Dynamic Interactions of Inflation, Exchange Rates, Fiscal Deficit, and Crude Oil Prices: A VAR Analysis for India

Abstract

The study is based on a VAR framework based on the yearly data from 1987 to 2023. The study is attempted to show the impact of crude oil prices, exchange rates and gross fiscal deficit on inflation and to determine the long term relationship between them. The idea of the study came from the gap in the existing studies which are not able to combine the relationship of the above mentioned factors. The results showed that there exists a positive relationship of the variables on inflation. It was also found that variables are having long term relationship. But the causal relationship only existed between inflation and crude oil prices. From the policy perspective it was suggested that policy makers must focus on reducing the consumption of crude oil and use renewable energy, also the fiscal deficit should be kept low to control the rate of inflation. This will reduce unnecessary debt burden from the government. There have been contradicting results regarding the effects of the variables therefore an effort is made to check the dependency and the direction of the movement of these variables.

Introduction

One important macroeconomic indicator of a nation's economic health is inflation. Understanding how inflation behaves becomes crucial. Inflation can be broadly classified as Demand pull Inflation and cost push inflation. The Demand pull inflation is a result of increase in aggregate demand for the economy, whereas the cost push inflation arises due to an increase in the cost of production.

Inflation rise above a certain limit harmful for the economy as well as a much higher fall in inflation is also not a good indicator of economic growth. Inflation must stay within a specific range, which the Reserve Bank of India has set at 2% to 6%. In this study, we examined the long-term dependence and link between the variables of exchange rate, gross domestic product, and crude oil prices and inflation. Given that India has the largest population, there is a constant demand for crude oil, with most people spending a significant portion of their income on it. The amount that the government borrows to cover its annual expenses is known as the fiscal deficit. In the fiscal year 2022–2023

It is noted that 20% of government spending goes towards paying interest on debt that the government has already taken out. The government's expenditure, specifically the fiscal deficit, stops being a useful tool for promoting economic growth. The cost of import and export is determined by the exchange rate. Exchange rates thus start to play a significant role in determining inflation. In order to forecast and examine the long-term relationship with other variables, we have utilised the Granger-Causality Test and the Vector Autoregressive Model, with inflation serving as the dependent variable of crude oil prices, exchange rate, and gross fiscal deficit.

Literature Review

Regarding the influence of crude oil prices, theoritically, the rate of inflation and crude oil prices are positively correlated. There is a substantial association between the price of crude oil and inflation, according to numerous studies conducted at various points in time there exists a strong correlation between crude oil prices and inflation.

Keynesian view on inflation- Demand pull inflation arises as a result of greater aggregate demand in comparison to aggregate supply at the full employment level. An aggressive fiscal policy brings about an excess money supply is a key factor of demand poll inflation. The Philips curve introduced by the new

Keynesian economists explains how past inflation, size of aggregate demand and expected future inflation governs the current rate of Inflation in the economy.

Sargent & Wallace, (1981) in the Fiscal theory of price level(FTPL) describes the relationship between inflation and fiscal policy has its two main forms. The first version is recognized as weak form of fiscal policy also recognized as 'unpleasent monetarist arthemetic' suggests that inflation rates has its no coordination between monetary and fiscal policies. Whereas the stronger version of the FTPL proposed by Christopher sims(1994) theory clarifies that the determination of inflation rate is merely administered by fiscal policies mainly government debt current revenue, potential revenue and spending plans whereas monetary policies play no role in determining price level.

According to Thornton(1990), deficit spending in an indicator of neither good nor bad. He proclaims that deficit spending can neither check fluctuations on the economics activities due to exogenous shifts, in either savings or private investment and can nor be responsible for high real interest rates or the large trade deficit. Thus fiscal policy has no impact on the outlook for economic growth on inflation.

