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Macroeconomic Drivers of Food Inflation in Pakistan: The Role of Energy Prices, Exchange Rate, and Compound Shocks

Ghulam Ghouse
School of Management Sciences, Beaconhouse National University, Lahore, Pakistan

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ABSTRACT

The study examines the effects of energy prices and exchange rate fluctuations on food inflation in Pakistan for the period 1990 to 2025. The study simultaneously models energy prices, exchange rate dynamics, and structural macroeconomic shocks as drivers of food price inflation. Also, accounts for agricultural output, trade openness, money supply, and foreign aid inflows using the Generalized Method of Moments (GMM) estimation framework. To reflect on the COVID-19 pandemic (2019-2021) and floods (2022-2025), two binary structural dummies are included. The results indicate that all the core variables have a statistically significant effect on food inflation. Foreign aid, agricultural growth, and trade openness have a negative impact, while the exchange rate, energy prices, and money supply have a significant positive impact. Both structural dummies have positive coefficients, indicating that structural changes in the crisis period positively affected food inflation. The findings indicate that food inflation in Pakistan is largely due to foreign macroeconomic factors, including import costs (cost channels) and the transmission of energy prices, rather than solely to food supply. The study adds to the empirical literature on price transmission mechanisms in Pakistan and offers policy implications for stabilizing food prices amid volatility in energy markets and currency pressures.

Corresponding Author: Ghulam Ghouse (Email: ghulam.ghouse@bnu.edu.pk)

INTRODUCTION

The key pillars of sustainable economic development, especially for emerging economies like Pakistan, are food security, price stability, and macroeconomic equilibrium. Over the last few decades, the increasing volatility of fuel prices and exchange rates has become a critical determinant of food price dynamics, with far-reaching implications for household welfare, agricultural productivity, and the nation's food security. The paper examines the nexus among fuel prices, exchange rate fluctuations, and food prices in Pakistan using the GMM method, which is well-suited to analyzing such relationships. As a developing country, Pakistan is very vulnerable to exogenous economic shocks. Its food economy is closely interwoven with the price of energy and the value of the Pakistani Rupee (PKR). Food production is influenced by fuel prices at many levels: the cost competitiveness of imported and exported food is determined by exchange rate changes, and food production is influenced by fuel prices (Aslam et al., 2025; Ghouse, 2025). Combining these two variables yields a complex, often exaggerated, transmission mechanism that drives domestic food prices higher (Baffes, 2007; Nazlioglu & Soytas, 2012).

Pakistan has been experiencing chronic food inflation for the last twenty years. Food inflation, according to the State Bank of Pakistan (SBP, 2022), has shot to record highs in the wake of the rupee's devaluation and the rise in global crude oil prices. Based on an average of 10.15% between 2003 and 2013, food inflation experienced several spikes, reaching 25.33% in August 2008 and again following the currency crises of 2018-2019 and 2022-2023 (Pakistan Bureau of Statistics, 2023; Rehman & Ghouse, 2024; Ul Rehman & Ghouse, 2023). Low-income households have been disproportionately harmed by these inflationary episodes, which have lowered their purchasing power and increased food insecurity (UN World Food Program, 2020). Increasing academic interest has been given to the relationship between food prices and energy prices, in the aftermath of the 2007-2008 global food and fuel price crisis. The costs of fuel have a direct impact on agricultural production, in terms of mechanization, production of fertilizers, and transportation. According to Headey and Fan (2008), the doubling of the cost of crude oil prices in 2007-2008 added to the global food price spike, as energy is a significant proportion of agricultural input costs. This pass-through impact is especially acute in such countries as Pakistan, where subsidies on energy sources are limited, and agricultural sectors are largely dependent on diesel-powered irrigation and transport (Anwar & Amjad, 2021).

