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The Impact of Crude Oil Price Shock: Evidence from Bangladesh

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ABSTRACT

This study aims to estimate the impact of crude oil price on the DSEX broad index of the Dhaka stock exchange using the Vector Error Correction Model (VECM) for the study period 2013:01-2022:12. It has decomposed the oil price shock into supply side and demand side oil shock. The empirical result shows that the stock price decreases significantly with crude oil prices driven by the shock in oil production. In contrast, the improvement in global economic activity results in a shock in the oil price which has a significant positive impact on the stock price. Furthermore, the accumulated shock in oil prices has a significant positive impact on stock prices. The variance decomposition under the VEC model shows that the demand shock of oil price contributes more to the variation in stock price for the oil-importing country Bangladesh. Since different oil price shocks have different impacts, the policy maker and investors implement decisions based on the understating of the sources of the shocks.

Keywords: Vector Error Correction Model, DSEX, Supply-Side Shock, Demand Shock
JEL Classifications: F62, G32

1. INTRODUCTION

The world oil price is subject to fluctuation and Chatziantoniou et al. (2021) identified some determinants of the oil price fluctuation such as the supply of oil, demand for oil, political events, and uncertainty in the financial market. They stated that oil price fluctuation is highly influenced by the shock in the financial market. Financial factors such as interest rates, and exchange rates have a great influence on oil price variation. Due to the immense use of oil in production, economic activity, and consumption, global oil price experience higher volatility over time (Swanepoel, 2006). Many researchers over time have tried to establish a relationship between crude oil prices and macroeconomic forces to predict the economic condition of a country since Hamilton (1983) in his pioneering work exhibited that oil price shocks are partially responsible for the recession of the U.S. followed by World War Two. From then, the crude oil price is subject to utmost attention for evaluating economic conditions (Gisser and Goodwin, 1986), stock market response, determining influence on other macroeconomic forces, and so on (Burbridge and Harrison, 1984). Hence, investors, policymakers, and political authorities are concerned regarding the influencing impact of oil price volatility (Goodness, 2015). Using different models, data, and over various periods, researchers tried to develop the nature of the association between oil prices and macroeconomic forces (Jimenez-Rodirguez and Sanchez, 2005; Coudert et al., 2008).

Since crude oil price change affects the economy of a country, it also affects the performance of the stock market. Many studies now have confirmed the effect oil price exerts on common economic forces, it also affects the stock market powerfully (Echchabi and Azouzi, 2017). There is numerous research solely based on the relationship between oil prices and the stock market. Different studies found different results which is why it is hard to provide a consensus on the relationship (Kilian and Park, 2009). Some studies identified a negative significant impact between them, some found out positive significant effect between them, some exhibited insignificant association and some studies provide

inconclusive findings. According to Bouoiyour and Selmi (2016), the relationship between oil price and the stock market is influenced by some attributes such as the country's dependency on oil, its global economic activity, characteristics of the economy, and type of the shocks. Soyemi et al. (2019) conducted a study on the energy firms to determine the relationship between the volatility of the oil price and the stock return of that country and found a direct positive association. The volatility of the stock market in the European market reacts differently toward the oil price shock. The supply shock doesn't influence the stock market volatility. However, demand shock has a great influence on stock market volatility (Degiannakis et al., 2014).

Bangladesh's economy is considered one of the fastest booming economies in the world. She has earned lower-middle-income status in 2015 by dropping poverty from 44% to 15% considering the international poverty line of $1.90 per day as a base (according to the 2011 P3 index). According to the World Bank report 2021, she is on the way to promotion from the least developed countries (LDC) list in 2026. Demographic dividends and steady ready-made garments (RMG) have a huge contribution to reaching such a position. Energy is the key force for the development of an economy. It acts as an input for every economic activity. Thus, economic growth, development, and welfare are also connected to energy. Oil price shock has heterogeneous effects in different countries. The response of these countries is directed by their position in the oil market such as whether the country is an oil exporting country or an oil importing country as a source of energy Bangladesh is highly vulnerable to the shock in oil prices since it greatly hampered the economy and electricity reform policy (Amin, 2015). As an oil-importing country, Bangladesh is highly affected by changes in oil prices (Khan et al., 2019). Sarwar and Hussan (2016) in their research of oil prices and Asian emerging stock markets confirmed that world crude oil price has a positive significant impact on the stock price. Ahmed et al. (2019) presented that fluctuation in other macroeconomic variables can be accounted for the shock in oil prices.

