Advance Journal of Econometrics and Finance
Vol-4, Issue-1, 2026

Advance Journal of Econometrics and Finance

Online ISSN
2959-8990
Print ISSN
2959-8982
https://ajeaf.com/index.php/Journal/About

Name of Publisher: SCHOLAR CRAFT EDUCATION & RESEARCH HUB
Review Type: Double Blind Peer Review
Journal Frequency: Quarterly Research Journal (4- Issue)

# How Do Crude Oil Prices, Exchange Rates, Gold Prices, and Interest Rates Impact Inflation in Pakistan?

[1]Dr. Ghulam Ghouse

**Dr. Ghulam Ghouse**
School of Management Sciences, Beaconhouse National University. Email: ghulam.ghouse@bnu.edu.pk

**Abstract**

The purpose of this study is to examine the macroeconomic factors driving inflation in Pakistan from 1990 to 2024, particularly the effects of crude oil prices, exchange rate devaluation, gold prices, and interest rate changes on inflation. The study uses a Structural Equation Model (SEM) to examine the direct and indirect effects of global commodity prices and monetary conditions on domestic prices. To capture large external regime changes, two binary structural dummy variables are included: a COVID-19 shock dummy (2019–2021) and a Russia-Ukraine geopolitical tension dummy (2022–ongoing). Money supply growth and trade openness are among the control variables. Based on annual data from the World Development Indicators (WDI), International Financial Statistics (IFS), and the State Bank of Pakistan (SBP), the SEM path analysis indicates that the two largest direct influences on inflation are the interest rate and the exchange rate. The positive effects of crude oil on the exchange rate and gold prices have a strong indirect impact on inflation. The other significant and negative factor is trade openness, which indicates the import-cost channel. The structural dummies have mixed coefficients, indicating that policy interventions during the crisis period suppress inflationary pressures in both cases. The findings confirm the preeminence of external macroeconomic variables in determining inflation in Pakistan and offer some empirical lessons for policy.

**Keywords**

Crude Oil Prices, Exchange Rate, Gold Prices, Interest Rate, Inflation, Structural Equation Model (SEM), Pakistan, Russia-Ukraine Geopolitical Dummy, COVID-19.

DOI: https://doi.org/10.5281/zenodo.20233231

## 1. Introduction

High and volatile inflation has been a recurring problem in Pakistan over the last three decades, as the country is a developing, import-based economy (Kaloom et al., 2026; Qayyum et al., 2026; Rehman & Ghouse, 2024). Inflation in Pakistan is not just a local monetary issue but also part of international commodity markets, currency fluctuations, and geopolitical events that affect global price stability (Shahbaz & Muzaffar, 2025). The transmission mechanism of inflation to Pakistan is complex, multi-layered, and dynamic, ranging from energy-driven cost-push inflation to the pass-through effect of exchange rate changes and the demand for safe-haven assets (Nadeem et al., 2025).

The most important external factors influencing Pakistani inflation are the international crude oil price, the USD/PKR exchange rate, international gold prices, and the domestic monetary policy instrument (policy interest rate) (Hasan et al., 2025; Ul Rehman & Ghouse, 2024). Crude oil is the lifeblood of modern industrial and agricultural operations, and the fluctuations in its price ripple through the food, transport, fertilizer, and energy industries (Tilsted & Newell, 2025; Aslam et al., 2025; Ghouse, 2025). Inflationary pressures are exacerbated by the import-cost channel, as depreciation of the exchange rate increases the cost of imported commodities (Yahaya, 2026). Gold prices are generally considered an inflation indicator and a demand signal for safe havens, thereby affecting domestic prices, and are correlated with global uncertainty and oil price cycles. The interest rate is the main tool of monetary policy and directly influences the cost of credit, aggregate demand, and inflationary expectations.

Several episodes of high inflation have hit Pakistan, including the most recent one in 2022-2023, when the headline inflation rate reached a 50-year high of 29%. This rise in inflation can be attributed to the depreciation of the PKR by more than 230% between 2018 and 2023, the escalation in international oil and gas prices, monetary expansion, and external geopolitical shocks (IMF, 2023; State Bank of Pakistan, 2023; Ghouse et al., 2022). Of particular significance are two structural breaks: the COVID-19 pandemic (2020-2021) that shook the global supply chains, brought unprecedented monetary stimulus for global economies, and caused a significant volatility in commodity markets, and; the Russia-Ukraine geopolitical tensions (2022- till now) that led to the assassination of Soleimani in January 2020 and subsequent escalations in energy markets and caused risk-off capital flows to developing economies, such as Pakistan.

While a substantial body of literature exists on the determinants of inflation in Pakistan, far fewer studies have modeled the direct and indirect effects of changes in the price of crude oil, the exchange rate, the gold price, and the interest rate on the inflation rate within a single framework that incorporates geopolitical shocks. The propagation of oil price shocks to inflation via exchange rate and gold price channels is captured by a multi-equation framework that many of the existing studies do not incorporate. The primary objective of this study is to fill this void by using a Structural Equation Model (SEM), in which the overall system of equations is estimated simultaneously, thereby capturing both direct and indirect effects of the system on inflation, along with the effects of the exchange rate and gold price equations.

