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Analysis Of Food Inflation's Determinants: Evidence From Pakistan

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Article Details

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ABSTRACT

Objective: This research intended to quantify the impact of various handles on the food prices in Pakistan. Research Gap: Very rare studies explained the impact of the environmental and economic handles on the food inflation in Pakistan. Methodology: It employed ARDL technique for Analysis and used TSD from 1990 to 2024. The study employed Augmented Dickey-Fuller Test, Bound test, AIC, Autoregressive Distributive Lag model, ECM model and various diagnostic tests, for the analysis of the data. Variables of the Study: The dependent variable is food inflation and independent variables are food imports, food exports, money supply, agricultural output, GDP, tax-to-GDP ratio and Rainfall index. The Main Findings: The results revealed that GDP, money supply, and interest rates influence food prices .Global food prices, crude oil prices, and fertilizer prices contribute to domestic food price inflation. Supply-side factors like food production, agricultural productivity, and supply chain disruptions affect food prices. Demand-side factors such as per capita income, population growth, and consumption patterns also play a role. Practical implications of the Findings: The study suggests that policymakers should focus on enhancing food production, managing macroeconomic variables, improving supply chains, and stabilizing exchange rates to control food price inflation. Additionally, governments should consider implementing policies to increase food grain availability, stabilize real exchange rates, and promote collaborations between researchers and governmental or non-governmental organizations to address food security issues.

INTRODUCTION

Inflation is a significant issue in developing countries, affecting the purchasing power of fixed-income individuals and exacerbating poverty. According to Phillips (1958), inflation is a sustained increase in the general price level of goods and services. Inflation impacts the poor by reducing their purchasing power, increasing food and energy costs, and limiting access to credit (Ravallion and Lokshin, 2001).Inflation has a negative impact on exports, reducing competitiveness, decreasing export volume, and leading to loss of market share (Krugman, 1986). There's an inverse relationship between inflation and unemployment, where lower unemployment rates correspond to higher inflation rates (Phillips, 1958). Moderate inflation (2-3%) can stimulate economic growth, while high inflation harms growth (Barro, 1995).

Excessive money supply increases food demand, driving prices up (Friedman, 1970). Oil price shocks impact food prices globally (Baffes, 2007; Kilian, 2008). Currency depreciation increases import costs, driving food prices up (Krugman, 1986). Higher interest rates reduce borrowing, decreasing food demand (Taylor, 1993). Tax policies impact food affordability and producer profitability (Bird, 2010).

Recent studies have shed more light on the issue. Caroline (2021) found significant effects of World Food Price Index and average prices of onions, rice, chili, and chicken on Consumer Price Index. Dua and Goel (2021) found demand factors like exchange rate, money supply growth, and output gap explain significant variation in inflation measures. Prates (2022) identified six statistical significant variables contributing to Brazil's food inflation hike. Nadeem (2021) found a significant positive impact of food export and import on food price inflation. Samal et al. (2022) found short-run bi-directional causality among per capita income, exchange rate, and food price inflation.

Other studies have also contributed to the understanding of inflation. Anwar and Guha (2023) found that food prices are affected by their own lagged prices and non-food prices in the short-run only. Inal et al. (2023) suggested that food production index and real effective exchange rate are important factors in determining food prices. Khor et al. (2023) proved that carbon dioxide emission, gross domestic product, and fertility rate have a significant relationship with food security in Malaysia. Nadani et al. (2023) explained that exchange rate depreciation leads to increased food inflation. Nagy and Ábel (2023) concluded that companies in the sectors studied significantly increased variables determining profitability, contributing to a dramatic increase in food prices.

OBJECTIVES

Following are the specific objectives of the study;

- To study the nexus between Agricultural output and food inflation.
- To learn the connection between food exports and food inflation.
- To examine the linkage between food imports and food inflation.
- To investigate the relationship between money supply and food inflation.
- To explore the junction between taxes and food inflation.
- To examine the intersection between GDP and food inflation.
- To analyze the bond between crude oil prices and food inflation.