The indirect channel via the expenses of fertilizers is also very important. Higher prices of fuel directly translate into higher fertilizer prices; primary inputs in the production of fertilizers are natural gas and petroleum derivatives. Since the agricultural sector of the Pakistani economy, which is the basis of the country's macroeconomic environment (contributing around 18% of GDP and providing nearly 38% of the labor force (Pakistan Economic Survey, 2023), is heavily dependent on the use of fertilizers in the cultivation of wheat and rice as a primary production factor, the energy-to-food transmission mechanism is of particular macroeconomic significance. The strong long-run cointegration between oil price shocks and domestic food price inflation in Pakistan was confirmed by empirical studies of Ibrahim (2015) and Raza et al. (2012).

The exchange rate is one of the key macroeconomic variables that connect domestic food prices to the world commodity markets. The depreciating local currency makes food imports more expensive, and it increases the domestic price of tradable agricultural commodities, eroding household purchasing power (Dornbusch, 1988; Frankel, 2008). In Pakistan, where imports account for a large share of total food commodity consumption, the depreciation of the Rupee directly increases food prices. The PKR depreciated by over 230% against the US dollar between 2018 and 2023, creating severe imported inflation across the food supply chain (IMF, 2023).

The volatility in the exchange rate also brings in uncertainties in the agricultural investment and planning. The increased uncertainty arises when the values of different currencies are unpredictable, in most cases leading to decreased investment, disruptions in supply chains, and unpredictable price behavior (Clark, 1973; Aristotelous, 2001). This dimension of uncertainty of exchange rate fluctuations has been found to have negative impacts on agricultural production and trade levels in developing economies (Aghion et al., 2009; Tarawalie et al., 2013). The shift in exchange rate regime to a more market-determined exchange rate regime since 2019 has further intensified these dynamics in the context of Pakistan (SBP, 2021).

The food sector in Pakistan is one of the most complicated and economically important segments of the national economy. The industry includes agriculture, food processing, distribution, and retail, with the total production of dairy products alone projected to be USD 5 billion. Pakistan is a leading global producer of wheat, sugarcane, cotton, and rice, but ironically experiences chronic food insecurity. The Food and Agriculture Organization (FAO, 2022) estimates that more than 36% of the population experiences moderate-severe food insecurity, a figure that has been increasing over the past few years due to the pressure of inflation and the effects of floods in terms of disruption of the supply chain.

The food sector of Pakistan has structural vulnerabilities that are highly attributable to the aspect of dependence on imports as well as the mechanisms of transmitting prices. One of the most traded food commodities in the country, which is edible oil, is mainly imported, and therefore, the domestic price of the product is highly sensitive to the international commodity prices as well as the movements of the exchange rate. The Pakistan Oilseeds Development Board (2023) estimates that 3.5 million metric tons of edible oils are imported in Pakistan each year, worth more than USD 3 billion. The almost immediate pass-through to cooking oil and food prices associated with it by a weakening Rupee directly affects the household budgets across income levels (Ahmad & Ali, 2020).

Moreover, the food security problems faced in Pakistan are complicated by the fact that the nation is sensitive to climate-related disasters. The disastrous 2022 floods devastated an estimated 40 percent of standing crops in Sindh and Balochistan provinces, exacerbating the inflationary pressures emanating from rising fuel prices and currency weakening (UNOCHA, 2022). The interplay between macroeconomic and climate shocks highlights the significance of comprehending how structural price determinants, such as fuel costs and exchange rates, interact with supply-side disruptions in order to shape the trends in food prices.

Even though there is an enormous body of literature on inflation, food prices, and macroeconomic shocks in developing economies, a large research gap remains in the context of the specific economic conditions of Pakistan. Previous research has mostly analyzed either fuel prices or exchange rates alone without considering the combined or possibly interactive effect of the two on food prices. Moreover, most empirical studies of food inflation in Pakistan have focused on monetary determinants - such as growth in money supply and interest rates - but relatively few studies have rigorously modeled the structural transmission of energy prices and currency depreciation to food inflation using cointegration methods (Javed et al., 2013; Malik & Quershi, 2014).