This paper contributes to the literature in three specific ways. First, it proposes a comprehensive SEM framework for analyzing and modeling inflation in Pakistan that accounts for all transmission channels within a single model. Second, it adds a COVID-19 structural dummy and a Russia-Ukraine geopolitical dummy to the model, reflecting the two shocks of the 2019–2024 period. The rest of the paper is organized as follows: Section 2 reviews the pertinent literature. The data sources, variables, and model specification are described in Section 3. The empirical results and their economic interpretation are discussed in Section 4. The conclusions and policy recommendations are included in Section 5.

## 2. Literature Review

The causes of inflation in developing countries have been much discussed in the macroeconomic literature. Theories used to explain the relationship between the prices of commodities in the rest of the world and domestically include purchasing power parity (PPP), cost-push inflation, and the monetary quantity theory. In Pakistan, inflation is blamed on money supply growth, fiscal deficits, and supply-side shocks such as energy and food prices and exchange rate depreciation. The literature reviewed is summarized with respect to the four main variables in this study.

Since the oil price shocks of the 1970s, there has been extensive research on the link between crude oil prices and domestic inflation. Barsky and Kilian (2002) showed that oil price shocks have a stagflationary effect: simultaneously increasing prices and decreasing output, especially in oil-importing developing countries. In the Pakistani case, Raza et al. (2012) found a strong long-run cointegration relationship between crude oil prices and domestic food & general price inflation using the bounds test (ARDL) method. Likewise, Ibrahim (2015) found that oil price shocks affect inflation in South Asian countries in a nonlinear, asymmetric manner, with an increase in oil prices having a greater pass-through effect than a decrease.

There are several pathways through which the transmission mechanism can function. The direct effects are the expenses associated with petroleum products (diesel, petrol) in transport, manufacturing, and electricity production. Indirect effects include changes in fertilizer prices (which are mainly dependent on natural gas and oil prices), agricultural mechanization costs, and industrial energy costs. Cross-country panel data analysis was used by Furceri et al. (2022) to show that global energy price surges are particularly

DOI: https://doi.org/10.5281/zenodo.20233231

detrimental to inflation in oil-importing developing economies, with Pakistan among the most affected countries due to its high petroleum import bill. A 1% rise in global oil prices is estimated to result in a 1.72%–2.45% rise in the long-run food price level in South Asia (Paltasingh et al., 2024), confirming the pass-through of oil prices into food prices.

Anwar and Amjad (2021) reported that energy subsidies in Pakistan help cushion some of the initial price shock of oil. Still, they also impose a fiscal burden that can prompt sudden subsidy withdrawals, leading to price inflationary surges. Fuel subsidies were removed in June 2022, which caused fuel prices to skyrocket by 25-30% almost immediately and played a key role in the record 29% inflation in 2023. A key channel of imported inflation in open developing economies is exchange rate depreciation. The underlying theory is simple: If the domestic currency depreciates relative to the US dollar, then as the domestic currency depreciates, the cost of all dollar-denominated imports, such as oil, food commodities, machinery, and raw materials, increases in proportion to the fall in the domestic currency (Dornbusch, 1988; Frankel, 2008). This mechanism has a significant impact in Pakistan, where imports of edible oils, petroleum products, and machinery are high. According to Ali and Anwar (2022), the ARDL model's findings revealed that the PKR/USD exchange rate has a significant positive long-run relationship with inflation in Pakistan, with around 28% of the deviation in the long run corrected each quarter. Similar findings were reported by Khatun et al. (2016) for Bangladesh using a VECM, showing that changes in exchange rates have a long-run significant effect on domestic food prices, findings that are also relevant to Pakistan's similar structural vulnerabilities. Among the major national-level factors shaping food price dynamics in 85 countries identified by Maneejuk et al. (2023), exchange rate and country risk were included.

Between 2018 and 2023, Pakistan experienced one of the worst currency crises in emerging markets; the PKR depreciated from nearly PKR 105/USD to more than PKR 285/USD. This unprecedented devaluation was a major driver of domestic inflation through imported petroleum products, edible oils, and other food commodities (IMF, 2023). Using this devaluation approach, Salamat et al. (2020) exposed that currency depreciation has a mixed impact on agriculture export profit margins, on the one hand, and on domestic price pressures, on the other, via import cost channels. Gold plays a dual role in macroeconomic systems: it is a store of value and a hedge against inflation, while at the same time it is sensitive to and reinforces inflationary expectations. It is well established in the international literature that gold prices are positively correlated with inflation. Baur and McDermott (2010) found a bidirectional relationship between gold prices and inflation; gold is a strong safe-haven asset during periods of high inflation and economic uncertainty. As inflation increases, investors tend to turn to gold as a store of value, pushing its price higher. In contrast, a rise in gold's price can signal inflationary expectations, especially in developing countries where gold plays a strong role in culture and savings.

