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AN EMPIRICAL ANALYSIS OF MACROECONOMIC DETERMINANTS OF FOOD INFLATION IN PAKISTAN

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ABSTRACT

This study is an attempt to explore the factors affecting food inflation in Pakistan. the study examine the impact of money supply growth, population growth, interest rate, exchange rate, Per capita GDP growth, energy prices growth, incidence of natural disaster, and aggregate consumption expenditure on food inflation. The data spans the period from 1980 to 2019. The study uses Autoregressive Distributed lag (ARDL) model for short run and ARDL Bound Testing approach for long run estimates. In the short run, food inflation is significantly influenced by its lagged values (showing a dampening effect), per capita GDP, money supply growth, natural disasters, real interest rates, energy prices, and consumption expenditure. Lagged inflation and consumption expenditure have stabilizing effects, while the other variables, particularly GDP, money supply, and natural disasters, drive inflation upward. In the long run, similar factors like GDP, money supply growth, natural disasters, real interest rates, and consumption expenditure play significant roles. However, GDP and natural disasters show more pronounced effects, while real interest rates exhibit a negative influence. Unlike the short run, energy prices are not statistically significant in the long run. These findings emphasize the varying impacts of macroeconomic variables and shocks over different time horizons.

Keywords:*Food inflation, GDP per capita growth, Macroeconomic determinants, Energy prices*

INTRODUCTION

According to study by Food and Agriculture Organization (FAO, 2009) food commodity values on international markets rose modestly in the early 2000s until reaching alarmingly high stages from 2006 to the middle of 2008. These high rises raised concerns about the global food economy's capacity to feed billions of people in the present and future. Globally, more than 820 million people are hungry, highlighting the enormous challenge of attaining the Zero Hunger objective by 2030. (FAO, 2019). The heighted food price further exacerbate the state of food insecurity and assert challenge to global communities.

High food prices are a problem for many poor countries that have to import food for their populations. The irregular food access is associated with high food prices in the primary and secondary markets. In the Eastern Africa it is estimated that more than 17 million people face problem of food insecurity which among other factors is associated

with the food price inflation (UNCTAD, 2017). Higher costs certainly bite hard in these scenarios, especially for impoverished families, causing them to cut back on the number of meals they eat, buy cheaper and less nutritious food, and spend less on social requirements like schooling and medical (FAO, 2019).

Food price increases are causing concern among governments and policymakers in both developed and developing nations, as well as their impact on the economy and consumers. Pakistan has not been spared the impacts of the war. Pakistan, being a developing country, faces price issues in the food sector. Controlling the food item is the more difficult challenge. Food price increases require special attention since they reduce the well-being of disadvantaged families (Loening et al., 2008). In 2014, 94.6 percent of all families spent more on food than on any other spending category, according to the Khazanah Research Institute's State of Households II study. Because lower-income people spend 75% of their income on food, it is most influenced by the economies bad (United Nations, 2008). According to Commodity Research Bureau (2009), inflationary food prices not only lower wellbeing, but they also limit revenue available for other uses, or cause people to eat less, or both. As a result, rising food prices have a substantial influence on low- and middle-income nations' living costs. Worldwide food inflation rates in November 2006 were 16.5 percent and 30.2 percent, respectively.

Food inflation is a typical occurrence in Pakistan, according to Awan and Imran (2015a), because the government continues to raise prices of basic need items. According to Awan and Waqas (2014), one of the biggest problems in emerging countries is rising inflation, which has made the lives of ordinary people unpleasant. According to Awan and Imran (2015b), as a result of feudal engagement in policy decision-making, governments in developing countries are compelled to boost agricultural commodity prices. It affects people of all income levels, especially those with little savings, everybody, from a child to an elder, can be affected by inflation in many ways. According to the National Bureau of Statistics (NBS, 2020), there has been a consistent rise in overall food costs throughout the last decade.

Figure 1 illustrates the dynamic pattern of food inflation in Pakistan from 1980 to approximately 2019, based on data from various rounds of the Economic Survey of Pakistan. In the early 1980s, food inflation was relatively low, starting at 3.93% in 1980 and experiencing moderate fluctuations until the mid-1980s, peaking at 7.9% around 1985. However, the late 1980s saw a significant drop to 2.58%, followed by a sharp increase, reaching 14.15% by 1990. The 1990s were marked by further volatility, with food inflation peaking at 16.49% in 1995 before declining sharply to 2.83% by the late 1990s. The early 2000s witnessed relatively stable and low inflation rates, but after 2005, food inflation rose dramatically, culminating in a record high of 23.7% around 2010. Post-2010, food inflation saw a notable decline, even dropping to negative values (-0.35%) around 2015, before stabilizing at approximately 4.15% by the end of the period. This analysis highlights the high variability in food inflation, with multiple sharp peaks and troughs, reflecting the challenges of maintaining price stability in Pakistan, particularly in the context of food commodities influenced by both domestic and international economic factors. In Pakistan, food inflation is frequently linked to a drop in wheat output, a rise in global food costs, and political economic pressures, and government incompetence. (Anam et al, 2014; Shair et al., 2024). Several previous studies revealed a favourable association between GDP and food inflation, however the majority of the studies found that GDP has a negative impact on inflation. (Ahsan et al, 2011).

