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IMPACT OF COVID-19 PANDEMIC ON OIL PRICES IN SOUTH ASIA: PANEL DATA ANALYSIS

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ABSTRACT
The COVID-19 pandemic has exerted an unprecedented impact on the oil prices across the globe and it is inevitable to capture the variations in oil prices caused by the COVID-19 pandemic. The current study objects to explore the effect of COVID-19 on oil prices in South Asian countries (Pakistan, India, Sri Lanka, and Bangladesh) by applying the Fixed-Effect Model (FEM) to the panel data from January 2019 to June 2021. The study has applied the Levin-Lin Chu test, Hardri LM test, and Im-Pesaran-Shin test to check the stationary properties of the panel data. The study has also applied the diagnostic tests i.e. White test, the Breush-Pagan test, the Breush-Pagan LM test, the Durban-Watson test, and the Hausman test. The results of all diagnostic tests authenticate the estimates of the Fixed-Effect Model (FEM). Findings of the study exhibit that the COVID-19 pandemic, natural gas production, and oil demand exert a negative impact on the oil price, whereas, exchange rate and oil supply have a positive impact on oil prices in South Asian countries during the stipulated period. The study has suggested that the authorities of South Asian authorities should devise such type of policies that could defeat the COVID-19 pandemic to cope with the hike in oil prices.
Keywords: COVID-19 pandemic; Oil Prices; Fixed-Effect-Model; South Asia.

INTRODUCTION

COVID-19 pandemic has unprecedented impact across the globe and there are several reasons why the impact of the Coronavirus in South Asian nations like Pakistan, India, Sri Lanka, and Bangladesh has been severe in all the sectors of these nations. South Asian region has been facing poor Healthcare facilities due to which, there has been greater insecurity to tackle the epidemics, especially COVID-19. Universal Health Security Index has provided a ranking of all the countries of the world in which South Asian regions have exhibited a dismal state.

For instance, there are 195 countries out of which India has been ranked at 57 with an average of 46.5, and Bhutan has been ranked at 85 with an average of 40.2. Except for these two countries in the South Asian region, the rest of the countries have been ranked greatly below the worldwide average. The rank of Pakistan is 105 with an average of 35.5, Nepal is ranked 111 with an average of 35.1, the rank of Bangladesh is 113 with an average of 35.0, the rank of Sri Lanka is 120 with an average of 33.9, the rank of Maldives stood at 121 with an average score of 33.8, and the rank of Afghanistan is 130 with an average score of 32.3. The status of average daily cases of COVID-19 in South Asian Countries is given in the following Table (1):

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Table1 No. 1 Status of Average Daily Cases of COVID-19 in South Asian Countries

Countries	Average Daily Cases	Average Daily Deaths	Average Daily Vaccine
Pakistan	1065.22	47.49	32712.99
India	17430.5	837	63540.42
Bangladesh	1014.93	30.85	20206.03
Sri Lanka	288.10	6.68	7386.20

Source: International Monetary Fund, 2020.

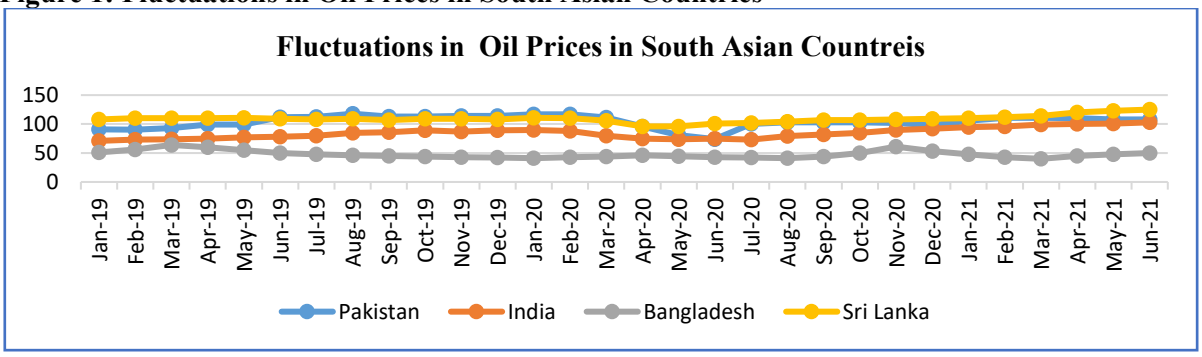
In the South Asia countries, the COVID-19 has adverse impact on economic growth as reported by the World Bank. South Asian countries were expected to shriveling during 2019 to 2020 as Afghanistan 3.9 to -1.9, Bangladesh 8.2 to 2.4, India dropped from 4.0 to -8.0, Maldives dropped from 7.0 to -32.0, Nepal fall down from 6.7 to -2.1, Pakistan was dropped from 1.3 to 0.5, and Sri Lanka was dropped 2.3 to -3.6. The current episode of low oil prices holds limited promise to boost the worldwide economy amongst extensive constraints and constricted room for the fiscal funding in developing economies (Wheeler et al., 2020). COVID-19 has serious impact on the economies with a deterioration in the growth rate of GDP, mounting unemployment (Pattanaik, 2020).

