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Research Article

Examine the Impact of Energy Cost on the Food Inflation: Fresh Evidence from Pakistan Economy

Sajid Ali *, Khalid Mahmood Mughal, Durdana Qaiser Gillani
Department of Economics, Preston University, Islamabad, Pakistan

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*Corresponding Email:
sajidch174@gmail.com

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Abstract

Food and fuel are essential components of human survival throughout the natural and economic cycles. Inflation and energy costs are major concerns among politicians and academics, particularly the global crude oil price shock after 1970 and the current surge in global oil prices. The growth in energy consumption has a variety of repercussions on the agri-industry, including increased agricultural output and food supply on the one hand, but also increased food prices. The main aim of the study is to investigate the effect of energy cost on food inflation in the case of Pakistan. To achieve the above objectives, this study used the data from 1973 to 2022 in the case of Pakistan, which was collected from World Development Indicators (WDI) and the economic survey of Pakistan, and employed the ARDL technique to estimate the model. This study found that in the long run, the agricultural land, machinery, petrol/oil consumption, and electricity in the agricultural sector, agricultural production, and water availability have a negative effect on food inflation. However, the energy inflation has a positive effect, while the gas consumption in the agricultural sector has no effect on food prices. This study concluded that energy cost has a harmful effect on food inflation. This study recommended that the government should have tight governance, subsidy reforms, farm sector changes, a shift from non-renewable to renewable energy, and a monetary policy free of political interference.

Keywords: Energy cost, Food inflation, Agricultural production, Machinery, Water availability.

Introduction

Food and fuel are critical components of human survival in both the natural and economic cycles. The modern world is heavily reliant on energy as a primary foundation of economic activity. Crude oil is a critical source of fossil-fuel energy (later on FFE), acting analogous to "the blood that flows through the veins of the Earth" (Hecht, 2022). From 2015-2040, oil's worldwide share in the global energy mix is expected to remain roughly 28.00%, higher than coal and gas. The contemporary world's progress is dependent on energy and oil markets. Future changes in the energy and oil markets, instead, are influenced by a number of variables, including population increase, technical breakthroughs, shifting demographics, structural transformation, GDPg, and oil-price volatility (World Oil Outlook, 2017). Crude oil serves as an economic engine and a lifeline for all economies' national growth. The upsurge in global oil-prices benefits oil-exporting countries (OEC) while harming oil-importing countries (OMC) (Shaikh et al., 2021).

The primary explanation for this occurrence is understandable: increased revenues provide greater financial-stability for OEC, while decreasing revenue produces financial instability for OMC, and vice versa (Kurihara, 2015). Crude-oil has a significant influence on people's lives due to its vast range of applications in various areas of the economy, including transportation, agriculture, industry, agriculture, and housing. As a result, when crude-oil prices are volatile and erratic, people's standard of living varies (Jahangir, 2017). Price-transmission variations in oil-prices may have an effect on the price of other items (Taghizadeh-Hesary et al., 2019). The continual rise in oil prices is recognized as a key component of both food and general inflation (Hamilton, 2009). In a cause-effect connection, oil and inflation are frequently related. Inflation upsurges when oil-prices upsurge, but begins to diminish when prices fall (Baffes & Haniotis, 2010). When GDPg stability is considered as the major indicator of a country's macroeconomic success, inflation is almost always a top priority in order to avert economic disaster (Acharya, 2010). Inflation is the adversary of the economy, especially in emerging nations such as Pakistan.

Between the policymakers and academicians the inflation and energy cost is the burning issue especially the prices shock of crude-oil around the world since 1970 and the present increase in the world oil-prices (Holland et al., 2013). As a result, the question of price stability through a combined upsurge in these two key macroeconomic elements goes unresolved, increasing overall inflation and food-costs, particularly in emerging markets (Nagyová et al., 2016). In reality, with rising F_INF induced by an increase in worldwide energy costs, it is now regarded as a sensible issue that must be properly addressed by responsible authorities for the sake of public welfare (Nigusse et al., 2019). The energy usage and inflation rate picture in Pakistan and it is primarily driven by swings in imported oil-price instability, which has an influence on domestic inflation rate via non-food and food-inflation rate. Food price increases not only cause budgetary delays for food essentials, but in an agricultural nation like Pakistan, the low-income person spends the 70.0% share of his/her income on food products, by reducing the expanses health and education. Despite its agri-economy, Pakistan is powerless to defend the welfare of these house-holds, which has been harmed by an increase in food costs. Given the significance of food, it is vital to understand how oil-price volatility affects economic expenses of living. In Pakistan, however, inflation is mostly associated with worldwide oil-prices and is commonly referred to as a monetary-phenomenon. According to the researcher, price is a transient reply to any economic-shocks connected with highly volatile apparatuses of inflation, such as raises food and non-food prices, which drive inflationary drifts, particularly in OMC. The classical and contemporary approaches to considerate inflation theories give some support for policy insights that aid in inflation management, although food inflation is often overlooked (Shaikh et al., 2021).