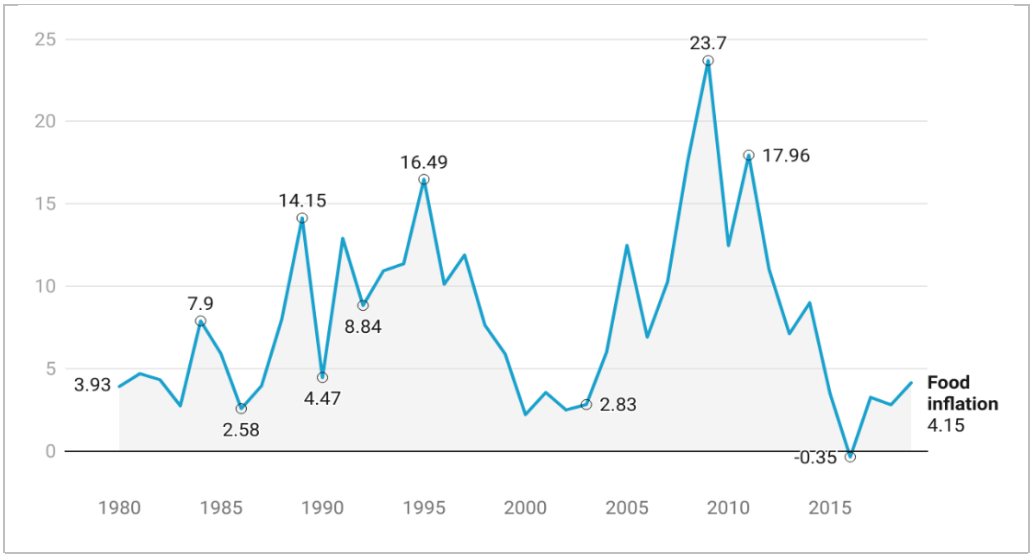


Figure 1. Dynamic pattern of food inflation in Pakistan
Source: Authors' own picture depiction based on different rounds of Economic Survey of Pakistan

The present study is an attempt to explore the factors affecting food inflation in Pakistan. the study examine the impact of money supply growth, population growth, interest rate, exchange rate, Per capita GDP growth, energy prices growth, incidence of natural disaster, and aggregate consumption expenditure on food inflation. These are some supply side factors, while others have demand side impact on the food inflation. The findings of study provides insights for policymakers to stabilize food prices, protect vulnerable populations, and foster economic development. Additionally, it contributes to existing literature, offering theoretical advancements and serving as a foundation for future research on inflation dynamics in developing economies like Pakistan.

Literature review

Tang (2001) used the unrestricted error correction model (UECM) to estimate Malaysia's inflation model while looking at the impact of bank lending. Import prices and real-income factors have an influence on Malaysian inflation, according to the model. Concurrent fiscal measures were later shown to have had a significant influence on the naira's depreciation and inflation. In Ethiopia, according to Shahnoushi et al (2009) another research was conducted to examine the elements that impact food inflation. Food prices show granger causality with money supply in long and short run. According to Loening et al (2008), as a consequence, it is self-evident that demand-side factors drive supply-side inflation in the region, as the study indicated that Food inflation in country was mostly driven by supply shocks and producer pricing.

Ularo et al (2010) found that rate of food price inflation in Malawi was significantly influenced by the Crop Diversification Index, fertilizer costs, maize prices, real exchange rates, fuel prices, and real interest rates., according to the findings. Furthermore, exports, imports, real exchange, nominal interest rates, and real interest rates are major determinants of real agricultural production (GDP) and national GDP. Nair and Eapen (2012) found that domestic food prices have been affected by global economic developments, mostly by passing on fluctuations in world oil prices, while imports of high-cost foods played a minor part. World food cost and exchange rates have a positive effect on long-run inflation rates, while money supply and agricultural supply shocks have a positive effect on inflation rates in the short to medium run (Irz et al., 2013; Haji & Gelaw, 2012; Durevall, 2012).

Shaari et al. (2012) found that in the short run, only fluctuations in cost of crude oil have a significant effect on inflation, while exchange rate has no impact. Sekhampu and Dubihlela (2012) found that low-income households are negatively affected by rising food costs, although the extent of the increase

is dependent on numerous socio-economic and demographic factors. Salman et al (2014) exposed various factors that have varied magnitudes of relationships with growing food costs in different conditions, energy prices, exchange rates, and money availability are all harmful effects of rising food prices. Misati and Munene (2015) using gap approaches and Phillips' curve calculations, show the link between food prices and total and non-food non-fuel inflation. For the period 1997-2012, the findings of gap models are used to verify for the occurrence of second-round impacts from food prices to inflation. The Phillips curve estimates a domestic food price pass-through of 0.49% to overall inflation and 0.38% to non-food non-fuel inflation. The pass-through of global food costs to overall inflation and non-food non-fuel inflation is predicted to be 0.09 and 0.08. Adam et al (2016) found that supply-side factors such as crop fluctuations or foreign market arbitrage play a vital significant role in deciding local food and fuel inflation, demand-side factors susceptible to monetary policy interference anchor core inflation. Sekhar et al (2017) suggested that supply and demand-side variables affect food inflation, but supply-side factors tend to have a greater impact. Inim et al (2020) conducted a study to highlight the other factors of inflation in Nigeria. According to the finding that Weak infrastructure growth, political instability, exchange rate, double taxation and corruption significantly stimulate inflation rather than just money supply.

Ahsan et al (2012) concluded that supply side variables have substantial effect on food costs, however, in the long and short term, demand side variables such as money supply are the major source of food price rises. Azeem et al (2012) demonstrated that crude oil price has a positive but statistically negligible influence in long run, but per capita income has a positive and statistically significant effect. In comparison to wheat, food prices are negatively affected by support prices, money availability. Aurangzeb (2012) found that the Inflation was affected by the currency rate, interest rate, budget deficit, and unemployment rate, all of which were positive, whereas GDP had the reverse effect. Shams et al (2013) revealed that macroeconomic variables such as inflation, domestic credit, and exchange rate have a long-run positive association, but GDP has a negative relationship with inflation. Ahmed et al (2013) showed that main causes of inflation in Pakistan were gross domestic product, energy crises, money supply, imports of goods, services, output gap, recent government expenditures and adaptive expectations, whereas development spending had a negative effect on inflation.

