

# Exploring Macroeconomic Determinants of Inflation in Pakistan; Fresh Insights from Vector Autoregressive Analysis

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## Abstract

It is a widespread argument that mild inflation is in favor of the economic growth of an economy. However, high inflation can be destructive to consumers as well as to businesses and the overall economy. Hence, identifying essential sources of inflation is crucial for both the central bank and economic units. The purpose of this study, therefore, is to examine the key determinants of inflation in Pakistan by using time series data over the period extending from July 1993 to May 2021 and employing the Vector Autoregressive (VAR) method. The variables are seasonally adjusted while growth rates of all the variables are used except for the interest rate in the study. The model results revealed that global crude oil prices, imports, money supply, and government borrowing are the most important determinants of inflation in Pakistan. Furthermore, the findings also showed that the exchange rate and interest rate have a positive effect on inflation and are statistically significant. Based on the findings, the study recommended that inflation may be kept under control by taking the following measures such as controlling government borrowings, money supply, and particularly, imports. Additionally, regulating exports and interest rates can also help in combating the problem of inflation.

**Keywords:** *Inflation, Money Supply, Government Borrowing, Imports, Purchasing Power*

**JEL Classification:** *E21, E31, H50*

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## 1. Introduction

Inflation seems to be a universal phenomenon in any economy. However, among other economic challenges in Pakistan, inflation in recent times is considered one of the most important in the country. In the words of Shapiro (1972), inflation is a steady rise in the general price level that results from the increase in the costs of goods and services in an economy over a period of time. However, high inflation is not in benefit of the economy as it has a negative impact on the economic activities of the country (see, Junejo et al., 2021; Runganga, 2020). When the prices of goods and services are continuously rising, then each unit of money in hands of consumers buys less and can leads economy to in unstable position, as people discourages to save larger and investment more. Hence, it is going to be difficult for the local currency to serve as a medium of exchange and a store of value in an inflationary economy without having a negative impact on income distribution, output, and employment along with a decline in the value of the country's currency and a rise in her exchange rate when compared to other currencies (Jhingan, 1997).

Inflation also creates panic in the people, and they begin hoarding essential items, to keep themselves save from paying more tomorrow. This negatively effects the daily supply chain and goods becomes

scare in the market, that slowdown the economic activities of the country (Runganga, 2020). However, the trend of inflation in Pakistan over the time was influenced by both demand and supply side factors. For instance, Bashir et al. (2016) reported both demand and supply side factors. In his words, the rise in inflation from the demand side is generally caused by roads and government expenditures. However, supply side factors that usually caused inflation includes high imports, huge external debts and government revenues (see also, (Iqbal et al., 2022; Ahmed et al., 2014a; Arif & Ali, 2012; Abdus & Zafar, 2005). The crude oil prices and the faster devaluation of the local currency also determine inflation and there is a negative correlation found between them (GENÇ et al., 2023; Hussain et al., 2022; Saleem et al., 2022). Moreover, the recent flood in the country that washed away a larger portion of crops, faster depreciation of local currency and rising of imports compared to the exports are also considered some of the important factor in creating inflation in Pakistan. Similarly, Aurangzeb and Haq (2012) suggested that interest rates, exchange rates, fiscal deficits, and unemployment rates are the important determinants that determines inflation in Pakistan

Hence, the identification of essential sources of inflation is very important for the policy makers to accurately forecast, and to efficiently and effectively design monetary policy for the purpose of prices stability in the economy (see, Ratnasiri, 2011). The objective of this study, therefore, is to have a fresh examination of the determinants of inflation in Pakistan. The rest of the study is organized as follows; Section 2 provides a brief literature review while section 3 covers the proposed estimation methodology which is followed by section 4, dedicated to results and discussions of the study. The last section provides concluding remarks of the study with some policy recommendations.

## **2. Literature Review**

Determinants of inflation are presented in various ways in the previous studies. For instance, Khan and Schimmelpfennig (2006) examined the monetary determinants that contributed to forecast inflation in Pakistan. Using a monthly data set from 1998 to 2005, the Johansen co-integration technique was employed in this study to establish the results. Based on the findings, role of monetary determinants was dominant in affecting the rate of inflation with a one-year lag. Furthermore, the growth of broad money and the growth of private sector credit were significant determinants of inflation that could be used to forecast future inflation. Similarly, in the study of Ellahi (2017), both the money supply and national expenditure have a significant impact on inflation, while national expenditure having a positive impact and the money supply having a negative impact. Moreover, imports of goods and services have a positive impact on inflation whereas GDP growth has a negative effect. The results for the short run effect suggested that none of the variables appear to be a significant determinant of inflation in the short run.

