and interest rate. These results postulate that decline in interest rate by 1 percent would cause the prices of wheat and rice to increase by 0.11 and 0.57 percent respectively, while decrease the price of tea by about 0.72 percent respectively. In the literature Ismail et al (2017) also exhibited mixed results regarding the impact of interest rate on the prices of various food commodities.

Table 11: Long-run Coefficients

Dependent (prices) \ Independent Variables	Exchange Rate	Interest Rate	Oil Price	International Price	Production	Support Price	c
Vegetable Group							
log (Onion price)	0.24	0.02	0.27**		0.67	-	-3.50
log (tomato price)	0.57	-0.53	0.40**	-0.56	-1.02**	-	-1.88
log (garlic price)	1.01	3.43	-0.99	-	-	-	-2.83
log (potato price)	0.48	-0.05	0.53***	-	-0.27	-	1.84
Meat Group							
log (beef price)	0.40	-0.19	0.05	0.58***	0.25	-	-1.07
log (chicken price)	-0.16	-0.03	0.15***	0.45***	0.18	-	1.37
Dairy Group							
log (egg price)	-0.54	-0.18	0.25***	-	-1.53***	-	-8.55***
log (milk price)	-1.18	0.48	0.90	0.12	1.26	-	-8.19
Cereal & Pulses Group							
log (wheat price)	-0.64***	-0.11***	0.05*	0.10***	-0.17	0.74***	5.52***
log (rice price)	0.12	-0.57***	0.48***	0.92***	-0.61	-	3.93
log (Pulse moong price)	-8.09	1.32	0.16	-	-2.02	-	49.95
log (pulse mash price)	-0.25	0.40	-0.14	-	-1.55***	-	20.17*
log (pulse masoor price)	-4.76	-0.27	0.06	-	-1.60***	-	30.05
Other Group							
log (sugar price)	0.07	-0.25	0.21***	0.56***	-1.20***	-	14.65
log (tea price)	0.08	0.72***	0.04	0.22**	-	-	-0.01

Source: Author's calculation, ***, **, * shows 1%, 5% and 10% level of significance

The other most important exogenous factor is the crude oil price. Table 11 shows the significant and positive impact of oil price on almost all the commodities. The largest impact of oil price increase is found on vegetable prices. Results reveal that 1 percent increase in crude oil price leads to 0.53 percent, 0.40 percent and 0.27 percent point increase on prices of potato, tomato and onion respectively. Similarly, chicken and egg prices are also affected by rising oil prices. A percentage point increase in oil price raises the prices of chicken meat and egg by 0.15 and 0.25 percentage point respectively. Wheat prices are also affected by oil price but its impact is minimal. Sugar price model, however, exhibits significant and positive impact of rise in oil price on sugar prices. These findings are consistent with the earlier findings as well. For instance, Herrmann (2009), Ismail et al. (2017) and several other researchers, showed that among other variables, crude oil price is the foremost factor in case of Pakistan that cause fluctuation in the commodity prices.

Table 11 confirms the proposition that international prices of commodities affect the local prices by increasing them even in the absence of trading activities [Ahsan et al. (2011) and ADB (2008)]. The study also found positive impact of international food prices, for prices of all staple food commodities, like beef, chicken, wheat, rice, sugar and tea. It is shown that 1 percentage point rise in international food price increase the local prices of beef, chicken, wheat, rice, sugar and tea by 0.58, 0.45, 0.1, 0.92, 0.56 and 0.22 percent respectively.

Another factor that plays a major role in reducing domestic prices by increasing the supply is total local production (TLP) [Tadesse et al. (2016)]. It is included in the models only for commodities, which are produced locally. Table 11 shows significant and negative impact of production of various commodities on their prices. For instance, 1 percentage point increase in local production of pulse mash, pulse masoor, sugarcane, tomato and egg would decline their prices by 1.55, 1.6, 1.2, 1.0 and 1.5 percent respectively. Literature also supports the findings of current study. Ahsan et al. (2011) found that decline in production of wheat and rice increase food prices in Pakistan.

Support price of wheat is the foremost policy tool of government to regulate wheat price. To the best of author's knowledge there is no empirical study regarding the link between wheat price and its support price, while Khan and Qasim, (1996) Sherani, Schimmelpfennig and Khan (2006) found a positive and significant link between wheat support price and food inflation in Pakistan. Considering its importance, the study includes it for empirical analyses in wheat model. Results as mentioned in Table 11 show positive and highly significant impact of wheat support price on wheat prices. Findings of the study prove that higher support price encourage farmers to increase yield, not only by increasing yield per acre but by utilizing more hectares of land for wheat cultivation.

Table 12: Short-run Coefficients

Dependent (prices) \ Independent Variables	ECT_{t-1}
Vegetable Group	
△log (Onion price)	-0.35***
△log (tomato price)	-0.41***
△log (garlic price)	-
△log (potato price)	-0.24***
Meat Group	
△log (beef price)	-0.12***
△log (chicken price)	-0.49***
Dairy Group	
△log (egg price)	-0.37***
△log (milk price)	-0.009***
Cereal & Pulses Group	
△log (wheat price)	-0.33***
△log (rice price)	-
△log (Pulse moong price)	-
△log (pulse mash price)	-0.04***
△log (pulse masoor price)	-
Other Group	
△log (sugar price)	-0.13***
△log (tea price)	-0.24***

Source: Author's calculation, *** shows 1% level of significance

Table 12 shows the coefficient of ECT_{t-1} for each model separately by employing equation 8. The estimator of ECT_{t-1} describes the short run[13] adjustment method. It would be worth mentioning here that the value of ECT coefficient between -1 to 0 represents that the correction to commodity prices in time period t is a proportion of the error in previous time period (t-1). In such cases, the ECT would cause the log prices of food commodities to monotonically converge to long-run equilibrium as a result of change in their determinants. However, the positive or lesser than -2 value of ECT coefficient would cause the log prices of food commodities to diverge. Whereas, the value between -2 and -1 represents the dampening oscillation in the log prices around their equilibrium trail.

Table 12, however, shows that the coefficient of ECT_{t-1} is between -1 and 0 for each model, provided that the long run bound test applied earlier proved the presence of long run cointegration among log prices of commodities and their determinants. Coefficient of all the

[13] Detailed Short run Coefficient results are reported in Table A-16 (Appendix).

models is highly significant, statistically, at the 1 percent level. This indicates that the error correction method monotonically converges to the equilibrium. The coefficient of ECT_{t-1} for log prices of onion, tomato, potato, chicken, egg, wheat and tea reveals higher pace of correction each month and implies that the divergence from the equilibrium level of prices in the current time period would be corrected by 35, 41, 24, 49, 37, 33 and 24 percent respectively in the next month. Whereas, the pace of adjustment is relatively slower for other commodities like beef, milk, pulse mash and sugar.

Following standard time series estimation process, this study performed residual diagnostic tests separately for each model to check their robustness. Table A-15 (Appendix) shows the results of tests for F-statistics, serial correlation, homoscedasticity and lag selection criteria. While Figure A-3 (Appendix) below shows the graphs of CUSUM stability test for each model. The test for serial correlation confirmed the Gauss-Markov assumptions of no serial correlation. The problem of heteroscedasticity is although detected for some of the models. These models, however, are re-estimated by employing robust standard error process. It is postulated that, for large sample size, robust standard errors overwhelmed the problem of heteroscedasticity and provide unbiased estimators for standard errors of slope coefficients. F^2 shows the overall significance of the models, thus confirmed the model accuracy.

Figure A-3 (Appendix) shows that CUSUM lines are inside the 5 percent level of significance critical bounds. This ensures the precision of long run and short run parameters of our models. This also proves that models are correctly specified.

CONCLUSION

The study is an attempt to analyse the dynamics of food prices through estimation of various stylized facts and volatility further to identify the main factors of food prices. For this purpose, monthly data from July 2002 to July 2021 is collected from monthly statistical bulletin for 14 large cities of Pakistan for 15 important food commodities. Total of 48090 observations are thus employed in this study.

Firstly, frequency of price change and duration of spells for each commodity is calculated at city level. It is concluded that vegetables, farm chicken and eggs proved to have the most flexible prices. Analyzing at city level, prices of almost all the food products change less frequently in Khuzdar city than rest of all other cities. It is also noticed that prices of most of the commodities change more frequently in big metropolitan cities, particularly, milk and beef.