The existing set of research according to the best of our knowledge are (Abdullah, Kalim, 2011; Ahsan et al., 2011; Ali et al., 2021; Azeem et al., 2012; Joiya & Shahzad, 2013; Anam et al., 2014; Awan & Imran, 2015a; Rehman & Khan, 2015; Bashir et al., 2016; Qayyum & Sultana, 2018; Afzal & Mian, 2020). These previous studies were conducted on investigating the factor which affects food price inflation in Pakistan. However, these past studies used different and limited variables while ignore the relevant variables which are related to supply and demand side impact such as final consumption expenditure (%GDP), interest rate, and natural disaster.

3. Model and methodology

The current empirical research aims to identify the impact of various factors that impact food inflation in Pakistan. After the inclusion of these variables the general form of the model for this study is:

$$FI = f(M, GDP, ER, R, POP, EP, NDF, CE) \quad (1)$$

So, the econometric form of the model then becomes

$$FI_t = \beta_0 + \beta_1 M_t + \beta_2 GDP_t + \beta_3 ER_t + \beta_4 R_t + \beta_5 POP_t + \beta_6 EP_t + \beta_7 (NDF)_t + \beta_8 CE_t + \varepsilon_t \quad (2)$$

In this study, food inflation (FI), represented by percentage of annual food inflation, is the dependent variable. Independent variables include money supply (M), per capita GDP (Gross Domestic Product), nominal exchange rate (ER), real interest rate (IR), population growth (POP), energy prices (EP, including electricity, gas, and other fuel prices), final consumption expenditure as a percentage of GDP (CE), and natural disasters (ND, such as floods). All the variables are in percentage point unit, except natural disaster, which is a dummy variable coded 1 for the year of disaster and zero otherwise. The time period (T) is incorporated to capture temporal effects, while β represents the slope coefficients for each variable, and μ denotes the error term.

The most often used technique for analysing cointegration long run relationships between variables is Johansen-Juselius (1990). At initial difference, all variables in this model are stationary.

Another restriction of this method is in the situation of a small sample. To avoid the boundaries, use the autoregressive distributed lag approach. This method was developed by Pesaran and Smith (1996), and it was further developed by Pesaran et al. (2001). Various econometric advantages of this strategy have attracted a lot of attention. According to Pesaran, any variables in a version can be fractionally included if they are I (0) and I (1). (1997). In light of the foregoing advantages of the ARDL technique, we propose the following model.

$$\Delta CPI_t = \alpha_0 + \sum_{i=1}^{p} \alpha 1 \Delta CPI_{t-i} \sum_{i=1}^{p} \alpha 2 \Delta CE_{t-1} + \sum_{i=1}^{p} \alpha 3 \Delta M_{t-i} + \sum_{i=1}^{p} \alpha 4 \Delta R_{t-i} + \sum_{i=1}^{p} \alpha 5 \Delta EP_{t-i} + \sum_{i-1}^{p} \alpha 6 \Delta ER_{t-1} + \sum_{i-1}^{p} \alpha 7 \Delta NDF_{t-1} + \sum_{i-1}^{p} \alpha 8 \Delta GDP_{t-1} + \beta 1 CPI_{t-1} \beta 2 EC_{t-1} + \beta 3 M_{t-1} + \beta 4 R_{t-1} + \beta 5 EP_{t-1} + \beta 6 ER_{t-1} + \beta 7 NDF_{t-1} + \beta 8 GDP_{t-1} + \varepsilon_t \quad (3)$$

On the right, the expression form β_1 to β_8 represents the variables' long-term connection, whereas the expression fromα_1 to α_8 with summation signs represents the variables' short-term dynamics. et, on the other hand, is Gaussian white noise and represents drift constant. After a series of phases and methods, ARDL bounds testing produces complete results for short- and long-run dynamics. In the 1st step, Eq (3) will be estimated using the ordinary least square (OLS) approach, and a F test will be used to check if the variables in Eq (3) have a long run relation (2). The null hypothesis in Eq (2) is Ho:$\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = 0$.

This means the absence of long run relationship. While alternative is Ho: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq \beta_7 \neq \beta_8 \neq 0$.

The calculated value is compared to the upper and lower critical values proposed by Pesaran et al (2001). The null hypothesis of no cointegration will be rejected if the estimated F value exceeds the upper critical value (1), regardless of whether the variables are I (0) or I (1). The R^2 criterion will be used in the 2nd step. To estimate long run relationships using the stated ARDL model, use the Hannan Quinn Criterion, Akaike Information Criterion (AIC), and Schwarz Criterion (SBC). The error correction model that follows is calculated in the 3rd step.

$$\Delta CPI_i = \beta_0 + \sum_{i-1}^{p} \alpha i \Delta CPI_{t-i} + \sum_{i-1}^{p} \alpha i CE_{t-i} + \sum_{i-1}^{p} \alpha i M_{t-i} + \sum_{i-1}^{p} \alpha i R_{t-i} + \sum_{i-1}^{p} \alpha i EP_{t-i} + \sum_{i-1}^{p} \alpha i ER_{t-i} + \sum_{i-1}^{p} \alpha i NDF_{t-i} + \sum_{i-1}^{p} \alpha i \Delta GDP_{t-i} + \alpha ECM_{t-1} + \varepsilon_t \quad (4)$$

The speed of adjustment back to long run equilibrium following a short run shock is shown by the error correction model result.

4. Data and Descriptive analysis

4.1 Data Source

The data spans the period from 1980 to 2019 and includes several key variables. The variables used in the analysis include Food Inflation (FI), which represents the percentage change in food prices as per the Economic Survey of Pakistan. Broad Money (M) refers to annual growth in percentage, sourced from the World Development Indicators (WDI). Final Consumption Expenditure (CE) is measured as a percentage, also sourced from WDI. The Real Interest Rate (IR) is expressed as a percentage, with data obtained from WDI. Per Capita GDP growth is represented as a percentage change in GDP and is sourced from WDI. Energy Prices (EP) indicate the percentage change in electricity, gas, and other fuel prices, as reported by the Economic Survey of Pakistan. Lastly, Natural Disasters (ND) are accounted for with a binary variable, where ND equals 1 for years of disaster and 0 otherwise, with data obtained from the Natural Disaster Management Authority and the Pakistan Weather Portal.