COVID-19 has unprecedented effect on the oil prices and the petroleum market is presently facing one of the most volatile situation in the history. These volatilities in the oil prices have affected both microeconomic and macroeconomic factors. Vagueness and capriciousness in the prices of oil caused by COVID-19 along with the war between the Russia and the Saudi Arabia both have badly affected investor's choices for portfolio allocation and the manufacture's decisions of industrial production in the economy. In this regard, South Asian countries have no exception from the unprecedented volatility in oil prices. The status of average daily oil prices in South Asian countries is very clear from the following Table (2)

Table No. 2 Status of Average Daily Oil Prices in South Asian Countries

Countries	2019	2020	2021
Pakistan	105.77	100.40	109.00
India	80.33	81.92	99.00
Bangladesh	50.33	46.06	45.67
Sri Lanka	109.00	104.75	117.33

Figure 1: Fluctuations in Oil Prices in South Asian Countries



The above figure (1) shows the oil price fluctuations during the period Jan 2019 to Jun 2021. There is clearly shown that during the COVID-19 the oil prices fluctuate in the South Asian countries. In the beginning, the oil prices slowly increase and then decrease. But after the period Jul 2020, the oil price increased persistently. The pandemic causes massive uncertainties both in developed and developing countries. The worst effect of COVID-19 spread in different parts of the economy such as stock market volatility, economic policy, and uncertainty in the oil market. Evidence from Asian countries which are net oil-importing, recommends a positive association between oil prices and stock returns during the first five months (Prabheesh et al., 2020). On another side, some researchers have explained the positive influence of COVID-19 on oil prices. However, in contrast, some studies indicate that the COVID-19 pandemic affected markets positively initially but later, there was a continuation of a negative link between the oil prices and stocks (Liu et al., 2020). It has also been reported that GARCH and ARCH estimates obtained during the positive and negative shocks have revealed the different

effects in each period and the obligation to design different policies during each period (Bildirici et al., 2020).

South Asian countries have observed a massive increase in patients with COVID-19 during a short period. Due to such an emergency, authorities imposed a lock-down to capture the outbreak of disease. Nevertheless, worried about the devastating economic effect of a long shutdown along with problematic choices in life and livelihood, countries have steadily restarted their economic activities. Literature on the effect of the COVID-19 pandemic on the prices of oil has revealed a vague picture, many studies have claimed a negative association between the COVID-19 pandemic and oil prices (see, for instance, Shaikh, 2020; Gil-Alana and Monge, 2020; Wheeler et al., 2020; Aruna and Rajesh, 2020; Apergis and Apergis, 2020; Pattanaik, 2020; Prabheesh and Kumar, 2021; Algamdi et al., 2021; Mugaloglu et al., 2021; Shehabi, 2021). Whereas, most of the studies have reported a positive relationship between the COVID-19 pandemic and oil prices (Lee et al., 2021; Wang et al., 2021; Zhang et al., 2021; Mugaloglu et al., 2021). The decision regarding the relationship between COVID-19 and oil prices is still debatable. Therefore, the need to capture the impact of COVID-19 on oil prices is essential. South Asian countries may be a good case in this regard. The purpose of the current research work is to find out the impact of the COVID-19 pandemic on oil prices and to suggest the policy implications for the South Asian countries. The remaining part of the paper will proceed as: section 2 will describe the review of literature, section 3 will be based on the statistical and econometrics techniques, and section 4 will analyze the results and discussions of the investigation. Finally, section 5 will provide the conclusion and recommendations.

REVIEW OF LITERATURE

This study has examined low oil prices during the COVID-19 pandemic. The study aimed to understand the impact of low oil prices due to COVID-19 on the economy. The study has used monthly basis data starting from the period January 1980 to April 2020 by using the SVAR model. The results indicated that the present period of fall in oil prices entails restricted promise to increase the oil prices in the global world and a reduction in the fiscal funding in energy-exporting emerging economies (Wheeler et al., 2020).

The relationship between the market of crude oil and the COVID-19 pandemic was examined. The purpose of that study was to explore the relationship between the pandemic impacts on the oil industry. Samples of the study were daily prices of the energy commodities, gold futures, stock index, and US dollar index from 2nd January 2018 to 30th June 2020. The study applied OLS and interaction of dummy variable model. The results indicated that the worldwide standard of crude oil and Brent have supposed an exceptional action during the first quarter of the pandemic year 2020. That study has recommended that OPEC countries should recognize that increase in the production of oil might be dangerous in case of the second wave of COVID-19 (Shaikh, 2020).

This study has scrutinized the oil prices during the impact of COVID-19. The study aimed to determine the association between Dubai and WTI crude oil prices daily closing prices and the COVID-19 crises. The study has used daily basis data of oil prices from 29th May 2006, to 31st March 2020, and has applied the LSTARGARCH model. Findings have shown that the effects and the volatility of the shocks due to COVID-19 must be evaluated by the method proposed by them (Bildirici et al., 2020).