This argument pushes us to look into the diffusion routes that are generating overall and food-price rises in an open-economy like Pakistan. Food inflation refers to the upsurge in the prices of food substances over time, leading to reduced purchasing power for consumers and potential food insecurity for vulnerable populations in Pakistan. The food inflation rate in Pakistan reached a record ever high, primarily due to shortage of staple foods like pulses, wheat, sugar, and edible oils. This was mainly caused by factors such as climate change, low productivity, hoarding, and smuggling. High food prices had hit low-income households leading to increased poverty and food insecurity. The government of Pakistan had implemented various measures to address the issue, such as increasing subsidies for essential food items, improving supply chain management and clamping down on hoarding and smuggling. However, more was to be done to ensure FS for all, particularly in light of the COVID-19 pandemic, which has further exacerbated the challenges faced by the agriculture and food sectors in Pakistan (Qayyum & Sultana, 2018).

The primary cause of inflation in the oil-importing countries (OMC) like Pakistan is the high international oil prices, which has a long-term impact on people's daily lives and well-being (Shahbaz et al., 2008). The country's internal energy needs are significantly reliant on oil-imports, accounting for 85.0% of total demand and just 15.0% satisfied through home-grown sources, costing the government roughly $14.00 billion per year in oil-imports. To fulfil local demand in the final eleven (11) months of fiscal year 2018-19, Pakistan spend more than $13.140 billion on oil import. Petroleum goods include crude oil, liquefied natural gas, and petroleum gas. These imports make up around 30% of total imports, with crude-oil accounting for half of the petroleum group's contribution (Sarwar et al., 2020). This significant burden on the BoP is moved to the ultimate consumer, either directly or indirectly, as a result of oil-price (later on OP) volatility in the form of inflation at gas stations and utility outlays (Mabro, 1984). According to the literature, crude oil prices varied between US

$18.00 and US $23.00 throughout the 1990s. It rose from $40.00 to $60.00 in 2004-05. Though, between 2007 and July 2008, it increased from US $70.00 to US $174.00, representing the greatest fluctuation in oil prices in history. Similarly, global food costs grew by 39% over this time (Lescaroux & Mignon, 2008). Pakistan's agricultural economy experienced stagflation1 during the 2007-08 global-financial-crisis (Hussain et al., 2014).

There are three study branches in the literature that investigate the relationship between these factors. The first line of study contends that there is no evidence to substantiate the impact of energy costs on food-prices (Reboredo, 2012), (Fowowe, 2016), and (Zhang et al., 2010). The second branch focuses on research on the link between energy and food costs across two (2) time periods. These investigations revealed no relationship between energy and food costs in the first (1st) period, but confirmed the presence of a link between the variables under research in the second (2nd) period (Nazlioglu et al., 2013) and (Chen et al., 2010). The third category includes research that discovered that variations in energy costs induce food price fluctuations (Radmehr & Henneberry, 2019), (Harri et al., 2015), (Nazlioglu & Soytas, 2012), (Hezareh, 2016), (Esmaeili & Shokoohi, 2011), and (Alghalith, 2010). The reason for such a strong association is the country's lack of oil-reserves. Oil is mostly utilized in the energy and transport industries (Economic survey of Pakistan, 2019-20). Oil prices and monetary worries in emerging countries such as Pakistan are the primary sources of inflation, both overall and food prices. Several international studies have found that F-INF in developing OMC provisions the being of oil-price possessions in both horizontal and vertical transmission-channels (Blanchard & Gali, 2007; Davidson et al., 2016; Nazlioglu et al., 2013). Many studies on the factors of F-INF in Pakistan have already been undertaken by various scholars, including (Ahsan et al., 2012; Arinze, 2011; Asghar et al., 2013; Batten et al., 2014; Jalil et al., 2014; Joiya & Shahzad, 2013).

