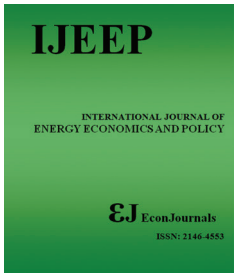

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Impact of Russia-Ukraine War on Sustainable Development Goals: A Study through Indian Financial Market Perspective

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ABSTRACT

This study measures impact of geopolitical crisis concerning Russia Ukraine War with reference to Sustainable development Goal 8. The researchers have analyzed the variables such as Indian stock market performance, MCX crude oil and Indian GDP Indices to calculate the linear interdependencies among crude oil, Indian stock market performance and Gross Domestic Product using monthly data from January 2016 to May 2022 using a Vector Autoregressive (VAR) model. Time series stationarity is checked using Augmented Dickey-Fuller test. The time series used for the analysis are MCX iCOMDEX crude oil Index, Nifty 50 Index, and GDP Index. Correlation is measured using the Granger Causality Test and VAR model. The outcome demonstrates that the lagged values of the Nifty and crude oil prices indexes are very effectively used to explain the GDP Index. Granger's Causation Matrix shows that past value of NIFTY Index causes change in GDP Index similarly past value of Nifty Index causes change in MCX Crude oil Index, whereas MCX crude oil does not cause much change in GDP Index. Further research could be done using a detailed time series for a longer period to find any impact of crude oil prices on GDP.

Keywords: MCX Crude Oil Index, Nifty Index, GDP Index, Vector Autoregression, SDG8
JEL Classifications: O16, O11, Q01, Q02

1. INTRODUCTION

Oil is an important asset for a few countries and an important element (direct or indirect factor of production) for many others. It is also one of the significant commodities for trade in the world. In India too, the oil and gas sector is vital but India is trying to become a self-sufficient nation by adopting alternative sources of energy. India is trying to lessen its reliance on crude oil as the crude oil rate is fluctuating and many other factors of production depend on it. Any huge increase or decrease in crude oil has an impact on the stock market and the GDP of any economy as per the report by UN and RBI. A business today article published in 2022 states that India is one of the world's biggest importers of crude oil with 30% of total energy consumption. Therefore, the study aims to understand the impact of crude oil on Indian economy.

Crude oil and geopolitical crisis are 2 faces of the same coin and since ages, there has been war and unrest due to this commodity. A geopolitical crisis arises when countries want to show dominance over others by taking over the assets of the country. It impacts every economy associated or not with the countries at war in many different ways. Some countries are importers of crude oil and their economy is impacted due to the import issues, some countries depend on other factors which is also disrupted. Geopolitical events impact crude oil prices which further impact the financial market across countries. The geopolitical crisis existing today between Russia and Ukraine is a cause of concern for all countries. The impact will be on the Sustainable Development Goals too.

India is trying to attain SDG goal 8 which is - Decent Work and Economic Growth (According to UN - Department of Economic and Social Affairs Sustainable Development) through programs

like Make in India, Startup India, Skill India, Digital India, etc. These programs are designed to develop Indian economy in terms of trade and manufacturing scale-up. As economic growth is one of the important point of SDG 8 and India is growing at the rate of 7.5% per annum (As per RBI), the goal can be attained easily with more focus on innovative manufacturing. This manufacturing sector, is vital for the economic growth of India and for the attainment of SDG8. The growth is visible by looking at the improving GDP rate from Figure 1 but it's struggling because of 2 shocks – Covid 19 and Russia Ukraine war which have scaled up crude oil prices. Figure 2 below shows the SDG 8.1 target for India and Annual growth in GDP which is fluctuating as per Figure 1.

Due to the current Russia-Ukraine war, oil and natural gas importing countries like India are under tension due to import constraints, actions etc as we have import dependency. High oil prices have hurt dented the economic growth prospects. Indian economy had just started to recover from the pandemic and this Russia-Ukraine war pushed the economy back. A country dependent on oil resources finds it difficult as the impact is on financial market and GDP. The value chain is also disturbed due to the crude oil availability and price volatility. The Indian government is aware about the situation and is trying to find out long term solutions like alternate sources of energy, alternate value chain etc. In light of this the paper attempts to find if the crude oil prices have any impact on GDP and eventually on SDG.