SIGNIFICANCE OF THE STUDY

Food inflation, a persistent increase in food prices, poses significant threats to food security, economic stability, and social welfare. Understanding the underlying factors driving food inflation is crucial for policymakers to implement effective strategies mitigating its adverse effects.

Determinants of food Inflation play a crucial role in food production and effective planning of economic growth. Policy maker can optimize revenue collection and trade facilitation through understanding the factors that are influencing the custom tax buoyancy which will ultimately improve economic growth.

Also this study provides valuable insights for central banks and monetary authorities, government agencies responsible for agriculture and food security, policymakers and economists, researchers and academics as well as international organizations focused on food security and economic development.

LITERATURE REVIEWS

Caroline (2021) concluded that the results of the analysis indicated that the independent variables of the World Food Price Index and the average prices of onions, rice, chili, and chicken in the provincial capital have a significant effect on the Consumer Price Index. However, per capita PDRB (an Indonesian term) does not have a significant effect on the Consumer Price Index in the provinces of Java and Sumatra.

Dua and Goel (2021) found similar results for both measures of inflation, indicating that demand factors such as exchange rate, rate of growth in money supply, and output gap explain significant variation in both measures. On the supply side, global factors like international oil

and food prices played a key role in determining both overall and food inflation in the economy. Prates (2022) concluded that six statistically significant variables contributed to Brazil's food inflation hike, including the failure to pass on international crude oil price reductions to domestic energy prices, stagnant production growth for staple foods, and high pass-through from the agriculture price index to the consumer price index.

Samal et al. (2022) used Granger causality estimates and found short-run bi-directional causality among per capita income, exchange rate, per capita net availability of food grain, and food price inflation. Furthermore, there is evidence of unidirectional causality running from global food prices to food price inflation.

Anwar and Guha (2023) found that food prices are affected by their own lagged prices and non-food prices in the short run only. The interest rate policy of RBI, which is supposed to influence the prices of non-food sectors faster, has a limited capacity to influence the prices of food sectors in the long run.

Inal et al. (2023) concluded that the slope coefficients obtained from the co-integration coefficients estimators are close to each other, indicating consistent results. As a result of the analysis, it is suggested that food production index and real effective exchange rate are more important factors in determining food prices.

Khor et al. (2023) proved that all independent variables (carbon dioxide emission, gross domestic product, and fertility rate) have a significant relationship with the dependent variable (food security in Malaysia) in the long run.

Nadani et al. (2023) explained that as the exchange rate depreciated, food inflation rose by 8.92% at the 25th quantile, 12.6% at the median, and later fell to 16% at the 90th quantile. The real GDP is significant across all quantiles. Lastly, the oil price is positive and significant at the OLS estimate and the 90th quantiles.

Nagy and Ábel (2023) concluded that companies in the sectors studied significantly increased the two variables determining profitability, which subsequently contributed to a dramatic increase in food prices.

Oral et al. (2023) generated a point of view indicating that global and macroeconomic factors had a great effect on food prices during the COVID-19 period. As an outcome of the variance decomposition, it was observed that food prices were more reactive to the exchange rate. Zehra and Sohail (2023) revealed a negative and significant impact of the real effective exchange rate on wheat prices in the long run. Similarly, the real interest rate affects wheat and rice prices

indirectly, while it has a direct impact on tea prices.

Bharti et al. (2024) applied the autoregressive distributed lag (ARDL) approach to co-integration and quantified the role of intermediaries by computing the price wedge between wholesale and retail prices of food grains. The study established the existence of both short-run and long-run relationships between price wedge and food grain inflation.

Hatami and Alavirad (2024) found a negative effect of economic growth and investment on food inflation, while interest rate and exchange rate increases have a positive effect. Sharma et al. (2024) confirmed with the help of ARDL that international food prices, wage rates, and weighted average call money rate were major factors that played a role in food inflation in the long run. NARDL results showed significant asymmetric effects of money supply, wage rate, crude oil prices, international food prices, real effective exchange rate, and weighted average call money rate on food inflation in the long term.