Some research, such as Khan et al. (2007) and Khan et al. (1996), focused on internal monetary and monetary policy issues that induced inflation, whilst others looked at foreign ones. According to the literature, the rise in food costs in Pakistan is mostly caused by increasing monetary enlargements, which are impacted by a huge amount of borrowing from both sectors (private and public) (Khan et al., 1996). Though, domestic inflation is caused by more than just monetary and fiscal components; external shocks, notably oil price volatility, have also played a role. In Pakistan, changes in global oil prices are often seen as a deputation for changes in domestic-inflation (Shaikh et al., 2021). Recent research on the Oil-Inflation nexus in Pakistan, such as Qayyum and Sultana (2018), has exposed that upsurges in F-INF in Pakistan are influenced by worldwide oil-price upsurges, rising income-levels, a fast spike in local demand, and macroeconomic policy adjustments. Similarly, Hanif et al. (2017) utilized Pakistan's data from 1992-VII to 2014-VI, and found that global OP volatility have a substantial impact on inflation than metal and cotton prices, and that oil price inflation causes F-INF by up to 2.00%. The upsurge in the energy-use effects the agri-industry in many dimensions like increase the agricultural productivity and food availability on one side but on other hand it's also increase the prices of food. Therefore, the links between EC in food systems and energy resource restrictions are intricate. Furthermore, continuous variations in food-production and consumption practices that coincide with globalization, urbanization, and demographic shifts highlight the relevance of energy usage in food-systems as a food-security issue. Here, we examine the present level of knowledge about the energy intensity (EI) of agricultural and food-systems (Pelletier et al., 2011).

Because, on yearly basis, food prices and food insecurity apprehensions have been arising and glowing at the alarming situation around the world. Eradication of absolute hunger, ensuring food security holds a central space in the UN-SDGs to be attained by nation's up to 2030. Pakistan, a low-income economy; economical and physical accessibility of foodstuffs significantly determined the FS status in the country. UNFAO has revealed that rising cost of food products depriving a significant segment of community to obtain required food causing the food insecurity in Pakistan. The relevant literature has been reviewed and found that the link between the price of food stuffs. The magnitude and volume of the impact need to be quantified empirically. Particularly demand-side factors of economical and physical food access during natural catastrophe, deficiencies in economic growth in response to income shocks. The supply-side also threatens the food security with the increase in the input prices need to be booked. It has been found that very few studies are available which review the entire variable i.e., food inflation at one place threatens by the energy prices. Therefore, this study was conducted to investigate the effect of energy cost on food inflation in Pakistan tried to minimize the gap and significantly contribute in the existing body of knowledge.

Review of Literature

In general, price-transmission (later on PTran) may be defined as a variation in one good's price due to other good's price change (Norazman et al., 2018). According to Cachia (2014), PTran in the food sector is F_INF due to inflation in global market. According to Listorti and Esposti (2012), horizontal PTran refers to price links between raw commodity and producer levels. It can also be seen as links between multiple markets at the same point in the supply chain. Other factors that influence the horizontal PTran process include the number of periods and the conforming contractual activities like transportation etc. (Davidson et al., 2011), as well as the government's subsidy and price control policies. All of this points to the importance of the food industry's level of competition and government involvement in shaping domestic food price behaviour in reaction to global market shocks (Norazman et al., 2018). Davidson et al. (2011) discovered that global commodity prices only had an indirect influence on UK food price inflation, with the horizontal PTran being through oil-price effects. The former is concerned with factors such as trade costs, and geographical distances that may influence between global F_INF and domestic producer prices, also known as farm gate prices (Asche et al., 2007; Bakucs et al., 2015; Davidson et al., 2011; Listorti & Esposti, 2012). Zilberman et al. (2008) assume that food consumption remains constant and that price rises are the result of lower supply due to rising energy prices. However, the same causes that are driving increased fuel consumption, such as economic development in developing nations like India and China, may also drive-up food demand. This income impact causes increased food costs during periods of increasing energy-prices, and the compounded food price effect causes an additional increase in the price of water, reducing the chance of instances in which higher energy prices raise the price of water while decreasing its consumption. The rise in energy prices caused by Middle Eastern upheaval may be to blame for recent global food price inflation, which might occur via a transmission mechanism (Uyi & Demir, 2023).