4.2 Descriptive statistics

The descriptive statistics of the variables used in the analysis are given in the table 1. The number of observations used in the analysis are 40. The descriptive statistics exhibits that the average value of food inflation is 7.94 with the standard deviation of 5.24 and maximum and minimum values 23.70 and -0.35 respectively. Average value of Energy prices7.99 and with a standard deviation of 4.95. While 20.43, and 0.88, 1.35 are the maximum and minimum values respectively. Whereas the average value of final consumption expenditure (CE) is 88.25 with the stander deviation of 3.80 and maximum and minimum value 94.58 and 82.60 respectively. However, the average value of GDP is 2.10 with the stander deviation of 1.88 and maximum and minimum values of 6.69, and -1.84 respectively. Although the average value of Broad money supply (M) is 15.16 with stander deviation of 6.75 and maximum and minimum value of 42.90 and 4.31 respectively. Whereas the average value of NDF is 0.2 with the stander deviation of 0.40 and maximum and minimum 1 and 0. While the average value of R is 7.22 with stander deviation of 3.77 and maximum

and minimum value of 17 and 1.14 respectively. The probability value of EP, GDP, CE, and R is greater than 0.05 which shows that residuals are normal and insignificant. Null hypothesis is accepted because the data is normal and insignificant. If the probability value is less than 0.05 it means that residuals are not normal.FI value shows normal skewness & mesokurtic because FI value is 3.51 = 3 its mean that distribution is symmetric around its mean.

Energy prices value shows that skewness is normal and platykurtic because 2.47< 3. Final consumption expenditure skewed is negative and platykurtic because final consumption expenditure value is less than 3(1.60<3). Per capita GDP value is less than 3 (2.67<3) has long left tail, lower value with negative skewed and platykurtic. Money supply has a long right tail, higher value with positive skewed and leptokurtic. Natural disaster flood (NDF) has a positive skewed and mesokurtic because of natural disaster of flood value is 3. 25=3.Real interest rate value is 2.10<3 shows normal skewed and platykurtic.

Table 1. Descriptive statistics of variables used in analysis

	FI	EP	CE	GDP	M	ND	R
Mean	7.948842	7.993399	88.25934	2.108629	15.16829	0.200000	7.220400
Median	7.022916	6.367472	87.92797	2.121762	14.65619	0.000000	6.752500
Maximum	23.70383	20.43349	94.58940	6.695194	42.90887	1.000000	17.00000
Minimum	-0.35422	-0.88006	82.60073	-1.84370	4.314225	0.000000	1.142000
Std. Dev.	5.248391	4.951607	3.809823	1.885866	6.758576	0.405096	3.770904
Skewness	0.912976	0.561419	-0.03988	-0.01055	1.696638	1.500000	0.501380
Kurtosis	3.515906	2.471993	1.607633	2.679173	8.578985	3.250000	2.703432
Jarque-Bera	6.000438	2.565927	3.241750	0.172293	71.06566	15.10417	1.822469
Probability	0.049776	0.277215	0.197726	0.917460	0.000000	0.000525	0.402028
Sum	317.9537	319.7360	3530.374	84.34515	606.7317	8.000000	288.8160
Sum Sq. Dev.	1074.279	956.2182	566.0753	138.7032	1781.456	6.400000	554.5688
Observations	40	40	40	40	40	40	40

Source: Own calculation by using data (1980-2019)

4.3 Correlation Analysis

Table 2 shows the correlation coefficients of the variables used in the analysis. Energy prices is positively associated with the food inflation; however, this effect is moderate because estimated absolute value of coefficient falls in the range of 0.40 to 0.59. It has been observed the negative associations of food inflation with the final consumption expenditure. The intensity of the association is fall in the very weak range because in absolute it is in the range of 0.00 to 0.19. Similarly, the negative associations between the food inflation and GDP growth also observed.

While this association is weak because it falls in the range of 02 to 0.39. Money supply are negatively associated with the food inflation; however, this effect is very weak because estimated absolute value of coefficient falls in the range of 0.00 to 0.19. As expected, the strong positive associations between the food inflation and natural disaster are observed. The estimated coefficient falls in the range of 0.00-.19. However, this effect is very weak. Real interest rate is positively associated with the food inflation; however, this effect is weak because estimated absolute value of coefficient falls in the range of 0.20 to 0.39.

Table 2 Correlation coefficients of the variables used in the analysis

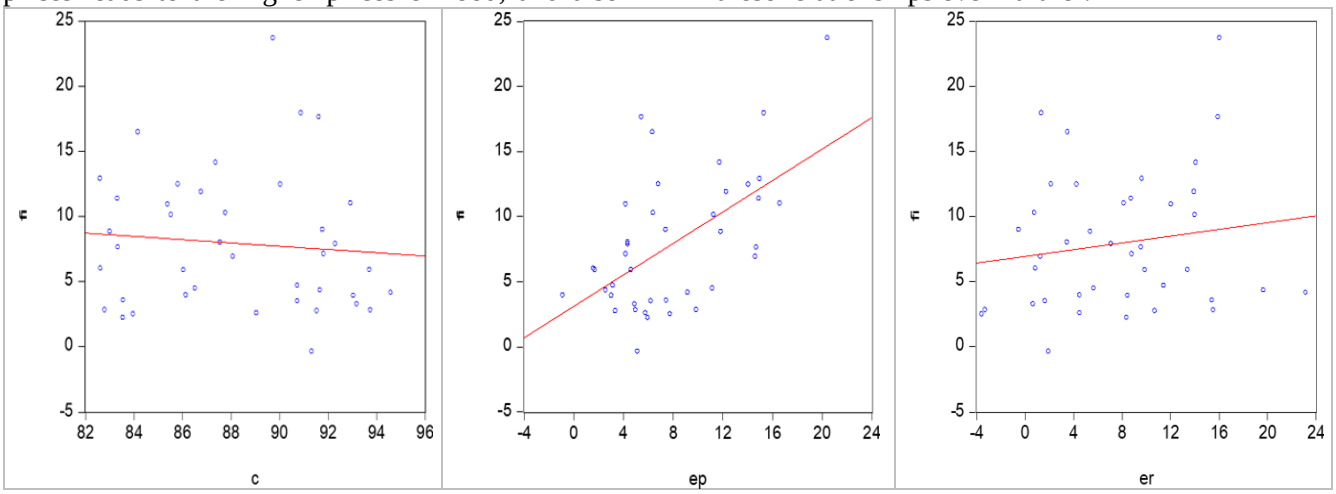
	FI	EP	CO1	GDP	M	ND	R
FI	1.000000	0.569704	-0.091239	-0.377794	-0.006028	0.284546	0.248585
EP	0.569704	1.000000	-0.182501	-0.424557	0.284113	0.207649	0.016212
CE	-0.091239	-0.182501	1.000000	0.106031	-0.231213	0.101586	-0.056300
GDP	-0.377794	-0.424557	0.106031	1.000000	0.212579	-0.100450	-0.138744
M	-0.006028	0.284113	-0.231213	0.212579	1.000000	-0.26386	-0.154646
Nd	0.284546	0.207649	0.101586	-0.100450	-0.026386	1.000000	-0.162923