THEORETICAL FRAMEWORK AND ECONOMETRIC METHODOLOGY

Mankiw (2021) and Timmer (2000) explained a fundamental economic principle: when agricultural output increases, food supply rises, leading to lower prices if demand remains constant. Conversely, a decrease in agricultural output (a supply shock) creates scarcity, driving up food prices and contributing to supply-side food inflation. Baffes & Dennis (2013) and Sands & Westcott (2011) analyzed how crude oil, a critical input in food production and distribution, impacts costs. Higher crude oil prices increase costs for fertilizers and pesticides, which are often petroleum-based or require significant energy to produce.

Kornher & Kalkuhl (2013) and Okpe & Ikpesu (2021) investigated how increased food exports reduce domestic food supply. If local demand remains strong, this reduction can create scarcity within the country, pushing up domestic food prices. Miranda & Glauber (1995) and Durevall et al. (2013) noted that increased food imports augment the domestic food supply.

The Quantity Theory of Money (QTM) suggests that increasing the money supply without a corresponding rise in output leads to inflation; monetarism stresses controlling the money supply to maintain economic stability. Friedman (1963) and Hasan Ansari (2024) described the QTM, which posits that inflation is primarily a monetary phenomenon: an increase in the money supply unmatched by real output growth reduces money's purchasing power, resulting in higher prices.

Niang et al. (2014) and IPCC (2018) investigated the impact of adverse rainfall conditions. They found that insufficient or excessive rainfall (such as droughts or floods) can decrease agricultural

output by destroying crops, reducing yields, and disrupting agricultural supply chains.

Musgrave & Musgrave (1989) and Canto et al. (1983) analyzed the complex relationship between taxation (like the tax-to-GDP ratio) and food prices. They noted that an increase in indirect taxes (e.g., VAT on food items) directly increases consumer costs, leading to higher food prices and contributing to cost-push inflation.

VARIABLES OF THE STUDY

The objective of this study was to quantify the impact of environmental and economic determinants on food inflation. The various handles used in this paper are tabulated below.

$$food\ inflation\ =\ f\ (GDP, ER, FI, \mathrm{FE}, COP, T, RI)$$

LONG-RUN

$$food\ prices = \beta_0 + \beta_1 GDP + \beta_2 ER + \beta_3 FI + \beta_4 FE + \beta_5 COP + \beta_6 T + \beta_7 RI + \mu 1$$

SHORT-RUN:

$$\Delta\ (\ Govt\ expenditure)$$
$$= a_0 + a_1 \Delta GDP + a_2 \Delta ER + a_3 \Delta FI + a_4 \Delta FE + a_5 COP + a_6 T + a_7 RI + ecm(-1) + \mu 2$$

TABLE OF VARIABLES

S/No	Variables	Abbreviation	Measurement	Expected outcomes
01.	FOOD INFLATION	FI	FPI	
02.	MONEY SUPPLY	ER	MPKR	Positive
03.	FOOD EXPORTS	FE	USMD	Positive
04.	FOOD IMPORTS	FI	USMD	Positive
05.	CRUDE OIL PRICES	COP	US DOLLAR	Positive
06.	TAXES TO GDP RATIO	T	PKR	Positive
07.	RAINFALL INDEX	RI	MM	Negative
08.	GROSS DOMESTIC PRODUCT	GDP	current US$	Negative

ECONOMETRIC TECHNIQUE AND RESEARCH METHODOLOGY:

The Augmented Dickey Fuller Test (ADF) is unit root test for stationary. Unit roots can cause unpredictable results in time series analysis.

The Augmented Dickey-Fuller test can be used with serial correlation. The ADF test can handle more complex models than the Dickey-Fuller test, and it is also more powerful. That said, it

should be used with caution because like most unit root tests it has a relatively high Type I error rate.