The frequency of price change is further disaggregated to determine the frequency of price increase and decrease separately along with the magnitude of these increase and decrease in prices. It is found that most of the commodities display an increase in prices followed by decrease and thus both frequencies of price increase and decrease are higher. For instance, eggs, chicken, tomatoes, onion and potato. On the other hand, other commodities exhibit higher frequency of price increase with seldom decrease in prices, like, tea, milk, beef and rice.

Size of price change clearly envisaged that price of tomatoes record highest magnitude of price change, which is followed by onion. Huge ups and downs in the prices are recorded in the prices of tomatoes because of the production and supply shocks. Although, milk and beef commodities record seldom events of price decrease but the magnitude of these decrease in prices is relatively high. At city level, small but frequent increase in prices of pulses are recorded. Intensive and extensive margin of inflation for pulses shows the transmission of international prices into the domestic market.

As far as synchronization of price change across city is concerned, tea exhibits the higher degree of synchronization among all other products. It is considered that the price of the tea mainly depends on international tea prices, hence its price change simultaneously in all cities. Synchronization ratio for tomatoes is relatively higher. Similarly, prices of chicken, refined sugar, onion and egg are also found relatively well synchronized. Remaining commodities are found to be quasi synchronized. Although, price list of food items are released by government to maintain the harmonized system, however, these results prove the implementation problems and proper check and balance of prevailing prices across cities.

For in-depth assessment of food price dynamics, and to understand the risk factor associated with the production and supply of food commodities, volatility in food prices at commodity- city level is assessed. The volatility is assessed by both the standard deviation and ARCH/GARCH and

IGARCH methods. It is identified that log return price series of all food commodities in each city are stationary at level. Through standard deviation method it is found that beef, chicken, egg, sugar and all vegetables are highly volatile over the given period as compare to other commodities. Further, the ARCH-LM test concluded that most of the food price series have short term time varying volatility in their residuals which allow the application of ARCH/ GARCH model. It is elaborated from the results that, in Cereal and Pulses group, Milk and Tea for most of the cities; both the residual effects and past variance are responsible for the current volatility. While in log return prices of Sugar, Egg and commodities exist in vegetable group, the main reason of volatility in most of the cities is only the external factors. It is recommended that the government should formulate a system by making investment to monitor the market prices of highly volatile food commodities (beef, chicken, egg, sugar and vegetables) in each city. It would help to stabilize the food prices.

Further on the basis of ARDL bound test the study identifies that there is a negative and significant impact of REER on wheat prices in long run. While real interest rate, has mixed effects on food prices in long run. It inversely affects wheat and rice prices while has direct impact on tea prices. It is noticed that the increase in international crude oil prices significantly increase the prices of vegetables except garlic, further it also increases the prices of chicken, egg, wheat, rice and sugar in long run. The study intensely supports the role of international food price transmission in domestic prices in long run. As the increase in international prices of beef, chicken, wheat, rice, sugar and tea significantly increase their domestic prices. Moreover, the study explains that in long run, the increase in local production of tomato, egg, pulse mash, pulse masoor, and sugar significantly reduce their prices. It is also attributed that government policy of adjusting (increasing) wheat support prices also has a positive and significant impact on wheat prices.

Moreover, results indicate that the log prices of onion, tomato, potato, chicken, egg, wheat and tea would monotonically converges to the equilibrium. It implies that the divergence from the equilibrium level of prices in the current time period would be corrected by 35, 41, 24, 49, 37, 33 and 24 percent respectively in the next month. Whereas, the pace of adjustment is relatively slower for other commodities like beef, milk, pulse mash and sugar. It is recommended that government should invest in agricultural sector to increase the local production further to increase the production of diversified crops, which reduce the consumer reliance on imported commodities. It would reduce both the domestic as well as international inflationary pressure on food commodities. Moreover, to encourage the investment in crop production by local farmers, it is important to provide loans at low rate. The results exhibits that the high crude oil prices increases the food prices of most of the commodities. As the high international crude oil prices are out of government's control, the government should provide crude oil at subsidize rate to the producers to reduce the input cost. Further, there is a need to construct proper transportation system from farms (villages) to the cities' markets to reduce the transportation cost.

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APPENDIX

Box A-1: Selection Criteria of Food Commodities

CPI basket contains 487 items of goods and services prevailing in 40 major cities of Pakistan. Out of this basket, food and non-alcoholic beverages constitutes 34.84 percent share. The food commodities are selected, keeping in view their relative importance and share in average household food expenditure. According to HIES 2018-19, the percentage share of food and beverages group in total expenditure of households is about 36 percent. Whereas, the selected commodities of this study constitute more than 60 percent share in total food expenditure. Within these commodities milk alone constitute about 22.5 percent share, which is followed by wheat (11.2 percent) and vegetables (8.7 percent). Whereas, expenditure on rice, sugar, tea, beef and chicken are hovering around 3 percent share. Hence, these commodities are the basic food commodities, which have direct welfare impact on households. All of these commodities are also included in CPI basket of food commodities for computing food inflation.

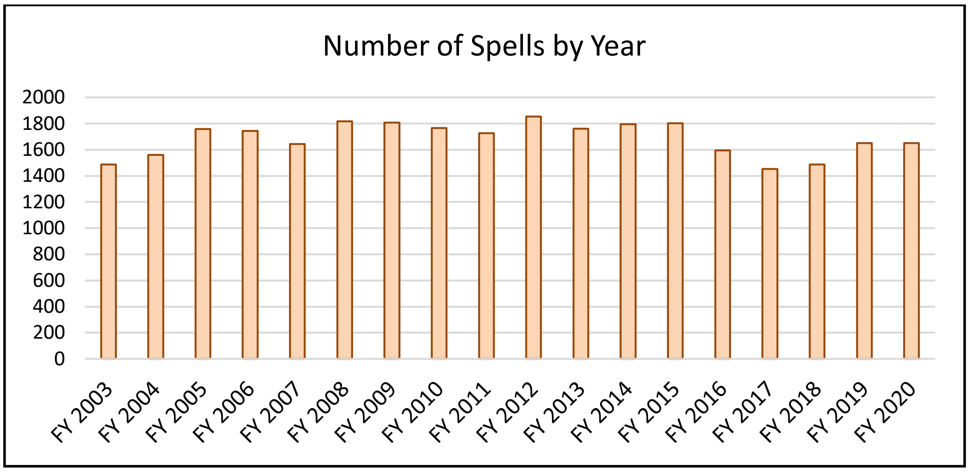
Table A-1: Units of Commodities

Commodity	Units
Beef	1 kg
Chicken	1 kg
Pulse Mash	1 kg
Pulse Masoor	1 kg
Pulse Moong	1 kg
Rice IRI	1 kg
Wheat	1 kg
Garlic	1 kg
Ginger	1 kg
Potatoes	1 kg
Onions	1 kg
Tomatoes	1 kg
Milk	1 liter
Eggs	1dozen
Sugar	1 kg
Tea (Lipton Yellow Label)	200 gm.

Source: Pakistan Bureau of Statistics

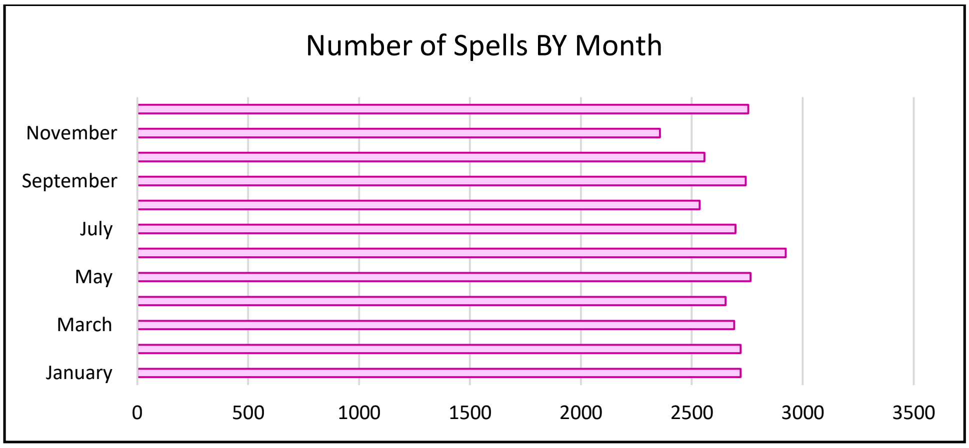
BOX A-2: Price Spell of Food Commodities

Price spells of fifteen commodities and fourteen cities are presented graphically below. The figure reveals the number of price spells of the sampled data employed in the study per year. The higher number of price spells show that occurrence of price change is more frequent in that particular year of era. Glimpse of graph shows that the number of food price spells are relatively lesser in the years 2017 and 2018 and highest in the year 2012 to 2015. Although higher number of spells does not necessarily means higher inflation rather it shows more instability.