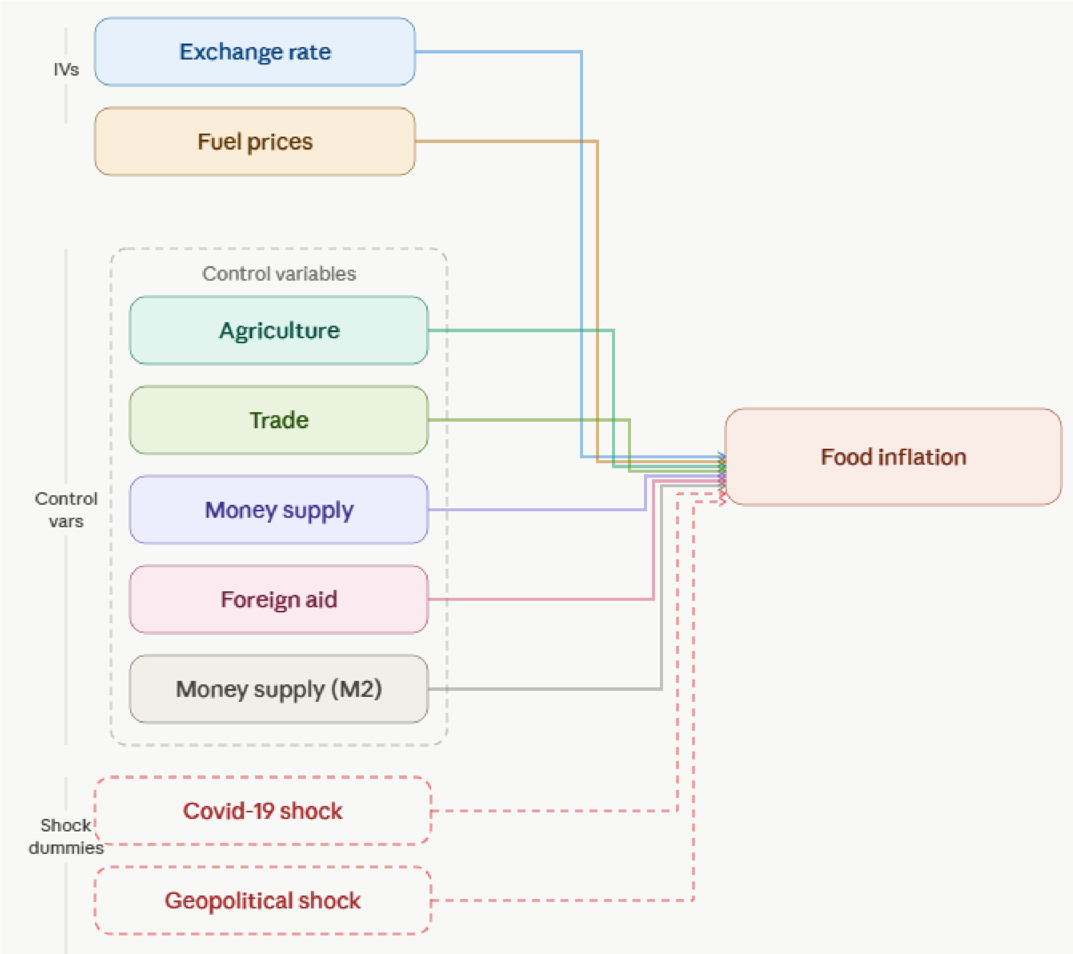

Figure 1: Linkages between exchange rate, fuel prices, and food inflation.

In this study, the gaps are filled by using an integrated analytical framework that simultaneously explains the fuel prices, exchange rate dynamics, and global commodity prices as the determinants of inflation of food prices in Pakistan. In such a way, it will contribute to the empirical literature on the mechanisms of price transmission in developing economies and provide practical implications to policymakers struggling with the issue of food price stabilization in the context of a volatile energy market and pressure on currency devaluation (Kalkuhl et al., 2016). The purpose of this study is to test the impact of energy price shocks and exchange rate volatility on food price inflation in the country. To generate policy implications of food price stabilization and macroeconomic management in Pakistan.