In the study, we conduct our analysis using time series data of Nifty, Crude prices, and GDP collected for the period from 2015 to 2022. The authors believe that investors and businessmen will use our research and analysis to evaluate the stock market during any geopolitical crisis. The study is essential to understand if sustainable development understood based on GDP Index is dependent on crude oil Index as GDP is the key pillar to ascertain economic growth of an economy.

2. LITERATURE REVIEW

The geopolitical risk refers to any risk related with war, tension between countries etc and it impacts most all of the economies directly or indirectly related to the countries at war. This risk is also an important indicator of stock market fluctuations or financial markets as a whole (Carney, 2016). A few recent studies carried out by Caldara and Iacoviello (2018) used an index to show how the stock market and economic activity of any country are significantly impacted due to geopolitical risk. The war between the 2 countries Russia and Ukraine is causing tension among many other countries and this is visible in the worldwide growing tension. Many studies have stated that the impact of such tensions are long term and cause eternal changes to the financial market and the behaviour of market (Aslam and Kang, 2015; Kollias et al., 2013b; 2013a; Pástor and Veronesi, 2013). Thus the relation between geopolitical risk and stock market behaviour is provisional and depends on time factor.

It is acknowledged that the stock market is important for the development of an economy and also the economy is dependent on the investment pattern. Fundamentally stock markets exist due to the existence of buyers and sellers and are considered as a

Figure 1: Annual Growth Rate of GDP (2018 to 2023)

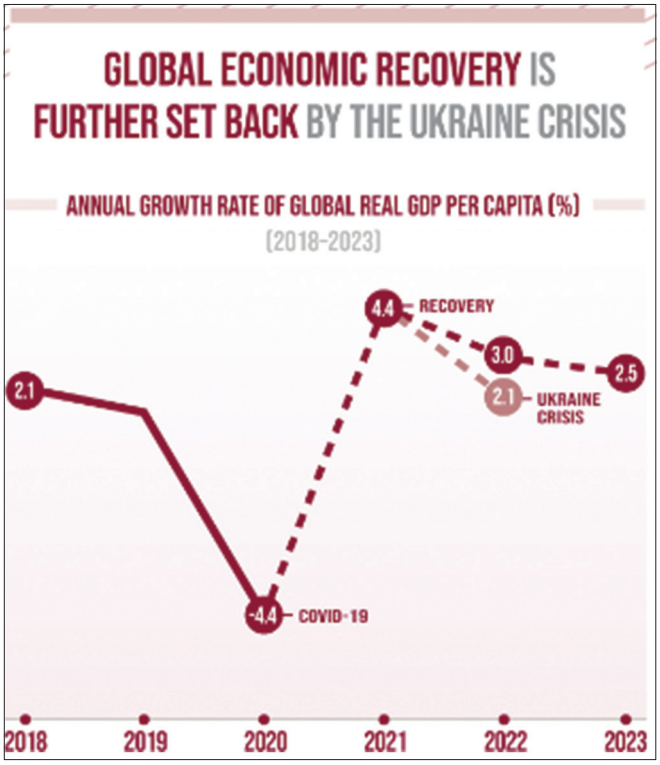

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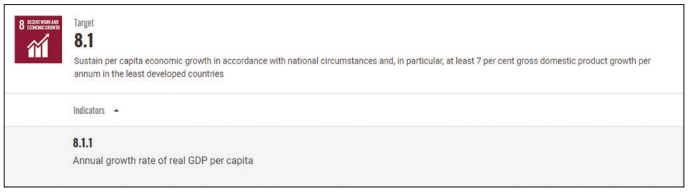
Figure 2: SDG8.1 defined by UN



(https://sdgs.un.org/goals/goal8)

reflection of economic progress. The stock market prices depend largely on crude oil prices (as a commodity) directly or indirectly as a factor of production. This instability in the crude oil prices is a cause of concern for researchers and analysists since many years. The most common energy sources utilised globally are petroleum and natural gas and both have a noteworthy impact on financial markets again directly as raw material or indirectly as a factor of production. Therefore, the oil rich countries like Russia, Turkey, Brazil and India may be affected in positive or negative manner due to the volatility in the crude oil prices. The changes in the price of crude oil causes fluctuations in the stock prices and therefore this is important for every economy on the globe. In this backdrop, the present research study has undertaken the review of literature leading to following discussion.