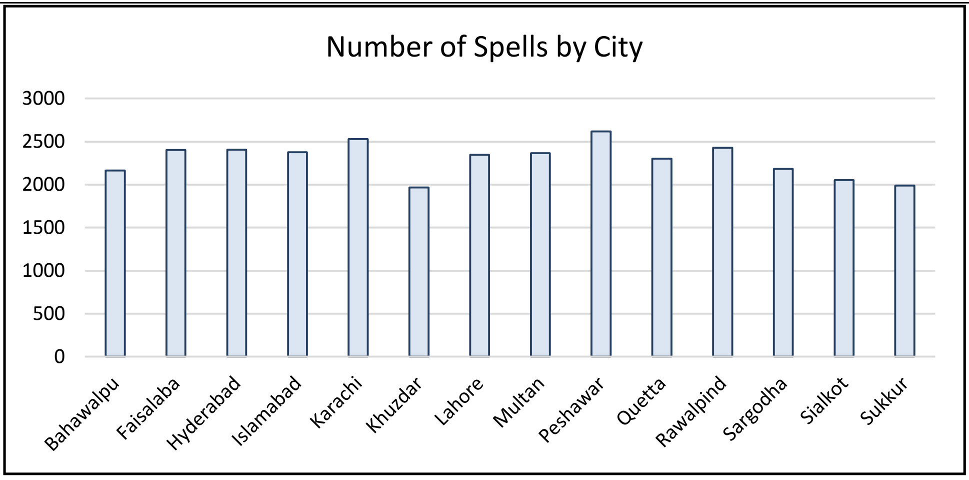
Source: Author's illustration

Total number of food price spells, are graphed in the following figure. It is an attempt to identify the months, in which prices were recorded to revise. It is shown that revision in prices is higher in the months of June and December. This shows that prices of most of the products changes by the end of fiscal and financial years.



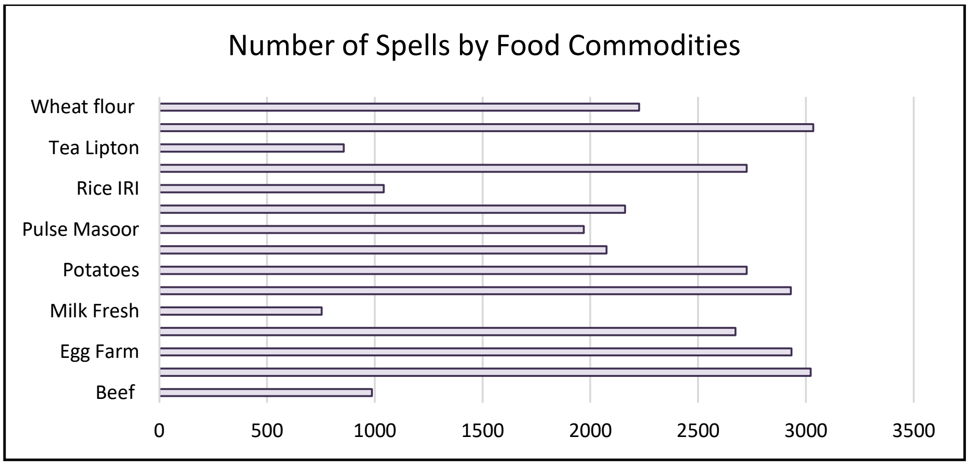
Source: Author's illustration

Differences in the number of regular price spells is even more pronounced when analyzed at city level shown in figure given below. Highest number of spells observed in most of the big cities like Peshawar, Karachi, Rawalpindi, Islamabad etc. It shows that prices of the food commodities are relatively short lived in these cities compared to Khuzdar, Sukkur and Sialkot. While other cities like Quetta, Sargodha, Multan, Lahore and Bahawalpur show moderate number of spells.



Source: Author's illustration

The following graph shows the considerable heterogeneity in number of regular price spells at the level of commodities. Variations by products are most apparent. Highest number of regular price spells, thus the short lived durations were recorded for products, like, milk, tea, beef and rice. In contrast, tomatoes, farm chicken, farm eggs, onion, potato and sugar recorded the highest occurrence of price change.



Source: Author's illustration

Table A-2: Commodity and City Wise Unit Root test Results of Food Prices

City	Order of Integration														
	Beef	Chicken	Egg	Milk	Garlic	Onion	Potato	Tomato	Pulse Mash	Pulse Masoor	Pulse Moong	Rice IRI	Wheat	Sugar	Tea
Bahawalpur	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Faisalabad	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Hyderabad	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Islamabad	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Karachi	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Khuzdar	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Lahore	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Multan	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Peshawar	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Quetta	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Rawalpindi	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Sargodha	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Sialkot	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Sukkur	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)

Source: Author's estimation, I(0) represents that series is stationary at level.

Table A-3: Commodity Wise High and Low Volatility Periods

Year	Beef	Chicken	Egg	Milk	Garlic	Onion	Potato	Tomato	Pulse Mash	Pulse Masoor	Pulse Moong	Rice IRI	Wheat	Sugar	Tea
2002-03	1	0	1	0	1	0	0	0	0	0	0	1	0	0	1
2003-04	1	1	1	0	0	1	1	1	1	0	0	1	1	1	0
2004-05	1	1	1	0	1	1	1	1	0	0	0	0	1	1	0
2005-06	1	1	1	1	0	0	0	1	1	0	1	0	0	1	1
2006-07	0	1	1	0	1	1	1	1	0	1	1	1	0	0	0
2007-08	0	1	1	1	0	0	0	1	0	1	1	1	1	0	0
2008-09	0	0	1	1	0	1	1	1	1	1	0	1	1	0	1
2009-10	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0
2010-11	1	0	0	1	0	1	1	0	0	0	0	0	0	1	0
2011-12	0	0	0	1	1	1	0	0	1	1	1	1	1	1	0
2012-13	0	0	0	0	1	1	0	0	0	0	0	0	1	0	1
2013-14	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1
2014-15	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0
2015-16	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1
2016-17	1	0	0	0	1	0	1	1	1	1	1	0	0	1	1
2017-18	0	0	0	0	0	1	0	0	1	1	1	0	0	0	1
2018-19	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1
2019-20	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
2020-21	1	1	1	1	1	0	0	1	0	0	1	0	1	1	0
Median	2.6	14.4	14.4	2.8	13.5	24.8	21.9	42	4.8	4.2	5.2	3.4	4.4	5.6	4.3

Source: Author's calculation "Medians are mentioned in percentages"

Table A-4: High and Low Volatile Commodities

Beef	1
Chicken	1
Egg	1
Milk	0
Garlic	1
Onion	1
Potato	1
Tomato	1
Pulse Mash	0
Pulse Masoor	0
Pulse Moong	0
Rice IRI	0
Wheat	0
Sugar	1
Tea	0
Median (in %)	8.5

Source: Author's calculation

Table A-5: ARCH- LM TEST

City	P-Value							
	Beef	Chicken	Egg	Milk	Garlic	Onion	Potato	Tomato
Bahawalpur	0.0062	0	0.0003	0	0.333*	0	0	0.31*
Faisalabad	0.0031	0.0001	0	0	0	0	0	0
Hyderabad	0	0	0	0	0	0.006	0	0
Islamabad	0	0.12*	0	0	0	0	0.0018	0
Karachi	0	0	0	0	0	0	0.056*	0
Khuzdar	0.0864*	0.0017	0	0.39*	0	0	0	0
Lahore	0.017	0	0.047	0	0	0.7*	0.001	0
Multan	0	0.0008	0	0	0.028	0	0.8*	0.0071
Peshawar	0	0.0043	0	0	0	0.0001	0	0
Quetta	0.86*	0	0	0	0	0	0	0
Rawalpindi	0	0	0	0	0	0	0.0001	0
Sargodha	0	0	0	0	0.001	0	0.0003	0
Sialkot	0	0	0.045	0	0.0003	0.48*	0.0001	0
Sukkur	0.186*	0.0003	0	0	0	0	0.0002	0.45*

City	P-Value						
	Pulse Mash	Pulse Masoor	Pulse Moong	Wheat	Rice IRI	Tea	Sugar
Bahawalpur	0	0.88*	0.38*	0	0	0	0.022
Faisalabad	0	0	0.008	0.007	0	0	0.0005
Hyderabad	0	0	0.29*	0.013	0	0	0
Islamabad	0	0	0.007	0	0	0	0.33*
Karachi	0	0.27*	0.0006	0	0	0	0
Khuzdar	0.9*	0	0.0027	0	0.61*	0	0
Lahore	0.32*	0.88*	0	0	0.033	0	0
Multan	0	0.22*	0	0.019	0	0	0
Peshawar	0	0.002	0	0	0	0.22*	0.021
Quetta	0	0.015	0	0	0	0	0.116*
Rawalpindi	0	0.035	0	0	0	0	0
Sargodha	0	0	0	0.12*	0	0	0.012
Sialkot	0	0.0001	0.77*	0	0.2*	0	0.0035
Sukkur	0	0.004	0	0	0.0035	0	0

Source: Author's calculation, *p-values are greater than 0.05 showing acceptance of null hypotheses means volatility is not time varying and so on.