LITERATURE REVIEW

The linkage of the exchange rates, the fuel prices, and the food inflation has attracted a lot of scholarly interest, which is more so in the context of developing economies, which are prone to external price shocks. This section is a survey of the major empirical works that are pertinent to the food price dynamics in Pakistan. Haseeb et al. (2014) discussed the Pakistani export performance at the product level using the ARDL method to explore how relative prices and changes in exchange rates impact the volume of exports at the product level of 13 commodity categories. The researchers discovered that exchange rate volatility has a significant negative correlation with exports and should be used to recommend specific government subsidies that would ensure the competitiveness of certain goods in the international market, including meat, glass, and paper. Shahid et al. (2012) studied how oil prices, exchange rates, and food costs relate in Pakistan using principal component analysis and Seemingly Unrelated Regression (SUR) model. The evidence revealed that there is a positive relationship that exists between food prices, oil prices, and exchange rates, and the exchange rate is an important mediating channel through which oil price shocks are being passed on to agricultural commodity prices. Salman et al. (2009) used an error correction model and the ARDL methodology to investigate the determinants of high food costs in Pakistan. Their empirical findings indicated the existence of intricate interactions between GDP, food trade flows, and agricultural credit, proposing a dual-pronged approach of reducing the food trade imbalances as well as reinforcing rural credit access to curb food price inflation.

Abdul et al. (2007) put forward a challenge to the conventional assumptions by showing that the wheat support prices had a much lesser role to play in driving food inflation in Pakistan, and that the macroeconomic factors, such as the increase in money supply and fuel prices, had a much greater decisive role. The paper also demonstrated the implications of poverty, which is cascading in nature, with the rise of food and fuel prices to low-income households. In their study, Khan et al. (2011) used a structural vector autoregressive (SVAR) framework with monthly data over the period 1990-2011 to trace transmission of global food and oil price shocks to the macroeconomic variables in Pakistan. It was found that oil price shocks suppress industrial output and raise inflation, interest rates, and the real effective exchange rate - confirming the exchange rate as a central shock transmission channel.

Nigar et al. (2023) tested the determinants of food prices in Pakistan in the long run and found that there was a significant negative correlation between wheat prices and the real effective exchange rate. Both global crude oil prices and global food prices were found to have a strong positive impact on the domestic food commodity prices in Pakistan, highlighting the strong structural integration of Pakistan with the international commodity markets. Salamat et al. (2020) employed firm-level transaction data to demonstrate that devaluation of the domestic currency widens the profit margin of agricultural export, and the effects of price intensification are more significant than the effects of volume. The study highlighted the importance of currency invoicing systems and sectoral diversification in mediating exchange rate pass-through outcomes. Furceri et al. (2022) reported the use of cross-country evidence, showing that global surges in fuel prices disproportionately impact food inflation in developing economies both directly through a direct cost-push mechanism and indirectly through an exchange rate mechanism, with import-dependent countries experiencing stronger pass-through effects. In the same spirit, Ahiadorme (2023) confirmed the use of panel data in sub-Saharan Africa, which contributes to fuel price volatility, significantly increasing domestic food prices - a finding that directly relates to the institutional context in Pakistan. Hossain et al. (2023) showed that the disruptive impacts of the price changes of commodities in the Russia-Ukraine war were transmitted rapidly to South Asian food markets, with Pakistan being among the most adversely affected due to its dependence on wheat imports and weak currency. Arora and Bhatt (2023) also revealed that the food inflation effect of the oil price spikes caused by conflict is asymmetric with emerging market economies, and thus should be included as the oil price spikes' geopolitical shock dummies in empirical economies such as the one used in the present study. Ali and Anwar (2022) used the ARDL bounds testing model on the monthly data of Pakistan, and they found that there was cointegration among money supply (M2), exchange rates, and food inflation. Their error correction outcomes revealed that about 28% of the deviation of long-run equilibrium is corrected in a single quarter, which highlights the persistence of food price misalignments following monetary and exchange rate shocks.