This research work has find out the effect of COVID-19 cases and shock in oil prices on stock returns in India. The objective of the research work was to find out the association between stock return and sources of oil price shocks and COVID-19 cases. The study has used the weekly data from January 3, 2020, to April 10, 2020, and applied the Structural VAR model. The study has indicated that the COVID-19 shock may not have an immediate negative impact on stock returns. Hence, it was concluded that the far spread of COVID-19 has a positive influence on the stock market (Aruna and Rajesh, 2020).

This study has analyzed the COVID-19 pandemic and oil price linkages in the US. The purpose of that research work was to investigate the association between the COVID-19 and oil prices in the USA. This study used daily basis data from 21st January 2020 to 30th April 2020 and applied the mixed data sampling technique. The results implied that the political leaders have wanted low for partisan gains during the worrying times. The findings have suggested the polarization of both COVID-19 and oil prices (Apergis and Apergis, 2020).

This research work has examined the link between oil prices and COVID-19 in the perseverance of shock. The purpose of the study was to examine the influence of COVID-19 on oil prices. Long

Memory techniques were applied to examine the effect, by using time series daily observations from May 04, 2010, until May 04, 2020, leading to 2,611 observations. The oil price series was persistent and the order of integration was 0.84. It was found that the data before the start of COVID-19, the first-order integration hypothesis could not be refuted. The findings were found in line with the evidence of the market efficiency which was estimated before the start of the crisis. The evidence has revealed that the shock of oil prices would be temporary and exert long-lasting properties (Gil-Alana and Monge, 2020).

This study has explained the historical oil price variation during the COVID-19 pandemic and the sources of these fluctuations. The purpose of the study was to determine the association between the COVID-19 cases, crude oil prices, UA dollar index, and the uncertainty index of economic policy for the United State. The autoregressive distributed lag model was used on daily series from 17th January to 14th September 2020 to examine the short-run and long-run relationships. The findings of the study have revealed that the increase in the COVID-19 pandemic, the uncertainty of economic policy of the US, and anticipated volatility of the stock market have also contributed to the decrease in the oil prices, while the fall in the worldwide stock markets was appeared to be reduced. It was recommended that policy actions might help alleviate the sharp fall in oil prices (Lee et al., 2021).

This research work has explored the variations in the oil prices, the stock market, and exchange rates under COVID-19 uncertainty. The purpose of the study was to examine the relationship between the bilateral nominal, exchange rate, stock returns, and uncertainty index. The study used daily data for the period 31st December 2019 to 28th April 2021 by applying the Structural Vector Auto Regression (SVAR) model to evaluate the relationship. The study found that COVID-19 persuaded insecurity and diminished oil prices and the stock market. Additionally, it was suggested that uncertainty induced by COVID-19 has deteriorated the dynamics among oil and stock prices in the starting period (Prabheesh and Kumar, 2021).

This study has compared the COVID-19 along with SARS during 2002 and the worldwide financial crises through the year 2008. The purpose of that study was to explore the stock market returns and volatile behavior of the oil prices during the period of three crises. The authors have used three different samples first from November 2002 to 15 May 2005 second sample was from April 2007 to the end of 31 March 2010 and the last sample was from December 2019 to 13 April 2021 by using the GARCH model. The results have confirmed the existence of volatility effects with the highest level of unevenness throughout COVID-19. This evidence jointly has made the COVID-19 more indeterminate and unenthusiastic (Rizvi and Itani, 2021).

This research work has explored the relationship between oil prices, COVID-19, the stock price of electronic sports, and the uncertainty index. The study has investigated the impact of fluctuation in oil prices, on daily news-based indexes on Electronic Art. The study has applied Quintiles' Autoregressive Distributed Lag (QARDL) from 2019 to 2020. The results revealed the cumulative short-run impact of COVID-19, oil price, and EPU on stock prices of electronic arts. The study recommended significantly improving the decision-making capabilities for controlling the negative long-run linkage (Wang et al., 2021).

This study has inspected the effect of COVID-19 death cases on the oil prices in Saudi Arabia. That paper aimed to explain the death cases, uncertainties, investor fears, and accelerated volatility of oil prices in the financial market. The time-series data was used from 22 January 2020 to June 2020 by applying the ARDL model. The results indicated the significant impact of COVID-19 on oil prices. It was suggested that further work was needed and many countries have adopted absolute measures, and many economies like the USA have adopted the financial support steps (Algamdi et al., 2021).

This research work has investigated the shocks in oil prices throughout the COVID-19 from Energy Stocks of the United Kingdom. The purpose of the study was to examine the association between universal oil prices, gas stock returns, and oil and the stock market in the United Kingdom by using a VAR methodology during the outspread of COVID-19 and using the data of Brent oil prices from 09/2014 to 09/2020. The results of structural VAR have suggested that the effect of structural shock related to the universal oil prices on the index returns has become less imperative and has lost its descriptive power during the period of the pandemic (Mugaloglu et al., 2021).