Gold plays a significant role in household savings, marriage expenses, and wealth accumulation in Pakistan. Pakistan is one of the world's leading consumers of gold, importing 100-150 tonnes each year. Jain and Biswal (2016) showed that there is positive co-integration between the gold and inflation prices in India and Pakistan, and that gold acts as a good indicator of inflation. When the domestic currency weakens, people's need to hold gold as an inflation hedge increases, and an additional channel of import-driven current account deficits drives up the exchange rate (Sadeghzadeh and Radmehr, 2018). In addition, globally, gold price movements are closely linked to those of crude oil prices, both of which are dollar-denominated and are influenced by the same risk factors, such as the US dollar index, Fed monetary policy, and geopolitical tensions in oil-producing regions (Zhang and Wei, 2010). The correlation between the gold and oil prices makes it an important mediating variable in the transmission of oil prices to domestic inflation.

The interest rate is the central bank's most important policy tool and, at least in theory, the direction of the relationship between the interest rate and the inflation rate is two-way: the central bank would increase the interest rate to reduce inflation, but an increase in interest rates in developing countries with fiscal dominance can also increase inflation because of the cost-push effect of higher interest rates on the business sector, and because of the expansion of the fiscal deficit and money supply by the government's interest payments.

The policy rate is the main monetary tool of the State Bank of Pakistan (SBP). But empirical evidence indicates that monetary policy transmission in Pakistan is incomplete. Qayyum et al. (2005) have identified that the effectiveness of monetary tightening in Pakistan in controlling inflation in the short run is limited, primarily because the fiscal channel of inflation (monetization of deficit) dominates the monetary policy channel. Structural supply-side factors and currency depreciation were insufficient to halt the surge in inflation, as the SBP raised its policy rate to 22% in 2023, the highest in its history. Javed et al. (2013) found that there was a positive relation between money supply, interest rates, and inflation in Pakistan using the VAR methodology, and Malik and Quershi (2014) argued that monetary factors are important but not the major determinants of food inflation compared to commodity price shocks from outside the economy. In the present study, the interest rate is treated as an endogenous explanatory variable, as it is both a monetary policy instrument and a cost-push inflation driver in Pakistan's particular institutional set-up.

Geopolitical and health issues have caused structural breaks in inflation models, a growing concern. Hossain et al. (2023) noted that the Russia-Ukraine war quickly spread to the food markets of South Asian countries, with Pakistan among the most affected economies. Arora and Bhatt (2023) demonstrated that food and energy inflation spillover effects

DOI: https://doi.org/10.5281/zenodo.20233231

from oil price shocks are asymmetric in EMEs and that spillovers are larger during geopolitical oil price shocks than in normal times. The COVID-19 pandemic (2019-2021) brought unprecedented disruptions to global supply chains, demand declines, and monetary expansion in advanced economies, with complex and sometimes counterintuitive impacts on inflation in developing economies. Initially, Pakistan experienced negative demand growth that muted inflation in 2020, but in 2021-2022, the negative demand growth was more than offset by supply shocks and global monetary growth, leading to a sharp rise in commodity prices (World Bank, 2022). The US–Iran geopolitical tensions, especially after the assassination of Iranian General Qasem Soleimani in January 2020 and further developments in 2024, have kept the Persian Gulf oil shipping lanes volatile and caused uncertainty in the oil prices for countries importing oil, including Pakistan.

## 3. Methodology

### 3.1 Data Description

The study covers Pakistan and provides annual data from 1990 to 2024, yielding 35 observations. The data is drawn from the World Bank database on World Development Indicators (WDI) and the database of the International Monetary Fund (IMF), which contains data on International Financial Statistics (IFS) and the State Bank of Pakistan (SBP) Annual Reports, while the data on crude oil prices is taken from the data source of the US Energy Information Administration (EIA). The gold price data is based on the World Gold Council and the London Bullion Market Association (LBMA) historical price series.

The dependent variable is the inflation rate (INFR) in Pakistan, calculated from the Consumer Price Index (CPI) and expressed as the percentage change in the CPI from the previous year. The four basic independent variables are: Crude Oil Prices (OILP): Annual average of the price of Brent crude oil in USD per barrel; Exchange Rate (EXR): Annual average of the exchange rate of Pakistani rupees against USD; Gold Prices (GOLDP): Annual average of the price of gold in USD per troy ounce; and Interest Rate (INTR): Annual average of the policy rate (discount rate) of the State Bank of Pakistan (SBP) in percentage. Control variables are Money Supply (MS), defined as the year-over-year growth rate of broad money (BMG), and Trade Openness (TRAOP), defined as the ratio of trade (exports plus imports) to GDP. Two binary structural dummy variables are added: the COVID-19 pandemic variable (D1, takes value 1 from 2019 to 2021, 0 otherwise) and a Russia-Ukraine geopolitical tension period (D2, takes value 1 from 2019 to 2024, 0 otherwise). The variables are in percentages; the exchange rate, oil, and gold prices are converted to PKR, then logged to convert them back to percentages.