Radmehr and Henneberry (2019) studied how oil prices, the US dollar exchange rate, and interest rates affect level-household food costs in Iran. They apply panel-VAR algorithms with household survey data released by Iran. Their investigation applies to twelve agricultural goods, and monthly data from 2003 to 2013 is used. They reveal that food costs are positively correlated with the value of the US dollar. They discovered that, whereas interest rate increases have a favourable influence on food prices in the near term, they have a negative impact on F_INF in the LR. Furthermore, their findings suggest that food costs rise in both the short and long run-in reaction to an increase in oil prices. It is worth noting that a considerable portion of the volatility in food costs can be explained by the swings themselves. *Nigusse et al.(2019)* used ARDL approaches to study the determinants of inflation in Ethiopia during a 32-year period from 1985-2016. They included macro-economic factors that affect or vary inflation levels as assessed by the CPI, such as money-supply, real GDP, global oil-price, budget-deficit, and real exchange-rate. The findings of the bound test verified the long-period link between explanatory factors and the Ethiopian CPI. Their empirical findings suggested that the money supply, world oil price, budget deficit, and real exchange-rate all have a long-period optimistic impact on inflation in Ethiopia, whereas real GDP has no effect on price levels. Finally, our analysis found that in the near-run, the real exchange-rate, budget-deficit, money-supply, and global oil price are the most important drivers of F_INF in Ethiopia. Su et al. (2019) investigated the causal relationships between oil and F_INF. Given structural-changes, the long-period nexus utilizing full-sample data is found to be unstable, implying that the causality test is unreliable. Instead, a time-varying rolling-window approach is used to re-evaluate the dynamic causal linkages. Their empirical findings show that there is time-varying positive bi-directional causality between oil and F_INF over specific sub-periods. Additionally, their data show that PTran between two series exists for agri-commodities utilized directly and indirectly in bioenergy production. To maintain a generally steady price level for oil and agri-commodities, the system requiring global collaboration and coordinated action should be expanded to include a strategic petroleum reserve. Furthermore, regulators should reduce speculation in the commodities derivatives market. Furthermore, a subsidy provision for certain commodities should be established to mitigate the contagious effect of unexpected price changes.

Asgari et al. (2020) investigated the overshooting-hypothesis, which states that agri-prices may fall faster than their long-term equilibrium-levels (i.e., overshoot) in the SR. Their findings add to the overshooting literature by incorporating the energy-sector into the overshooting-model. The theoretical results demonstrate that flexible energy-prices share the shock weight with other flexible pricing, causing agricultural prices and the exchange rate to overshoot albeit to a lesser extent than previous research. Their empirical findings corroborate the theoretical hypothesis that agri-commodities change more quickly than industrial prices, but energy-prices limit the amount to which agri-prices overshoot. Alteration behaviour has ramifications for farmers' revenue stability and financial-viability. Similarly, Ngarava (2021) investigates the link between F_INF, energy, and water, as well as if there were spill overs in SA, used data 2002-I–2020-IV and VAR model for estimation. Prior to 2013, the F_INF was greater than for water and electricity. After 2017, water has a greater F_INF than energy and food. Furthermore, energy inflation boosted both water and F_INF, whereas water inflation did the same for food inflation. They determined that there is a link between lateral inflation in food, energy, and water. Moreover, Lundberg et al. (2021) argue that the inconsistent findings are due in part to variation in the pass-through connection across time periods. They employ a novel wavelet-based regression method to investigate horizon-based heterogeneity in the link between oil and agri-commodities prices. They discover significant evidence of variability between time periods and commodities. They create a simplified model of agricultural output and demonstrate how agricultural contracts can cause price stickiness, resulting in variability in input prices over different time periods. They also discover evidence that recent technology advancements have resulted in a structural alteration in this horizon-based heterogeneity.

