

Study of Long Term Relationship between Crude Oil Price and Exchange Rate in the context of India and Emerging Countries

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Abstract

The study is aimed at finding relationship between crude oil price in international market and exchange rate of Indian currency. As Indian economy is import dependent with high degree of inclination to crude oil import, the forex outgo due to this impacts Indian economy. The depreciation of Indian currency due to higher demand of US Dollar and increasing trend of import dependency on crude oil aggravates the fiscal framework. The analysis is desired to find causality and autoregressive relationship between these two variables. The Real Exchange Rate return has been compared in the process with real Crude Oil price which is found after adjusting it with CPI inflation of US. The Vector Autoregressive (VAR) model was used to identify lag relationship and subsequently lag length criteria was performed. The lag exclusion test specified the significant lag order. The Granger Causality and Block Exogeneity test was subsequently performed and the parameters were found to be Block Exogenous and not Granger Causal. This outcome was re-established with the help of Variance Decomposition test. However, the Impulse test signifies impact of crude oil price shock on exchange rate of Indian currency and vice versa. The shock analysis also emphasizes the volatility of the parameters on its own shocks. The outcome concludes neither unidirectional nor bidirectional granger causality of the variables with no significant auto regression of the variances of the parameters. The analysis of impulse test confirms the short run impacts on exchange rate due to shock in the oil prices, henceforth which proves the fact about that demand of oil is elastic in short run, which is observed in most of the oil importing and emerging countries.

Keywords: Crude oil WTI prices • Exchange rate • Variance decomposition • Shock analysis

Introduction

The economic health and well-being of any country, be it a developed or a developing one, depends on its macroeconomic state which is more or less identified with some well-established indicators namely GDP growth, fiscal deficit, inflation, exchange rate, gross capital formation, employment scenario etc. However, these indicators are interdependent in nature where a slightest variation in one impact the movement of others. The impossible trinity or Mundell - Fleming trilemma of free flow of capital, fixed exchange rates and independent monetary policy is a reflection of the phenomenon. While ascertaining such dependence of mutually exclusive variables, it has been assessed that some of them maintain strong causality (both unidirectional and bidirectional) with external variables.

India's Current Account Deficit has increased from 1.8% of GDP FY 2018 to a whopping 2.1% FY 2019 resulting in a net outflow of \$57.2 Billion. This not only reflects the health of India's import-dependence but also is a matter of concern when the expected

currency depreciation can be foreseen. The total import of approximately \$ 450 Billion and a considerable 25% contribution from the import of crude oil depicts the extraordinary crude oil centric import dependency of Indian economy (Table 1). The related outflow of foreign exchange weakens the fiscal structure of economic framework by reducing the demand of home currency compared to foreign currency. Hence the variation in crude oil price impacts the exchange rate to a great extent. Any shock on the crude oil price also results in a subsequent change in exchange rate with an interdependent lag structure.

As that India's exchange rate vis-a-vis dollar had depreciated by around 78.5% from its previous level in 2008 as compared to its current level in 2018. We have also analyzed the annual variation of emerging market currency, which are dependent on oil import we can see that there is a depreciation of 61% to 10% in the countries exchange prices vis-a-vis dollar prices for the year 2017.

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Country	Depreciation country currency dollar	of Oil Importing/Exporting vis-a-vis
Turkey-Lira	61%	Importing
South African-Rand	15%	Importing
India-Rupee	14%	Importing
Indonesia-Rupiah	10%	Importing

Table 1. Depreciation of country currency vis-a-vis dollar.

We cannot say in the absolute terms that this is the result of impact of oil prices in global market and import dependency of emerging market economies on crude oil. Past literature review gives us an evidence on the short term dependency of exchange rate on oil prices shocks.

In this research, we are going to examine the impact of the oil prices on exchange rate taking into fact the inflation effect by bring out into consideration the real exchange rate and WTI oil prices deflated by CPI inflation of US. So that we can measure the long term and short term implications of oil prices on exchange rates in real terms.

Literature Review

The earliest study done by Golub in 1983 had suggested an oil exporting country experiences exchange rate appreciation in response to soaring oil prices and vice versa. It had also suggested that oil importing countries may experience depreciation in exchange rate when oil price rises and vice versa. The work of Hamilton in 1983 had shown the connection between the changes in oil prices and US Business cycle. Then Blomberg and Harris, in 1995, stated that oil, being a homogeneous and globally traded commodity priced in US dollar, had shown that depreciation in dollar increases the purchasing power of foreign currency which in turn increases the price of crude oil through the demand effect.