A recent study conducted by GENÇ et al. (2023) for Pakistan and Turkey, showed that currency depreciation causes inflation in both nations. Other factors contribute to inflation in both nations, includes interest and oil prices. Using time series data from 1970 to 2020 and employing ARDL model for Pakistan, Shoukat et al. (2023) concluded that economic globalization, government expenditures have a positive and significant impact on inflation in Pakistan while GDP and exchange rate (insignificant) show a negative impact on inflation in their study. Furthermore, Saleem et al. (2013) empirically examined the impact of macroeconomic variables such as the fiscal deficit, interest rate, gross domestic product, exchange rate, and unemployment rate on the inflation rate in Pakistan's economy. The study used time series data from the period of 1990 to 2011. According to the findings, there is a negative correlation between the unemployment rate, the fiscal deficit, and inflation, whereas there is a positive correlation between the exchange rate, GDP, interest rates, and inflation (see also, GENÇ et al., 2023; Ghumro & Memon, 2015).

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**Table 1.** Summary of recent empirical literature

| <b>Studies</b>            | <b>Country/<br/>Time period</b>      | <b>Approach(es)</b>            | <b>Findings</b>  |
|---------------------------|--------------------------------------|--------------------------------|--|
| GENÇ et al. (2023)        | Pakistan and Turkey<br>2010 to 2021  | Wavelet Coherence Model        | Currency depreciation, interest and oil prices causes inflation in both nations.   |
| Shoukat et al. (2023)     | Pakistan<br>1970 to 2020             | ARDL                           | Economic globalization and government expenditures positively related with inflation while GDP negatively related with inflation, however, the negative impact.                        |
| Hussain et al. (2022)     | Pakistan<br>1980 to 2020             | ARDL                           | Exports, gross fixed capital formation, the money supply, and oil prices are all positively correlated with inflation.   |
| Iqbal et al. (2022)       | Pakistan<br>1989 to 2019             | ARDL                           | In the long run, the exchange rate was negatively but M2 positively related to inflation. However, in the short run, GDP and Exchange rate was positive but M2 was negatively related. |
| Saleem et al. (2022)      | Pakistan<br>2001 to 2018             | VECM model                     | There is a negative correlation between inflation and devaluation of the currency.   |
| Iqbal et al. (2021)       | Pakistan<br>1991 to 2019             | ARDL Co-integration Analysis   | Increase in energy demand leads to energy inflation.   |
| Junejo et al. (2021)      | Pakistan<br>1990-2020                | Quantitative Research Approach | Inflation has negative impact on Economic growth.  |
| Zakaria et al. (2021)     | South Asia<br>1980M1–<br>2018M12     | Co-integration and VAR         | The positive oil price shock significant and rises inflation but the negative is insignificant.  |
| Runganga (2020)           | Zimbabwe<br>1981 to 2018             | Dynamic Ordinary Least Squares | Inflation negatively affect Economic growth.   |
| Ahmed et al. (2018)       | Pakistan<br>July 2001 -<br>June 2017 | Vector Autoregressive          | Imports and exports positively cause inflation.  |
| Khan and Khan (2018)      | Five Asian Countries<br>1973 to 2016 | Panel Estimation               | Inflation is harmful for the rate of economic growth.  |
| Qayyum and Sultana (2018) | Pakistan<br>1970 to 2017             | Regression Analysis            | All the variables positively and influencing food inflation except money supply.   |
| Ellahi (2017)             | Pakistan<br>1975 to 2015             | ARDL                           | Expenditure and imports positive, but money supply and GDP growth implies negative impact on inflation.  |