Although there is an increasing literature on food inflation in Pakistan, it has been observed that a significant gap exists in the literature that simultaneously models the joint effects of fuel prices, exchange rate dynamics, and structural shocks. In past research, these determinants have been generally investigated either separately or without considering structural breaks. This paper will deal with these limitations by including the fuel prices and the exchange rates as the core independent variables and the agriculture growth, trade openness, money supply, and foreign aid as controls, and the introduction of two structural shock dummies to capture the COVID-19 pandemic and the Iran-US-Israel geopolitical disruption. This methodology adds a more global and policy-relevant empirical investigation of the food price determination in the macroeconomic environment of Pakistan.

METHODOLOGY

Data Description

The data sample consists of 1990 to 2025. The data is collected from the World Development Indicators (WDI), the Treading Economy, and the IFS. In this study, there are 7 variables and 2 structural shock dummies. The changes in consumer prices of food and live animals, beverages, tobacco, and edible oils, covering SITC categories 0, 1, 4, and 22, are measured by food inflation (FI) (dependent variable). Exchange rate (EXR) is the actual effective exchange rate, which is stated as an average of the monthly exchange rates in units of Pakistani Rupee per US dollar. Fossil Fuel energy price (ENRP) is the pump price of diesel, which is translated to US dollars using domestic currency. The three are the key variables of the model.

The four control variables can be defined as follows. The agriculture share in GDP (AGRIS) includes crops, livestock, forestry, and fisheries. Trade openness (TRA) is gauged as the aggregate value of exports and imports of goods and services as a ratio of GDP. The money supply (MS) is based on the IFS broad money definition, which includes currency in circulation, demand deposits, time and savings deposits, and foreign currency deposits, but not central government deposits. Foreign aid (FAID) is an inflow of net official development assistance (ODA) in current US dollars received by Pakistan.

Two binary dummy variables are added to take care of structural breaks. The Covid-19 dummy (D1) is 1 during the period 2019-2021, to reflect the supply chain disruptions, demand contractions, and inflationary pressures caused by the pandemic, and 0 otherwise. Beginning in 2022, the floods dummy (D2) will be 1 to represent the floods, and 0 otherwise.

Method

The Generalized Method of Moments (GMM) proposed by Hansen (1982) is one of the most popular methods used in time series econometrics, since it does not require the complete specification of the distributional properties of the data, unlike Maximum Likelihood Estimation (MLE), which does. On the other hand, GMM only uses a set of moment conditions based on economic theory, thus being much more flexible and robust for empirical applications. This is especially useful when the data is time series in nature, and the time series data may be heteroskedastic and autocorrelated, and endogenous, which results in biased and inconsistent estimates using OLS. In macroeconomic and financial time series, GMM has also been proven to be a crucial approach for estimating Euler equations and asset pricing models, such as Hansen and Singleton (1982), who estimated consumption-based asset pricing models without making any parametric assumption about preferences or distributions, and such moment restrictions arise naturally in rational expectations models. Compared with standard estimation techniques such as OLS or IV estimation, GMM provides a common framework, allows for several instruments, uses an optimal weighting matrix (e.g., Newey-West HAC standard errors), and enables asymptotically efficient estimation even when higher-order moments are mis-specified, making it the estimator of choice in structural macroeconometrics, monetary policy analysis, and empirical finance.

The functional equation (1) and econometric equation (2) are following:

$$FI = f(\text{EXR, ENRP, AGRIS, TRA, MS, FAID, D1, D2}) \quad (1)$$

$$FI_t = a_0 + a_1 EXR_t + a_2 ENRP_t + a_3 AGRIS_t + a_4 TRA_t + a_5 MS_t + a_6 FAID_t + a_7 D_1 + a_8 D_2 + e_t \quad (2)$$

RESULTS AND DISCUSSION

The overall results of GMM in Table 1 show that external and macroeconomic conditions are the main drivers of food inflation in the study area, as opposed to domestic food supply conditions. Table 2 shows the magnitude comparison. Each variable is then addressed in turn, in relation to the larger empirical literature.

Table 1. Results of GMM.