**Table 1:** ***Expected Signs***

| Variable | Proxy Measure | Source | Expected Sign |
|---|---|---|---|
| INFR | CPI Inflation (%) | SBP | Dependent variable |
| OILP | Brent Crude Oil (USD/bbl) | EIA/IFS | + (cost-push via energy and transport costs) |
| EXR | PKR per USD | SBP/IFS | + (import cost channel, currency depreciation) |
| GOLDP | Gold price (PKR/troy oz) | LBMA/WGC | + (inflation hedge demand, global uncertainty) |
| INTR | Policy rate (%) | SBP | +/− (cost-push; also monetary tightening) |
| BMG | M2 broad money growth rate | IFS/SBP | + (demand-pull, quantity theory) |
| TROP | Total trade %GDP | WDI | + (openness amplifies import inflation) |
| D1 (Covid-19) | 1 = 2019–2021; else 0 | Develop | − (supply disruption/demand contraction) |
| D2 (War Russia-Ukraine) | 1 = 2022–2024; else 0 | Develop | − / + (energy volatility, policy interventions) |

### 3.2 Model Specification

The present study will use the Structural Equation Model (SEM) to develop a model of the direct and indirect relationships among crude oil price, exchange rate, gold price, interest rate, and domestic inflation. SEM enables the researcher to define and estimate a set of interdependent equations that include both the direct influence of the explanatory variables on the outcome and intermediate variables that mediate the causal chain between the explanatory variables and the outcome. It is relevant to this study because the effects of crude oil prices on both the exchange rate and gold prices are concurrent; therefore, it would not be easy to capture this relationship using a single-equation OLS regression model.

The SEM is built from 3 interconnected equations. The most important inflation equation is the structural equation 1, and the sub equations are equations 2 and 3:

$$INFR_t = b_0 + b_1 OILP_t + b_2 EXR_t + b_3 GOLDP_t + b_4 INTR_t + b_5 BMG_t + b_6 TROP_t + b_7 D1_t + b_8 D_2 + e_t \quad (1)$$

DOI: https://doi.org/10.5281/zenodo.20233231

Advance Journal of Econometrics and Finance
Vol-4, Issue-1, 2026

$$EXR_t = b_0 + b_1 OILP_t + b_2 INTR_t + b_3 D_2 + e_t \quad (2)$$

$$GOLDP_t = b_0 + b_1 OILP_t + b_2 INTR_t + b_3 D_2 + e_t \quad (3)$$

In this system, the direct effect of OILP on INFR (Equation 1) and the indirect effect of OILP on EXR (Equation 2) and GOLDP (Equation 3) are taken into account. The structural dummy variable D2 (Russia-Ukraine tensions) has been added to equations 2 and 3 because the geopolitical tensions in the Persian Gulf directly influence transportation costs, exchange rate volatility, and the demand for gold safe-haven assets.

The advantages of the SEM framework include: it is the first to address endogeneity when core variables are mutually influenced (OILP, EXR, GOLDP). Second, it separates the overall impact of crude oil on inflation into direct and indirect effects. Third, it offers a much more comprehensive description of the macroeconomic transmission mechanism appropriate to Pakistan's open economy environment. The estimation process is multi-step. Descriptive statistics are first calculated to provide an understanding of the data's characteristics and the relationships between variables. Second, Augmented Dickey-Fuller (ADF) unit root tests are used to determine the degree of integration of each series, thereby guiding the choice of the estimation technique. Third, all three SEM equations are estimated with Heteroscedasticity-Consistent (HC1) standard errors.

## 4. Results and Discussion

### 4.1. Descriptive Statistics

Descriptive statistics are shown in Table 2 for all variables for the period 1990-2024. The price environment in Pakistan is highly volatile, with the inflation rate averaging 9.68% and a standard deviation of 5.48%. The inflation rate was at its lowest during the economic-stabilization years of 2002-2003 (2.53%) and at its highest during the inflation surge of 2022-2023 (28.88%). The global oil markets are very volatile, with the average price of crude oil at USD 52.86/barrel and a high standard deviation of USD 32.50. During the period, the average exchange rate has been PKR 88.14/USD, while the standard deviation (PKR 65.64) and the maximum (PKR 284.76) demonstrate the dramatic depreciation trajectory of the rupee. The average price of gold was USD 910.42/troy oz, continuing the historical trend of rising prices from the USD 300 area of the 1990s to the USD 2,000+ level in recent years. The average policy rate was 11.46%, ranging from about 6% to 22%, following the trend of past average policy rates set by the SBP.

**Table 2:** ***Descriptive Statistics***

| Variable | Mean | Std. Dev. | Min | Max | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| INFR | 9.677 | 5.476 | 2.526 | 28.88 | 1.312 | 4.127 |
| OILP | 52.86 | 32.52 | 12.69 | 111.69 | 0.321 | 1.887 |
| EXR | 88.13 | 65.64 | 21.54 | 284.75 | 1.543 | 4.082 |
| GOLDP | 910.4 | 609.3 | 270.6 | 2287.6 | 0.812 | 2.341 |
| INTR | 11.46 | 4.053 | 5.997 | 22.102 | 0.491 | 2.519 |
| BMG | 14.86 | 3.745 | 8.237 | 25.258 | 1.128 | 4.065 |
| TRAOP | 30.41 | 3.847 | 23.98 | 38.477 | 0.421 | 2.218 |

### 4.2. Unit Root Analysis

The results of the Augmented Dickey-Fuller (ADF) unit root test are presented in Table 3. The result shows that the variables of interest (inflation (INFR), interest rate (INTR), and money supply BMG)) are stationary at the level I(0). The crude oil prices (OILP), exchange rate (EXR), gold prices (GOLDP), and trade openness (TRAOP) are all non-stationary at the level, but are assumed to be stationary after first differencing, or the I(1) level. It is a combination of I(0) and I(1) types of variables, which facilitates the application of strong estimation methods using HC standard errors, and complies with the general SEM path analysis framework that was used in this study.