|                                  |                              |   |  |
|----------------------------------|------------------------------|---|--|
| Kartikasari (2017)               | Indonesia<br>2009 to 2016    | Panel Data<br>Regression<br>Analysis      | Imports negatively affecting the economic growth.  |
| Bashir et al. (2016)             | Pakistan<br>1972 to 2014     | ARDL                                      | All explanatory variables were significant in influencing inflation.   |
| Ghumro and Memon (2015)          | Pakistan<br>1980 to 2012     | ARDL                                      | Gross national expenditure, total reserve, exchange rate, money supply are positively influencing inflation.                                 |
| Lim and Sek (2015)               | 28 Countries<br>1970 to 2011 | ARDL                                      | All variables in the analysis have significant in influencing inflation.   |
| Saleem et al. (2013)             | Pakistan<br>1990 to 2011     | Regression<br>Analysis                    | Exchange rate, GDP, interest rate positively correlated and inflation while unemployment rate, fiscal deficit, and inflation are negatively. |
| Arif and Ali (2012)              | Bangladesh<br>1978 to 2010   | Co-integration<br>Error<br>Correction     | Broad money, import, GDP, and government expenditure have positively but export and Government Revenue negatively influence inflation.       |
| Sahadudheen (2012)               | India<br>1996Q1 to<br>2009Q2 | Co-integration<br>and Error<br>Correction | The exchange rate had a negative correlation with inflation whereas the GDP and broad money had a positive.                                  |
| Tafti (2012)                     | Iran<br>1971 to 2005         | Vector<br>Autoregressive                  | Liquidity and import prices have positive impact on inflation.   |
| Altowaijri (2011)                | Saudi Arabia<br>1996 to 2010 | Formal<br>Theoretical<br>Model            | Money supply has no impact on inflation.   |
| Khan and Schimmel pfennig (2006) | Pakistan<br>1998 to 2005     | Johansen co-<br>Integration               | Monetary factors have positive impact on rate of inflation   |

Junejo et al. (2021) reported that inflation have a significantly negative impact on the economic growth in Pakistan (see also, Haider et al., 2024; Runganga, 2020; Khan & Khan, 2018; Kartikasari, 2017). On the same line, Tafti (2012) examined the determinants of inflation in the Islamic Republic of Iran. For the years 1971 to 2005, the quarterly time series data was used. The vector autoregressive approach was employed in the present study. The dependent variable was inflation while the independent variables were gross domestic product and import price index. According to the findings, the consumer price index had a weak response to a shock in GDP, but had a strong response to a shock in import price index and liquidity. Altowaijri (2011) investigated the external and internal factors that causes inflation in Saudi Arabia over the years 1996 to 2010. The analysis suggested external factors as the primary source of inflation in Saudi Arabian kingdom, whereas the money supply had no impact on inflation. Likewise, Arif and Ali (2012) conducted study on inflation for Bangladesh by employing co-integration error correction techniques and using data from 1978 to 2010. According to the findings, government revenue and exports have a negative long-term impact on inflation, while broad money, GDP, imports, and government expenditure all have positive effects. The main short-run contributing factor, however, is money supply, which is caused by inflation.

Lim and Sek (2015) studied the factors that influence inflation in two groups, (low inflation and high inflation countries). The study utilized ARDL to a data set spanning the years 1970 to 2011 and

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concluded that none of the determinants significantly affect inflation in high income countries, while all of the variables in low-income countries experience significant effects in short run. Similarly, Tolasa et al. (2022) explored macroeconomic determinants of inflation in Ethiopia by using annual data from 1981 to 2020 and employing ARDL model. They found that in the short run, money supply, real GDP, population growth, gross national saving and previous year imports are the key drivers of inflation while in the long run: real GDP, real effective exchange rate, lending interest rate are positive and significant determinants of inflation. However, Sahadudheen (2012) investigated the relationship between inflation and exchange rate in India, concluding that the GDP and broad money had a positive influence on inflation while the exchange rate had a negative impact. Moreover, using data for Pakistan from 1972 to 2014 and the ARDL model, Bashir et al. (2016) came to the conclusion that the supply side factors of inflation are imports, government revenue, electricity generation, and external debt, while the demand side factors of inflation are population, roads, and government expenditure. Long-term factors that contribute to inflation include external debt, government revenue, imports, and government expenditure. Over time, population growth, electricity production, and foreign direct investment all result in a decline in price level.