They have used co-integration and error correction model for real effective exchange rate and crude oil prices with a conclusion that oil prices were one of the main reasons for US dollar exchange rate shocks. Chaudhuri and Daniel in 1998 have used cointegration and causality tests in which they had demonstrated the nonstationary behavior of US dollar real exchange rates due to the nonstationary behavior of real oil prices in the post Bretton Woods period. Perry Sadorsky in 2000 have found out the interaction between energy futures prices and exchange rates and have shown that futures prices of crude oil is co-integrated with a trade-weighted index of exchanges rates.

Perry Sadorsky, Abdul Basher and Alfred Haug, in 2012, have shown that positive shocks to oil prices depress the emerging market stock price as well as US dollar exchange rates in the short run. They also examined that positive oil production shock lowers oil prices and a positive shock to real economic activity increases oil prices which is evident by the empirical theory of demand and supply.

Chen and Chen in their paper in 2007 had investigated the long-run relationship between real oil prices and real exchange rates by using a monthly panel of G7 countries from 1972 to 2005. They had shown that real oil prices may have been the dominant source of real

exchange rate movements and there is a link between real oil prices and real exchange rates. They had also examined whether real oil prices can be used to predict real exchange rates. In the same year 2007, observed the impact of oil on real effective exchange rate of dollar between 1974 to 2004 and revealed that approximate 10% rise in oil prices result in nearly 4.3% appreciation of the dollar in the long run for an oil exporting country. In 2007 Huang and Guo had investigated using a four-dimensional VAR model that real oil price shocks lead to a minor appreciation of the long-term real exchange rate of china RMB due to China's lesser dependence on imported oil. This was the first time that an analysis for dependence of oil prices and exchange rate was done for an emerging country.

Ghosh in 2011 had examined the oil price and exchange rate relationship for India using daily data for the time span from July 2, 2007 to November 28, 2008 using GARCH and EGARCH approach and have found that an increase in the oil price leads to the depreciation of Indian currency compared to US dollar. The study also establishes that positive and negative oil price shocks have similar effects in terms of magnitude on exchange rate volatility.

Turhan, Sensoy and Hacıhansanoğlu, in 2014, had done a comparative analysis of exchange rate and oil prices for G20 member countries and they found that for each pair of oil price-exchange rate, empirical evidence confirms a strong negative correlation in the last decade. They had also suggested that events such as US invasion of Iraq in 2003 and the 2008 global financial crisis are associated with the shifts of correlations to stronger negative level, while the first event had impacted the developed countries and the latter event had impacted all the G20 countries.

Tiwari and Albulecu, in 2016, have used continuous wavelet approach and deployed asymmetric, multi-horizon Granger-causality tests between the return series of the oil price and the India-US exchange rate, over the time-span 1980–2016. They have highlighted the co-movements of both the variables in the post-reform period, especially in 2–4 years band and in the short run Causality runs from oil to exchange rate. They had also found that Granger-causal relationship between variables is non-linear, asymmetric and indirect. Sharma, Rishad and Kumar, in their paper in 2017, have used Toda and Yamamoto approach on daily time series data from 16th February 2015 to 1st February 2018 and they have found that there is a unidirectional causality running from oil price to exchange rate, not vice versa.

Since a lot of research have been done on the relationship between oil prices and exchange rates, this paper consists of an analysis from January 1994 to April 2019 between the real exchange rate return and real crude oil price return analyzing the short term and long term impact of both the variables on each other.

Initial theoretical framework

As the objective of this study is to find out the causality and relationship between the two variables of crude oil price and exchange rate, a multivariate model called Vector Autoregressive model or VAR model has been considered as the basis of analysis. Monthly data has been analyzed from January 1994 to April 2019 and a total of 304 data points have been taken into consideration. The log return of the month wise data series has been considered for this purpose to normalize the dataset and to reduce the variances.

Real Broad Effective Exchange Rate for India has been considered as Exchange rate data whereas CPI adjusted Global price of WTI Crude has been used as crude oil price. The nominal crude oil price has been adjusted with CPI inflation of US to obtain the real rate of crude oil price and to bring relevant parity with Real Exchange Rate. Once the comparable data set is prepared, the analysis has been performed estimating the parameters with Vector Autoregressive model. Then the VAR model lag order selection criterion has been implemented to assess the significance of the lag orders. Lag exclusion Wald test followed to reiterate the dependency need of the parameters. Granger Causality / Block Exogeneity Wald test was executed then to establish the bidirectional causality. In continuation with this, the parameter were tested with both impulse response test and variance decomposition test using Cholesky factors to assess the shock impact of one variable on other.