Many studies have been done by researchers to identify the relationship between oil price shock and the stock market (Kilian and Park, 2009). They have further extended the research by decomposing the source of shocks (Kilian, 2009). and considering the country as an importer or exporter (Wang et al., 2013). However, research focusing on the impact of oil price shock arising from demand shock and supply shock on the stock market has not been done yet in Bangladesh. Thus, it is possible to identify new insights from this study by exploiting the gap in the existing research. This study aims to gauge the impact of crude oil prices on the DSEX broad index of the Dhaka Stock Exchange. The findings of the model will be derived using Vector Error Correction Model (VECM). The main objectives of the study are as follows:

- To identify the response of the DSEX index to the demand side of crude oil price shocks
- To find out the reaction of the DSEX index to the supply side of crude oil price shock
- To spot the combined (supply and demand) impact of oil price shock on the DSEX index.

The empirical results from the VEC model estimation show that there is a positive significant impact on the real stock price to the oil price shock which is driven by the demand for crude oil. In addition, the supply-side oil price shock has a negative significant impact on the real stock price and lastly, the aggregate oil price shock has a positive significant impact on the real stock price.

This study is very relevant and current as it sheds some insights in the emerging country like Bangladesh. Bangladesh is a developing country and relies on oil imports for its energy consumption. Hence it is greatly affected by oil price shocks (Sarwar and Hussan, 2016). A study of the impact of oil price shocks on the stock price is crucial to understand the effect of oil price changes on the economic and financial stability of the country. The expected significance of the study is given as follows-

a. The findings of the study will help market participants, shareholders, and portfolio managers to take any sort of investment decisions concerning stock and the stock market
b. This study will help to understand that impact of oil price shock on stock price varies depending on the sources of the shock and policymakers can develop policies based on the findings
c. It will help the regulatory authority to have an advanced understanding of the broad index and Dhaka Stock Exchange (DSE).

The structure of the rest of the study is as follows: Chapter 2 displays a literature review, chapter 3 illustrates data and methodology, chapter 4 exhibits the empirical result of the study, and lastly, chapter 5, it terminates with findings, suggestions for further research, and conclusions.

2. LITERATURE REVIEW

Oil price is an important economic indicator of a country since the rise in world oil prices also increases the oil price in the domestic country followed by a rise in energy costs. Production of energy is dependent on the level of oil. Thus, energy costs also boost when the price of crude oil increases, and ultimately the price of consumer goods also grows. Cong et al. (2008) in their research conducted in the Chinese stock market found no significant impact of the oil price shock on the real stock return. Nevertheless, manufacturing companies and oil companies' returns are affected by the oil price change since speculation in these stocks increases with the swell in oil prices. They also claim that oil price is a better explanatory factor than the interest rate for the indices of the manufacturing companies.

Oil price movement is a matter of concern as a surge in oil price results in inflation in the economy which further affect the interest rate and investments. Phan et al. (2015) using a vector autoregressive model verify that both oil price volatility and oil price direct economic activity. In their study, they also state positive oil price shock lowers the real stock return and which in turn impacts interest rate and production positively. According to Bastianin et al. (2016), stock market volatility reacts to the oil price shock counting on the source of the oil price movement which is demand or supply side shocks. It shows that the volatility of

the stock market of the group of seven countries is unresponsive to the oil price movement incurring from the supply of oil and significantly responsive to the demand side shock that results in oil price changes.

Oil price shock influences the stock market heterogeneously based on the underlying reasons for the oil price movement. One study took into account 12 European oil-importing countries and found that the real stock return of these countries significantly negatively reacts to oil price shock and these returns are directed by the supply side shock (Cunado and Gracia, 2014). Oil price shock can originate from the demand side or the supply side. The influence of the oil price shock on the stock market varies depending on whether the shock is a demand shock or the shock is a supply shock (Sadorsky, 1999). This literature identifies that the effect of the oil shock arising from the supply side is statistically insignificant and negative. On the other hand, the significant positive response of the stock market to the total demand and demand from only oil-specific sides is visible. It argues that 47% variation in Nigerian stock market price can be explained by oil price shock.