This study has explored the long period effects of COVID-19 on oil prices in the Gulf Oil Economy. The study aimed to find the oligopolistic behavior of Kuwait, the relationship between the shares of GDP, the share of total exports, net exports over output, and COVID-19 cases. The study has

used cross-sectional data for 2020 and applies the Computable General Equilibrium (CEG) model. The model simulations found that the shock of COVID-19, its mitigating measures, and the decline in oil price, greatly harm the GDP of the economy and caused to fiscal deficit. The study suggested the urgent need for structural and fiscal reforms which were politically contentious and difficult in Kuwait (Shehabi, 2021).

This research work has examined the impact of COVID-19on the stock return oil prices predictability pattern. The purpose of the research was to explore the link between Nikkei stock average volatility indexes and the percentage return of the Nikkei price index. The study has used Monday to Friday of the week as dummy variables. The time series daily data of the stock market of the Japanese from 1st April 2020 to 17th March 2021 was used and the General Predictability model was applied. The results were robust due to different specified models and controlled for the seasonality. The study has suggested particular elements were responsible for the deterioration in the association between oil prices and the stock return (Zhang et al., 2021).

Rationale of the Study

A review of all the earlier studies indicates that most of the studies have scrutinized the impact of the COVID-19 pandemic in different countries by using time series data for the case of a single country, for instance, Shaikh (2020) has observed the effect of COVID-19 on oil prices in the US; Aruna and Rajesh (2020) explored the effect of COVID-19 pandemic on the oil price for the case of India; Apergis and Apergis (2020) checked the relationship between COVID-19 pandemic and oil prices for the case of USA; Lee et al. (2021) and Wang et al. (2021) analyzed the effects of COVID-19 pandemic on oil prices for the case of United State; Algamdi et al. (2021) for Saudi Arabia; Mugaloglu et al. (2021) studied the effect of COVID-19 on the oil prices for the UK; and Zhang et al. (2021) examined the COVID-19, stock return and oil prices in Japan. Only one study is found in the literature which has quantified the impact of COVID-19 on oil prices in the economy of the Gulf by using cross-sectional data. There is a dearth of literature on the case of panel analysis, only a few studies (e.g., Wheeler et al., 2020; Pattanaik, 2020; Salisu et al., 2020; Prabheesh and Kumar, 2021) have used the panel data to measure the impact of COVID-19 on the oil prices. The findings of all these studies vary from country to country and region to region. Literature is yet to provide a definitive conclusion on the impact of COVID-19 on oil prices. Furthermore, none of the studies has explored the impact of the COVID-19 pandemic on the oil prices for the case of South Asian countries. Therefore, this research work intends to fill this gap and will be worth contributing to the literature on economics.

Objectives of the Study

Main objectives of this study are followings:

(i) To estimate the impact of the COVID-19 pandemic on the oil prices for the case of South Asian countries.

(ii) To provide policy implications for the South Asian economies.

Hypotheses of the Study

Null-Hypothesis (H_0): COVID-19 have no impact on oil prices in South Asian economies.

Alternative-Hypothesis (H_1): COVID-19 have impact on oil prices in South Asian economies.

METHODS OF THE STYDY

This study intends to examine the impact of COVID-19 on the oil prices in South Asian countries by using the monthly data from Jan 2019 to Jun 2021. The study has collected the data from different sources like World Development Indicators (WDI, 2021), Federal Reserve of economic data (FRED, 2021), Central European International Business Information (CEIBI, 2021), Nepal oil Corporation Limited (NOCL, 2021), and Trading & Economics (T&E, 2021).

Based on the literature review and theoretical framework the study concludes some determinants of oil prices such as oil demand, oil supply, COVID-19, gas production, US$ exchange rate, and the oil reserves, etc. The results of the Hausman test have authenticated to select the Fixed-Effect Model (FEM) because the study area contains four countries and FEM is suitable for such a selected sample of research. To get the estimates of the FEM, this study has specified the following model (1).

$$OP = f\ (COVID - 19, NGP, ER, OD, OS) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (1)$$

Econometrics transformation of the model (1) is given as:

$$OP = \beta_0 + \beta_1\ COVID - 19 + \beta_2\ NGP + \beta_3 ER + \beta_4 OD + \beta_5\ OS + Ui \ldots\ldots\ldots (2)$$

Generalized form of econometrics model in equation (2) can be transformed for the panel as under:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 X_{it} + \beta_3 X_{it} + \beta_4 X_{it} + \beta_5 X_{it} + \mu_{it} \ldots\ldots\ldots\ldots\ldots (3)$$

Y_{it} = Dependent Variable
β_0= Intercept of the Model
X_{it} = Respective Independent Variables
β_i= Respective Slope
μ_i = Error Term of Model

Table No. 3: Description of Variables

Variables	Abbreviation	Measurement
Oil Price	OP	Retail Price (per day)
COVID-19 Cases	COVID-19	New COVID-19 cases reported
Oil Demand	OD	Thousand barrel per day (Mb/d)
Oil Supply	OS	Thousand barrel per day (Mb/d)
Exchange Rate	ER	US Dollar
Gas Production	GP	Thousand barrel per day (Mb/d)

Sources of Data

Different sources of all the data for all South Asian countries are briefly given; sources of oil prices were Pol Archives for Pakistan, The Economic Time for India, Central European International Business Information for Bangladesh, and Sri Lanka. Data on Covid-19, Oil Demand, and Oil Supply for all the countries were obtained from Over World In Data, and Energy Information Administration respectively. Data on Exchange rates in Pakistan and Bangladesh were taken from Exchange Rate and for India and Sri Lanka, data on the exchange rate was taken from the Federal Reserve of Economic Data. Data of Gas Production for all the countries was taken from Energy Information Administration.