4.3 Scatter plot

Figures 2 shows the plots for food price inflation with various covariates. There is a negative association between the independent variable final consumption expenditure and dependent food price inflation. Similarly, it also depicts the negative relationship between the GDP growth and food price inflation in Pakistan. It implies that higher the level of final consumption expenditure or Per capita GDP growth leads to decrease food price inflation.

However, the slope of per capita GDP growth is higher than the slope of final consumption expenditure .in other words we can say that the slope of final consumption expenditure is less than the Per capita GDP growth. On the other hand, Energy prices (EP) depicts the positive relationship with the food inflation. Similarly, the exchange rate of Pakistan also depicts the positive relationship between the food prices of Pakistan. It follows that higher energy prices leads to the higher prices of food, and also higher exchange rate cause to higher food prices. The slope of exchange rate is less the slope of energy prices. On the other hand, slope of energy prices is greater than the slope of exchange rate.

It also victim of negative association between the population growth and food price. It shows that the supply of money has no effect on the price of food. On the other hand, natural disaster depicts the positive relationship with the food price in the figure. Moreover, it is depicting positive relationship between real interest rate (R) and food price (CIP). Its mean higher real interest rate leads to higher food price in Pakistan. However, the slope of real interest rate is higher than the slope of natural disaster. In other words, the slope of natural disaster flood is less the slope of real interest rate. A scatter plot can produce inaccurate findings from the final conclusion of any definite causal relationship. The final econometric analysis is then used to confirm these relationships even further.