Table A-6: ARCH (1) Results

City	P-Value							
	Beef	Chicken	Egg	Milk	Garlic	Onion	Potato	Tomato
Bahawalpur	0.12**	0.31*	0.55*	0.40*		0.41*	0.80*	
Faisalabad	0.24*	0.30**	0.47*	0.21*	0.19*	0.36*	0.27*	0.35*
Hyderabad	0.20**	0.27**	0.48*	0.42*	0.79*	0.19**	0.16**	0.34**
Islamabad	0.35*		0.46*	0.21*	0.88*	0.50*	0.28**	0.51*
Karachi	0.32*	0.31*	0.55*	0.22*	0.66*	0.27*		0.35*
Khuzdar		0.14**	0.42*		0.60*	0.11*	0.30**	0.30**
Lahore	0.44*	0.16*	0.53*	0.98*	0.24*		0.20**	0.42*
Multan	0.18**	0.31**	0.56*	0.48*	0.24**	0.31*		0.51*
Peshawar	0.61*	0.25**	0.45*	0.36*	0.39*	0.22**	0.13*	0.44*
Quetta		0.90*	0.35*	0.55*	0.03*	0.37*	0.11*	0.50*
Rawalpindi	0.70*	0.19**	0.13**	0.13*	0.26*	0.38**	0.29*	0.30*
Sargodha	0.22*	0.33*	0.50*	0.24**	0.22*	0.30**	0.24*	0.55*
Sialkot	0.24*	0.30**	0.18*	0.20*	0.23*		0.29**	0.50*
Sukkur		0.26**	0.51*	0.42*	0.24**	0.47*	0.25*	
City	P-Value							
	Pulse Mash	Pulse Moong	Pulse Masoor	Rice IRI	Wheat	Sugar	Tea	
Bahawalpur	0.14*			0.41*	0.13*	0.21*	0.45*	
Faisalabad	0.18*	0.28**	0.16*	0.46*	0.28*	0.29**	0.48*	
Hyderabad	0.59*		0.32*	0.58*	0.32*	0.28*	0.56*	
Islamabad	0.42*	0.29*	0.22*	0.32*	0.50*		0.27*	
Karachi	0.15*	0.19*		0.91*	0.33*	0.38*	0.55*	
Khuzdar		0.11**	0.22*		0.53*	0.14**	0.52*	
Lahore		0.34*		0.60*	0.17*	0.27*	0.42*	
Multan	0.10*	0.70*		0.32*	0.30*	0.55*	0.48*	
Peshawar	0.12*	0.48*	0.17**	0.82*	0.28*	0.46*		
Quetta	0.22**	0.52**	0.26*	0.22*	0.69*		0.44*	
Rawalpindi	0.35*	0.53*	0.22*	0.27*	0.70*	0.32*	0.17*	
Sargodha	0.16**	0.39**	1.10*	0.40*		0.29**	0.48*	
Sialkot	0.30*		0.30*		0.86*	0.36*	0.54*	
Sukkur	0.23*	0.40*	0.18*	0.59*	0.21**	0.27**	0.43*	

Source: Author's calculation, '*'and '**' represents significant at 1%and 5% respectively.

Table A-7: GARCH (1,1) Results for Meat Group

	BEEF			CHICKEN		
City	ARCH COEFFICIENT (α)	GARCH COEFFICENT (β)	α + β	ARCH COEFFICIENT (α)	GARCH COEFFICENT (β)	α + β
Bahawalpur	0.104**	0.720*	0.824	0.317*	-0.056	0.261
Faisalabad	0.703*	0.047**	0.75	0.296**	0.011	0.307
Hyderabad	0.156*	0.753*	0.909	0.265**	0.037	0.302
Islamabad	0.562*	0.303*	0.866			
Karachi	0.241*	0.477*	0.718	0.304*	-0.041	0.262
Khuzdar				0.115**	0.550*	0.665
Lahore	0.504*	0.169**	0.673	0.157*	0.077	0.234
Multan	0.114*	0.629*	0.743	0.310**	0.002	0.312
Peshawar	0.514*	0.358*	0.872	0.242**	0.11	0.352
Quetta			0.358	0.093**	0.904*	0.997
Rawalpindi	0.195*	0.534*	0.728	0.192**	-0.114	0.078
Sargodha	0.165*	0.161*	0.325	0.150*	0.600**	0.75
Sialkot	0.348*	0.298*	0.646	0.285**	-0.313	-0.03
Sukkur				0.276**	0.239	0.515

Source: Author's calculation, '*'and '**' represents significant at 1%and 5% respectively.

Table A-8: GARCH (1,1) Results for Dairy Group

	EGG			MILK		
City	ARCH COEFFICIENT (α)	GARCH COEFFICENT (β)	α + β	ARCH COEFFICIENT (α)	GARCH COEFFICENT (β)	α + β
Bahawalpur	0.561*	0.043	0.603	0.220**	0.339*	0.559
Faisalabad	0.445*	-0.163	0.281	0.155*	0.470*	0.625
Hyderabad	0.481*	0.031	0.513	0.324*	0.405*	0.729
Islamabad	0.418*	-0.19	0.227	0.215*	0.018	0.233
Karachi	0.553*	-0.02	0.533	0.158*	0.784*	0.942
Khuzdar	0.430*	-0.124	0.307			
Lahore	0.469*	0.04	0.509	0.081*	0.746*	0.827
Multan	0.556*	0.083	0.638	0.351*	0.005*	0.356
Peshawar	0.447*	-0.017	0.431	0.143*	0.847*	0.99
Quetta	0.183*	0.743*	0.926	0.769*	0.074*	0.842
Rawalpindi	0.135*	-0.055	0.08	0.124*	-0.194	-0.07
Sargodha	0.513*	0.153	0.666	0.727*	0.002	0.73
Sialkot	0.269*	0.237	0.507	0.209**	-0.02	0.189
Sukkur	0.526*	0.075	0.601	0.150**	0.600*	0.75

Source: Author's calculation, '*'and '**' represents significant at 1%and 5% respectively

Table A-9: GARCH (1,1) Results for Vegetable Group

City	GARLIC ARCH COEFFICIENT (α)	GARLIC GARCH COEFFICENT (β)	GARLIC α + β	ONION ARCH COEFFICIENT (α)	ONION GARCH COEFFICENT (β)	ONION α + β
Bahawalpur				0.410*	0.117	0.526
Faisalabad	0.093*	0.649*	0.742	0.361*	0.19	0.551
Hyderabad	0.283*	0.628*	0.911	0.186**	0.251	0.437
Islamabad	0.545*	0.05	0.595	0.498*	0.011	0.509
Karachi	0.682*	-0.009	0.673	0.282*	0.116	0.398
Khuzdar	0.482*	0.289	0.771	0.105*	0.069	0.174
Lahore	0.319*	0.241	0.56			
Multan	0.354*	0.355*	0.709	0.317*	0.16	0.478
Peshawar	0.150*	0.600*	0.75	0.218**	0.009	0.228
Quetta	0.338*	0.416*	0.754	0.370*	0.002	0.372
Rawalpindi	0.248*	0.106	0.354	0.447*	0.636*	1.083
Sargodha	0.284*	-0.192	0.092	0.300**	0.013	0.314
Sialkot	0.256*	-0.19	0.066			
Sukkur	0.843*	0.221**	1.064	0.434*	0.405*	0.839