Test of Unit Root

For this purpose, following regression standard equation can be estimated for the Levin-Lin Chu (LLC, 2002) test:

$$\Delta y_{i,t} = \propto_t + \theta_t + \delta_t t + \rho_i y_{i,t-1} + \sum \alpha_t \Delta y_{t-i} + u_{i,t} \ldots\ldots\ldots\ldots (4)$$

t = 1,2,3,4,……, T: i = 1,2,3,4,…..…..N: where 'i' and 't' show the countries and time period respectively. The model is very general since it permits for both entity-specific and time-specific through α_t and θ_t respectively. Null hypothesis is assumed as: H_0: $\rho_i \equiv \rho = 0 \; \forall \; i$ and alternative hypothesis is assumed as: H_1: $< 0 \forall$. So the autoregressive dynamic are the same for all series under the alternative.

Estimation Techniques

Representation of Fixed Effect Model within the group

$$Y_{it} = \beta_1 + \sum_{j=2}^{k} \beta_j X_{j,it} + \propto_i + \delta_t + \varepsilon_{it} \ldots\ldots\ldots (5)$$

This study assumes a simplified multi-input production function as given below:

$$Y_t^d = f\left(K_t^d, N_t^d, E_t^d\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where Y_t^d is total production, K_t^d is assumed as capital input, N_t^d is assumed as labor input, and $E_t^d \; dd$ is assumed as energy input. If we assume all variables in (6) as in per capita form, then model will be converted as:

$$\frac{Y_t^d}{N_t^d} = f\left(\frac{K_t^d}{N_t^d}, \frac{E_t^d}{N_t^d}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Assuming the above production function:

$$y_t^d = f\left(k_t^d, q_t^e\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

$Equation\ (8)$ can be disaggregated as:

$$q_t^e = v\left(q_t^o + q_t^g\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

Where q_t^o crude oil is input and q_t^g is natural gas input as natural gas. Cobb-Douglas production function may be as:

$$y_t^d = f\left(k_t^d\right)^{\alpha} (q_t^e)^{\beta} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

$$\text{\& s.t. } \alpha + \beta = 1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

$$\frac{\partial f}{\partial k_t^d} = \frac{\alpha y_t^d}{k_t^d} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

$$\frac{\partial f}{\partial q_t^e} = \frac{\alpha y_t^d}{q_t^e} \text{.....(13)}$$

Profit equation may be transformed as:

$$\text{Max } \pi_t^d = p_t^y y_t^d - i_t k_t^d - e_t p_t^e q_t^e \text{.....(14)}$$

$$\text{s.t. } \alpha + \beta = 1 \text{.....(15)}$$

Lagrange function can be derived as:

$$\mathcal{L} = \left(p_t^y y_t^d - i_t k_t^d - e_t p_t^e q_t^e\right) - \lambda\left[y_t^d - \left(k_t^d\right)^{\alpha}(q_t^e)^{\beta}\right] \text{.....(16)}$$

$$\frac{\partial \mathcal{L}}{\partial k_t^d} = -i_t + \lambda\left(\frac{\alpha y_t^d}{k_t^d}\right) = 0 \text{.....(17)}$$

$$\frac{\partial \mathcal{L}}{\partial q_t^e} = -e_t p_t^e + \lambda\left(\frac{\alpha y_t^d}{q_t^e}\right) = 0 \text{.....(18)}$$

$$\frac{\partial L}{\partial y_t^d} = p_t^y - \lambda = 0 \text{.....(19)}$$

$$-i_t + p_t^y\left(\frac{\alpha y_t^d}{k_t^d}\right) = 0 \text{.....(20)}$$

$$k_t^d = \frac{\alpha p_t^y y_t^d}{i_t} \text{.....(21)}$$

$$-e_t p_t^e + p_t^y \frac{\beta y_t^d}{q_t^e} = 0 \text{.....(22)}$$

$$q_t^e = \frac{\beta p_t^y y_t^d}{e p_t^e} \text{.....(23)}$$

The log linear oil demand side will be as:

$$\log q_t^e = \log \beta + \log p_t^y + \log y_t^d - \log e_t - \log p_t^o - \log p_t^g \text{.....(24)}$$

$$q_t^d = d_0 + d_1 p_t^o + d_2 p_t^g + d_3 y_t^d + d_4 e_t + u_{dt} \text{.....(25)}$$