As stated in the methodology, the data analysis started with the estimated equation for Vector Auto Regression (VAR) model where both the log returns of exchange rate and crude oil price data was considered as endogenous variables. While assessing the outcome of VAR model, it is found from the t-statistics that for both the variables, some of the lags are significant in defining the nature and movement of the variables. Return of crude oil price and its second order lag, return of exchange rate with its first and second order lags have these significance. Subsequently, when we modelled the data for lag order selection up to 8th lag, we obtained coherent outcome where Schwarz and Hannan Quinn information criterion pointed out first order lag but Akaike Information criterion selected second order lag. For establishing the veracity of the actual lag, we then executed Lag Exclusion Wald test with an aim to assess the correct lag order.

This has been performed for two lags where the hypothesis is:-

- H0: The lag order can't be excluded
- H1: The lag order can be excluded and the next lag order can be tested.

The joint p-statistics of lag order 1 is very much significant

resulting in rejection of Null Hypothesis and the need to test second order lag. The Joint p-statistics for second order lag is not significant at 5% level and establishes the Null Hypothesis. Hence the dilemma from the lag length criteria to select the lag order is statistically resolved with the lag exclusion test establishing the second order lag.

The granger causality block exogeneity Wald test was performed next which is proved to be instrumental for the outcome of the paper. The Chi-square values and the probabilities of bidirectional testing for both exchange rate and oil price return (Table 2) can't reject the Null Hypothesis of no Granger Causality. Both the test statistics clarify that although the two variables are having some significance with their lag orders, they are not Granger Causal. Hence, near accurate forecasting of any of these can't be performed with the help of the other as they are not causal in the long term from 1994 to 2019, but the we can see a clear relation between the variables in short term. It also emphasises that the test variables are Block Exogenous.

Var Granger Causality/Block exogeneity Wald Test

Included Observations :- 301, Dependent variables – Return on REER

Excluded	Chi-Sq	Df	Prob.	Ho can be rejected or not
Return on ROIL	1.759643	2	0.4149	Ho is significant
All	1.759643	2	0.4149	Ho is significant

Excluded	Chi-Sq	Df	Prob.	Ho can be rejected or not
Return on REER	0.170961	2	0.9181	Ho is significant
All	0.170961	2	0.9181	Ho is significant

Table 2. Dependent variables return on ROIL and REER.

Once the causality test clarifies the block exogeneity of the variables, the impulse test is performed to assess the shock impact of the variables on its own and on the other in short term. The result shows that the shock of oil price return on exchange rate return stabilizes sooner than vice-versa. The shock impact of the variables on its own signifies higher volatility and longer stability duration. The variance decomposition test, which indicates the contribution of one variable on another during auto regression, has been performed then to reemphasize the phenomenon. The result shows that the error variance of both the variables is self-dependent and can't be ascertained by exogenous shocks to the other variables. With these we establish the fact of block exogeneity and non-causality of both these variables in long term although they have significant lag relationship.

The above analysis examines the monthly data spanning from January 1994 to April 2019 for India. Real exchange rates (effective) are found from the RBI website database. Crude oil prices are obtained from data available at FRED and it is further deflated by US consumer price Index to do away with the effect of Inflation. Further the return of Real Effective Exchange rate and real oil prices are evaluated and the natural logarithm is used to normalize the effect of residuals errors.

Further, we can examine the other variables which can impact the exchange rate i.e. a representative variable to indicate the competitiveness of a country. We may use variables like expenditure in research and development, capital investment as a percentage of GDP. These micro variables impact the exchange rate of emerging market in the long run. Investment in research and capital expenditure may result in raising the competitiveness of country export and will be able to drive the exchange rate in long terms.

In terms of limitations, exchange rate could be influenced by global shocks like economic recession, Emerging market crisis, Brexit events. These subjective variables were difficult to incorporate in our research.

Conclusion

Our research started with a defined goal to have a thorough cross-country study of the relationship between exchange rate and crude oil price. Various related research papers from countries with different

economic profile have been studied and multifarious aspects pertaining to the causality were identified. Some of the countries depicted auto regression, few have shown short term causality whereas many of them depicted either non-causality or minor interdependency. The similar analysis was performed for India where the outcome initially hinted a relationship of the endogenous variables but subsequently proved to be non-causal. This outcome emancipates the very fact about the Indian currency that it is capable of absorbing crude oil price shock whereas the future error variance of the exchange rate doesn't depend on crude oil price. In addition to this, they are tested to be Granger non-causal in long term comparing more than 300 data points highlighting the fact that both unidirectional and bidirectional causality are absent. This shows that various macroeconomic factors ranging from fiscal and monetary prudence contribute considerably in the exchange rate variation in long term. This non-causality in an emerging market like India is an eye-opener as the forecasting of exchange rate, being non-causal with crude oil price, can be performed with its own past value or with autoregressive modelling of other suitable parameters.

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