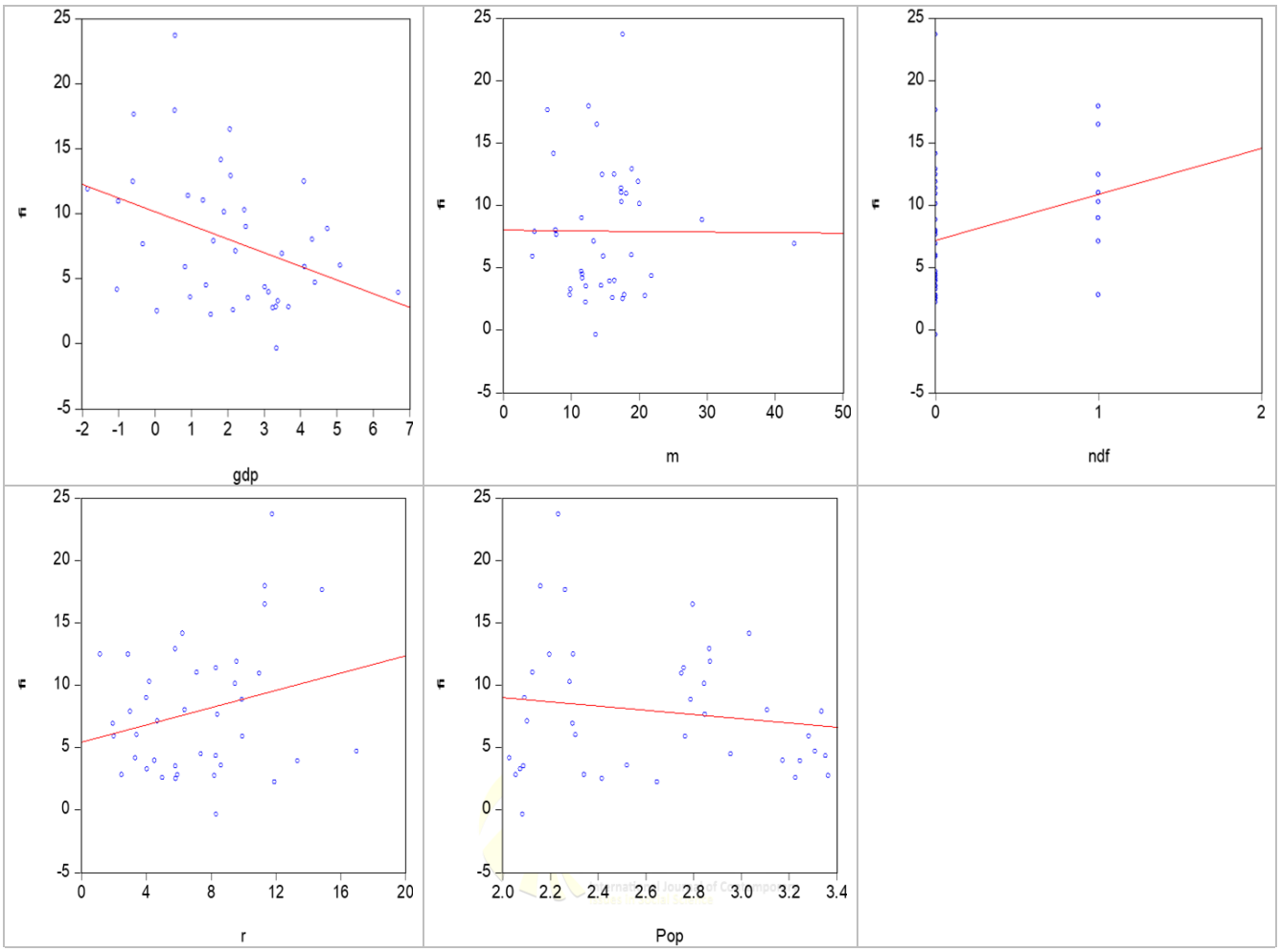


Figure 2. Scatter plot of food inflation with covariates

5. Results and Discussion

5.1 Pre-estimation test

5.1.1 Unit root test

Table 3 shows stationarity of variables, according to the results of Augmented Dickey Fuller test. The findings revealed that the ADF tests at the level are not stationary. The variables in the ADF test at first difference are stationary. The findings showed that the probability value of the variables is less than 0.05, which indicates that the data is stationary. We can rely on the results as it avoids from the spurious results and gives valid results. It is clear from the results that the variables are not stationary at I (0) and stationary at I (1).

Table 3. ADF test of unit root

Level				
Variables	**Intercept**		**Trend and Intercept**	
	t-statistic	**p-values**	**t-statistic**	**p-values**
CE	-1.439178	0.5533	-1.805876	0.6827
EP	-4.505834***	0.0009	-4.599322***	0.0037
ER	-3.798106***	0.0061	-3.720866**	0.0326
FI	-3.459639***	0.0153	-3.469862*	0.0585
GDP	-4.271451***	0.0017	-4.281788***	0.0084

M	-4.939057***	0.0002	-4.893788***	0.0017
POP	-1.260023	0.6351	1.000804	0.9998
R	-3.784561***	0.0064	-3.808158**	0.0267
NDF	-4.120251***	0.0026	-4.473588***	0.0051
1st Difference				
	Intercept		**Tend and Intercept**	
	t-statistic	**p-values**	**t-statistic**	**p-values**
EC	-7.117163***	0.0000	-7.482209***	0.0000
EP	-7.335877***	0.0000	-7.313958***	0.0000
ER	-7.354178***	0.0000	-7.364450***	0.0000
FI	-8.950886***	0.0000	-8.910556***	0.0000
GDP	-7.475804***	0.0000	-7.309832***	0.0000
M	-7.534930***	0.0000	-7.415469***	0.0000
POP	-1.869140	0.3418	-5.883303***	0.0002
R	-7.977091***	0.0000	-7.921926***	0.0000
NDF	-8.899438***	0.0000	-8.799648***	0.0000

, ** and * show 10%, 5% and 1% level of significance respectively*

5.1.2 Co-integration Test

Table 4 shows the results of the ARDL Boud test approach to confirm the presence of long-run relationship. The estimated F-statistics is 14.386 which is greater than the upper bound limit 3.23 at 10% level of significance and 3.61 at 5% level of significance respectively. It is indicating that there is a long run relationship between the variables, we can say that there is cointegration.

Table 4. ARDL Bound test

F-statistics=14.386 **K= 6**		
Significance level	**Lower bound I (0)**	**Upper bound I (1)**
10%	2.12	3.23
5%	2.45	3.61
2.5%	2.75	3.99
1%	3.15	4.43

5.2. The Short-run and Long-run results

To estimate the determinants impacting food price inflation in Pakistan, the ARDL techniques for cointegration are employed. The estimated short and long run relation between the variables is shown in Tables (5 and 6). The results of the short-term Autoregressive Distributed Lag (ARDL) model, with food inflation (measured in percentage terms) as the dependent variable and per capita GDP (also in percentage terms) as an independent variable, provide key insights. The coefficient for the lagged value of food inflation is -0.630319, indicating a negative relationship. This suggests that higher food inflation in the previous period leads to a decrease in current food inflation. The t-statistic of -23.958276 and the p-value of 0.0017 confirm the statistical significance of this effect. Similarly, the coefficient for per capita GDP is 2.5083, showing that a 1% increase in GDP is associated with a 2.5083% increase in food inflation, highlighting a positive relationship. The high t-statistic of 41.137079 and the extremely low p-value of 0.0006 further validate

the strength and significance of this relationship. Overall, the findings demonstrate that food inflation is significantly influenced in the short term by its own lagged values and per capita GDP, with the former having a dampening effect and the latter driving food inflation upward.

The coefficient for money supply growth is 0.4234, indicating that a 1% increase in money supply growth leads to a 0.4234% increase in food inflation in the short term. This positive relationship suggests that the expansion of money supply contributes to rising food prices, likely due to increased demand or liquidity effects in the economy. The t-statistic of 37.055549 highlights the strength of this relationship, while the p-value of 0.0007 confirms its statistical significance at conventional levels. Overall, the results demonstrate that money supply growth is a key driver of food inflation in the short term.

The natural disaster variable, represented as a dummy coded 1 for years with a natural disaster and 0 otherwise, has a coefficient of 2.322690. This indicates that during years of natural disasters, food inflation increases by an average of 2.3227%. This positive effect suggests that natural disasters contribute to higher food prices, likely due to disruptions in agricultural production, supply chains, and infrastructure. The t-statistic of 11.690095 highlights the strength of this relationship, while the low p-value of 0.0072 confirms its statistical significance. Overall, the results underscore the significant inflationary impact of natural disasters on food prices in the short term.