Finally, the structural demand equation (26) may be transformed as:

$$q_t^d = d_0 + d_1 p_t^o + d_2 p_t^g + d_3 ip_t^o + d_4 ip_t^c + d_5 ip_t^i + d_6 e_t + u_{dt} \text{.....(26)}$$

The oil demand side may be as:

$$q_t^S = f(K_t^S, N_t^S, R_{t-1}) \text{.....(27)}$$

Transformation of (27) in per capita will be as:

$$\frac{Y_t^S}{N_t^S} = f\left(\frac{K_t^S}{N_t^S}, \frac{R_{t-1}}{N_t^S}\right) \text{.....(28)}$$

Thus, we can obtain:

$$y_t^S = (k_t^S, r_{t-1}^o) \text{.....(29)}$$

According to Taghizadeh-Hesary and Yoshino (2014), oil supply will be equal to oil production as under:

$$\mathrm{Q_t^s} = \sum_{t=0}^{T} \mathrm{q_t^s} \text{.....(30)}$$

Equation (31) illustrates the decreasing amount of proven every period by q_t^S.

$$r_t^o = r_{t-1}^o - q_t^S \text{.....(31)}$$

The extraction cost will be as under:

$$C_t(q_t^S, r_t^o) = \alpha(q_t^S) + \frac{1}{2}\beta(r_t^o - r_{t-1}^o)^2 > 0, \alpha > 0, \beta > 0 \text{.....(32)}$$

Problem of maximization may be identified for the oil supply, and producer's profits maximization will be as below:

$$\pi_t^S = e_t p_t^e q_t^S - \left[\alpha(q_t^S) + \frac{1}{2}\beta(r_t^o - r_{t-1}^o)^2\right] \text{.....(33)}$$

$$\text{Max } \pi_t^S = e_t p_t^e q_t^S - \left[\alpha(q_t^S) + \frac{1}{2}\beta(r_t^o)^2\right] \text{.....(34)}$$

$$\text{s.t. } (r_t^o - r_{t-1}^o) = -q_t^S \text{.....(35)}$$

Therefore, from the above we can obtain:

$$\frac{\partial \pi_t^S}{\partial q_t^S} = e_t p_t^e - [\alpha(q_t^S) + \beta(r_{t-1}^o - q_t^S)] = e_t p_t^e - \alpha(q_t^S) + \beta(r_{t-1}^o - q_t^S) \text{.....(36)}$$

$$e_t p_t^e - (\alpha + \beta) q_t^S + \beta(r_{t-1}^o) = 0 \text{.....(37)}$$

$$q_t^S = (e_t p_t^e + \beta r_{t-1}^o)/(\alpha + \beta) \text{ .....(38)}$$

Finally, log-linear form will be as:

$$q_t^S = s_0 + s_1 p_t^e + s_2 e_t + s_3 r_{t-1}^o + u_{st} \text{.....(39)}$$

Furthermore, we assume that supply is equal to demand (market clearing condition) and equate (26) to (39):

$$d_0 + d_1 p_t^o + d_2 p_t^g + d_3 ip_t^o + d_4 ip_t^c + d_5 ip_t^i + d_6 e_t + u_{dt} = s_0 + s_1 p_t^e + s_2 e_t + s_3 r_{t-1}^o + u_{st} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (40)$$

Final oil price equation, 41 can be written as:

$$p_t^o = \frac{[(d_0 - s_0) + d_2 p_t^g + d_3 ip_t^o + d_4 ip_t^c + d_5 ip_t^i + e_t(d_6 - s_2) - s_3 r_{t-1}^o + (u_{dt} - u_{st})]}{(s_1 - d_1)} \ldots\ldots\ldots (41)$$

The empirical analysis of the model given in equation (41) is explained in the next section.

Results and Discussion

Econometrics analyses starts from checking the stationary of the data by applying Levin-Lin Chu (LLC), Hadri LM Stationarity (HLM), and IPS tests and then apply the Fixed Effect Model (FEM).

Table No. 4 Results of Unit Root Tests

Variables	LLC	Hadri LM (HLM)	IPS
Oil Price	I(1)	I(1)	I(0)
Covid-19	I(1)	I(0)	I(1)
Oil Demand	I(1)	I(0)	I(1)
Oil Supply	I(1)	I(1)	I(1)
Gas Production	I(1)	I(0)	I(1)
Exchange Rate	I(1)	I(0)	I(1)

Results in Table (4) indicate that some variables are stationary at I(0) and some are stationary at I(1). The results of the Levin Lin Chu test reveal that all variables are stationary at I(1) but the COVID-19 is stationary at the level.

The results of descriptive statistics are given in the following Table (6).