In second step of econometric methodology this study will employ Autoregressive Distributed Lag Model (ARDL). For ARDL the variables should be stationary of mixed order, some should be non-stationary at level and other should be stationary at 1st difference, $I(1)$. While the dependent variable should be stationary at level $I(0)$.

$$food\ inflation\ =\ f\ (GDP, ER, FI, \mathrm{FE}, COP, T, RI)$$

LONG-RUN ARDL

$$food\ prices = \beta_0 + \beta_1 GDP + \beta_2 ER + \beta_3 FI + \beta_4 FE + \beta_5 COP + \beta_6 T + \beta_7 RI + \mu 1$$

SHORT-RUN ECM

$$\Delta\ (\ Govt\ expenditure)$$
$$= a_0 + a_1 \Delta GDP + a_2 \Delta ER + a_3 \Delta FI + a_4 \Delta FE + a_5 COP + a_6 T + a_7 RI + ecm(-1) + \mu 2$$

DATA SOURCES

The study spans data from 1991 to 2023, utilizing most important and trustworthy sources like international monetary fund, World Bank and state bank of Pakistan to provide a comprehensive analysis of food inflation trends in Pakistan.

DATA ANALYSIS AND INTERPRETATION

ADF TEST

TABLE: 4.1 RESULTS OF ADF TESTS

S/No	Name	ADF	Test	Critical	P-value	Results
01	Food inflation	Level	-4.696173	-3.580623	-	$I(1)$
		1st difference	-5.397939	-5.397939	0.0006	
02	Agriculture output	Level	-1.919382	-3.568379	0.6197	$I(1)$
		1st difference	-5.641303	-3.574244	0.0004	
03	Food imports	Level	-2.200866	-3.557759	0.4731	$I(1)$
		1st difference	8.443146	-3.557759	0.0000	
04	Food exports	Level	-2.395162	-3.548490	0.3753	$I(1)$
		1st difference	-6.234416	-3.552973	0.0001	
05	Crude oil price	Level	-2.827204	-3.548490	0.1979	$I(1)$
		1st difference	-8.094727	-3.552973	0.0000	
		Level	-0.898790	-3.574244	0.9426	

06	GDP	1st difference	-3.969512	-3.574244	0.0473	***I* (1)**
07	Money supply	Level	4.627958	-3.557759	1.0000	***I* (1)**
		1st difference	-6.029845	-3.552973	0.0001	
08	Rainfall index	Level	-5.849916	-3.548490	0.0002	***I* (0)**
		1st difference	-12.92571	-3.552973	0.0000	
09	Tax to GDP ratio	Level	1.833141	-3.587527	1.0000	***I* (1)**
		1st difference	-3.522233	-3.587527	0.0570	

The ADF test results showed that variables were integrated of different order, some variables were integrated at level *I* (0) and some variables were integrated at first difference, *I* (1). The rainfall index is integrated at level, *I* (0). While other of variables were non-stationary at level and stationary at first difference *I* (1). The results were according to the Autoregressive Distributive Lag Model (ARDL).

BOUND TEST

TABLE: 4.2 RESULTS OF BOUND TEST

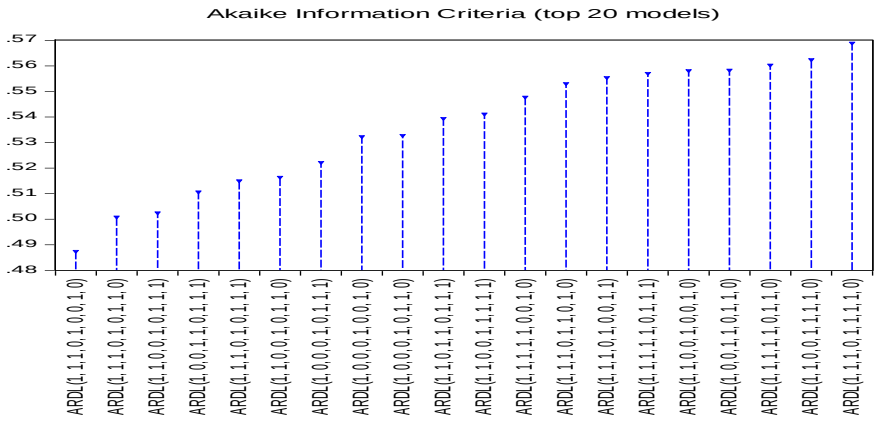
Test Statistics	**Statistics value**	**Level of significance**	**Lower Bound**	**Upper Bound**	**Results**
F-Statistics	4.149187	10%	1.85	2.85	ARDL co-Integration exists

The result of the Bound test has confirmed the existence of ARDL type Co-integration among the variables. The F-calculated was greater than the upper bound. The results have rejected the Null Hypothesis of the non-existence of the ARDL co-integration.