City	POTATO ARCH COEFFICIENT (α)	POTATO GARCH COEFFICENT (β)	POTATO α + β	TOMATO ARCH COEFFICIENT (α)	TOMATO GARCH COEFFICENT (β)	TOMATO α + β
Bahawalpur	0.694*	0.239*	0.932			
Faisalabad	0.279*	0.173	0.452	0.350*	-0.086	0.264
Hyderabad	0.161**	-0.069	0.091	0.348**	-0.117	0.232
Islamabad	0.274**	-0.136	0.137	0.511*	0.053	0.564
Karachi			0	0.440*	-0.391	0.049
Khuzdar	0.298**	0.136	0.434	0.201**	0.708*	0.909
Lahore	0.236*	-0.315	-0.079	0.425*	0.036	0.461
Multan			0	0.576*	0.125	0.701
Peshawar	0.131*	0.037	0.169	0.437*	0.009	0.446
Quetta	0.109*	-0.069	0.04	0.477*	-0.146	0.331
Rawalpindi	0.287*	0.043	0.33	0.303*	0.004	0.307
Sargodha	0.233*	-0.038	0.195	0.510*	0.097	0.607
Sialkot	0.286**	0.244	0.53	0.496*	0.096	0.592
Sukkur	0.312*	-0.218	0.094			

Source: Author's calculation, '*'and '**' represents significant at 1%and 5% respectively

Table A-10: GARCH (1,1) Results for Cereal and Pulses Group

	PULSE MASH			PULSE MASOOR		
City	ARCH COEFFICIENT (α)	GARCH COEFFICENT (β)	α + β	ARCH COEFFICIENT (α)	GARCH COEFFICENT (β)	α + β
Bahawalpur	0.081*	0.821*	0.902			
Faisalabad	0.138*	0.868*	1.006	0.273*	0.519*	0.792
Hyderabad	0.660*	0.373*	1.033	0.291*	0.255*	0.546
Islamabad	0.340*	0.667*	1.007	0.212*	-0.019	0.193
Karachi	0.145*	0.401*	0.546			
Khuzdar				0.184*	0.726*	0.91
Lahore						
Multan	0.076*	0.794*	0.87			
Peshawar	0.109*	0.814*	0.924	0.069**	0.890*	0.959
Quetta	0.232*	-0.004	0.228	0.067**	0.917*	0.984
Rawalpindi	0.251*	0.767*	1.019	0.231*	0.616*	0.847
Sargodha	0.177**	0.426**	0.603	0.599*	0.506*	1.106
Sialkot	0.339*	-0.117	0.222	0.184*	0.788*	0.972
Sukkur	0.199*	-0.203	- 0.004	0.376*	0.577*	0.953
	PULSE MOONG			RICE IRI		
City	ARCH COEFFICIENT (α)	GARCH COEFFICENT (β)	α + β	ARCH COEFFICIENT (α)	GARCH COEFFICENT (β)	α + β
Bahawalpur				0.143*	0.780*	0.923
Faisalabad	0.291*	0.681*	0.97	0.145*	0.693*	0.839
Hyderabad				0.562*	0.378*	0.94
Islamabad	0.231*	0.748*	0.98	0.174*	0.727*	0.901
Karachi	0.244*	0.584*	0.83	0.150**	0.600**	0.75
Khuzdar	0.079*	0.822*	0.90			
Lahore	0.341*	0.373*	0.71	0.702*	0.233*	0.935
Multan	0.584*	0.388*	0.97	0.239*	0.447*	0.686
Peshawar	0.478*	0.402*	0.88	0.226*	0.813*	1.038
Quetta	0.523**	0.056	0.58	0.165*	0.417*	0.581
Rawalpindi	0.575*	0.208*	0.78	0.327**	0.501*	0.828
Sargodha	0.391**	0.284	0.68	0.343*	0.449*	0.792
Sialkot						
Sukkur	0.373*	0.553*	0.93	0.139*	0.868*	1.007

Source : Author’s calculation, ‘*’and ‘**’ represents significant at 1%and 5% respectively

Table A-11: GARCH (1,1) Results for Cereal and Pulses Group

	WHEAT		
City	ARCH COEFFICIENT (α)	GARCH COEFFICENT (β)	α + β
Bahawalpur	0.109*	0.640*	0.749
Faisalabad	0.201*	0.683*	0.884
Hyderabad	0.318*	0.627*	0.945
Islamabad	0.453*	0.510*	0.963
Karachi	0.437*	0.540*	0.976
Khuzdar	0.322*	0.425*	0.748
Lahore	0.319*	0.532*	0.851
Multan	0.160*	0.692*	0.852
Peshawar	0.144*	0.726*	0.87
Quetta	0.279*	0.696*	0.975
Rawalpindi	0.580*	0.425*	1.005
Sargodha			
Sialkot	0.779**	0.161*	0.94
Sukkur	0.286**	0.577*	0.863

Source: Author's calculation, '*'and '**' represents significant at 1%and 5% respectively

Table A-12: GARCH (1,1) Results for Other Group

	SUGAR			TEA		
City	ARCH COEFFICIENT (α)	GARCH COEFFICENT (β)	α + β	ARCH COEFFICIENT (α)	GARCH COEFFICENT (β)	α + β
Bahawalpur	0.139**	0.456	0.595	0.343*	0.615*	0.958
Faisalabad	0.288**	0.008	0.296	0.298*	0.589*	0.887
Hyderabad	0.278*	0.002	0.280	0.363*	0.573*	0.936
Islamabad				0.139*	0.698*	0.836
Karachi	0.192*	0.647*	0.838	0.379*	0.587*	0.966
Khuzdar	0.128**	0.249	0.377	0.276*	0.625*	0.902
Lahore	0.196**	0.363	0.559	0.371*	0.615*	0.987
Multan	0.542*	-0.013	0.529	0.346*	0.605*	0.951
Peshawar	0.492*	0.092	0.585			
Quetta				0.208*	0.702*	0.91
Rawalpindi	0.361*	-0.129	0.232	0.178*	0.803*	0.98
Sargodha	0.295**	-0.115	0.180	0.222*	0.702*	0.924
Sialkot	0.293**	0.152	0.446	0.359*	0.608*	0.967
Sukkur	0.254**	-0.111	0.143	0.341*	0.592*	0.933

Source: Author's calculation, '*'and '**' represents significant at 1%and 5% respectively

Table A-13: IGARCH Results for all commodities

Commodity	City	ARCH COEFFICIENT (α)	GARCH COEFFICENT (β)	α + β
Chicken	Quetta	0.08	0.92	1
Milk	Peshawar	0.07	0.93	1
Garlic	Sukkur	0.06	0.94	1
Onion	Rawalpindi	0.16	0.84	1
Pulse Mash	Islamabad	0.12	0.88	1
Pulse Mash	Faisalabad	0.07	0.93	1
Pulse Mash	Hyderabad	0.12	0.88	1
Pulse Mash	Rawalpindi	0.17	0.83	1
Pulse Masoor	Sargodha	0.08	0.92	1
Rice IRI	Peshawar	0.11	0.89	1
Rice IRI	Sukkur	0.07	0.93	1
Wheat	Rawalpindi	0.19	0.80	1

Source: Author's calculation, '*'and '**' represents significant at 1%and 5% respectively

Table A-14: Group Unit Root Test (First Difference)

Variables	Lags	P-Values
Vegetable Group		
(a) Onion		
Method	Statistic	Probabilities
ADF - Fisher Chi-square	592.357	0.0000
ADF - Choi Z-stat	-23.5522	0.0000
Domestic Price	0	0.0000
Exchange Rate	0	0.0000
Interest Rate	1	0.0000
Oil Price	0	0.0000
Production	0	0.0000
(b) Tomato		
Method	Statistic	Probabilities
ADF - Fisher Chi-square	543.860	0.0000
ADF - Choi Z-stat	-22.3832	0.0000
Domestic Price	6	0.0000
Exchange Rate	0	0.0000
Interest Rate	1	0.0000
Oil Price	0	0.0000
Production	0	0.0000
International Price	9	0.0000
(c) Garlic		
Method	Statistic	Probabilities
ADF - Fisher Chi-square	443.085	0.0000
ADF - Choi Z-stat	-20.3277	0.0000
Domestic Price	0	0.0000
Exchange Rate	0	0.0000
Interest Rate	1	0.0000
Oil Price	0	0.0000