Table No. 5 Results of Descriptive Statistics

	Oil Price	COVID-19 Cases	Natural Gas Production	Exchange Rate	Oil Demand	Oil Supply
Mean	86.40567	271230.3	41.06667	124.3897	1346.079	269.5417
Standard deviation	25.61762	1105403	50.16037	47.66705	2025.213	397.5731
Maxima	125	9010080	148	197.8595	5147	1018
Minima	40	5	3	68.7391	3.708333	4.7
Observations	120	120	120	120	120	120

Table No. 6 Results of Pair Wise Correlation

	OP	COVID-19	GP	ER	OD	OS
OP	1.0000					
COVID-19	0.0675	1.0000				
GP	-0.0697	0.3472	1.0000			
ER	0.7376	-0.2428	-0.6630	1.0000		
OD	-0.0407	0.3574	0.9898	-0.5365	1.0000	
OS	-0.0379	0.3690	0.8922	-0.6214	0.6042	1.0000

Table (6) shows the pair-wise correlations matrix for the overall six variables which describes the summary statistics for panel data. The oil price correlates positively with the COVID-19 and the value of the correlation is 0.067, gas production is negatively related to the oil price, and the value of the correlation between them is -0.069. Finally, we can see that the oil demand is negatively related to the oil demand the value of correlation is 0.04. An interesting feature is that the (absolute) correlation coefficients between oil price and COVID-19 are higher if we compare them.

Results of Fixed Effect Model (FEM)

As mentioned in the previous section the Hausman test must be done to find out Fixed-Effects model is appropriate or not. Hausman test designates that the Fixed Effects model is the most applicable for the data.

No. 7 Results of Fixed Effect Model

Dependent Variable		Oil Price		
Method Used		Fixed Effect Model		
Sample Adjustment		Jan 2019 to Jun 2021		
Variables	**Symbol**	Coefficient	t-statistics	P-value
COVID-19	β_1	0.0000026	2.68	0.009
NGP	β_2	-0.269132	-1.85	0.066
ER	β_3	0.40989	2.39	0.019
OD	β_4	-2.11352	-1.29	0.201
OS	β_5	97.3859	2.22	0.029
C	β_0	-117.82	-1.39	0.168
R^2		0.8953		
Adjusted R-Square		0.8907		
Prob (F-Statistics)		0.000		
Durbin Watson (DW)		2.130		
Rho		0.98803		

RESULTS AND DISCUSSION

Results are given in Table (7) reveal that there is a significant and positive impact of COVID-19 on oil prices which means that COVID-19 has caused a hike in the oil prices in South Asian countries. Empirical evidence of oil prices in South Asian countries also indicates that in the beginning, the oil prices slowly decrease/increase and then decrease/increase but after the period Jul 2020 the oil price increased persistently. The price of WTI became negative for the first time in history during the Covid-19, world coronavirus media hype index was affecting negatively crude oil market and progressively presented positive outcomes in the second wave of COVID-19 (Shaikh, 2020). The pandemic causes massive uncertainties both in developed and developing countries. The worst impact of COVID-19 spread in different parts of the economy such as stock market volatility, economic policy, and uncertainty in the oil market. This result is in line with the results derived from many studies ((Bildirici et al. 2020; Liu et al., 2020; and Prabheesh et al., 2020). Similarly, Algamdi et al. (2020) have reported a positive impact of the COVID-19 death cases on oil prices for the USA. Oil importing Asian countries have also suggested a positive linkage between oil prices and stock return during the first five months (Prabheesh et al., 2020). The findings of the study, given in Table (7) show that the impact of natural gas production on oil prices is negative which means that increase in natural gas production causes to curtail the oil prices in South Asian countries.

Oil and gas prices have depicted, respectively, negative and positive links with oil prices (Yoshino, 2019). Results also reveal that the exchange rate exerts a positive impact on oil prices in South Asian countries. Table (6) point out the strong pair-wise positive correlation between the exchange rate and the oil price of currencies. A large number of empirical literature has suggested that exchange rates and oil prices became interrelated. Findings have shown a positive and significant relationship between the oil price and exchange rate in the engaged sample during the period of COVID-19. The correlation between oil price variations and exchange rate investigated the bidirectional relation between oil price and exchange rate (Kim, and Jung, 2018); Kumar, 2019). Presently, the co-movement between oil price and the exchange rate has also been reviewed (Beckmann et al., 2020). As a result, the currency exchange rate affects the prices of oil. Kilian and Zhou (2019) have maintained that because of the international trade which is identical to the findings drawn by Fratzscher, et al., (2013). The association between oil prices and exchange rate can be positive (Kilian and Rebucc, 2009; Hasanov et al., 2017), and negative (Colacito et al., 2007; Blokhina et al., 2014). In turn, Brahmasrene, Huang, and Sissoko (Filis et al., 2011) have reported that in the short run, the exchange rate exerts negative effects on oil prices, but in a long run, oil prices have a positive impact on the exchange rate. Prices of petroleum are a major source of variations in the exchange rates of the currencies of different

states of the G7 (Kim, 2018; Mensi et al., 2021) in some small, open developing economies (Nelson, 1991; and Candila et al., 2021) the states of OPEC have strongly depended on crude oil and the developing countries in Asia and Africa (Asgharian et al., 2015; and (Yang et al., 2019). It is also found that oil demand is negatively related to oil prices in South Asia. The coefficient value of the oil supply has a positive impact on the oil prices.