### **3. Methodology and Data**

On the bases of economic theories and literature, we have selected the following economic variables to explore the possible relationship between them and inflation rate for Pakistan economy. We have selected, exchange rate (EXR), import (M), global crude oil (OilPB), monetary aggregate (M2), government borrowings (GB), large scale manufacturing index (LSM) as a proxy of GDP growth, interest rate along (DISR) with consumer price index inflation of Pakistan (CPI), details are given in table 2. This study utilized monthly data series starting from July 1993 to May 2021. The data is collected from Pakistan Bureau of Statistics (PBS) and State Bank of Pakistan (SBP). For this study we take growth rate (YoY) of seasonally adjusted data series except for the interest rate variable. In the study, consumer price index (CPI) is used as a proxy of inflation. This proxy is also recently used by Tolasa et al. (2022), Iqbal et al. (2022), Ahmed et al. (2018), and Ahmed et al. (2014a). The examination of unit root problem is considered as the foremost step in the time series data analysis. For this purpose, the Unit Root Test is employed to determine whether or not the data is stationary. However, the majority of the economic variables show a non-stationary trend. R-square and the t-score will increase if the variables are non-stationary, and this will cause spurious regression, which makes the results invalid. The first difference of such a time series will be stationary if the time series has a unit root (non-stationary). To check for stationarity in the data set, the Augmented Dickey-Fuller (ADF) unit root test under Schwartz information criteria is used. The ADF test includes the estimation of the following regression (Gujarati, 2004);

$$\Delta Y_t = \alpha + \beta_t + \delta_i Y_{t-1} + \sum_{i=1}^n \gamma_i \Delta Y_{t-i} + \varepsilon_t \quad (1)$$

Where  $Y_t$  is the variable under consideration,  $\Delta$  is the first difference operator,  $t$  captures the temporal trend,  $\varepsilon_t$  is the random error term and  $n$  is the maximum lag length. The optimal lag length is determined to ensure that the error term is white noise error term, while  $\alpha$ ,  $\beta$ ,  $\delta$  and  $\gamma$  are the parameters to be estimated. It is evident that the series under consideration has a unit root and is, thus, nonstationary if the null hypothesis of the test  $\delta = 0$  is not rejected. In addition, we used Granger causality approach to find the structures of the causal relationships between Consumer Price Index and other variables. For the purpose of establishing whether one-time series may cause another, the Granger causality test is used.

The hypothesis would be considered rejected at that level if the probability value is less than 5%, and causality would be assumed to exist.

In this way we can find lags of the variables with appropriate lag length which causes inflation. If we find either a mix causality relationship or bivariate causality relationship, then we will be unable to find that which variable is endogenous and exogenous. In that case we switch to Autoregressive model. The test involves the estimation of the following pair of regressions (Gujarati, 2004);

$$Y_t = \sum_{i=1}^n \alpha_i X_t + \sum_{j=1}^n \beta_j Y_t + U_{1t} \tag{2}$$

$$X_t = \sum_{i=1}^n \lambda_i X_t + \sum_{j=1}^n \delta_j Y_t + U_{2t} \tag{3}$$

Where it is assumed that the disturbances  $U_{1t}$  and  $U_{2t}$  are uncorrelated. In passing, note that we will deal with bilateral causality in case we have two variables. However, in multivariable case in time series econometrics, this is extended to multivariable causality through the technique of vector auto regression (VAR).

### 3.1 Model Specification

One of the most effective, simple, and adaptive approaches for the analysis of multivariate time series is the vector auto-regression (VAR) model. Moreover, dynamic multivariate time series are a natural extension of the univariate autoregressive model. The VAR model has been shown to be particularly effective for forecasting and characterizing the dynamic behavior of economic and financial time series. In addition, the VAR model is utilized not only for data description and forecasting but also for structural inference and policy research. For a set of  $n$  time series variables  $Y_t = (Y_{1t}, Y_{2t}, Y_{3t}, \dots, Y_{nt})$  a VAR model of order  $p$  [VAR ( $p$ )] can be written as:

$$Y_t = C + A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_p Y_{t-p} + U_t \tag{4}$$

where  $C$  is a  $n \times 1$  vector of constants (intercepts), the  $A_p$ 's ( $n \times n$ ) matrices of coefficient and  $U_t = (U_{1t}, U_{2t}, U_{3t}, \dots, U_{nt})$  is an  $n \times 1$  vector of error terms satisfying;  $E(U_t) = 0$  means that every error term has zero mean and  $E(U_t U_{t-n}) = 0$  means that there is no serial correlation in individual error terms. The selection of the VAR lag order is an important first step in the model-building process. In this work we use the commonly used lag-order selection criteria Akaike Information Criteria (AIC) to choose the lag order.