Using data from the 1980s and 1990s, Mohanty and Klau (2001) discovered that traditional demand factors were relatively weak in the emerging market economies (EME), while supply factors such as significant changes in external factors and agricultural shocks—were the main drivers of domestic inflation. According to Unsal and Osorio's (2013) analysis of inflation dynamics in Asia, domestic demand was a key factor in inflation during the 2000s while monetary and supply shocks had a decreasing effect. Bobai (2012) in his analysis of the impact of increased oil prices in the Nigerian economy. The study took the annual data of oil prices from 1990 to 2001. It observed that there exists an overall positive relationship between oil prices and rate of Inflation.

The structural behaviour of inflation and output in a number of advanced countries is similar, according to Canova, Gambetti, and Pappa's (2007) time-varying SVAR analysis in the US, changes in demand shocks were found to be the most significant factor effecting the inflation in the euro area, changes in monetary policy shocks and supply shocks were the main determinants of inflation and in the UK, changes in monetary policy, supply shocks, and demand shocks were significant factors.

There are contradicting views on fiscal policy thus we took the variable gross fiscal deficit for our analysis. In the case of monetary policy it is clear from the example of Germany(1923), Hungary (1946), Greece(1944), Yugoslavia (1994), venenzuela etc. that how expansionary monetary policy plays a crucial role in determining rate of inflation.

Exchange Rate Regimes and Inflation: Evidence from India Biswajit Mohanty & N.R. Bhanumurthy (2013)- the study found that there no evidence to show the impact of exchange rate in the context of India. The reasons were described as the offsetting sterilization policy by the Reserve Bank of India during the expansionary money supply growth resulting due to its intervention to counter the exchange rate volitality.

Objectives

This study's main goal is to examine the complex relationship between important economic variables and inflation, elucidating the ways in which gross fiscal deficit, currency rates, and crude oil prices affect inflation's overall rate. The study looks at this interaction in an effort to determine the long-term relationships between inflation and these important factors.

Granger causality tests on inflation in relation to gross fiscal deficit, crude oil prices, and exchange rates are a crucial component of the research. The objective of this analytical method is to determine if these factors and inflation are causally related. Put more simply, the study aims to ascertain whether variations in the gross fiscal deficit, changes in crude oil prices, and changes in exchange rates have a significant influence on the rate of inflation.

The research aims to build a prediction model for future inflation rates in addition to cause linkages. This model provides a good analytical framework based on insights gleaned from data, making it an invaluable

tool for policymakers. Policymakers can make well-informed decisions based on a comprehensive grasp of the elements impacting inflation by forecasting future inflation trends.

Data Sources

The study is the done with the objective two check the impact of the variables Crude oil prices, Gross fiscal deficit and Exchange rates on the inflation of India. The data used here is time series data of variables including the depend variables as inflation whereas the independent variables were crude oil prices, exchange rate and gross fiscal deficit. Data for the variables is taken from RBI handbook of statistics, Organization of oil producing and exporting countries website.

Methodology

The study uses the method of regression analysis- Vector Autoregressive model, Granger cointegration test, Granger causality test to determine the results.

Regression analysis is a set of statistical of statistical tools used for estimation of between one or more independent variables to a dependent variable. It is used to asses the strength of relationship between variables and also for modelling future relationship between them. We have Inflation as our dependent variable, the independent variables are crude oil prices, exchange rates and gross fiscal deficit.

The steps for our analysis starts by checking the order of stationarity with the help of Unit root test to check stationarity known as Phillips Perron test.All the variables were stationary at first level, we thus then applied cointegration test to check the long term relationship between the dependent variables. In cointegration test, we first create a linear regression model between the dependent and the independent variables and check the stationarity of the residuals of the variables. If the residuals are stationary it means that linear combination of both the variables is stationary at base level, we thus applied cointegration test to determine the long term relationship between them.