Akbulaev et al. (2022), has measured the correlation in their research, between Brent oil, crude oil (WTI), and natural gas (NG) prices and Moscow Stock Exchange Index (RTSI) by using different methods of examination. Borsa Istanbul Index (XU100), Bovespa Brazilian Stock Exchange Index (BVSP), and Indian National Stock Exchange Nifty 50 Index (NSEI) were

also included to take an overall measure of significance in VAR model. The outcome of the VAR model showed the Brent oil and crude oil prices have noteworthy impact on the various indices comprehended in the analysis.

Cunado et al. (2020), has analysed the impact of geopolitical risks (GPRs) in their research paper. The data taken for the period from February 1974 to August 2017 measures the impact on real oil returns by using a time-varying parameter structural vector autoregressive (TVP-SVAR) model. These 2 variables are included in the model and additionally the model also contains growth parameter for the world oil production, global economic activity (to attain oil-demand), and world stock returns. The findings of the research state that GPRs have a substantial negative effect on oil returns mainly because of drop in oil demand. This demand is calculated by the global economic activity measured. The findings also state that the peril of collaborating all GPRs with oil supply shocks are mostly associated with geopolitical stress in the Middle East which increase volatility oil prices.

The adverse relationship between equity market return and oil price shock has been examined by many studies and these studies mostly focus on developed markets (Jones and Kaul, 1996; Sadorsky, 2001; Narayan and Gupta, 2015; Cuñado and Pérez de Gracia, 2014). In many of the studies, less attention was paid to the impact of these (equity market return and oil price shock) in developing markets, such as India. Sahu et al. (2014), in his research focused his study on developing countries with relation to finding the relationship between the 2 factors. (oil price shocks and Indian stock market) and included data for the period starting from January 2001 to March 2013. The findings concluded that Indian stock markets and crude oil prices are dynamically exogenous as per the variance decompositions (VDCs) analysis. Also from another test - impulse response functions (IRFs) analysis it was found that a positive shock in oil price has a small but increasing positive impact on Indian stock markets in short run.

Strategically, the Indian oil and gas sector is vital and has a significant impact on decisions made in every other sector of the economy (Sharma, 2018). Depending on whether a country imports or exports crude oil, changes in the price of oil have a favourable or negative impact on the economies of those countries. India, a developing nation, imports 70% of the crude oil it needs. Hence, deriving the relationship between crude oil prices and the stock market is crucial for both investors and policymakers (Sharma, 2018). In this backdrop various researches have been undertaken globally to study the impact of oil prices on the stock exchanges. As Park and Ratti (2018) examined the consequences of oil price shocks and inconsistency on the real stock returns for the US and 13 European nations. For this study the data was collected between 1986:1 and 2005:12. The association between oil price shocks and real stock returns and between oil price shocks and interest rates, was determined by using multivariate VAR analysis and error variance decomposition analysis.

Basher et al. (2012) investigated the linkage between oil prices and two other variables: exchange rates and emerging stock markets. The relationship was established using the VAR technique. According to their research findings, soaring oil prices incline to temporarily oppress emerging market stock prices and US dollar exchange rates.