## 4. Results and Discussions

The results of the descriptive statistics of the present study are given in Table 2. The descriptive statistics show that all the variables CPI, LSM, EXR, M, OilPB, M2, GB, and DISR have 335 total observations. The median and standard deviation value of each employed variable is also given in the present study. However, the mean value of each variable in Table 2 shows the average value of each variable and all variable values demonstrate positive signs of average values and high variability from their mean values. Having provided the descriptive statistics of all the variables used in the present study, next in time series analysis, the concept of correlation is very important. The aim of correlation analysis is to establish a relationship between two variables and to spot patterns or trends between them based on how they change in relation to other aspects. If there is a correlation between any two variables, it signifies that whenever one variable is changed methodically, the other variable also changed systematically.

**Table 2. Descriptive Statistics of Variables Used in the Study**

| Variable | Mean | Median | Std. Dev | Min  | Max   | Obs. |
|----------|------|--------|----------|------|-------|------|
| CPI      | 8.18 | 7.94   | 4.07     | 1.34 | 22.17 | 335  |

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|       |       |       |       |        |        |     |
|-------|-------|-------|-------|--------|--------|-----|
| LSM   | 4.51  | 4.01  | 9.13  | -40.34 | 70.09  | 335 |
| EXR   | 7.06  | 4.09  | 8.27  | -7.40  | 32.52  | 335 |
| M     | 7.96  | 7.07  | 21.15 | -38.54 | 98.86  | 335 |
| OilPB | 9.66  | 4.29  | 37.40 | -69.05 | 200.84 | 335 |
| M2    | 14.03 | 14.14 | 3.48  | 2.77   | 20.85  | 335 |
| GB    | 15.58 | 14.55 | 13.91 | -11.57 | 71.35  | 335 |
| DISR  | 11.29 | 10    | 3.59  | 6.25   | 20     | 335 |

**Data Source:** State Bank of Pakistan & Pakistan Bureau of Statistics

Over a particular amount of time, the variables change together. Usually, the variables are evaluated in terms of a base variable and are measured as positive or negative. If both variables rise at the same time, there is a positive correlation. If not, there is a negative correlation between the variables. Since our series are time series, we utilize Pearson correlation to examine the correlation between them over different lags. In table 3, the correlation of CPI with LSM is negative on level as well as on lags too. As the lag's length increases, the correlation between CPI and LSM decreases.

**Table 3: Correlations between Inflation Rate and Economic Variables**

| Correlation of CPI with | LSM    | EXR   | M     | OilPB | M2    | GB    | DISR  |
|-------------------------|--------|-------|-------|-------|-------|-------|-------|
| Level                   | -0.234 | 0.344 | 0.132 | 0.107 | 0.175 | 0.642 | 0.517 |
| lag-1                   | -0.225 | 0.324 | 0.169 | 0.149 | 0.203 | 0.634 | 0.489 |
| lag-2                   | -0.258 | 0.306 | 0.201 | 0.172 | 0.230 | 0.618 | 0.458 |
| lag-3                   | -0.244 | 0.285 | 0.219 | 0.196 | 0.261 | 0.598 | 0.425 |
| lag-4                   | -0.220 | 0.259 | 0.231 | 0.218 | 0.281 | 0.569 | 0.388 |
| lag-5                   | -0.199 | 0.230 | 0.244 | 0.234 | 0.306 | 0.538 | 0.353 |
| lag-6                   | -0.173 | 0.203 | 0.222 | 0.245 | 0.334 | 0.501 | 0.322 |
| lag-7                   | -0.140 | 0.180 | 0.206 | 0.241 | 0.353 | 0.454 | 0.288 |
| lag-8                   | -0.134 | 0.156 | 0.185 | 0.227 | 0.369 | 0.415 | 0.257 |
| lag-9                   | -0.115 | 0.137 | 0.163 | 0.213 | 0.383 | 0.376 | 0.227 |
| lag-10                  | -0.108 | 0.123 | 0.127 | 0.188 | 0.386 | 0.343 | 0.198 |