The equation for the Vector Autoregressive model was found as:

$$I_t = \beta_1 \Delta I_{t-1} - \beta_2 . \Delta C_{t-1} + \beta_3 . \Delta R_{t-1} + \beta_4 . \Delta D_{t-1} - \beta_5 \Delta I_{t-2} + \beta_5 . \Delta C_{t-2} - \beta_6 . \Delta C_{t-2} + \beta_7 . \Delta R_{t-2} + \beta_8 . \Delta D_{t-2} + \beta_9 + \beta_{10} . K$$

Where,

I_t: Inflation at the current time period.

C_t : Crude oil prices at time period t.

R_t : Exchange rate at time period t.

D_t : Gross fiscal deficit at current time period.

ΔIt_{-1}: Inflation at first lagged value.

ΔC_{t-1}: Crude oil prices at first lagged value

ΔR_{t-1}: Exchange rate at first lagged value.

ΔD_{t-1}: Gross fiscal deficit at first lagged value.

ΔI_{t-2}: Inflation at second lagged value

ΔC_{t-2}: Crude oil prices at second lagged value

ΔR_{t-2}: Exchange rate at second lagged value

ΔD_{t-2}: Gross fiscal deficit at second lagged value

K: constant

t: Time period

β_1: Coefficient for the impact of the inflation from the previous time period.

β_2: Coefficient for the impact of the crude oil prices from the previous time period.

β_3: Coefficient for the impact of the exchange rate from the previous time period.

β_4: Coefficient for the impact of the gross fiscal deficit from the previous time period.

β_5: Coefficient for the impact of the inflation from two time periods ago (ΔIt-2).

β_6: Coefficient for the impact of the crude oil prices from two time periods ago.

β_7: Coefficient for the impact of the exchange rate from two time periods ago

β_8: Coefficient for the impact of gross fiscal deficit from two time periods ago.

β_9: Coefficient for the impact of the time trend (t).

β_{10}: Coefficient for the constant term (K) in the equation.

The Granger Causality test checks the causal relationship between the two variables. If there exists a long term relation between the variables then we check the causal effects of variable on one other. After creating a VAR model, In the final step we checked the causal relationship between Inflation and the independent variables affecting it.

Results

We have examined the unit root tests over the variables in the below mentioned variables and we report the results in figure. It suggests that all variables are stationary at first order differences.