Moessner (2022), used cross-country panel estimate of Phillips curves to investigate the impact of exchange rate (later on EXR) pass-through on F_INF and energy-CPI and its dependency on the CPI environment. He examines a broad panel of OECD member covering data from 1994-I-2021-IV. He discovered that EXR pass-through is highest for energy-CPI and very substantial for F_INF. 10% exchange rate depreciation causes a rise in energy-CPI, as well as an upsurge in F_INF of around 0.30pp and 2.0pp at any horizons. He also discovered evidence that EXR pass-through to F_INF and energy-CPI is dependent on the INF-environment, with higher-INF resulting in greater pass-through. Uyi and Demir (2023) examined the impact of energy-costs on F_INF in three (3) Asian countries: China, the Philippines, and Vietnam, using data from 2002-1-2020-12. The Panel-VAR model results show that shocks in energy-prices and GDP-growth have an optimistic and substantial effect on F_INF, whereas shocks in EXR and AgGDP have a harmful but immaterial effect. The PVAR causality results showed that GDPg predicts F_INF, energy-prices, currency rates, and agricultural productivity. Furthermore, there is a link between economic development and the EXR, as well as between the EXR and AGDP. This means that there is a response effect between GDPg and the EXR, as well as GDP growth and AGDP. Moreover, Köse and Ünal (2024) use a structural vector auto regression model to investigate the effects of temperature, oil-price, EXR, and wages on food prices, using data from 2003-I to 2020-XII in Latin American countries. They are concerned about how much the elements impact food costs. Their empirical findings demonstrate that oil prices and temperature might be important determinants in minimizing F_INF. The EXR explains a major portion of F_INF in general, although its influence does not vary much over time. The effects of oil-price and temperature were small in the initial months, but they resulted in significant variations with time. The EXR was a key factor in explaining F_INF in all countries except Ecuador. This country effectively minimized the negative effects of the EXR, although F_INF was partial by oil-prices and temperature.

Methodology

This research is quantitative in nature and the used data from 1973 to 2022 in the case of Pakistan. The data was collected from World Development Indicators (2024) and different issues of economic survey of Pakistan.

Model Specification

This study used the food price index as proxy for food inflation is also used by Egwuma et al. (2017), consumer price index as proxy for energy prices are also used Mahadevan and Asafu-Adjaye (2007), Anton and Nucu (2020), and Tang and Tan (2013) used gas also used by Farandy (2020) and Güdükçam (2023), oil also used by Baimaganbetov et al. (2021) and Güdükçam (2023), and electricity consumption also used by Farandy (2020) and Güdükçam (2023), agricultural land also used by Ismaya and Anugrah (2018), agricultural machinery also used by Ismaya and Anugrah (2018) and Nechaeva et al. (2019), transportation services also used by Farandy (2020), water availability also used by Farandy (2020) and Güdükçam (2023), agricultural production also used by Bhattacharya and Gupta (2018), net food export also used by Chand (2010), population growth also used by Bhattacharya and Gupta (2015), household consumption expenditure also used by Farandy (2020) and Güdükçam (2023), as independent variables.

$$F\_INF_t = \beta_0 + \beta_1 AgL_t + \beta_2 AgM_t + \beta_3 EI_t + \beta_4 TRNP_t + \beta_5 AgGas_t + \beta_6 AgElec_t + \beta_7 WA_t + \beta_8 AgGDP_t + \beta_9 NFX_t + \beta_{10} PG_t + \beta_{11} HHFC_t + \mu_t \quad (1)$$

Where

F_INF_t: Food Inflation

AgL_t : Agricultural land (% of land area)

AgM_t: Agri machinery, tractors per 100 sq. km of arable land

EI_t: Energy Inflation (Use Inflation, consumer prices (annual %) as proxy)

$TRNP_t$: Transport services (% of commercial service exports)

$AgGas_t$: Agriculture sector consumption of Gas (mm cft)

$AgElec_t$: Agriculture sector consumption of Electricity (GWh)

WA_t: Water availability (MAF)

$AgGDP_t$: Agriculture, forestry, and fishing, value added (% of GDP)

NFX_t: Net Food Exports (% of merchandise)

PG_t: Population growth (annual %)

$HHFC_t$: Households and NPISHs final consumption expenditure (% of GDP)

ARDL Model

There are too many approaches in the econometrics to measure the link between the variables. But, the ARDL allow the both mixed and similar order of integration and eliminating autocorrelation and originate ECM model. Furthermore, the ARDL is suitable too small sample and fixes the endogeneity issue, therefore, the outcome of ARDL model is unbiased and consistent (Ahmad & Wajid, 2013).