**Source:** Authors' calculations

The correlation of CPI with EXR and GB (Government Borrowing) is highly positive in terms of level as well as on lag months too. In lag months, the correlation of CPI and EXR and GB decreases as the lag months' increases. Similarly, the correlation of CPI with M (Import), OilPB (Global Crude Oil), M2, government borrowing and DISR is also positive. The impact of export, import and oil prices is small initially at level but then it eventually increases as the lag month also increases and then onwards decreases as the lag months' increases. The correlation of CPI with M2 is positive but small at level while when the lag months' increase, the correlation of CPI with M2 increases. The correlation of CPI with DISR is positive. This positivity of correlation between the CPI and DISR is due to the price puzzle (Hayat & Hanif, 2016).

**Table 4: Augmented Dicky Fuller Test for Unit Root**

| Variables | Level      |                   | 1 <sup>st</sup> Difference |                   |
|-----------|------------|-------------------|----------------------------|-------------------|
|           | Intercept  | Trend & intercept | Intercept                  | Trend & intercept |
| CPI       | -1.649693  | -1.568019         | -9.886246*                 | -9.897228*        |
| LSM       | -3.460650* | -3.345745         | -4.670365*                 | -4.682645*        |
| EXR       | -2.756405  | -3.145375         | -8.444504*                 | -8.418983*        |
| M         | -3.405927* | -3.376871         | -6.804350*                 | -6.749748*        |

|       |            |            |            |            |
|-------|------------|------------|------------|------------|
| OilPB | -3.754473* | -3.786997* | -8.426489* | -8.396363* |
| M2    | -2.452900  | -2.429659  | -7.338598* | -7.329391* |
| GB    | -2.117563  | -2.211186  | -8.534605* | -8.518999* |
| DISR  | -1.664963  | -2.532136  | -11.30310* | -11.31017* |

**Source:** Authors' calculations, \* shows significance at 5% level of significance

Referring to table 4, this study used standard Augmented Dickey-Fuller (ADF) unit test under Schwartz information criteria in order to check the stationarity of the series. The results show that OilPB are stationary at level. However, LSM and M are stationary at intercept only. The rest of variables are non-stationary at level. In order to avoid over estimation in the results, all variables are become stationary after taking the first difference.

**Table 5: Granger Causality Test**

| Causality       | Probability |        |        |         |
|-----------------|-------------|--------|--------|---------|
|                 | Lags 2      | Lags 4 | Lags 6 | Lags 13 |
| CPI Cause LSM   | 0.01*       | 0.08   | 0.09   | 0.15    |
| CPI Cause EXR   | 0.10        | 0.03*  | 0.03*  | 0.02*   |
| M Cause CPI     | 0.00*       | 0.05*  | 0.00*  | 0.11    |
| OILPB Cause CPI | 0.00*       | 0.00*  | 0.00*  | 0.08    |
| M2 Cause CPI    | 0.05*       | 0.10   | 0.07   | 0.05*   |
| CPI Cause GB    | 0.02*       | 0.01*  | 0.00*  | 0.18    |
| DISR Cause CPI  | 0.08        | 0.07   | 0.08   | 0.00*   |
| CPI Cause DISR  | 0.00*       | 0.00*  | 0.00*  | 0.00*   |

**Source:** Authors' calculations, \* shows significance at 5% level of significance

The results in Table 5 show that in two months lag between CPI and LSM, the hypothesis that CPI does not Granger cause LSM can be rejected at the 5% level of significance. Thus, we found unidirectional causality running from CPI to LSM. In four, six- and thirteen-months lag between CPI and EXR, we found unidirectional causality running from CPI to EXR. In the result in two, four, and six-months lag between CPI and M, it is found that unidirectional causality exists, running from M to CPI. In two, four- and six-months lag between CPI and OilPB, it is found that unidirectional causality exists, running from OilPB to CPI. In two and thirteen lag months between CPI and M2, we found unidirectional causality is running from M2 to CPI. In two, four- and six-months lag between CPI and GB, it is found that unidirectional causality exists, running from GB to CPI. While in two, four, six-, and thirteen-months lag between CPI and interest rate, it is found that unidirectional causality is exist at two-, four- and six-month lag running from CPI to Interest rate and at thirteen-month lag bidirectional causality exist while in the rest of lags, causality does not exist. For all the variable Granger causality testing is applied at 5% level of significance respectively.