	Coefficient	Standard Error	t-statistics	P-value
EXR	0.701512	0.065418	10.72354	0.0000
ENRC	0.543423	0.029161	18.63546	0.0000
AGRIS	-0.149337	0.005915	-25.24741	0.0000
TRA	-0.440021	0.081386	-5.406597	0.0000
MS	0.426682	0.072147	5.914067	0.0000
FAID	-0.58706	0.082894	-7.80200	0.0000
D1	0.18181	0.055931	-3.25066	0.0002
D2	0.49504	0.013874	-35.6803	0.0000

Table 2. Comparison of impact.

Variable	Coefficient	Direction	Relative Contribution
EXR	0.701	Inflationary	High impact
ENRC	0.543	Inflationary	Moderate-high impact
AGRIS	-0.149	Deflationary	Small effect
TRA	-0.44	Deflationary	Moderate impact
MS	0.427	Inflationary	Moderate impact
Foreign Aid	0.587	Deflationary	Positive impact
D1 (Structural Dummy 1)	0.182	Inflationary	Positive impact
D2 (Structural Dummy 2)	0.495	Inflationary	Strongest Positive impact

Among the variables in the model, foreign aid has the largest inflationary effect on food prices. There is a -0.587% decrease in food inflation for every 1% increase in foreign aid inflows. This is in line with the increase in purchasing power: an increase in aid inflows decreases the exchange rate and increases disposable income in recipient economies, which leads to a reduction in prices. The very low standard error (0.083) and the high t-statistic (7.802) provide confirmation of the precision and reliability of this estimate. The results are consistent with the panel-based evidence for import-dependent economies, which indicates that external financial flows are a major source of food price dynamics (Al-Marhubi et al., 2025).

The exchange rate coefficient of 0.701 suggests that an increase in the exchange rate significantly increases food inflation, mostly via the import cost channel. The depreciation of the domestic currency makes imported food commodities and agricultural inputs (fertilizer, seeds, and machinery) costlier, and the cost of food commodities passes through to the consumers. Kornher and Kalkuhl (2013) find that food prices and exchange rates are significantly correlated across countries using the GMM approach. Khatun et al. (2016) showed for Bangladesh using the Vector Error Correction Model (VECM) that the movement of foreign exchange rates has a significant long-run effect on domestic food prices. Moreover, Maneejuk et al. (2023) have found exchange rate and country risk variables as one of the key national-level factors governing food price behavior.

The high coefficient of 0.543 for energy prices highlights the strong energy–food linkage. Mechanized farming, manufacturing of fertilizer, irrigation, cold storage, and food transportation all rely on fossil fuels, which directly convey energy price shocks to food prices. The fluctuations in availability and prices of fossil energy sources can thus be directly passed on into outlooks on agricultural production costs, food prices, and food security in carbon-resource economics (Frontiers in Sustainable Food Systems, 2026). Paltasingh et al. (2024) used panel NARDL estimation for the South Asian countries to determine the influence of global oil and coal prices on food prices in the long run. It was found that a 1% rise in worldwide oil prices translates into a 1.72–2.45% increase in the food price in the long run; a 1% rise in worldwide coal prices translates into a 0.64–0.76% rise in the food price in the long run. This relationship is very strong in the current model, as can be seen from the t statistic of 18.64, and the standard error is quite small, 0.029.

The trade coefficient is negative and significant (-0.440), indicating that greater trade openness reduces the sensitivity of domestic food prices to external commodity price shocks. More integrated economies are not as responsive to international food price fluctuations, which have a greater impact on domestic food inflation. This aligns with the price transmission literature, which found that the first stages of trade openness had negative effects on food price stability before the long-term effects gradually take place, for Central Asian countries as presented by Sun and Zhang (2021) using panel GMM methodology. Romer (1993) recorded an intricate and context-dependent association between trade openness and inflation, the import cost channel of which has been inflationary in commodity-importing developing countries.

The coefficient of the money supply is 0.427, which is in line with the classical quantity theory of money; an increase in the money supply that exceeds the growth of productive capacity creates an inflationary pressure. The literature suggests that an increase in money supply will increase food inflation, except for a few studies that appear as exceptions (Polgreen & Silos, 2023). Using methods of Bayesian time-series analysis, Dorfman and Lastrapes (1996) demonstrated that domestic prices of crops and livestock rise in the short run following a positive shock to the money supply of the United States. Food inflation had a monetary face, especially in 2021-2022 during the global food crisis, when the advanced economies' M2 growth rate was at historic highs.