The magnitude and direction of the Stock market return reaction vary depending on whether the country is an oil importing country or an oil exporting country and also from which source the oil shock is originating. In addition, oil price shock can greatly explain the stock return variation if the country is more oil-exporting than importing country and the dependency of the economy on oil (Wang et al., 2013). For oil-exporting countries, the real stock return is positively associated with a rise in oil prices. On the other hand, in the European stock market, real return fell due to volatility in oil prices. The surge in real oil prices also rises the interest rate for the short term.

Literature shows that only the demand side shock of the oil price has an asymmetric effect on the stock return not the supply side shock. These effects are both for the long term and short term. Numerous studies have been conducted to ascertain the impact crude oil price exerts on the stock market return aggregately. By reviewing different literature, this study came to understand that there is no exact concluding remark for the effect of oil price shock on the stock market return. Despite dictating the effect of crude oil price on the stock market, one study evaluated the response of stock return of the firms in the oil supply chain to the variation in crude oil price. Any oil price shock, whether it is a negative or positive shock, has a positive influence on the stock return of the oil producers as oil demand is inelastic (Bastianin et al., 2016). However, the oil price shock has a heterogeneous effect on the stock return of oil consumers. The demand for crude oil among different consumers is not the same. Different industries such as transportation, manufacturing, construction, and chemical industry have different oil consumption levels. Hence, the stock return elasticity of these different consumer sectors of crude oil is different from oil price shocks. One study (Kilian, 2009) found that oil price shocks have a significant negative impact on stock market returns in the United States, with the effect being larger for small firms than for large firms. Another study by (Gencay et al., 2009) found that oil price shocks hurt stock market performance in developed countries, but the effect is less pronounced in developing countries.

There is an interconnection between the commodity market and the financial market. The oil price has a significant impact on other macroeconomic variables and Bangladesh is no exception. Audry and Ulfat (2021) spotted out positive significant relationship between oil price and the exchange rate that the increase in oil price results in appreciation in the exchange rate. According to Ahmed et al. (2019), macroeconomic factors are highly sensitive to little oil price shock and this finding can help to reform the public policy of these countries. Khan and Yousuf (2013) included crude oil prices among other macroeconomic forces such as CPI, interest rate, money supply, etc. to evaluate the influence of these forces on stock price and found a significant positive influence of crude oil price. Energy price shock that is oil price shock has a significant adverse effect on GDP and consumer welfare (Amin, 2015). Golder et al. (2020) in their study presents that the variation in the DSEX index can be explained by the innovation in crude oil price other than foreign reserve and exchange rate. Oil price shock significantly affects the fluctuation in stock prices (Islam et al., 2020). The response of the stock market to any unprecedented event or shock is highly dependent on which type of efficiency form that stock market belongs. Hence, market efficiency determines when and what information will impact the stock price. DSE represents weak form efficiency as any shock in the macroeconomic volatility is slowly absorbed into the stock market (Chowdhury, 2004). According to the study done by Sen et al. (2021), the local stock market has significant integration with the international price of oil. Therefore, the world oil price has a significant impact on the stock price (DSEX).

3. DATA AND METHODOLOGY

3.1. Research Methods and Data Collection

The focus of the study is to estimate the impact of the oil price shocks whether resulting from the demand side or supply side of the oil on the index price of the Dhaka stock exchange, Bangladesh which is an oil importing country. The world oil production, crude oil price, global economic activity, and the DSEX index prices are the four variables used in the study. The monthly data of 10 years are used over the period ranging from 2013 to 2022 containing a total of 120 observations. In agreement with Kilian and Park (2009), the demand and supply side oil shocks are explained by oil production, global economic activity, and oil prices. In their research, they decomposed the shocks in the oil price into demand-side oil shock and supply-side oil shock. The frequency of the data collected is set in months. The crude oil price data is the refiner's average imported crude oil acquisition costs and the oil production data is measured in thousands of barrels. Both of the data are obtained from the U.S. Energy Information Administration. The crude oil production data have been used to refer to the supply of crude oil including lease condensate. The percentage change in oil production is used in this study to capture the supply-side crude oil price shock. Similarly, the index of global real economic activity which is developed by Kilian and collected from the Federal Reserve Bank of Dallas. The purpose of constructing the index is to consider the industrial commodities demand globally not consider the real economic value added in the world. This index of real economic activity is developed by the single voyage freight rates of the dry cargo such as grain, coal, copper, gold, metals,