Ghosh and Kanjilal (2016) conducted research on the most volatile period in the history of oil price shocks, also known as the subprime crisis, and determined that fluctuations in global oil prices have an impact on the Indian stock market. The study ascertained that relationship was consistently positive, often very strongly and demonstrates the direct influence of crude oil price volatility on industry share prices. As a part of The 2030 Agenda for Sustainable Development published by the UN and collaboration team, has made 17 SDG goals for all the nations under economical, ecological and social sciences. SDG 8.1 being one of these goals, calls for inclusive and sustainable economic growth (ILO 2019). Further SDG8.1 deals with prevalent economic policy goals like GDP growth. The oil and gas sector has the potential to make a contribution to all SDGs with appropriate planning and implementation. In the view of aforesaid discussion, the present research attempts to determine the impact of Russia-Ukraine crisis on oil prices, nifty index and GDP.

2.1. Research Objectives

1. To study the impact of Russia Ukraine war on Crude Oil, Nifty Index, GDP Index and SDG.
2. To find correlation between MCX Crude Oil, Nifty Fifty Index and GDP Index.
3. To analyse the impact of change in one index for forecasting the change in other index.
4. To determine if Crude Oil volatility causes change in SDG8.

3. RESEARCH METHODOLOGY

The stock market performance is measured using NIFTY 50 monthly data from 1st January 2016 to 1st May 2022. The NIFTY 50 is an Indian stock market index that serves as a benchmark and represents the weighted average of 50 of the country's major firms listed on the National Stock Exchange. The crude oil data is analyzed using MCX iCOMDEX Crude Oil Index data from 1st January 2016 to 1st May 2022 to find the relationship between GDP Index and NIFTY Index performance. Data published by Organization for Economic Co-operation and Development (OECD) is refereed for GDP Index analysis. The present analysis is established on the monthly data of three time series namely MCX iCOMDEX crude oil, NIFTY 50 Index and GDP Index for a total of 77 monthly observations.

In order to analyse how three different time series, interact with one another, Vector Autoregression (VAR), a multivariate forecasting algorithm, is employed using Python Statistics Library. All of the time series variables in the data should be stationary before using the VAR model. Time series with constant mean and variation throughout time are said to be stationary, according to statistics. The Augmented Dickey-Fuller (ADF) test is one of the frequently used procedures to do a stationarity assessment. The null hypothesis in the ADF test is that the time series is non-stationary. As a result, the test rejects the null hypothesis and

concludes that the time series is stationary if the p-value is smaller than the significance level.

The three VAR equations that were employed in the study are listed below:

NIFTY_INDEX=C(1)*NIFTY_INDEX(L1)+C(2)*NIFTY_INDEX(L2)+C(3)*CRUDE OIL_INDEX(L1)+C(4)*CRUDE OIL_INDEX(L2)+C(5)*GDP_INDEX(L1)+C(6)*GDP_INDEX (L2)

CRUDE OIL_INDEX=C(7)*NIFTY_INDEX(L1)+C(8)*NIFTY_INDEX(L2)+C(9)*CRUDE OIL_INDEX (L1)+C(10)*CRUDE OIL_INDEX (L2)+C(11)*GDP_INDEX (L1)+C(12)*GDP_INDEX (L2)

GDP_INDEX=C(13)*NIFTY_INDEX(L1)+C(14)*NIFTY_INDEX(L2)+C(15)*CRUDE OIL_INDEX (L1)+C(16)*CRUDE OIL_INDEX (L2)+C(17)*GDP_INDEX (L1)+C(18)*GDP_INDEX (L2)

A statistical hypothesis test called the Granger causality test is also used in this research paper to determine whether one time series is a factor and can provide useful information for forecasting another time series. Granger's causality tests the null hypothesis that the coefficients of past values in the regression equation is zero. If a given p-value is < significance level (0.05), then, the corresponding X series (column) causes the Y (row).

4. ANALYSIS AND FINDINGS

Table 1 shows the results of the Augmented Dickey Fuller (ADF) test and reflects whether the time series is stationary or not. We have checked the stationarity status of the Nifty Index, MCX Crude oil Index and GDP Index which showed initial status as non-stationary but after the first difference, the series becomes stationary.