$$F\_INF_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} F\_INF_{t-i} + \sum_{i=0}^{n} \beta_{2i} AgL_{t-i} + \sum_{i=0}^{n} \beta_{3i} AgM_{t-i} + \sum_{i=0}^{n} \beta_{4i} EI_{t-i} + \sum_{i=0}^{n} \beta_{5i} TRNP_{t-i} + \sum_{i=0}^{n} \beta_{6i} AgGas_{t-i} + \sum_{i=0}^{n} \beta_{7i} AgElec_{t-i} + \sum_{i=0}^{n} \beta_{8i} WA_{t-i} + \sum_{i=0}^{n} \beta_{9i} AgGDP_{t-i} + \sum_{i=0}^{n} \beta_{10i} NFX_{t-i} + \sum_{i=0}^{n} \beta_{11i} PG_{t-i} + \sum_{i=0}^{n} \beta_{12i} HHFC_{t-i} + \mu_t \quad (2)$$

$$\Delta F\_INF_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta F\_INF_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta AgL_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta AgM_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta EI_{t-i} + \sum_{i=0}^{n} \beta_{5i} \Delta TRNP_{t-i} + \sum_{i=0}^{n} \beta_{6i} \Delta AgGas_{t-i} + \sum_{i=0}^{n} \beta_{7i} \Delta AgElec_{t-i} + \sum_{i=0}^{n} \beta_{8i} \Delta WA_{t-i} + \sum_{i=0}^{n} \beta_{9i} \Delta AgGDP_{t-i} + \sum_{i=0}^{n} \beta_{10i} \Delta NFX_{t-i} + \sum_{i=0}^{n} \beta_{11i} \Delta PG_{t-i} + \sum_{i=0}^{n} \beta_{12i} \Delta HHFC_{t-i} + \gamma_1 AgL_t + \gamma_2 AgM_t + \gamma_3 EI_t + \gamma_4 TRNP_t + \gamma_5 AgGas_t + \gamma_6 AgElec_t + \gamma_7 WA_t + \gamma_8 AgGDP_t + \gamma_9 NFX_t + \gamma_{10} PG_t + \gamma_{11} HHFC_t + \mu_t \quad (3)$$

Results and Discussions

Unit Root Test Results

Table 1 presents the PP tests results, which shows that agricultural production, food inflation, energy inflation, agricultural land, and water availability are stationary at level and have zero-degree order of integration (1(0)), while the rest of variables are stationary at 1st difference and have 1st degree order of integration (1(1)). The order of integration of the variables is mixed; therefore, the data behavior of this study recommended the use of ARDL techniques for estimation.

Table 1. PP Tests Results.

Variables	At Level	1st Difference	Decision
F_INF_t	-3.7835* (0.0056)	----	Stationary at level
$AgGDP_t$	-2.9402** (0.0480)	----	Stationary at level
EI_t	-3.2319** (0.0240)	----	Stationary at level
AgL_t	-4.2841* (0.0013)	----	Stationary at level
AgM_t	-1.7606 (0.3953)	-5.8884* (0.0000)	Stationary at 1st difference
$AgGas_t$	-2.0083 (0.2825)	-6.9205* (0.0000)	Stationary at 1st difference
$AgElec_t$	-2.4935 (0.1232)	-6.2139* (0.0000)	Stationary at 1st difference
WA_t	-5.8066* (0.0000)	----	Stationary at level
$TRNP_t$	0.2056 (0.9703)	-7.3231* (0.0000)	Stationary at 1st difference
NFX_t	-1.8312 (0.3614)	-9.5351*(0.0000)	Stationary at 1st difference
PG_t	-1.0762 (0.7180)	-3.6967*(0.0072)	Stationary at 1st difference
$HHFC_t$	-1.2801 (0.6316)	-7.8402* (0.0000)	Stationary at 1st difference

Note: *, ** and *** depicted the consequence level at 1.0%, 5.0% and 10.0% respectively.

Regression Results

Table 2 presents the ARDL results of the effect of the energy cost on food inflation, In the long run (LR), the AgL has harmful and noteworthy effect on F_INF. Which means that a percent increase in the agricultural land, on average, leads to decrease the food inflation by 0.10%. However, the agricultural machinery has also harmful but inconsequential effect on F_INF. However, the energy inflation has optimistic and noteworthy effect on F_INF. Which means that a percent increase in the agricultural land, on average, leads to raise the F_INF by 0.03%. According to Uyi and Demir (2023), shocks to energy-prices and GDPg have an optimistic and large influence on F_INF, but shocks to the EXR and AgGDP have an adverse but small effect. According to their findings and results, multiple scholars identified sudden increases in the prices of natural resources (crude oil, biofuel) as one of the major factors contributing to the occurrence of shocks in the agri-sector in an economy (Abbott et al., 2008; Baffes, 2007; Balcombe & Rapsomanikis, 2008; Chang & Su, 2010; Fowowe, 2016; Mitchell, 2008; Rosegrant et al., 2008; Yang et al., 2008). In comparison, a number of researchers have found that there is no thru correlation between crude-oil prices and F_INF (Zhang et al., 2010), and that sudden upsurges in crude-oil prices do not support increases in food commodity prices (maize or sugarcane). Using demand and supply theory of electricity, it was found that the correlation between cotton, gold, wheat, copper, cocoa, petroleum-oil, and timber prices is zero (Pindyck & Rotemberg, 1990).