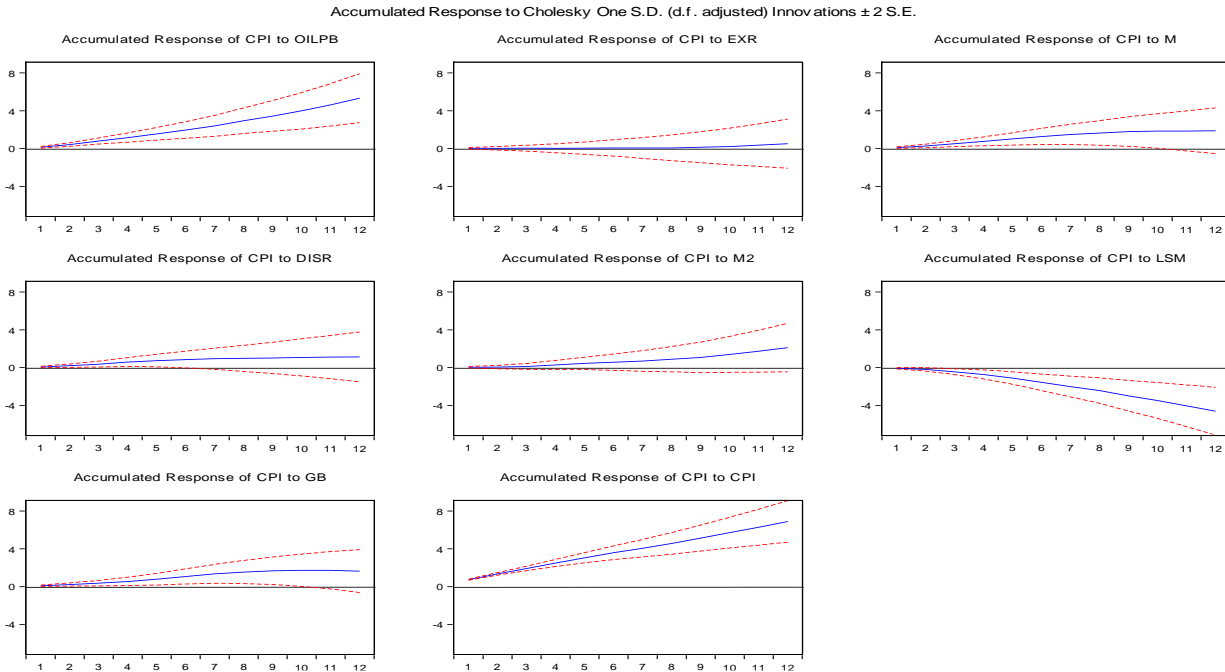
The VAR modeling is one of most successful, flexible, and easy way for multivariate time series analysis, standard VAR models can employ more than 6 to 8 variables. Since we have a large number of variables and due to large set of variables, there may be a chance of degree of freedom problem in VAR modeling. As a means of reducing this dimensionality problem, we have dropped Government Borrowing (GB) variable in VAR Modeling approach.

**4.1 Impulse Response**

In this section, impulse response functions are used to analyze the model's dynamic properties. The following figure shows the response of the CPI (inflation rate) to a standard deviation shock to the Global Crude oil (OILPB), Exchange Rate (EXR), Import (M), Interest Rate (DISR), Monetary aggregate (M2), Large-Scale Manufacturing Index (LSM), Government Borrowing (GB) and CPI, respectively. The time horizon, or the length of the shock, is represented by the x-axis, while the direction and magnitude of the impulse, or the dependent variable's percent variation, are shown by the y-axis. The impulse responses were generated using analytical (asymptotic) simulations that were 100 repetitions from the VAR.