TESTING THE ORDER OF THE ARDL

This study employed akaike graphical method to identify the lag order of ARDL model.

FIG: 4.1 RESULTS OF AIC LAG SELECTION TEST



To identify the optimal order of ARDL model and the how many lags of dependent and independent variables might be used in the model many criteria could be used but this study employed the Akaike Information Criteria (AIC).

LONG RUN ANALYSIS OF FOOD PRICES HANDLES

TABLE: 4.3.RESULTS OF ARDL CO-INTEGRATION

S.No	Variables	Coefficients	p-value	Remarks
01	FOOD INFLATION(-	-0.190815	0.4926	
02	IMPORTS M$	3.787200	0.0002	
03	IMPORT M$(-1)	1.314475	0.1127	
04	GDPWB M$	-8.675953	0.0009	
05	GDP M$(-1)	-1.398898	0.1422	
06	EXPWB M$	0.255211	0.7982	
07	BMS MPKR	2.251148	0.0789	
08	BMS MPKR(-1)	2.667357	0.0350	
09	OIL PRICE TRENDS	0.091671	0.7057	
10	RAINFALL INDEX	-0.375643	0.3217	
11	AGRI GDP	-0.335291	0.0737	
12	AGRI GDP(-1))	1.620663	0.0012	
13	TAX REVENUES	1.290572	0.1974	
14	C	27.15246	0.0004	

The impact of agriculture output on food inflation is negative, an inverse relationship, and its coefficient is -0.335291, which is a statistically significant relationship. As the agriculture output is in percentage of GDP, a 1 percent increase in the percentage of GDP will cause the food inflation index to fall.

Crude oil prices are measured in US dollars, and there is a positive relationship between food inflation and crude oil prices. As crude oil prices increase, food prices also increase. For every 1 dollar per barrel increase in prices, there will be a 0.091671 percent increase in food prices.

Exporting food leads to a shortage of food inside the country and causes prices to increase, which is also a significant relationship. A 1 million dollar increase in food exports will cause the index to increase by 0.255 percent. In several contexts, increased food exports have been associated with higher domestic food prices due to a reduced local supply.

Food imports have a negative relationship with food inflation. Considering a year, as we import,

our inflation reduces. A 1 million dollar increase in imports leads to a decrease in food inflation by 3.7872 percent. The relationship of GDP with food inflation is negative; as a 1 million dollar increase in GDP will lead to a -8.6759 percent fall in food inflation. It is also a statistically significant relationship. The supply-side theory explains that the supply of goods increases. Imports also cause an increase in the supply of goods.

Money supply has a positive relationship with food inflation. A 1 percent increase in the money supply as a percentage of GDP will cause inflation to rise by 2.2511 percent. It is a statistically significant relationship.

The rainfall index has a positive relationship with food inflation. As rainfall increases, food inflation also increases because of a lack of proper water infrastructure and dams, which causes floods and food destruction. As one mm increase in rainfall will cause food inflation to rise up to -0.3756 percent.

The tax-to-GDP ratio shows that as taxes increase, food inflation also increases. There is a positive relationship between food inflation and the tax-to-GDP ratio. A 1 percent rise in the tax-to-GDP ratio will cause a 1.290 percent rise in food inflation.