The coefficient for the real interest rate is 0.438345, indicating that a 1% increase in the real interest rate leads to a 0.4383% rise in food inflation in the short term. This positive relationship suggests that higher real interest rates may contribute to increased food inflation, possibly due to cost-push effects or reduced agricultural investment resulting from tighter credit conditions. The t-statistic of 14.713709 underscores the strength of this relationship, while the p-value of 0.0046 confirms its statistical significance. Overall, the findings reveal that real interest rates play a notable role in driving food inflation in the short term.

The short-term results of the Autoregressive Distributed Lag (ARDL) model, with food inflation (measured in percentage terms) as the dependent variable, demonstrate a significant relationship between energy prices and food inflation. The coefficient for energy prices is 0.697334, indicating that a 1% increase in energy prices results in a 0.6973% rise in food inflation in the short term. This positive relationship highlights the significant role of energy costs in driving food inflation, as energy is a critical input in food production, processing, and transportation. The t-statistic of 31.695435 underscores the strength of this relationship, while the p-value of 0.0010 confirms its statistical significance. Overall, the findings reveal that energy price fluctuations are a major determinant of food inflation in the short term.

The coefficient for consumption expenditure as a percentage of GDP is -0.878725, indicating that a 1% increase in consumption expenditure reduces food inflation by 0.8787% in the short term. This negative relationship suggests that higher consumption expenditure may stabilize food prices by improving supply-side dynamics or balancing demand. The t-statistic of -18.932922 underscores the strength of this relationship, while the p-value of 0.0028 confirms its statistical significance. Overall, the results emphasize the important role of consumption expenditure in reducing short-term food inflation and indicate that food inflation partially corrects itself over time. Additionally, the error correction term has a coefficient of -0.156705, reflecting that about 15.67% of the deviation from the long-term equilibrium in food inflation is corrected in each period. While the t-statistic (3.472867) and p-value (0.0738) indicate moderate significance, the negative value suggests a gradual adjustment process toward the long-term equilibrium.

Table 5. Short term ARDL

Variable	Coefficient	Std, Error	t-statistics	Prob.
D(F(-1))	-0.630319***	0.026309	-23.958276	0.0017
D(GDP)	2.5083***	0.060975	41.137079	0.0006
D(M)	0.4234***	0.011429	37.055549	0.0007
D(NDF)	2.322690***	0.198689	11.690095	0.0072
D(R)	0.438345***	0.029792	14.713709	0.0046

D(EP)	0.697334***	0.022001	31.695435	0.0010
D(CE)	-0.878725***	0.046413	-18.932922	0.0028
CointEq (-1)	-0.156705	0.045123	3.472867	0.0738
R-squared		0.999963		
Adjusted R-squared		0.999360		
Durbin-Watson stat		2.757399		

, ** and * show 10%, 5% and 1% level of significance respectively*

The long-run results of the ARDL Bound Testing approach presented in Table 6 reveal significant insights into the factors affecting food inflation over the long term. The coefficient for GDP (2.551896) suggests that a 1% increase in per capita GDP leads to a 2.5519% rise in food inflation. This positive relationship indicates that economic growth, while beneficial, can contribute to higher food prices. The t-statistic (3.525021) and p-value (0.0721) confirm that this effect is statistically significant at the 10% level. Similarly, money supply growth has a strong positive impact on food inflation, with a coefficient of 2.450742. A 1% increase in money supply growth results in a 2.4507% rise in food inflation, a statistically significant relationship at the 5% level (t-statistic: 4.354031, p-value: 0.0489). Natural disasters also play a significant role in driving long-term food inflation. The dummy variable for natural disasters shows a coefficient of 4.243006, indicating that the occurrence of a natural disaster increases food inflation by 4.243%. This effect is significant at the 10% level, as reflected in the t-statistic (3.482051) and p-value (0.0735). Real interest rates, on the other hand, have a negative impact on food inflation, with a coefficient of -1.818695. A 1% increase in the real interest rate reduces food inflation by 1.8187%, a statistically significant effect at the 10% level (t-statistic: -3.741006, p-value: 0.0646). Energy prices, although positively associated with food inflation (coefficient: 0.466593), are not statistically significant in the long term, as indicated by a t-statistic of 1.869084 and a p-value of 0.2025. Consumption expenditure as a percentage of GDP has a positive impact on food inflation, with a coefficient of 0.390607. This suggests that a 1% increase in consumption expenditure results in a 0.3906% rise in food inflation, a significant relationship at the 10% level (t-statistic: 3.506838, p-value: 0.0726). Overall, the results highlight the critical roles of GDP, money supply growth, natural disasters, real interest rates, and consumption expenditure in determining long-term food inflation. While energy prices do not show statistical significance, macroeconomic factors and external shocks, such as natural disasters, emerge as key determinants of food price dynamics.

Table 6. Long run results of ARDL Bound testing

Variables	Coefficient	Std. Error	t-Statistic	Prob.
GDP	2.551896*	0.724057	3.525021	0.0721
M	2.450742**	0.562957	4.354031	0.0489
NDF	4.243006*	1.218195	3.482051	0.0735
R	-1.818695*	0.485975	-3.741006	0.0646
EP	0.466593	0.249637	1.869084	0.2025
CE	0.390607*	0.111384	3.506838	0.0726
C	-8.712492	9.822269	-0.887014	0.4687

5.3 Post-estimation test

Table 7 presents the results of the Breusch-Pagan-Godfrey Heteroskedasticity Test indicate no evidence of heteroskedasticity in the model. The F-statistic value of 0.396580 has an associated probability (Prob. F) of 0.9043, which is much greater than the standard significance levels (e.g., 1%, 5%, or 10%), suggesting that the null hypothesis of homoskedasticity cannot be rejected. These results collectively suggest that the model satisfies the assumption of homoskedasticity, ensuring reliable estimation and inference.