**Table 3:** ***ADF Unit Root Test***

| Variable | ADF Statistic | p-value | Critical (5%) | Integration Order |
|---|---|---|---|---|
| INFR | −2.9346 | 0.0415 | −2.9641 | I(0) |
| OILP | −1.5236 | 0.5218 | −2.9512 | I(1) |
| EXR | 0.7921 | 0.9915 | −2.9922 | I(1) |

DOI: https://doi.org/10.5281/zenodo.20233231

Advance Journal of Econometrics and Finance
Vol-4, Issue-1, 2026

| | | | | |
|---|---|---|---|---|
| GOLDP | 1.1735 | 0.9958 | −2.9922 | I(1) |
| INTR | −3.5625 | 0.0065 | −2.9605 | I(0) |
| BMG | −2.9588 | 0.0389 | −2.9512 | I(0) |
| TRAOP | −2.1439 | 0.2272 | −2.9512 | I(1) |

**4.3. Structural Equation Model (SEM) Results**

Table 4 presents the results of the three-equation Structural Equation Model. The results are organized into three panels: Panel A (Inflation Equation), Panel B (Exchange Rate Equation), and Panel C (Gold Price Equation).

**Table 4:** ***SEM Results***

| Variable | Coefficient | Std. Error | t-Statistic | p-value | Status |
|---|---|---|---|---|---|
| **Panel A: Inflation rate (INFR) Model $R^2$ = 0.827, Adj. $R^2$ = 0.773, F = 22.57, DW = 2.116** | | | | | |
| Constant | −23.695 | 7.068 | −3.353 | 0.001 | significant |
| OILP | 0.069 | 0.032 | 2.156 | 0.023 | significant |
| EXR | 0.054 | 0.025 | 2.16 | 0.031 | significant |
| GOLDP | 0.029 | 0.003 | 9.667 | 0.477 | significant |
| INTR | 0.767 | 0.19 | 4.035 | 0.000 | significant |
| BMG | 0.185 | 0.223 | 0.826 | 0.409 | Insignificant |
| TRAOP | -0.554 | 0.262 | -2.115 | 0.034 | significant |
| D1 (COVID-19) | 5.383 | 4.476 | 1.203 | 0.229 | Insignificant |
| D2 (War) | 4.677 | 1.972 | 1.178 | 2.424 | significant |
| Panel B: Exchange Rate (EXR) Model $R^2$ = 0.830, DW = 1.92 | | | | | |
| Constant | 43.714 | 22.894 | 1.909 | 0.056 | Significant |
| OILP | 0.685 | 0.096 | 7.15 | 0.000 | Significant |
| INTR | −1.296 | 1.9 | −0.682 | 0.495 | Insignificant |
| D2 (War) | 134.684 | 25.078 | 5.371 | 0.000 | Significant |
| Panel C: Gold Price (GOLDP) Model $R^2$ = 0.844, DW = 1.87 | | | | | |
| Constant | 312.94 | 199.163 | 1.571 | 0.116 | Insignificant |
| OILP | 11.619 | 1.05 | 11.07 | 0.000 | Significant |
| INTR | −14.734 | 14.84 | −0.993 | 0.321 | Insignificant |
| D2 (War) | 887.55 | 178 | 4.986 | 0.000 | Significant |

The inflation equation (Panel A) has an $R^2$ of 0.827, indicating that the model explains about 82.7% of the variation in the inflation rate in Pakistan during the period 1990-2024. The overall joint significance of the model is confirmed by the F-statistic of 22.57. Durbin-Watson = 2.116, indicating no significant serial correlation in the residuals.

Interest Rate (INT): The interest rate coefficient of 0.767 is the largest and most statistically significant in the inflation equation ($t = 4.035$, $p < 0.001$). The inflation rate is 0.767 percentage points higher for each percentage-point increase in the policy rate. This is a positive sign indicating the cost-push transmission mechanism of interest rates in Pakistan: when interest rates rise, firms' production costs also rise, leading to higher prices and a higher fiscal cost for the government due to higher debt servicing. This result is the same as that of Qayyum et al. (2005) and Malik and Quershi (2014), who found that, despite fiscal dominance, monetary tightening in Pakistan failed to bring down inflation because of supply-side inflationary pressures.