etc. These freight rates are deflated by the U.S. CPI to adjust the inflation and detrended linearly (Kilian, 2009). This detrending is done by them to eliminate any trend included in the data and to identify any patterns or cyclical effects. It is used to determine the demand side of the oil shock in the global crude oil market price. For the stock price, this study has taken the DSEX broad index that is attained from the Dhaka stock exchange. All the variables deployed in this study are expressed in their real values. The imported nominal crude oil price, dollar per barrel, is transformed into real crude oil price by deflating it with the U.S.A consumer price index. The U.S. Bureau of Labour Statistics is the source from where the U.S. CPI is obtained. Similarly, the real index price is determined by deflating the nominal index price with the monthly CPI of Bangladesh. It is collected from the Bangladesh bank over the study period from 2013 to 2022. The percentage change in oil production is used in this study to capture the supply-side crude oil price shock. Table 1 presents all the variables that are included in the study. OILPROD refers to the percentage change in crude oil production, GEA refers to the index of global real economic activity, ROILP refers to the logarithm of the real crude oil price, and the last variable is RDSEX which is the real stock price. By taking into account (Kilian and Park, 2009; Gupta and Modise, 2013; and Effiong, 2014), this study has selected all the variables and transformed them.

Figure 1 presents the time series plot of the variables used in the study such as world crude oil production expressed in thousands of barrels, the Index of global real economic activity, world crude oil price, and the DSEX broad index. These graphical plots clearly show the effect of covid-19 pandemic since there is a great drop in the variables in 2020 and started to recover in 2021. It also exhibits the non-stationarity of these variables as the mean and variance of these data series vary over the study periods.

3.2. The Model

Two variables are adjusted for inflation in their nominal values and the real values of the variables are calculated. For the crude oil prices, the nominal values are deflated by U.S. CPI, and for the DSEX index prices, the nominal prices are deflated by the Bangladesh CPI. These real values are calculated using the formula as follows:

Real values

$$= Nominal\ values\ in\ a\ given\ month \div \left(\frac{CPI\ of\ that\ month}{CPI\ of\ the\ base} \right) \quad (1)$$

Table 1: Variable description and data sources

Name	Description	Source
OILPROD	Percentage change in oil production (thousands of barrels)	U.S. Energy Information Administration
GEA	Index of global real economic activity	Federal Reserve Bank of Dallas
ROILP	The logarithm of real crude oil price	U.S. Energy Information Administration
RDSEX	The logarithm of the real DSEX index	Dhaka Stock Exchange

OILPROD: Oil production, GEA: Global real economic activity, ROILP: Real oil price, RDSEX: Real stock price

This study has applied the methodology after Marashdeh (2017) who in his research developed a relationship between oil price shock and stock market return.

The first requirement for analyzing time series data is to check for stationarity. The reason for checking stationarity is to determine whether all the variables that have been used in the study are stationary or not because it is difficult to predict the non-stationary time series appropriately. Unit root test is conducted to determine the stationarity of the time series. This study for each time series data has applied Augmented Dickey-Fuller (ADF) unit root tests with the null hypothesis that the time series contains a unit root. This means the time series are non-stationary. To apply the Vector Autoregressive Model, one condition needs to meet that is all the variables must be non-stationary in level I (0) and stationary in the first difference I (1).

Most often the reaction of the dependent variable is not instantaneous to the independent variable rather it responds after a period. This lapse of time is referred to as lag. Before applying any model, it is important to select the optimal lag for the model since it can cause multicollinearity, serial correlation, and loss of a degree of freedom. Choosing lag order is an empirical issue but this study has taken into account information criteria to choose the optimum lag order. Akaike information criterion (AIC), Schwarz information criterion (SC), and Hannan-Quinn information criterion (HQ) are the three most popular information criteria and any of them can be used to select optimum lag order.

Table 2 displays the Johansen cointegration statistics. The long-run relationship of the variables is determined using this test (Johansen and Juselius, 1990). It includes two statistics that are the trace and max statistics with the null hypothesis that there is no cointegration among the variables ($r \leq 0$). All the variables used in this test are in their level form (Johansen, 1988).