(d) Potato		
Method	Statistic	Probabilities
ADF - Fisher Chi-square	549.063	0.0000
ADF - Choi Z-stat	-22.5697	0.0000
Domestic Price	6	0.0000
Exchange Rate	0	0.0000
Interest Rate	1	0.0000
Oil Price	0	0.0000
Production	0	0.0000
Meat Group		
(a) Beef		
Method	Statistic	Probabilities
ADF - Fisher Chi-square	727.967	0.0000
ADF - Choi Z-stat	-26.0537	0.0000
Domestic Price	0	0.0000
Exchange Rate	0	0.0000
Interest Rate	1	0.0000
Oil Price	0	0.0000
Production	0	0.0000
International Price	0	0.0000
(b) Chicken		
Method	Statistic	Probabilities
ADF - Fisher Chi-square	592.152	0.0000
ADF - Choi Z-stat	-21.9616	0.0000
Domestic Price	2	0.0000
Exchange Rate	0	0.0000
Interest Rate	1	0.0000
Oil Price	0	0.0000
Production	11	0.0857
International Price	0	0.0000
Dairy		
(a) Egg		
Method	Statistic	Probabilities
ADF - Fisher Chi-square	428.660	0.0000
ADF - Choi Z-stat	-18.0830	0.0000
Domestic Price	9	0.0000
Exchange Rate	0	0.0000
Interest Rate	1	0.0000
Oil Price	0	0.0000
Production	11	0.0000
(b) Milk		
Method	Statistic	Probabilities
ADF - Fisher Chi-square	612.330	0.0000
ADF - Choi Z-stat	-23.3152	0.0000
Domestic Price	2	0.0000
Exchange Rate	0	0.0000
Interest Rate	1	0.0000
Oil Price	0	0.0000
Production	0	0.0000
International Price	1	0.0000

Cereal & Pulses Group		
(a) Wheat		
Method	Statistics	Probabilities
ADF - Fisher Chi-square	615.707	0.0000
ADF - Choi Z-stat	-22.5829	0.0000
Domestic Price	0	0.0000
Exchange Rate	0	0.0000
Interest Rate	1	0.0000
Oil Price	0	0.0000
Production	11	0.0000
International Price	0	0.0000
Wheat Support Prices	11	
(b) Rice		
Method	Statistics	Probabilities
ADF - Fisher Chi-square	628.433	0.0000
ADF - Choi Z-stat	-24.0702	0.0000
Domestic Price	0	0.0000
Exchange Rate	0	0.0000
Interest Rate	1	0.0000
Oil Price	0	0.0000
Production	0	0.0857
International Price	0	0.0000
(c) Pulse Moong		
Method	Statistics	Probabilities
ADF - Fisher Chi-square	517.882	0.0000
ADF - Choi Z-stat	-21.6735	0.0000
Domestic Price	1	0.0000
Exchange Rate	0	0.0000
Interest Rate	1	0.0000
Oil Price	0	0.0000
Production	0	0.0000
(d) Pulse Mash		
Method	Statistics	Probabilities
ADF - Fisher Chi-square	617.970	0.0000
ADF - Choi Z-stat	-24.0504	0.0000
Domestic Price	0	0.0000
Exchange Rate	0	0.0000
Interest Rate	1	0.0000
Oil Price	0	0.0000
Production	0	0.0000
(e) Pulse Masoor		
Method	Statistics	Probabilities
ADF - Fisher Chi-square	427.919	0.0000
ADF - Choi Z-stat	-19.2625	0.0000
Domestic Price	2	0.0000
Exchange Rate	0	0.0000
Interest Rate	1	0.0000
Oil Price	0	0.0000
Production	0	0.0000
Others Group		
(a) Sugar		
Method	Statistics	Probabilities
ADF - Fisher Chi-square	639.151	0.0000
ADF - Choi Z-stat	-24.3413	0.0000
Domestic Price	1	0.0000
Exchange Rate	0	0.0000
Interest Rate	1	0.0000

Oil Price	0	0.0000
Production	0	0.0000
International Price	0	0.0000
(b) Tea		
Method ADF - Fisher Chi-square ADF - Choi Z-stat	Statistics 488.457 -21.2557	Probabilities 0.0000 0.0000
Domestic Price	1	0.0000
Exchange Rate	0	0.0000
Interest Rate	0	0.0000
Oil Price	0	0.0000
International Price	1	0.0000

Source: Author's calculation

Table A-15: Residual Diagnostic Test/ Model Robustness

Dependent Variables	F^2Stat	R^2	$\chi^2_{Serialcorrelation}$	χ^2_{hetero}	AIC lag selection
Vegetable Group					
log (Onion price)	101.7606***	0.90	0.89	Robust SE (HAC)	(4, 0, 3, 1, 3)
log (tomato price)	49.08887***	0.71	0.80	Robust SE (HAC)	(1, 0, 1, 0, 0, 0)
log (garlic price)	1832.16***	0.98	0.86	Robust SE (HAC)	(2, 2, 0, 0)
log (potato price)	131.8729***	0.94	0.93	Robust SE (HAC)	(4, 4, 5, 4, 0)
Meat Group					
log (beef price)	3840.197***	0.99	0.11	0.93	(4, 0, 0, 1, 0, 0)
log (chicken price)	229.9765***	0.95	0.20	Robust SE (HAC)	(4, 1, 3, 0, 1, 0)
Dairy Group					
log (egg price)	260.0035***	0.94	0.30	0.24	(1, 0, 2, 1, 4)
log (milk price)	31401.96***	0.99	0.81	Robust SE (HAC)	(2, 1, 0, 0, 1, 1)
Cereal & Pulses Group					
log (wheat price)	2575.58***	0.99	0.435	Robust SE (HAC)	(2, 2, 0, 0, 0, 4, 3)
log (rice price)	7057.850***	0.99	0.65	Robust SE (HAC)	(2, 0, 2, 0, 3, 0)
log (Pulse moong price)	4970.500	0.99	0.17	0.13	(3, 0, 0, 0, 2)
log (pulse mash price)	2181.496***	0.99	0.59	Robust SE (HAC)	(3, 0, 5, 0, 1)
log (pulse masoor price)	3847.106***	0.99	0.72	Robust SE (HAC)	(4, 1, 0, 2, 0)
Other Group					
log (sugar price)	552.98***	0.98	0.31	Robust SE (HAC)	(3, 0, 3, 1, 2, 3)
log (tea price)	2804.805***	0.99	0.41	Robust SE (HAC)	(1, 4, 4, 1, 0)

Source: Author's Calculation

Table A-16: Short Run coefficient results

1- Onion

ARDL Error Correction Regression
Dependent Variable: D(LOG_DOMESTIC_ONION_PRICE)
Selected Model: ARDL(4, 0, 3, 1, 3)
Case 2: Restricted Constant and No Trend
Date: 03/01/22 Time: 22:52
Sample: 2002M07 2021M04
Included observations: 222

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_DOMESTIC_ONION_PRICE(-1))	0.263204	0.065474	4.019992	0.0001
D(LOG_DOMESTIC_ONION_PRICE(-2))	0.164573	0.067392	2.442025	0.0155
D(LOG_DOMESTIC_ONION_PRICE(-3))	0.126888	0.068311	1.857493	0.0647
D(LOG_INTERESTRATE)	-0.402843	0.121423	-3.317689	0.0011
D(LOG_INTERESTRATE(-1))	-0.251147	0.131542	-1.909251	0.0576
D(LOG_INTERESTRATE(-2))	-0.227947	0.123138	-1.851154	0.0656
D(LOG_OILPRICE)	-0.164396	0.138085	-1.190544	0.2352
D(LOG_PRODUCTION)	0.731073	0.472104	1.548541	0.1230
D(LOG_PRODUCTION(-1))	0.318318	0.471672	0.674872	0.5005
D(LOG_PRODUCTION(-2))	1.565533	0.468465	3.341839	0.0010
P1	-0.401215	0.060654	-6.614869	0.0000
P2	-0.154287	0.035738	-4.317228	0.0000
P3	-0.063871	0.026093	-2.447833	0.0152
CointEq(-1)*	-0.349545	0.048949	-7.141035	0.0000

R-squared	0.261443	Mean dependent var	0.003852
Adjusted R-squared	0.215283	S.D. dependent var	0.221489
S.E. of regression	0.196204	Akaike info criterion	-0.358334
Sum squared resid	8.007191	Schwarz criterion	-0.143751
Log likelihood	53.77510	Hannan-Quinn criter.	-0.271699
Durbin-Watson stat	1.995908		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	8.294759	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

2- Tomato

ARDL Error Correction Regression

Dependent Variable: D(LOG_DOMESTIC_TOMATO_PRICES)

Selected Model: ARDL(1, 0, 1, 0, 0, 0)

Case 2: Restricted Constant and No Trend

Date: 03/01/22   Time: 22:37

Sample: 2002M07 2021M04

Included observations: 203

ECM Regression

Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_INTERESTRATE)	-0.754049	0.170927	-4.411527	0.0000
P1	-0.589483	0.086824	-6.789408	0.0000
P2	-0.361164	0.060952	-5.925348	0.0000
P3	-0.313846	0.055783	-5.626240	0.0000
CointEq(-1)*	-0.412506	0.053936	-7.648106	0.0000