Moreover, the transportation services have optimistic and noteworthy effect on F_INF. Which means that a percent increase in the transportation services, on average, leads to raise the F_INF by 0.03%. Similarly, the AgGas has positive and noteworthy effect on food prices. This means that a percent upsurge in the gas consumption in the agricultural sector, on average, leads to raise the F_INF by 0.36%. Similarly, the AgElec has positive and noteworthy effect on F_INF. This means that a percent upsurge in AgElec, on average, leads to raise the food prices by 0.63%. However, the water availability has adverse and noteworthy effect on F_INF. Which means that a percent increase in the water availability, on average, leads to decline the food prices by 0.28%. Naraghi et al. (2021) demonstrate that agri-prices respond harmfully to any shock from energy-consumption. Moreover, Alghalith (2010) demonstrated that increased oil output leads to lower F_INF. On the other hand, other research indicates that there is no direct relationship between oil and F_INF (Abbott et al., 2008; Gilbert, 2010; Pindyck & Rotemberg, 1990; Zhang et al., 2010). Jiranyakul (2019) failed to show a long-term relationship between oil price fluctuations and CPI in Thailand. Abdlaziz et al. (2016) discovered that harmful oil price fluctuations had no discernible impact on F_INF. Meyer et al. (2018) discovered a substantial LR and optimistic relationship between oil price rises and F_INF. They did, however, demonstrate that there is no association between drops in oil prices and food costs.

Moreover, the agricultural production has adverse and noteworthy effect on F_INF. Which means that a percent increase in the agricultural production, on average, leads to decline the food prices by 0.09%. Similarly, the net food exports have adverse and noteworthy effect on F_INF. Which means that a percent increase in the agricultural production, on average, leads to decline the food prices by 0.04%. According to Ismaya and Anugrah (2018), the following variables of general F_INF are particularly significant: AgGDP, contributed to high F_INF, but overall food price inflation has lowered them. Furthermore, Olatunji et al. (2012) revealed a clear association between changes in AgGDP and CPI. In addition, a rise in the previous year's inventory change of agricultural produce raises the CPI. Moreover, Mbah et al. (2022) showed that the transfer of AgGDP to CPI in Nigeria is a LR phenomenon. Augmented agricultural production causes an optimistic shift in food costs, but an increase in F_INF leads to a LR decrease in inflation.

However, the population growth has optimistic and noteworthy effect on F_INF. Which means that a percent increase in the agricultural land, on average, leads to raise the F_INF by 0.03%. Similarly, the household final consumption has optimistic and noteworthy effect on F_INF. Which means that a percent increase in the agricultural land, on average, leads to raise the F_INF by 0.02%. According to Bobeica et al. (2017) that there is an optimistic LR association between CPI and LFP in the euro zone nations as a whole, as well as in the United States and Germany. Similarly, Weiske (2019) discovered that falling PG has reduced both the natural-rate and CPI by around 0.4 %age points. Moreover, according to Qayyum and Sultana (2018) that GDP, food export and import, and taxes are contribute to high F_INF, whereas the money supply reduces food costs. Similarly, Lim and Papi (1997) findings showed that the exchange rate had no influence on price levels, however money growth, export and import prices all had a beneficial impact on inflation in Turkey's economy.

Furthermore, In the Short run, the agricultural land has adverse and noteworthy effect on F_INF. Which means that a percent increase in the agricultural land, on average, leads to decrease the food inflation by 0.03%. Similarly, the agricultural machinery has also adverse and noteworthy effect on F_INF. Which means that a percent increase in the agricultural land, on average, leads to decrease the food prices by 0.01%. However, the energy inflation has optimistic and noteworthy effect on F_INF. Which means that a percent increase in the agricultural land, on average, leads to raise the F_INF by 0.01%. Similarly, the transportation services have optimistic and noteworthy effect on F_INF. Which means that a percent increase in the transportation services, on average, leads to raise the F_INF by 0.01%. However, the AgGas has inconsequential outcome on F_INF. Similarly, the AgElec has also immaterial effect on F_INF. Similarly, the water availability has inconsequential effect on F_INF. However, the agricultural production has adverse and noteworthy effect on F_INF. Which means that a percent increase in the agricultural production, on average, leads to decline the food prices by 0.03%. However, the net food exports have inconsequential effect on F_INF. Similarly, the population growth has also inconsequential effect on F_INF. However, the household final consumption has optimistic and noteworthy effect on food-prices. Which means that a percent increase in the agricultural land, on average, leads to raise the F_INF by 0.02%.