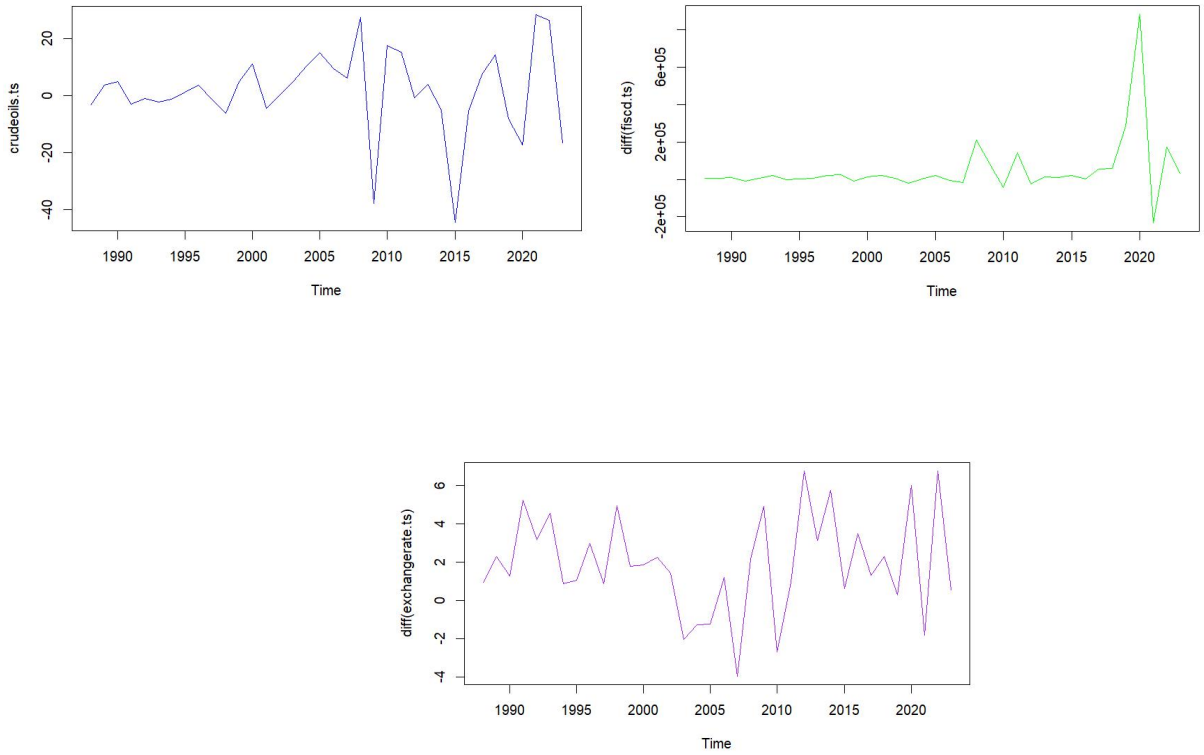


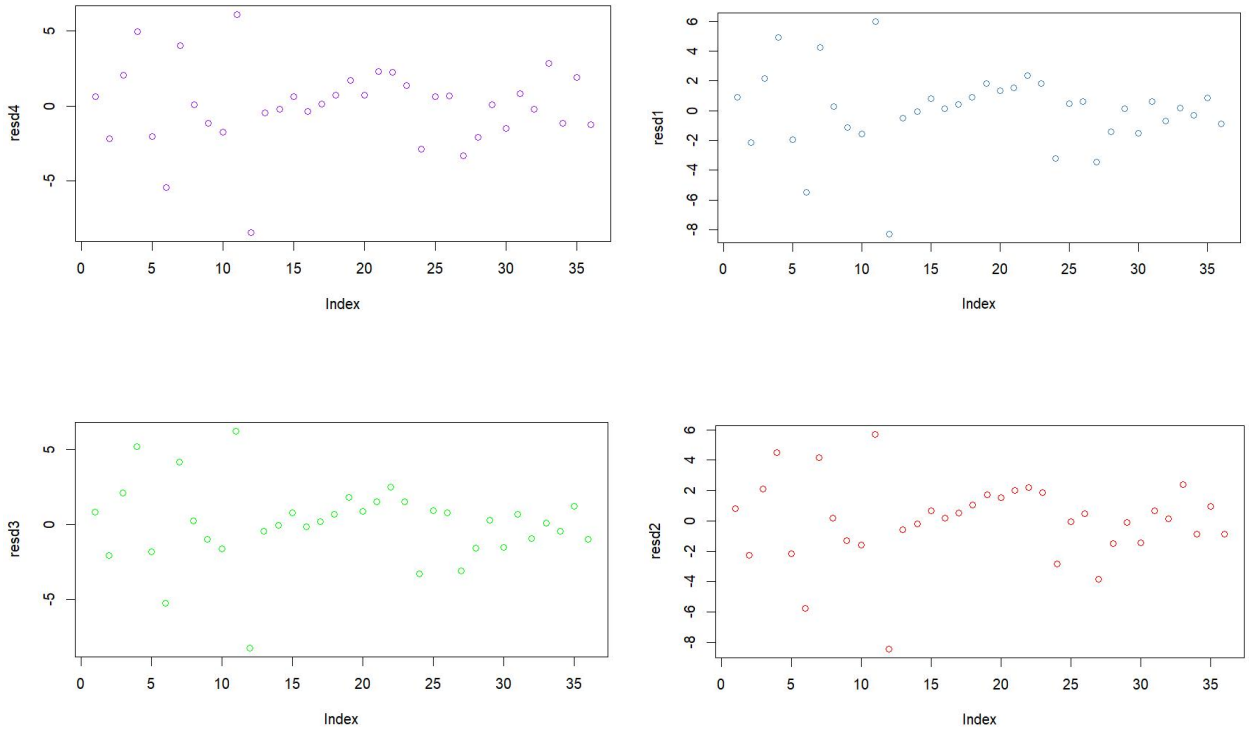
Figure 1- Results of Unit root Tests-Degree of non-stationarity