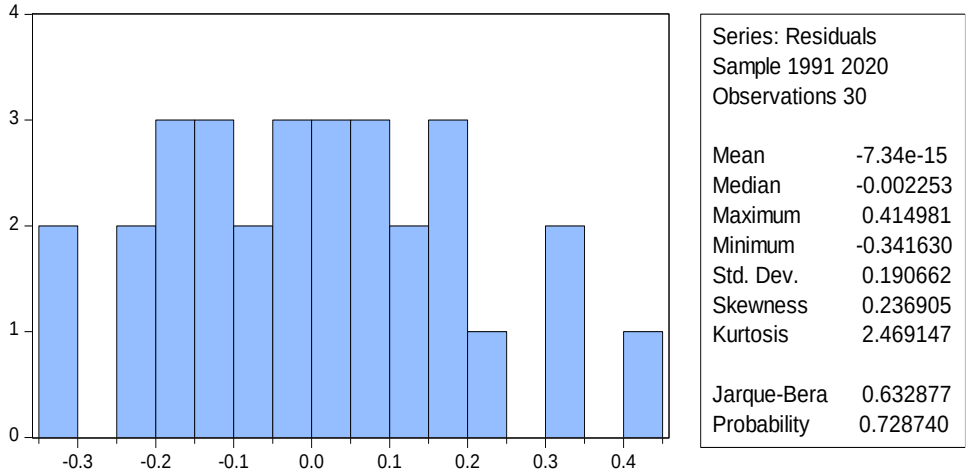
DIAGNOSTIC TESTS

S/no	Test Type	Null Hypothesis	Test St	P-Values
01	R-Squared		0.875278	0.773941
02	F-Test	Model is overall insignificant	8.637334	0.000061
03	Breush-Pagan -Godfrey	No Hetro-ccedasticity	1.154980	0.3573
04	Breush-Godfrey	No Autocorrelation	2.776289	0.0965

The total 87 percent of the variations were explained as shown by R-square. The F-statistic exposed that model was overall significant. Breusch-Pagan-Godfrey calculated test indicate that there was no heteroskedasticity. Breusch-Godfrey statistics quantified that there was no autocorrelation.

JARQUE-BERA TEST OF NORMALITY

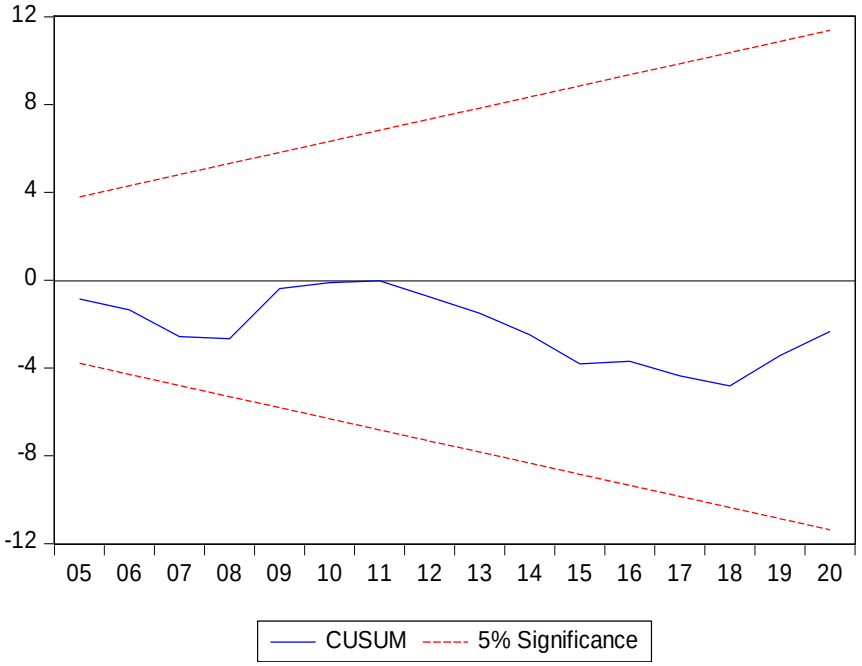
FIG: 4.1 JARQUE-BERA TEST



The JB Test was used to check the model specification errors. It followed the χ 2 distribution. The JB statistics p-value was 0.728740, which showed that residual were normally distributed because p-value is greater than 0.05, so we reject null hypothesis. Also the model was correctly specified.