R-squared	0.297166	Mean dependent var	0.005351
Adjusted R-squared	0.282967	S.D. dependent var	0.351528
S.E. of regression	0.297667	Akaike info criterion	0.438636
Sum squared resid	17.54386	Schwarz criterion	0.520242
Log likelihood	-39.52157	Hannan-Quinn criter.	0.471651
Durbin-Watson stat	1.939690		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	8.102999	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

3- Potato

ARDL Error Correction Regression
Dependent Variable: D(LOG_DOMESTIC_POTATO_PRICES)
Selected Model: ARDL(4, 4, 5, 4, 0)
Case 2: Restricted Constant and No Trend
Date: 02/28/22 Time: 22:18
Sample: 2002M07 2021M04
Included observations: 221

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_DOMESTIC_POTATO_PRICES(-1))	0.361678	0.060532	5.974960	0.0000
D(LOG_DOMESTIC_POTATO_PRICES(-2))	0.051254	0.064994	0.788594	0.4313
D(LOG_DOMESTIC_POTATO_PRICES(-3))	0.116443	0.063731	1.827085	0.0692
D(LOG_EXCHANGERATE)	1.515590	0.641585	2.362258	0.0191
D(LOG_EXCHANGERATE(-1))	-0.596664	0.664823	-0.897478	0.3706
D(LOG_EXCHANGERATE(-2))	-0.385382	0.659401	-0.584442	0.5596
D(LOG_EXCHANGERATE(-3))	1.499199	0.640834	2.339449	0.0203
D(LOG_INTERESTRATE)	-0.254831	0.087492	-2.912617	0.0040
D(LOG_INTERESTRATE(-1))	-0.227075	0.095248	-2.384042	0.0181
D(LOG_INTERESTRATE(-2))	-0.247158	0.095167	-2.597095	0.0101
D(LOG_INTERESTRATE(-3))	-0.026306	0.093669	-0.280842	0.7791
D(LOG_INTERESTRATE(-4))	-0.344141	0.085118	-4.043126	0.0001
D(LOG_OILPRICE)	-0.065174	0.102338	-0.636853	0.5250
D(LOG_OILPRICE(-1))	0.155346	0.108326	1.434063	0.1531
D(LOG_OILPRICE(-2))	-0.081600	0.108763	-0.750253	0.4540
D(LOG_OILPRICE(-3))	0.226070	0.105645	2.139913	0.0336
P1	-0.333672	0.048528	-6.875872	0.0000
P2	-0.226715	0.036918	-6.140956	0.0000
P3	-0.109945	0.023693	-4.640361	0.0000
CointEq(-1)*	-0.244828	0.034278	-7.142469	0.0000

R-squared	0.410877	Mean dependent var	0.005736
Adjusted R-squared	0.355189	S.D. dependent var	0.169045
S.E. of regression	0.135744	Akaike info criterion	-1.069958
Sum squared resid	3.703699	Schwarz criterion	-0.762432
Log likelihood	138.2304	Hannan-Quinn criter.	-0.945785
Durbin-Watson stat	2.000867		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	8.290972	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

4- Beef

ARDL Error Correction Regression

Dependent Variable: D(LOG_DOMESTIC_BEEF_PRICE)

Selected Model: ARDL(4, 0, 0, 1, 0, 0)

Case 2: Restricted Constant and No Trend

Date: 03/02/22 Time: 19:36

Sample: 2002M07 2021M04

Included observations: 222

ECM Regression

Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_DOMESTIC_BEEF_PRICE(-1))	-0.640265	0.063103	-10.14628	0.0000
D(LOG_DOMESTIC_BEEF_PRICE(-2))	-0.381343	0.073033	-5.221512	0.0000
D(LOG_DOMESTIC_BEEF_PRICE(-3))	-0.213329	0.063359	-3.366981	0.0009
D(LOG_OILPRICE)	0.047200	0.026470	1.783124	0.0760
P1	-0.065784	0.016597	-3.963697	0.0001
P2	-0.026467	0.010828	-2.444313	0.0153
P3	-0.037509	0.009667	-3.880252	0.0001
CointEq(-1)*	-0.123140	0.021525	-5.720803	0.0000

R-squared	0.405542	Mean dependent var	0.009877
Adjusted R-squared	0.386097	S.D. dependent var	0.049177
S.E. of regression	0.038531	Akaike info criterion	-3.639319
Sum squared resid	0.317718	Schwarz criterion	-3.516700
Log likelihood	411.9644	Hannan-Quinn criter.	-3.589813
Durbin-Watson stat	2.045895		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	4.544285	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

5- Chicken

ARDL Error Correction Regression
Dependent Variable: D(LOG_DOMESTIC_CHICKEN_PRICE)
Selected Model: ARDL(4, 1, 3, 0, 1, 0)
Case 2: Restricted Constant and No Trend
Date: 03/02/22 Time: 18:27
Sample: 2002M07 2021M04
Included observations: 222

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_DOMESTIC_CHICKEN_PRICE(-1))	0.220526	0.068875	3.201840	0.0016
D(LOG_DOMESTIC_CHICKEN_PRICE(-2))	0.046846	0.063341	0.739591	0.4604
D(LOG_DOMESTIC_CHICKEN_PRICE(-3))	-0.207603	0.060512	-3.430779	0.0007
D(LNEXCHANGE_RATE)	1.504946	0.437883	3.436871	0.0007
D(LOG_INTERESTRATE)	-0.281170	0.057883	-4.857585	0.0000
D(LOG_INTERESTRATE(-1))	-0.137129	0.064316	-2.132125	0.0342
D(LOG_INTERESTRATE(-2))	-0.102434	0.060674	-1.688281	0.0929
D(LOG_INTERNATIONAL_CHICKEN_PRICE)	0.517944	0.138355	3.743594	0.0002
P1	-0.074722	0.017690	-4.223987	0.0000
P2	0.043713	0.013669	3.197887	0.0016
P3	0.015706	0.012464	1.260065	0.2091
CointEq(-1)*	-0.493269	0.075443	-6.538344	0.0000

R-squared	0.448821	Mean dependent var	0.008558
Adjusted R-squared	0.419949	S.D. dependent var	0.127140
S.E. of regression	0.096831	Akaike info criterion	-1.779159
Sum squared resid	1.969015	Schwarz criterion	-1.595230
Log likelihood	209.4866	Hannan-Quinn criter.	-1.704900
Durbin-Watson stat	2.058745		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.932645	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

6- Egg

ARDL Error Correction Regression
Dependent Variable: D(LOG_DOMESTIC_EGG_PRICES)
Selected Model: ARDL(1, 0, 2, 1, 4)
Case 2: Restricted Constant and No Trend
Date: 03/02/22 Time: 00:19
Sample: 2002M07 2021M04
Included observations: 222

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_EXCHANGERATE)	0.032970	0.555398	0.059363	0.9527
D(LOG_EXCHANGERATE(-1))	1.106785	0.566700	1.953035	0.0522
D(LOG_OILPRICE)	-0.073238	0.084911	-0.862521	0.3894
D(LOG_PRODUCTION_EGG)	2.492709	0.492852	5.057721	0.0000
D(LOG_PRODUCTION_EGG(-1))	0.563083	0.495211	1.137057	0.2568
D(LOG_PRODUCTION_EGG(-2))	1.060626	0.494832	2.143407	0.0332
D(LOG_PRODUCTION_EGG(-3))	1.563136	0.497421	3.142479	0.0019
SEASONALDUMMY	0.121015	0.020802	5.817534	0.0000
CointEq(-1)*	-0.370886	0.047334	-7.835516	0.0000

R-squared	0.300675	Mean dependent var	0.006862
Adjusted R-squared	0.274409	S.D. dependent var	0.144986
S.E. of regression	0.123501	Akaike info criterion	-1.305432
Sum squared resid	3.248806	Schwarz criterion	-1.167485
Log likelihood	153.9029	Hannan-Quinn criter.	-1.249737
Durbin-Watson stat	1.909566		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	9.992351	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

7- Milk

ARDL Error Correction Regression

Dependent Variable: D(LOG_DOMESTIC_MILK_PRICES)

Selected Model: ARDL(2, 1, 0, 0, 1, 1)

Case 2: Restricted Constant and No Trend

Date: 03/01/22 Time: 23:44

Sample: 2002M07 2021M04

Included observations: 224

ECM Regression

Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_DOMESTIC_MILK_PRICES(-1))	-0.141593	0.064974	-2.179224	0.0304
D(LOG_EXCHANGERATE)	0.122210	0.065316	1.871052	0.0627
D(LOG_OILPRICE)	0.035044	0.010201	3.435410	0.0007
D(LOG_INTERNATIONAL_MILK_PRICE)	0.021271	0.011218	1.896199	0.0593
CointEq(-1)*	-0.008780	0.001046	-8.394350	0.0000