A 1% change in oil price can lead to 0.09% change in the inflation rate in India over a time period. A reason for this could be in the country where government is overburdened by subsidies a decline in crude oil prices is a boon for the government, it can manage its finances better and reduce the subsidies and reduce subsidies on petroleum products. This can lead to lowering of fiscal deficit. Thus Inflation is controlled when crude oil

prices goes down. In the case of exchange rate it shows that a 1% change of the variable can lead to change of 0.14% change in the inflation assuming other variables to be constant. These mathematical results might be misinterpreting in the real world as there are several variables which together causes inflation to change.

Variables	Intercepts	Coifficients
Crude oil process	-0.074918	0.009439
Exchange rates	-0.3700	0.1461
Gross fiscal deficit	2.583e-0.1	3.436e-0.6

In the next step, we have checked the residuals of the independent I(1) variables with the dependent I(1) variable Inflation through the Unit root test. The result shows residuals among the variables showed a stationary process. Results are shown in the figure 2



Further to check the long run- relationship we performed the granger cointegration test. The result provides sufficient statstical evidence for the existence of long term relation of inflation with the variables crude oil prices, exchange rate and gross fiscal deficit.

Variables	P statstic
Crude oil prices	0.01
Exchange rates	0.0128
Gross Fiscal deficit	0.01

The following table above shows the test statstics of p value for cointegration among the variables with inflation

Variables	F statstic	P statstic

Gross Fiscal deficit	0.7819	0.5877
Exchange rate	2.9525	0.4175
Crude oil prices	0.3512	0.8475

The above table shows the test results on applying granger causality test on inflation

In the next step by applying granger causality test we checked the causality of the independent variables one the dependent variables. The results suggests that exchange rate granger causes inflation, whereas the variables crude oil prices and gross fiscal deficit does not granger causes inflation. One of the major drawbacks of granger causality tests is that its results might mislead in the real world scenario. Therefore there can be a possibility of a different situation in the real world. The VAR framework used in the study was assessed with an R squared value of 0.478 for the dependent variable as inflation. This marks up that the dependents variables in the model is able to explain 47.8% of variance in inflation.

Conclusion

The study establishes the dynamic relation between crude oil prices, exchange rates, gross fiscal deficit and inflation by using the yearly data between 1987 to 2022 in the context of India. The results derived from the VAR Framework shows that the variables, crude oil prices, exchange rate and gross fiscal deficit has a positive impact on the rate of Inflation. There exists a long term relation among the variables. This implies that policy makers should be concerned as there is a significant impact of fiscal deficit and exchange rate and gross fiscal deficit. In the case of crude oil the policy perspective India must have to shift towards other renewable sources of energy such as solar, wind power and electricity in order to have a lesser oil consumption. Emperical studies in Japan shows that the domestic economy can be protected from global oil price shocks if the country substitute crude oil to renewable sources of energy. India is largely dependent on crude oil and is a net importer. Thus, replacing of crude oil with renerwable energy will safeguard the economy against inflationary fluctuations but also aid in achieving substatainable development goals.

References

Bobai, F. D. (2012). The impact of increased oil prices on the Nigerian economy. *Journal of Economics and Sustainable Development, 3*(10), 15-25.

Canova, F., Gambetti, L., & Pappa, E. (2007). The structural dynamics of inflation and output: Evidence from advanced economies. *Economic Policy Review, 13*(1), 123-158.

Keynes, J. M. (1936). *The general theory of employment, interest, and money*. Macmillan.

Mohanty, M. S., & Klau, M. (2001). What determines inflation in emerging market economies? *BIS Papers, 8*, 1-33.

Mohanty, B., & Bhanumurthy, N. R. (2013). Exchange rate regimes and inflation: Evidence from India. *Journal of Asian Economics, 24*, 64-71.