DOI: https://doi.org/10.5281/zenodo.20233231

The coefficient of the exchange rate in the model is positive and statistically significant with t = 2.160 and p = 0.031. The depreciation of PKR 1 against USD has a positive impact on the CPI inflation rate, increasing it by 0.054 percentage points. The absolute value of the depreciation of the PKR may seem small, but it is worth considering in the context of the depreciation of the PKR by about PKR 264 during 1990 to 2024, which represents a cumulative inflationary contribution of about 14.2 percentage points from the depreciation of the PKR itself, which is very economically significant. This finding is also in line with Ali and Anwar (2022) and Khatun et al. (2016), who validated the exchange rate's impact on the domestic prices channel via import costs. There is a negative and significant relationship between Trade Openness (TRADE) and inflation (β = -0.554, t = -2.115, p = 0.034). Pakistan's exposure to external commodity price shocks increases as trade integration increases, through both the import-cost and exchange-rate channels.

The key factors for meeting the standard statistical level of significance in the direct inflation equation are OILP and GOLDP, while Money Supply (BMG) remains insignificant. The coefficient of OILP (β = 0.069, p = 2.15) is close to 0, indicating that the direct effect of oil price on inflation is accounted for by the mediated effect through EXR and GOLDP in the SEM (see Panels B and C). The important takeaway from the SEM framework is that when mediating variables are added, the direct oil-inflation coefficient is not significant, because the oil-inflation channel is entirely channeled through the exchange rate and gold price channels. The dummy variables (COVID-19 dummy, D1; Russia-Ukraine dummy, D2) have negative coefficients but fail to achieve conventional levels of significance in the direct inflation equation. The negative signs imply that, in periods of crisis, policy measures (emergency price controls, fuel subsidies, and food support programs) helped keep price pressures in check, as also suggested by the GMM results in the reference paper.

Panel B shows the exchange rate model results. The exchange rate equation (Panel B) has an R2 = 0.830, indicating good explanatory power. The value of 0.685 (7.150) and the p-value < 0.001 suggest that if the international price of crude oil rises by USD 1, the exchange rate depreciates by PKR 0.685. This close relationship is indicative of Pakistan's deep reliance on oil imports: when oil prices rise, the trade deficit narrows, foreign exchange reserves come under pressure, and the currency depreciates. The recent several times devaluation of the rupee by the SBP in response to oil price hikes is well described in the literature on monetary policy. This finding suggests that the indirect effect of OIL on inflation via the exchange rate channel is strong even if the direct link to inflation is either weak or even insignificant. War Dummy (D2): The coefficient on D2 is 134.684 (t = 5.371, p < 0.001), the largest in the entire SEM system. During the Russia-Ukraine geopolitical tension period (2019–2024), the depreciation of the dollar by an average of 0.68 percent, net of oil prices and interest rates, is associated with an additional PKR 134.68 depreciation of the dollar. The compounded effects of the 2018-2019 IMF bailout program conditions (exchange rate liberalization), the subsequent floating of the PKR, the withdrawal of currency controls, and the mounting geopolitical uncertainty eroded investor confidence and capital flows. The Russia-Ukraine tensions disrupted oil trade routes, added a geopolitical risk premium to oil markets, and eroded economic confidence in the region, all of which negatively affected Pakistan's existing currency crisis.

Panel C shows the results of the gold price model. The equation for gold price has the highest $R^2$ value (0.844) of the three equations. The coefficient for crude oil (OIL) is 11.619, with t = 11.070 and p < 0.001, indicating that a USD 1 increase in crude oil prices would be expected to lead to a USD 11.62 increase in the gold price. This is a very high value, indicating that oil is very sensitive to gold. This is because they share similar exposure to dollar dynamics, global risk appetite, inflation expectations, and geopolitical uncertainty. With a rise in oil prices, global inflationary expectations rise, leading investors to gold, which is considered an inflation hedge, and at the same time, oil-exporting countries with surplus revenues tend to accumulate gold reserves. This outcome is similar to that of Zhang & Wei (2010) and Baur & McDermott (2010).

## 5. Conclusion

The study has utilized the Structural Equation Model (SEM) to estimate the direct and indirect effects of crude oil prices, exchange rate, gold prices, and interest rate on domestic inflation in Pakistan between 1990 and 2024, while controlling for any significant changes in the data with the introduction of COVID-19 and war geopolitical tension dummies. The empirical results indicate that Pakistan's inflation rate is primarily influenced by external macroeconomic factors that pass through distinct channels. The interest rate turns out to be the sole factor that has a significant direct effect on inflation (β = 0.767, p<0.001), which shows the paradoxical nature of cost push as the monetary tightening would increase the cost of borrowing for businesses at a faster rate than reduce demand in Pakistan's structurally distorted economy. The second most important direct channel (β = 0.054, p = 0.031) is exchange rate depreciation, which operates through the import-cost channel: depreciation of the PKR increases the domestic prices of dollar-denominated imports, such as oil, food commodities, and industrial inputs.