In this research, oil retail price is a dependent variable which is the panel of four South Asia countries. Due to the COVID-19 pandemic, there are numerous factors affecting the oil market. Further, there are different types of impacts of a pandemic on the oil prices in different economies. The decomposition identifies a positive supply shock caused by the failure of the OPEC agreement that has curtailed the prices and at the same time raised the worldwide oil output (Wheeler et al., 2020). Economic disturbances due to the COVID-19 have caused a reduction in output and mobility of the people all over the world, which has caused a major drop in universal demand for oil even at very low prices of oil. Contrary to this, a negative demand shock has reduced oil prices (Wheeler et al., 2020). Asian countries (oil-importing) have also suggested a positive link between oil price and the stock return during the first five months (Prabheesh et al., 2020). However, in contrast, some studies have indicated that the COVID-19 pandemic has affected markets positively initially but later, there was a continuation of the negative relationship between prices of oil and stocks (Liu et al., 2020).

In the South Asian countries due to devaluation of the currency has led to accelerating the inflationary pressure, an increase in the budget deficit, and exerts the downward pressure on the exchange rates due to which imports become more costly. The hike in oil prices caused by the COVID-19 pandemic is a major concern for all the South Asian countries. This reveals a positive effect of COVID-19 on the oil prices in these countries. Algamdi (2020) has evaluated the case outside the US and reported the positive effects of the COVID-19 on oil prices. The economic reason for positive relation is that there is the inflationary effect on the oil prices and on the other hand the currency devaluation also causes to increase in the oil prices for the South Asian nations.

The COVID-19 pandemic has caused increased poverty and substantially, increased inequality in income and wealth in South Asian countries. The results of R2 and adjusted R2 are very high which entails that the model is best fitted. The value of F-statistics shows the overall significance of the model and the value of F-statistics is 0.002 which is less than the one percent and it authenticates that overall the model is significant at a one percent significant level. The result of the Durbin Watson (DW) statistic indicates that there is no autocorrelation in the sample. Rho indicates the variance in the model due to the randomness of the sample and the estimated value of the Rho of the model is 0.98803 which shows that the sample is heterogeneous across the countries and implies that the Fixed-Effect Model is suitable which further authenticates the application of the Fixed Effect Model (FEM).

Diagnostic tests are performed as a part of the basic analysis in econometrics. These tests are used to diagnose the Heteroscedasticity, autocorrelation, misspecification of the functional form, etc.

Table No. 8 Results of Diagnostic Tests

Test Statistics	Null Hypothesis (H_0)	Prob.	Decision
Breusch-Pagan Test	H_0: Homoscedasticity	0.2195	Accept H_0
White Test	H_0: Heteroscedasticity	0.0009	Reject H_0
Breusch-Pagan LM Test	H_0: Fixed-Effect-Model is Appropriate	1.000	Accept H_0
Hausman Test	H_0: Fixed-Effect-Model is not Appropriate	0.000	Reject H_0

To check the Heteroscedasticity Breusch-Pagan test and the White test are applied for the robustness. This test is applied to check the Heteroscedasticity in a regression model. In the panel data analysis, this test verifies that either Fixed Effect Model is suitable or Random Effect Model is suitable. Results of the Breusch-Pagan test and White test are given in Table (8) which shows that there is no problem with Heteroscedasticity and Homoscedasticity is present in the model. To check the validity of the Fixed Effect Model (FEM), the Bruesch-Pagan LM test is also applied which has supported that Fixed Effect Model (FEM) is appropriate.

To address the problem of multicollinearity in the model, VIF and Tol tests are applied. The results of these tests are given as under:

Table No. 9 Results of Multicollinearity Tests

Variables	VIF	Tol	Conclusion
COVID-19	1.15	0.871699	No Multicollinearity
Exchange Rate	1.81	0.552490	No Multicollinearity
Oil Demand	2.88	0.346756	No Multicollinearity
Natural Gas	9.18	0.108887	No Multicollinearity
Oil Supply	5.56	0.179834	No Multicollinearity

Table (9) reveals the results of the Variance Inflationary Factor (VIF) test and Tolerance (Tol) test which ensures that there is no multicollinearity in the model because the value of VIF is less than 10.

CONCLUSION AND POLICY IMPLICATIONS

This study concludes the positive impact of COVID-19 on the oil prices in the south Asian countries. Increasing COVID-19 cases have caused a hike in the oil price. The Demand of oil is negatively related to the oil prices in the pandemic area. During the period of COVID-19 due to the high inflation rate in the South Asian countries and on the other hand, the devaluation of the currencies is a major reason for increasing the oil price and depreciating the exchange rate.

This study suggests that Governments of South Asian countries should develop strategic policies to eliminate the adversative consequences of COVID-19 by clear-cut directions and instructions of Standard Operating Procedures (SOPs). The adverse effects can be eliminated through the awareness campaigning about vaccination, mask use, social distance, and the user of the hand sanitizer. Adverse impacts of natural gas and oil demand on the oil price must be addressed to avoid further hikes in oil prices as well as policies regarding exchange rate and oil supply should be revised to cope with the current states of the South Asian nations.

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