We fit increasing orders of the VAR model iteratively to figure out the best lag order, then choose the order that results in the model with the lowest AIC. For implementing the VAR model, loop was executed in the Python statistics library to decide the number of lags for time series analysis. Table 2 output shows that, the AIC drops to lowest at lag order 2, then increases from lag order 3 onwards. The VAR model was checked for 9 lag orders and the value of AIC is minimum for lag order 2. Therefore, we have employed two lags in the time series for VAR model implementation.

The outcomes of the VAR model are shown in Tables 3-5. The dependent variables are represented by the columns, and the independent variables are represented by the rows. To comprehend how values of the independent variable in the past explicate the dependent variables, the independent variables have been taken for two lags. In the Tables 3-5, we can see all coefficients, standard error value, t test and model's probabilities for lag1 and lag 2. From the results obtained, we will only consider the variables where P-value is less than 0.05. If we consider the GDP Index as a dependent variable as shown in Table 5, it is identified that lag 1 GDP Index and lag 2 GDP Index are likely to be useful in our prediction. In order to forecast the GDP, we should use lag 1 of GDP Index and lag 2 of GDP Index. All the coefficients values of lags of VAR equation shows the direction of their respective dependent variables. Keeping this equation in mind, we can further predict the future values of the dependent variables.

Table 6 correlation matrix of residuals provides the information that the correlation between Nifty Index and GDP Index is high and there is slight correlation between NIFTY and MCX crude oil index and MCX Crude oil index and GDP Index. Table 7 of Granger's Causation Matrix shows past value of NIFTY Index causes change in GDP Index similarly past value of Nifty Index causes change in MCX Crude oil Index. We reject null hypothesis for MCX crude oil Index and GDP Index meaning MCX crude oil do not cause change in GDP Index.

SDG8.1 as discussed in Figure 2 is dependent on the GDP rate. We have used the GDP index to ensure the consistency of the study and time series analysis as SGD index is calculated annually.

Table 1: Unit root test

Variables	Level data	Probability	Stationary status	First difference data	Probability	Stationary status
Nifty Index	–1.857	0.676	Non-Stationary	–8.426	0.000	Stationary
MCX Crude Oil Index	–1.700	0.750	Non-Stationary	–7.897	0.000	Stationary
GDP Index	–3.080	0.110	Non- Stationary	–7.015	0.000	Stationary

Table 2: Selection of the order (P) of VAR model

	AIC	BIC	FPE	HQIC
Lag Order=1	26.972487976492236	27.343286074658046	517767378853.75195	27.12054358543478
Lag Order=2	26.9137005286352	27.567556838868814	488889616060.5657	27.17453184969595
Lag Order=3	27.113066066276982	28.054350768118784	598843362343.3059	27.488184276998375
Lag Order=4	27.293545850390746	28.52673999819111	722189895785.9656	27.784484092453354
Lag Order=5	27.406683545937007	28.93638261773959	818137023692.2227	28.01499639093302
Lag Order=6	27.63339438233608	29.46431193657627	1045226960440.556	28.36065715359959
Lag Order=7	27.632716713271282	29.769688152451266	1073353472061.3195	28.480524643186676
Lag Order=8	27.822932884712788	30.27091932424526	1350166000497.087	28.792900084054757
Lag Order=9	27.846469904567968	30.6105621438044	1460723467225.485	28.94022811713394

Table 3: Results for equation nifty index

	Coefficient	Std. error	t-stat	Prob.
Constant	141.169311	77.11559	1.831	0.067
L1.Nifty Index	–0.023271	0.147236	–0.158	0.874
L1.MCX Crude Oil Index	–0.061667	0.081657	–0.755	0.45
L1.GDP Index	42.620296	62.02208	0.687	0.492
L2.Nifty Index	–0.029741	0.150179	–0.198	0.843
L2.MCX Crude Oil Index	0.062459	0.078923	0.791	0.429
L2.GDP Index	–34.613797	55.33185	–0.626	0.532