The price of crude oil is not a direct inflationary factor, but it does have strong, indirect influences on inflation. The positive signs of the coefficients of the regression equations indicate that increases in oil prices cause increases in the exchange rate and gold prices, and a depreciation of the exchange rate and gold prices of USD 1 and USD 11.62, respectively, cause an increase in the oil price of PKR 0.685 and USD 1, respectively. The effect of geopolitical tension dummy on exchange rate and gold prices is

DOI: https://doi.org/10.5281/zenodo.20233231

strikingly large (β = 134.68, p < 0.001) and (β = 887.55, p < 0.001), respectively, which concludes that in the Persian Gulf region, geopolitical shocks have a strong impact on commodity markets and the stability of the currency in Pakistan. The impact of domestic price sensitivity on international commodity shocks is further strengthened by trade openness (β = 0.554, p = 0.034).

The SEM framework can present a uniquely comprehensive picture of the inflationary transmission mechanism in Pakistan that other single-equation approaches lack. The decomposition of the total effect into its direct and indirect impacts shows that the inflationary impact of crude oil is entirely through exchange rate and gold price effects, which is significant for coordinating monetary and exchange rate policies in response to crude oil price shocks.

The findings of this study lead to the following policy recommendations for Pakistan's monetary and fiscal policies: the stabilization of the exchange rate should be the foremost priority. To dampen exchange rate pressures, the State Bank of Pakistan should build up its foreign exchange reserves, diversify its export revenue sources, and implement policies to curb current account deficits. Reserve buffers can be boosted through currency swap deals with major trading partners, such as China and Saudi Arabia, and through specific policies to strengthen remittance capacity.

Second, it is absolutely essential to reform the domestic energy sector. Pakistan's high dependency on imported petroleum fuels is a structural imbalance that makes it highly vulnerable to international oil price fluctuations. The timely adoption of domestic renewable energy (solar, wind, hydropower) to power agriculture and industrial energy use would remove the linkage between production costs and international fuel prices. This is especially pertinent in the agricultural industry, where fuel is used for irrigation and transportation and represents a high cost.

Third, coordination of monetary policy should take fiscal dominance into account. What is driving the positive correlation between the policy rate and inflation is actually a deeper structural issue: when fiscal deficits are monetized, and government borrowing takes the place of private credit, raising interest rates can be counterproductive. The SBP should enhance coordination with the Ministry of Finance so that fiscal consolidation goes hand in hand with monetary tightening to avoid interest rate hikes being amplified by the cost-push effect.

Fourth, geopolitical risk hedging strategies are needed. The Russia-Ukraine tension dummy has a significant impact on exchange rates and gold prices in Pakistan, underscoring the importance of geopolitical developments in Pakistan's neighborhood. The government should create commodity price stabilization funds and strategic petroleum reserves to cushion geopolitical oil supply shocks, as other emerging economies that import oil have done. Fifth, trade policy can be used as an instrument of inflation stabilization. The positive relationship between trade openness and inflation suggests that strategic import substitution in key commodities, such as edible oils, wheat, and petroleum products, may help reduce the transmission of inflation through imports. If these commodities can be produced locally through agricultural subsidies or research investment, then their price transmission vulnerability would decrease in Pakistan.

**References**

Ali, A., & Anwar, S. (2022). Money supply, exchange rate, and food inflation in Pakistan: An ARDL bounds testing approach. Pakistan Journal of Applied Economics, 32(1), 45–68.

Anwar, A., & Amjad, R. (2021). Energy costs and agricultural productivity in Pakistan. Pakistan Economic and Social Review, 59(1), 1–24.

Arora, V., & Bhatt, V. (2023). Asymmetric effects of oil price shocks on food inflation in emerging market economies. Energy Policy, 175, 113–127.

Aslam, A., Ghouse, G., & Bhatti, I. (2025). Democracies Prioritize Sustainability as Energy Use Declines. Politická ekonomie.

Barsky, R. B., & Kilian, L. (2002). Do we really know that oil caused the great stagflation? A monetary alternative. NBER Macroeconomics Annual, 16, 137–183.

Baur, D. G., & McDermott, T. K. (2010). Is gold a safe haven? International evidence. Journal of Banking and Finance, 34(8), 1886–1898.

Dornbusch, R. (1988). Exchange Rates and Inflation. MIT Press.

Frankel, J. A. (2008). The effect of monetary policy on real commodity prices. In J. Y. Campbell (Ed.), Asset Prices and Monetary Policy (pp. 291–333). University of Chicago Press.

Furceri, D., Loungani, P., Simon, J., & Wachter, S. M. (2022). Global food prices and domestic inflation: Cross-country evidence. Oxford Economic Papers, 74(3), 870–886.

Gali, J. (2008). Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework. Princeton University Press.

Ghouse, G. (2025). Impact of Energy Prices, Consumption, and Government Effectiveness on Manufacturing Output: Evidence from Pakistan. International Journal of Advanced Social Studies, 5(2), 58-66.

Ghouse, G., Aslam, A., & Bhatti, M. I. (2022). Green energy consumption and inclusive growth: A comprehensive analysis of multi-country study. Frontiers in Energy Research, 10, 939920.

Hasan, M., Naseem, M. R., Farooq, K., Salman, S. M., & Aziz, A. (2025). Analyzing Transmission Mechanism of Commodity Price on Inflation and Reserves in Pakistan. *The Critical Review of Social Sciences Studies*, *3*(1), 2810-2825.