Table 7 Heteroskedasticity Test (Breusch-Pagan- Godfrey)

F-statistic	0.396580	Prob. F (33,2)	0.9043
Obs*R-squared	31.22772	Prob. Chi-Square (33)	0.5555
Scaled explained SS	0.064419	Prob. Chi-Square (33)	1.0000

To check whether the independent variables are correlated or not to check the multicollinearity, we applied Variance inflation factors in Table 8. There could be severe multicollinearity exist among the exogenous variables if value of (VIF) is equal or greater than 10. Results show that the value of VIF is less than 10 so we can conclude that multicollinearity not exist.

Table 8. Multicollinearity (Variance Inflation Factors)

Variable	Coefficient Variance	Uncentered (VIF)	Centered (VIF)
EP	0.029488	5.737834	1.562252
CE	0.035386	612.0074	1.109842
GDP	0.189941	3.331351	1.459677
M	0.013940	8.483803	1.375890
NDF	3.123844	1.384623	1.107698
R	0.035090	5.132441	1.078167

In the CUSUM plot in Figure 3a, the blue line (representing the cumulative sum of residuals) remains well within the red dashed lines, which denote the 5% significance bounds. This indicates that the model's parameters are stable over the analyzed period and do not exhibit significant structural breaks. In contrast, the CUSUM of Squares plot in Figure 3b shows the cumulative sum of squared residuals. Here, the blue line eventually crosses the 5% significance bounds (red dashed lines), indicating potential parameter instability in the long run. This suggests that there may be changes or structural breaks affecting the model over time, which could require further investigation or adjustment. In summary, while the CUSUM test confirms short-term parameter stability, the CUSUM of Squares test points to potential long-term instability in the model. This mixed result highlights the need for further diagnostic checks and potential model refinement.

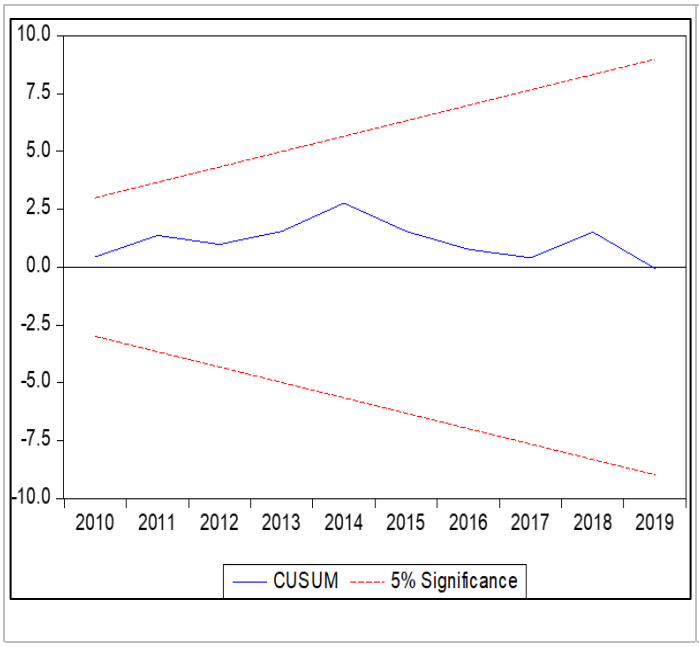


Figure 3a. CUSUM test

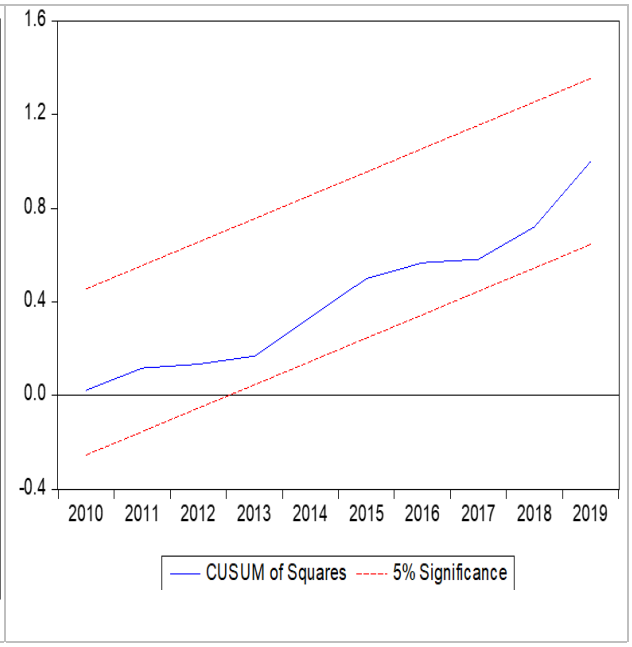


Figure 3b. CUSUM squares test

6. Conclusion

The ARDL model identifies key determinants of food price inflation in Pakistan over the short and long run. In the short run, food inflation is significantly influenced by its lagged values (showing a dampening effect), per capita GDP, money supply growth, natural disasters, real interest rates, energy prices, and consumption expenditure. Lagged inflation and consumption expenditure have stabilizing effects, while the other variables, particularly GDP, money supply, and natural disasters, drive inflation upward. The error correction term reflects a gradual adjustment toward long-term equilibrium, correcting about 15.67% of deviations per period. In the long run, similar factors like GDP, money supply growth, natural disasters, real interest rates, and consumption expenditure play significant roles. However, GDP and natural disasters show more pronounced effects, while real interest rates exhibit a negative influence. Unlike the short run, energy prices are not statistically significant in the long run. These findings emphasize the varying impacts of macroeconomic variables and shocks over different time horizons.

To mitigate food price inflation, policymakers should regulate money supply growth and implement fiscal measures to balance economic growth without driving inflation. Investment in disaster-resilient infrastructure and agricultural supply chains is essential to minimize the impact of natural disasters. Stabilizing real interest rates can also curb inflationary pressures. Policies promoting efficient energy usage and subsidies for agricultural production can address short-term volatility. Encouraging consumption expenditure through targeted subsidies may help stabilize prices in the short run. Long-term strategies should focus on sustainable GDP growth, improved supply chain efficiency, and building economic resilience to external shocks like natural disasters.

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