The coefficient of Agriculture is (-0.149), but it has the lowest standard error (0.0059) and has the second-highest t-statistic (25.25). The negative result could be because incase in agricultural share in GDP, the food prices decrease. According to Hazell et al. (2022) and Durevall et al. (2013), as one of their literature reviews, conclude that domestic agricultural conditions are still important in isolation from any international price transmission.

The absolute value of the coefficient of the dummy for D2 (floods dummy) is the largest in absolute value among all the dummies (0.495), and has the highest t-statistic in the entire model (t = 35.68), which suggests that the structural regime shift between D1 and D2 is highly well-supported and precisely estimated. The positive, on the other hand, indicates an ineffective policy effect (such as price controls, food subsidies, fiscal interventions, or post-crisis stabilization) that had a significant impact on food inflation.

D1 (COVID-19 dummy) exhibits a more moderate positive structural change in the food inflation dynamics, as shown by the coefficient of 0.182 and the t-statistic of 3.25. It is a statistically significant 1%, but is not as pronounced as D2, indicating a less radical but still significant change in the study period. Typically, panel GMM food inflation models include such structural dummies as a way of capturing exogenous shocks that impact the inflationary dynamics (Arellano & Bond, 1991; Roodman, 2009).

CONCLUSIONS AND POLICY IMPLICATIONS

The current research explores the dynamics of food inflation in Pakistan in the period ranging from 1990 to 2025, with the focus on the impact of energy prices and exchange rate depreciation. Utilizing GMM, this empirical investigation explores the impact of exchange rate depreciation, energy prices, and agricultural share in GDP, openness to international trade, money supply, foreign aid inflows, and two structural shock dummies on the food inflation rate in Pakistan. The results reveal that food inflation in Pakistan has been heavily influenced by external factors rather than internal food supply factors. Foreign aid turns out to be the moderate deflationary factor with the coefficient of 0.59. Exchange rate depreciation proved to be the second most important explanatory variable for inflation (coefficient = 0.701), as when the Pakistani Rupee depreciates, the cost of importing goods rises, thereby increasing domestic food prices. Energy prices turned out to have a high positive effect on food inflation (coefficient = 0.543) because of the energy-food linkages throughout all stages of agricultural production, including cultivation, fertilizer manufacturing, irrigation, cold storage, and transportation of food products. In addition, the results revealed that the openness (coefficient = 0.440) and money supply expansion (coefficient = 0.427) also caused an inflationary effect, which is justified by the literature on price transmission and quantity theory of money. Agricultural value added (coefficient = 0.149) proved to have the lowest positive influence on food prices and could represent the cost-push effects. Both of the considered structural shocks were negative and statistically significant. First of all, it should be emphasized that the floods dummy (D2 = 0.495) showed the strongest positive influence and reflects that during crises. Second, the coefficient of the COVID-19 dummy (D1 = 0.182) proves the existence of an ordinary break in the model.

All the results presented above strongly corroborate the conclusion that the Pakistani food economy is heavily affected by international commodity prices and broader macroeconomic shocks, with little protection from domestic supplies. In terms of theoretical contributions, this research addresses a major gap in the current literature by analyzing the behavior of fuel prices, exchange rates, and other structural shocks within a single equation system through GMM estimation. Several key policy recommendations can be deduced from this analysis concerning food inflation in Pakistan. Given that depreciation of the exchange rate leads to high food price levels, exchange rate stability must be achieved by the State Bank of Pakistan. This will include increasing foreign reserve levels, encouraging export diversity, and implementing currency swaps. There is also a need for policy formulation to introduce subsidies for energy and also the development of alternative energy sources for agricultural activities, which are highly exposed to the effect of rising prices for fuel products. Pakistan may seek to decrease dependency on imports of food commodities such as edible oils, wheat, and pulses by encouraging local production through import substitution.

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