Table 4: Results for equation MCX crude oil index

	Coefficient	Std. error	t-stat	Prob.
Constant	–67.647136	124.5894	–0.543	0.587
L1.Nifty Index	0.465495	0.237877	1.957	0.05
L1.MCX Crude Oil Index	–0.029691	0.131927	–0.225	0.822
L1.GDP Index	49.897305	100.204	0.498	0.619
L2.Nifty Index	0.176644	0.242632	0.728	0.467
L2.MCX Crude Oil Index	0.015065	0.127509	0.118	0.906
L2.GDP Index	–115.08349	89.39517	–1.287	0.198

Table 5: Results for equation GDP index

	Coefficient	Std. error	t-stat	Prob.
Constant	–0.032428	0.169724	–0.191	0.848
L1.Nifty Index	0.000327	0.000324	1.008	0.313
L1.MCX Crude Oil Index	–0.000035	0.00018	–0.196	0.845
L1.GDP Index	0.706927	0.136505	5.179	0.000
L2.Nifty Index	–0.000195	0.000331	–0.591	0.555
L2.MCX Crude Oil Index	0.000063	0.000174	0.361	0.718
L2.GDP Index	–0.442836	0.12178	–3.636	0.000

Table 6: Correlation matrix of residuals

	Nifty index	MCX crude oil index	GDP index
Nifty Index	1.000000	0.305314	0.597909
MCX Crude Oil Index	0.305314	1.000000	0.380584
GDP Index	0.597909	0.380584	1.000000

Table 7: Granger's causation matrix

	Nifty Index_x	MCX Crude Oil Index_x	GDP Index_x
Nifty Index_y	1.0000	0.3412	0.0080
MCX Crude Oil Index_y	0.0096	1.0000	0.1128
GDP Index_y	0.0313	0.6869	1.0000

From the above tests, as GDP cannot be significantly forecasted using MCX Crude oil Index, it is difficult to state if SDG8 accomplishment can be forecasted using the same. But as there is corelation between both the indices of MCX crude oil and GDP, we can say that SDG8 as a part of GDP will also be impacted due to the crude oil volatility.

The first objective of the study was to study the impact of Russia Ukraine war on Crude Oil, Nifty Index, GDP Index and SDG. For this objective, the authors did Unit root Test (Table 1). The Augmented Dickey Fuller (ADF) test shows that after the first difference, the data in time series becomes stationary. The P value in the test shows level of significance after each lag. Granger's Causation Matrix shows that past value of NIFTY Index causes change in GDP Index similarly past value of Nifty Index causes change in MCX Crude oil Index.

For the next objective in the study, the authors find correlation between MCX Crude Oil, Nifty Fifty Index and GDP Index where the corelation between Nifty Index and GDP Index is high, the correlation between NIFTY and MCX crude oil index is significant and corelation between MCX Crude oil index and GDP Index is less.

The next objective is achieved through the VAR model which uses the impact of change in one index for forecasting the change in another index. The results show that while MCX crude oil indices can predict the changes in NIFTY 50 indices but MCX crude oil indices cannot significantly predict the GDP Indices.

The fourth objective concludes that there is corelation between MCX crude oil index, GDP index and SDG8. While the VAR model also somewhat confirms this, but perhaps because there are less data points, the time series forecasting becomes difficult. As a result, given such less time series data, the SDG cannot be anticipated or predicted using the VAR model.

5. CONCLUSION

The current research examined the association between crude oil, Nifty and GDP to ultimately form and find a relation between crude oil and SDG. According to unit root analysis, crude oil indices, Nifty index and GDP indices are non-stationary at first and then stationary after first difference. The VAR model used for the study uses 3 indices for time series analysis. Findings exhibit that the GDP Index is adequately demonstrated by the lagged values of crude oil prices and Nifty index. Granger's Causation Matrix shows that past value of NIFTY Index causes change in GDP Index similarly past value of Nifty Index causes change in MCX Crude oil Index whereas MCX crude oil does not cause much change in GDP Index. The effect of any change in the crude oil on MCX Index causes a change in Index on Nifty but the effect of the same crude oil on MCX Index does not have much effect on GDP Index.

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