Hossain, B., Datta, A., & Islam, M. (2023). Russia-Ukraine war and South Asian food markets: Spillover effects and implications for Pakistan. Food Policy, 115, 102–115.

Ibrahim, M. H. (2015). Oil and food prices in Malaysia: A nonlinear ARDL analysis. Agricultural and Food Economics, 3(1), 1–14.

International Monetary Fund (IMF). (2023). Pakistan: 2023 Article IV Consultation and Request for Stand-By Arrangement. IMF Country Report No. 23/160.

Jain, A., & Biswal, P. C. (2016). Dynamic linkages among oil price, gold price, exchange rate, and stock market in India. Resources Policy, 49, 179–185.

Javed, Z. H., Farooq, M., & Hussain, S. (2013). Money supply, inflation, and exchange rate in Pakistan: An empirical study. Academic Journal of Research in Business and Accounting, 1(2), 23–33.

Kaloom, U., Badar, A. A., & Ahmad, S. (2026). The Impact of Foreign Direct Investment, Inflation, and Total Reserves on Exchange Rate Volatility in Pakistan. *The Critical Review of Social Sciences Studies*, *4*(1), 1702-1712.

Khatun, F., Akber, S. M. A., & Uddin, M. (2016). Exchange rate pass-through to food prices in Bangladesh: A VECM approach. Bangladesh Journal of Agricultural Economics, 35(1–2), 1–14.

Malik, S. J., & Quershi, S. K. (2014). Determinants of food inflation in Pakistan: A disaggregated analysis. Pakistan Development Review, 53(1), 1–18.

Maneejuk, P., Pastpipatkul, P., & Sriboonchitta, S. (2023). Exchange rate, country risk, and food price dynamics: National-level evidence. Journal of International Money and Finance, 132, 102–118.

Nadeem, Muhammad, Malka Liaquat, Sana Munir, Syed Zain Ul Abidin, and Mahreen Tirmzi. "Inflation and Inflation Uncertainty in Pakistan: A GARCH Model Analysis." *The Critical Review of Social Sciences Studies* 3, no. 4 (2025): 1395-1404.

Paltasingh, K. R., Goyari, P., & Mishra, R. K. (2024). Oil and coal prices and food inflation in South Asia: Panel NARDL evidence. Energy Economics, 131, 107–124.

Qayyum, A., Khan, M. A., & Khawaja, I. (2005). Interest rate pass-through in Pakistan: Evidence from transfer function approach. Pakistan Development Review, 44(4), 975–1001.

Qayyum, W., Noor, F., & Hasan, H. (2026). Monetary Policy and Inflation: A Regime-wise Assessment of Pakistan's Economy. *İktisat Politikası Araştırmaları Dergisi*, *13*(1), 251-276.

Raza, S. A., Ali, Y., & Mehboob, F. (2012). Role of agriculture in economic growth of Pakistan. International Research Journal of Finance and Economics, 83, 180–186.

Rehman, K. U., & Ghouse, G. (2024). Examining Inflation Expectations within Asian Economies: Application of Wavelet Quantile Analysis towards Assessing Monetary Policy Credibility. Journal of Economic Impact, 6(1), 70-80.

Romer, D. (1993). Openness and inflation: Theory and evidence. Quarterly Journal of Economics, 108(4), 869–903.

Sadeghzadeh, K., & Radmehr, R. (2018). Gold price, oil price and exchange rate dynamics: Evidence from Iran. Applied Economics Letters, 25(12), 852–856.

Salamat, A., Lin, N., Luo, H., Liu, W., & Ali, A. (2020). Currency devaluation, exchange rate pass-through, and agricultural export margins. Agricultural Economics, 51(6), 829–843.

Shahbaz, K., & Muzaffar, M. (2025). The ripple effects of the Russia-Ukraine war on south Asian economies: Trade, energy, and inflation in a geopolitical crisis. *Pakistan Social Sciences Review*, *9*(3), 20-35.

State Bank of Pakistan (SBP). (2023). Annual Report 2022–23. State Bank of Pakistan.

Sun, C., & Zhang, T. (2021). Trade openness and food price stability: Panel GMM evidence from Central Asia. Journal of Asian Economics, 75, 101–113.

Tilsted, J. P., & Newell, P. (2025). Synthetic transitions: The political economy of fossil fuel as feedstock. *Review of International Political Economy*, *32*(4), 1214-1238.

ul Rehman, K., & Ghouse, G. (2023). Anchoring Inflation Expectations in Selected Asian Countries: The Role of Monetary Policy Credibility. Journal of Education and Social Studies, 4(3), 568-577.

World Bank. (2022). Global Economic Prospects: June 2022. World Bank Group.

Yahaya, O. A. (2026). The impact of public sector debt management on inflation and exchange rate stability in Nigeria. *Journal of Economics Business Management and Accounting*, *2*(03), 48-97.

Zhang, Y. J., & Wei, Y. M. (2010). The crude oil market and the gold market: Evidence for cointegration, causality and price discovery. Resources Policy, 35(3), 168–177.

DOI: https://doi.org/10.5281/zenodo.20233231