CUSUM TEST: The CUSUM test was used to check the stability of the model. The blue line was inside the red lines and model was stable.

FIG: 4.2 CUSUM TEST



SHORT RUN ANALYSIS OF TAX REVENUE AND ITS DETERMINANTS

The short run nexus between the tax revenue and its determinants was captured through the Error Correction Model.

TABLE 4.5 SHORT RUN ECM ANALYSIS

S/No	Variables	Coefficients	p-value	Remarks
01	FOOD IMPORTS	2.066405	0.0047	
02	GDP	-1.419806	0.0771	
03	FOOD EXPORT	-0.722669	0.5076	
04	MONEY SUPPLY	-0.245345	0.7812	
05	OILPRICES	0.285381	0.1785	
06	RAINFAL INDEX	-0.539550	0.0532	
07	AGRI GDP	-0.448037	0.0248	
08	TAX REV	0.385766	0.7211	
09	ECM(-1)	-0.994610	0.0107	

Food imports, oil prices, tax revenue have direct and positive impact on food inflation according to economic theory. While GDP, food exports, money supply, rainfall index, agricultural outcome have negative relation with food inflation.

DIAGNOSTIC TEST OF SHORT RUN

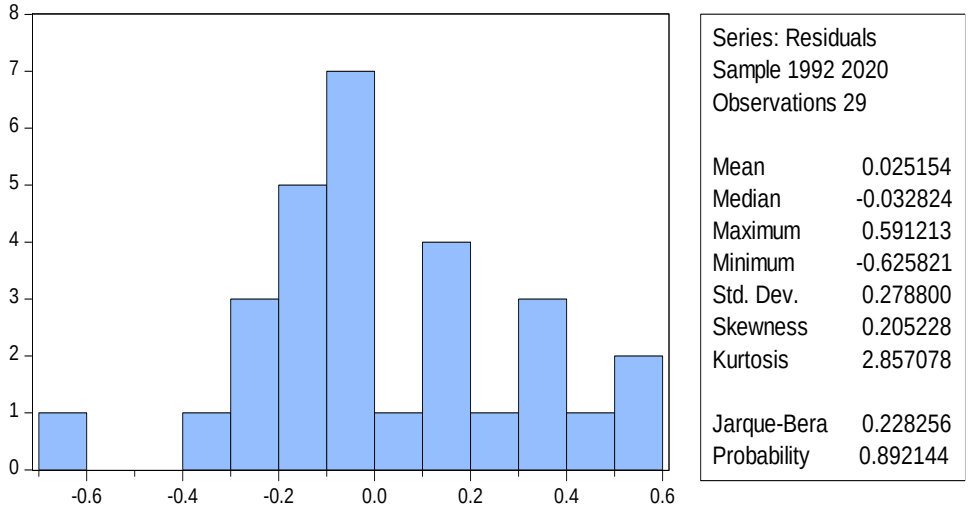
TABLE: 4.6 SHORT RUN DIAGNOSTIC TEST

S/N	Test Type	Null Hypothesis	Test St	P-Values
01	R-Squared		0.543398	0.360757
02	F-Test	Model is overall insignificant	0.936644	0.517130
03	Breush-Pagan - Godfrey	No Hetro-ccedasticity	0.936644	0.517130
04	Breush-Godfrey	No Autocorrelation	1.354234	0.2832

The total 54 percent of the variations were explained as shown by R-square. The F-statistic revealed that model was overall significant. Breusch-Pagan-Godfrey calculated test showed that there was no heteroskedasticity. Breusch-Godfrey statistics showed that there was no autocorrelation.