R-squared	0.125374	Mean dependent var	0.007926
Adjusted R-squared	0.109399	S.D. dependent var	0.015756
S.E. of regression	0.014869	Akaike info criterion	-5.557016
Sum squared resid	0.048418	Schwarz criterion	-5.480864
Log likelihood	627.3858	Hannan-Quinn criter.	-5.526277
Durbin-Watson stat	1.978323		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	9.790651	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

8- Wheat

ARDL Error Correction Regression
Dependent Variable: D(LNDOMESTIC_WHEAT_PRICE)
Selected Model: ARDL(2, 2, 0, 0, 0, 4, 3)
Case 2: Restricted Constant and No Trend
Date: 02/25/22 Time: 01:22
Sample: 2002M07 2021M04
Included observations: 222

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNDOMESTIC_WHEAT_PRICE(-1))	0.267274	0.058151	4.596204	0.0000
D(LNEXCHANGE_RATE)	0.058445	0.148191	0.394388	0.6937
D(LNEXCHANGE_RATE(-1))	0.276881	0.154337	1.793998	0.0743
D(LNPRODUCTION)	-0.017795	0.119306	-0.149153	0.8816
D(LNPRODUCTION(-1))	0.348951	0.120356	2.899334	0.0042
D(LNPRODUCTION(-2))	-0.097523	0.122535	-0.795879	0.4270
D(LNPRODUCTION(-3))	0.280544	0.114529	2.449538	0.0152
D(LNSUPPORT_PRICE)	0.095371	0.051094	1.866569	0.0634
D(LNSUPPORT_PRICE(-1))	-0.188388	0.056504	-3.334067	0.0010
D(LNSUPPORT_PRICE(-2))	-0.080585	0.055935	-1.440675	0.1512
P1	-0.084458	0.010834	-7.795808	0.0000
P2	-0.050082	0.007433	-6.737664	0.0000
P3	-0.009904	0.004272	-2.318214	0.0214
CointEq(-1)*	-0.326844	0.036543	-8.944094	0.0000

R-squared	0.359922	Mean dependent var	0.008475
Adjusted R-squared	0.319917	S.D. dependent var	0.039506
S.E. of regression	0.032579	Akaike info criterion	-3.949293
Sum squared resid	0.220773	Schwarz criterion	-3.734709
Log likelihood	452.3715	Hannan-Quinn criter.	-3.862657
Durbin-Watson stat	1.928906		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	9.663078	10%	1.99	2.94
k	6	5%	2.27	3.28
		2.5%	2.55	3.61
		1%	2.88	3.99

9- Pulse Mash

ARDL Error Correction Regression

Dependent Variable: D(LOG_DOMESTIC_MASH_PRICES)

Selected Model: ARDL(3, 0, 5, 0, 1)

Case 2: Restricted Constant and No Trend

Date: 03/20/22 Time: 14:20

Sample: 2002M07 2021M04

Included observations: 221

ECM Regression

Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_DOMESTIC_MASH_PRICES(-1))	-0.152043	0.067676	-2.246640	0.0257
D(LOG_DOMESTIC_MASH_PRICES(-2))	0.105092	0.065246	1.610706	0.1088
D(LOG_EXCHANGERATE)	0.079833	0.246732	0.323560	0.7466
D(LOG_EXCHANGERATE(-1))	-0.431372	0.254261	-1.696575	0.0913
D(LOG_EXCHANGERATE(-2))	0.195522	0.259260	0.754155	0.4516
D(LOG_EXCHANGERATE(-3))	0.657868	0.256929	2.560503	0.0112
D(LOG_EXCHANGERATE(-4))	0.561812	0.255590	2.198097	0.0291
D(LOG_PRODUCTION)	0.190138	0.103129	1.843686	0.0667
CointEq(-1)*	-0.039504	0.008631	-4.577131	0.0000

R-squared	0.167746	Mean dependent var	0.008577
Adjusted R-squared	0.136340	S.D. dependent var	0.058484
S.E. of regression	0.054351	Akaike info criterion	-2.946828
Sum squared resid	0.626259	Schwarz criterion	-2.808442
Log likelihood	334.6245	Hannan-Quinn criter.	-2.890950
Durbin-Watson stat	2.021585		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.409337	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

10- Sugar

ARDL Error Correction Regression
Dependent Variable: D(LOG_DOMESTIC_SUGAR_PRICES)
Selected Model: ARDL(3, 0, 3, 2, 1, 3)
Case 2: Restricted Constant and No Trend
Date: 03/20/22 Time: 00:04
Sample: 2002M07 2021M04
Included observations: 223

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_DOMESTIC_SUGAR_PRICES(-1))	-0.219462	0.064197	-3.418574	0.0008
D(LOG_DOMESTIC_SUGAR_PRICES(-2))	0.144759	0.063635	2.274813	0.0240
D(LOG_INTERESTRATE)	-0.020412	0.039177	-0.521014	0.6029
D(LOG_INTERESTRATE(-1))	-0.057522	0.041494	-1.386256	0.1672
D(LOG_INTERESTRATE(-2))	0.055681	0.039431	1.412110	0.1595
D(LOG_INTERNATIONAL_SUGAR_PRICE)	0.220227	0.125620	1.753120	0.0811
D(LOG_INTERNATIONAL_SUGAR_PRICE(-1))	0.238624	0.128952	1.850489	0.0657
D(LOG_OILPRICE)	-0.043531	0.045554	-0.955581	0.3404
D(LOG_PRODUCTION)	0.098631	0.124500	0.792216	0.4292
D(LOG_PRODUCTION(-1))	0.318871	0.126608	2.518563	0.0126
D(LOG_PRODUCTION(-2))	0.292025	0.129209	2.260097	0.0249
P1	-0.119453	0.026158	-4.566581	0.0000
P2	-0.054317	0.015203	-3.572868	0.0004
P3	-0.032092	0.010067	-3.187885	0.0017
CointEq(-1)*	-0.133280	0.027021	-4.932450	0.0000

R-squared	0.280158	Mean dependent var	0.006631
Adjusted R-squared	0.231707	S.D. dependent var	0.072740
S.E. of regression	0.063758	Akaike info criterion	-2.602551
Sum squared resid	0.845536	Schwarz criterion	-2.373369
Log likelihood	305.1844	Hannan-Quinn criter.	-2.510031
Durbin-Watson stat	2.045697		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.375323	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

11- Tea

ARDL Error Correction Regression
Dependent Variable: D(LOG_DOMESTIC_TEA_PRICES)
Selected Model: ARDL(1, 4, 4, 1, 0)
Case 2: Restricted Constant and No Trend
Date: 03/01/22 Time: 23:22
Sample: 2002M07 2021M04
Included observations: 216

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_EXCHANGERATE)	0.507702	0.147503	3.441990	0.0007
D(LOG_EXCHANGERATE(-1))	-0.135443	0.152923	-0.885699	0.3769
D(LOG_EXCHANGERATE(-2))	0.053160	0.150842	0.352422	0.7249
D(LOG_EXCHANGERATE(-3))	-0.467792	0.148750	-3.144810	0.0019
D(LOG_INTERESTRATE)	-0.069187	0.059201	-1.168675	0.2439
D(LOG_INTERESTRATE(-1))	-0.257865	0.062668	-4.114749	0.0001
D(LOG_INTERESTRATE(-2))	-0.256228	0.064101	-3.997233	0.0001
D(LOG_INTERESTRATE(-3))	-0.165645	0.064744	-2.558482	0.0113
D(LOG_INTERNATIONAL_TEA_PRICE)	-0.047595	0.032762	-1.452735	0.1479
P1	-0.024181	0.004645	-5.206078	0.0000
P2	-0.029880	0.006146	-4.862005	0.0000
P3	-0.006542	0.004145	-1.578306	0.1161
CointEq(-1)*	-0.241562	0.025199	-9.586254	0.0000

R-squared	0.387728	Mean dependent var	0.005174
Adjusted R-squared	0.351535	S.D. dependent var	0.038822
S.E. of regression	0.031262	Akaike info criterion	-4.034530
Sum squared resid	0.198394	Schwarz criterion	-3.831388
Log likelihood	448.7292	Hannan-Quinn criter.	-3.952460
Durbin-Watson stat	2.212518		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	14.93880	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37