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The results suggest that global crude oil has a significant effect on Consumer Price Index (CPI). A positive shock to global crude oil has initially positive and low effects on CPI but later on, particularly when the time periods increase, the effects of global crude oil on CPI sharply increases. This is consistent with the theory that an increase in global crude oil will increase the domestic price level. Moreover, this confirmed the findings of GENÇ et al. (2023), Sek (2023), and Zakaria et al. (2021). Similarly, a positive shock in the exchange rate leads to a positive response from the CPI. This positive impact persists for about one year six periods and then gradually dies. This finding is in line with the Hussain et al. (2022)'s study. Their study further added that crude oil prices and real effective exchange are most significant determinants inflation in Pakistan (GENÇ et al., 2023). Moreover, in the case of import, the effect of one standard deviation shock to import on the CPI increases after 2 periods, reaches to peaks and then after 8 periods gradually declines. This result is an accordance with the findings of Ahmed et al. (2018), Ellahi (2017), and Ahmed et al. (2014a). The impact of the interest rate has a positive effect on CPI and as the period increases, the impact effects are also increasing. This finding is in line with the recent study of GENÇ et al. (2023) and Tolasa et al. (2022). However, Hayat and Hanif (2016) concluded in their study that the positive correlation between the interest rate and CPI is due to the price puzzle. Moreover, interest rate and inflation are the two most important macroeconomic variables as their behavior have significant influence over economic growth (Mensah & Okyere, 2015). The positive monetary shock exerts inflationary pressure on CPI. Initially its impact is very little but after 6 periods, it tends to be increasing. This finding is also an accordance with the findings of Tolasa et al. (2022), Hussain et al. (2022), Ellahi (2017), and Nisar and Tufail (2013). As claimed by Lim and Papi (1997), the excessive money supply is the primary source of inflation (also see, Ujkani & Gara, 2023). The response of CPI to large scale manufacturing index (as a proxy of GDP growth) shows that the effect of one standard deviation shock to large scale manufacturing index on the CPI is negative impact. This finding is in line with studies i.e. Junejo et al. (2021), Khan and Khan (2018), and Ellahi (2017). Moreover, with one standard deviation shock, initially, the effect of government borrowing is weak, however, after 5 periods it exerts an inflationary pressure on CPI. This positive influence of government borrowing on CPI is already concluded by previous studies i.e. Tolasa et al. (2022), Ahmed et al. (2014b), and Khan et al. (2007). CPI shock seems to have a highly significant impact on itself. One standard deviation CPI shock is characterized by one standard deviation increase in CPI in the next period. Positive effect remains increasing as the period increases.

## 5. Conclusion and Policy Remarks

For the economic units, it is important to identify the key sources that influence inflation and to anticipate it properly to keep safe themselves from paying more tomorrow. However, it also helps the central bank to design its monetary policy in an efficient and effective way. Therefore, using a VAR-based approach, this study attempted to examine the factors that influenced inflation in Pakistan from July 1993 to May 2021. The data is collected from Pakistan Bureau of Statistics (PBS) and State Bank of Pakistan (SBP) and then the data (variables) is seasonally adjusted while growth rates of all the variables is used except for the interest rate variable. Moreover, Consumer Price Index is taken as an indicator of Inflation while the rest of the variables are considered as determinants of Inflation.

This study concludes that global crude oil growth, imports growth, money supply growth and large-scale manufacturing index growth are the most important determinants of inflation in Pakistan. The increase in global crude oil prices, rise in demand for imports, and more money supply rises inflation, however, the expansion in large scale manufacturing reduces inflation in Pakistan. The effect of the other variables includes exchange rate, interest rate and government borrowing on inflation is positive and statistically significant. However, initially the effect of exchange rate growth on inflation is not statistically significant but later onwards the exchange rate effect on inflation is rises while the impact of the interest rate has a positive effect on CPI and as the periods increases, the impact effects is also increasing. and after some periods then it remains the same. The effect of government borrowing in initial periods is not important, however, after a few periods it exerts a strong inflationary pressure on CPI.

Based on the findings of the study, it is recommended that inflation can be kept under check by controlling government borrowings, money supply, and particularly, regulating imports and interest rate as the government has the control over these variables. In addition, large scale manufacturing should be enhanced as involved in leading to lower inflation. Besides this, Pakistan needs to encourage exports and regulate fluctuations in the exchange rate. Also, foreign direct investment needs to be attracted while the outflow of funds should be discouraged, which will help in currency stabilization. Furthermore, the public sector should encourage development expenditures and needs to reduce the current government expenditures, to control and achieve the desired level of inflation as recommended by Shoukat et al. (2023).

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### Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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