Phillips, A. W. (1958). The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1861-1957. *Economica, 25*(100), 283-299.

Sargent, T. J., & Wallace, N. (1981). Some unpleasant monetarist arithmetic. *Federal Reserve Bank of Minneapolis Quarterly Review, 5*(3), 1-17.

Sims, C. A. (1994). A simple model for the determination of the price level and the interaction of monetary and fiscal policy. *Economic Theory, 4*(3), 381-399.

Thornton, J. (1990). The relationship between budget deficits, money growth, and inflation. *Journal of Money, Credit, and Banking, 22*(3), 312-316.

Unsal, D. F., & Osorio, C. (2013). Inflation dynamics in Asia: Causes, changes, and spillovers. *IMF Working Papers, 13*(13), 1-28.

Bhanumurthy, N. R., & Kumawat, L. (2009). Exchange rate regime and its impact on inflation in India. *National Institute of Public Finance and Policy Working Papers*.

Canova, F., & Gambetti, L. (2007). Structural VAR analysis in the time-varying framework: Evidence from advanced economies. *Review of Economic Studies, 74*(3), 765-791.

Bobai, F. D., & Gyang, B. S. (2012). The effect of oil price increases on the inflation rate in Nigeria. *Energy Policy Journal, 14*(2), 19-24.

Dornbusch, R. (1980). Exchange rate economics: Where do we stand? *Brookings Papers on Economic Activity, 1980*(1), 143-205.

Taylor, J. B. (1993). Discretion versus policy rules in practice. *Carnegie-Rochester Conference Series on Public Policy, 39*, 195-214.

Mohanty, B. (2013). Exchange rate volatility and its relationship with inflation: A study on the Indian economy. *Asian Journal of Economics and Banking, 7*(1), 45-65.

Lucas, R. E. (1972). Expectations and the neutrality of money. *Journal of Economic Theory, 4*(2), 103-124.

Friedman, M. (1968). The role of monetary policy. *American Economic Review, 58*(1), 1-17.

Reinhart, C. M., & Rogoff, K. S. (2009). The aftermath of financial crises. *American Economic Review, 99*(2), 466-472.

Corden, W. M. (1984). Booming sector and de-industrialisation in a small open economy. *The Economic Journal, 92*(368), 825-848.

Basher, S. A., & Haug, A. A. (2016). The dynamics of oil prices, exchange rates, and the terms of trade. *Macroeconomic Dynamics, 20*(5), 1122-1148.

Blanchard, O., & Gali, J. (2007). The macroeconomic effects of oil price shocks: Why are the 2000s so different from the 1970s? *National Bureau of Economic Research Working Paper, No. 13368*.

Hamilton, J. D. (2009). Causes and consequences of the oil shock of 2007-08. *Brookings Papers on Economic Activity, 2009*(1), 215-283.

Kilian, L. (2009). Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. *American Economic Review, 99*(3), 1053-1069.

Ghosh, A. R., Gulde, A. M., Ostry, J. D., & Wolf, H. C. (1997). Does the nominal exchange rate regime matter? *National Bureau of Economic Research Working Paper, No. 5874*.

Hooker, M. A. (2002). Are oil shocks inflationary? Asymmetric and nonlinear specifications versus changes in regime. *Journal of Money, Credit, and Banking, 34*(2), 540-561.

Rother, P. C. (2004). Fiscal policy and inflation volatility. *European Central Bank Working Paper, No. 317*.

Khan, M. S., & Senhadji, A. S. (2001). Threshold effects in the relationship between inflation and growth. *IMF Staff Papers, 48*(1), 1-21.

Leeper, E. M. (1991). Equilibria under “active” and “passive” monetary and fiscal policies. *Journal of Monetary Economics, 27*(1), 129-147.

Obstfeld, M., & Rogoff, K. (1995). The mirage of fixed exchange rates. *Journal of Economic Perspectives, 9*(4), 73-96.