Moreover, the ARDL bound test indicated that there is exist the LR co integration among the variables. Furthermore, the speed of adjustment from the SR to LR equilibrium is 53%. Moreover, the diagnostic tests results show that there are no heteroskedasticity, autocorrelation and specification error in the model.

Table 2. ARDL results: the effect of energy cost on food inflation.

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Long Run Coefficient				
AgL_t	-0.1038**	0.0481	-2.1591	0.0406
AgM_t	-0.0055	0.0056	-0.9804	0.3363
EI_t	0.0286*	0.0040	7.0625	0.0000
$TRNP_t$	0.0263*	0.0065	4.0292	0.0005
$AgGas_t$	0.3578**	0.1682	2.1273	0.0434
$AgElec_t$	0.6275**	0.2743	2.2879	0.0309
WA_t	-0.2813***	0.1546	-1.8196	0.0808
$AgGDP_t$	-0.0927***	0.0499	-1.8594	0.0748
NFX_t	-0.0430*	0.0145	-2.9730	0.0064
PG_t	0.2687**	0.1213	2.2145	0.0361
$HHFC_t$	0.0156**	0.0075	2.0828	0.0477
C	-1.2010	2.0764	-0.5784	0.5682
Bound Test		F-Statistics	5.1561*	
Short Run Coefficient				
$D(AgL_t)$	-0.0320*	0.0097	-3.2987	0.0022
$D(AgM_t)$	-0.0083**	0.0040	-2.0512	0.0478
$D(EI_t)$	0.0109*	0.0019	5.8922	0.0000
$D(TRNP_t)$	0.0099*	0.0022	4.4849	0.0001
$D(AgGas_t)$	0.0612	0.0616	0.9938	0.3272
$D(AgElec_t)$	0.0315	0.0847	0.3712	0.7127
$D(WA_t)$	0.0017	0.0351	0.0476	0.9623
$D(AgGDP_t)$	-0.0277***	0.0148	-1.8706	0.0698
$D(NFX_t)$	-0.0008	0.0040	-0.2034	0.8400
$D(PG_t)$	0.0474	0.0604	0.7840	0.4383
$D(HHFC_t)$	0.0188**	0.0070	2.6807	0.0111
ECM_{t-1}	-0.5317*	0.0200	-26.571	0.0000
C	0.0290**	0.0121	2.4016	0.0218
Diagnostic Tests Results				
B.P.G Heteroskedasticity test Result H_o=Homoskedasticity		F-Statistic	0.7390	0.7616
Ramsey RESET Test		t-Statistic	0.4131	0.6832
H_o=No Specification Error in the model.		F-Statistic	0.1706	0.6832
B.G Serial Correlation LM Test H_o=No Serial Correlation.		F-Statistic	0.2949	0.7474

Note: *, ** and *** depicted the consequence level at 1.0%, 5.0% and 10.0% respectively and the critical values for Bound test is (2.41-3.61) for 1%.

Conclusion and Recommendations

Pakistan, like many other developing countries, is regarded as one of the most hit by food-insecurity, poverty, and natural catastrophes. Approximately two-thirds of Pakistan's population live in rural regions and are directly or indirectly dependent on the agricultural industry for food and income. To achieve the above objectives this study used the data from 1973 to 2022 in case of Pakistan, and employ ARDL technique to estimate the model. This study found that in the LR, the agricultural land, machinery and the petrol/oil consumption and electricity in the agricultural sector, agricultural production and water availability has negative effect on food inflation. However, the energy inflation has positive, while, the AgGas has no effect on food prices. Similarly, in the short run, the agricultural land, production and machinery and water availability has negative, while, energy inflation, petrol/oil and gas consumption in the agricultural sector has positive effect on food prices. However, the electricity consumption in the agricultural sector has no effect on food prices. This study concluded that energy cost has negative effect on food inflation. This study recommended that the government required to strengthen the administrative control, reforms in subsides system, reforms in agricultural sector, use the renewable energy instead of non-renewable energy, and stop the political interference in the monetary policy.

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