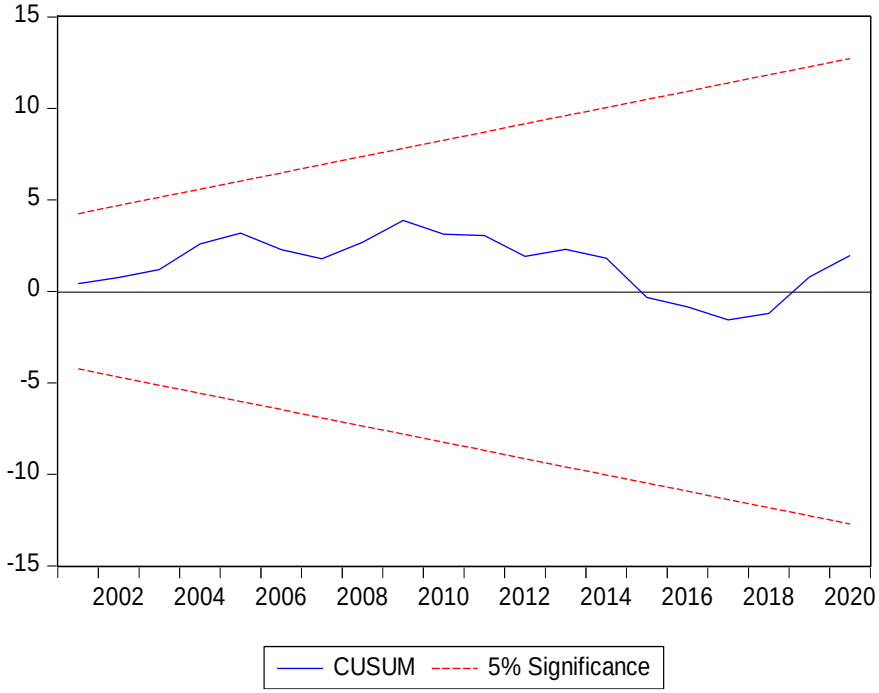
JARQUE-BERA TEST OF NORMALITY

FIG:4.5 JARQUE-BERA TEST OF NORMALITY



The JB Test was used to check the model specification errors. It followed the χ 2 distribution. The JB statistics p-value was 0.892144, which showed that residual were normally distributed because p-value is greater than 0.05, so we reject null hypothesis. Also the model was correctly specified.

CUSUM TEST OF STRUCTURAL STABILITY



The CUSUM test explained that blue line was inside the red lines and model was stable.

CONCLUSION AND RECOMMENDATIONS

CONCLUSION

The objective of this study was to understand the effect of environmental and economic handles on food prices in Pakistan. The major handles of the food price index were GDP, food imports, food exports, rainfall index, money supply, tax-to-GDP ratio, and crude oil prices. The study employed TSD from 1990 to 2024. The study employed the Augmented Dickey-Fuller Test, bound test, and ARDL Co-integration to evaluate the data. The variables were integrated of mixed order, and the dependent variables were stationary at level I(0), which paved the way for ARDL co-integration, and the bound test confirmed the ARDL co-integration. The models were estimated for the long run with ARDL co-integration and for the short run with ECM.

RECOMMENDATIONS

Agriculture output, as a percentage of GDP, has a negative relationship with price and food inflation. The government should introduce policies that lead to an increase in agriculture output, which will lead to a decrease in food prices. Policies should be adopted to cause a reduction in oil prices, which will further lead to a decline in food prices. Food exports also have a positive relationship with food inflation. The government should adopt policies and strategies that lead to a reduction in food prices by reducing the export of food. Food imports have a negative relationship with food inflation. Considering a year, as we import, our inflation reduces. The authorities have to implement policies that cause a reduction in food prices by increasing food imports of those products that are expensive in the home country. The relationship of GDP with food inflation is negative; as a one million dollar increase in GDP will lead to an -8.6759 percent fall in food inflation. The government has to introduce strategies that lead to a rise in economic growth/GDP in order to reduce food prices. Money supply has a positive relationship with food inflation. An increase in the money supply will lead to a reduction in food inflation. The rainfall index has a positive relationship with food inflation. As rainfall increases, food inflation also increases because of a lack of proper water infrastructure and dams, which causes floods and food destruction. The tax-to-GDP ratio shows that as taxes increase, food inflation also increases. There is a positive relationship between food inflation and the tax-to-GDP ratio. A reduction in taxes will cause a reduction in food prices.

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