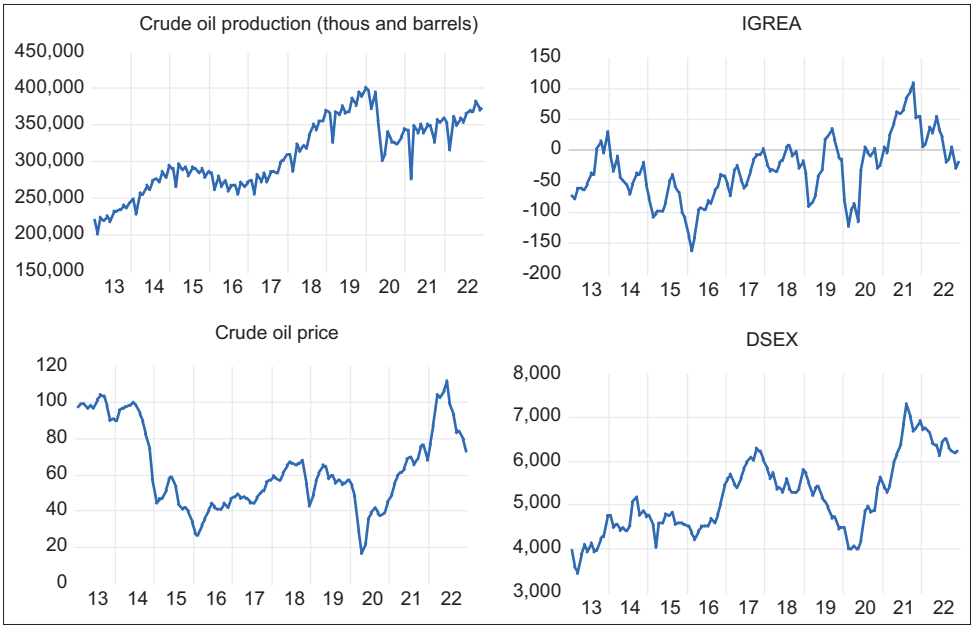
First this study has applied the vector autoregressive model (VAR) with the vector error correction model (VECM) to determine the lag order and to determine the impact of the crude oil price on the stock market index. The VAR model is one of the most popular models that is employed by many researchers such as (Bernanke et al., 1997; Lee et al., 1995; Hamilton, 1983; 1996; 2011), and others to find out the dynamic interaction of various macroeconomic variables. The VAR model is specified by Sims (1980) with k number of variables and p lag order are given as follows:

$$y_t = A_0 + \sum_{i=1}^{P} A_i y_{t-i} + u_t \quad (2)$$

Here, y_t refers to the vector of the present value of endogenous variables (percentage change in oil production, global real economic activity, real crude oil price, and real stock price). A_0 indicates the vector of the constant of the variables. A_i refers to the vector of (K × K) that is (4*4) total of 16 unknown coefficients of the variables. y_{t-i} and u_t indicate the vector of the past values of the selected variables and the vector of the error terms respectively.

The conditions that must be satisfied by the error terms are given below:

Figure 1: Time series plot of the variables



Source: Own calculation

Table 2: Vector autoregressive model lag order selection criteria

Lag	LoqL	LR	FPE	AIC	SC	HQ
0	−166.9912	NA	0.000256	3.080923	3.178564	3.120533
1	−104.9565	118.4807	0.000112	2.251468	2.739672	2.449518
2	−54.72196	92.32294	6.03e-05	1.634630	2.513396*	1.991120
3	−30.22190	43.26137	5.19e-05	1.481476	2.750805	1.996405
4	−1.581765	48.50761	4.16e-05	1.253725	2.913618	1.927095
5	31.73690	54.03027*	3.07e-05*	0.941677*	2.992133	1.773487*

*Lag order selected by the criterion. Source: Own calculation. AIC: Akaike information criterion, Schwarz information criterion, HQ: Hannan-Quinn information criterion, NA: Not available

$$E(u_t) = 0 \forall_t,\ E\left(u_s u_t^{'}\right) = \Omega \text{ if s = t},\ E\left(u_s u_t^{'}\right) = \text{o if s} \neq \text{t}$$

Here, $u_t^{'}$ must be free from serial correlation and might be correlated contemporaneously. Ω indicates the variance-covariance matrix of the error term with non-zero off-diagonal elements.

When all the selected variables are cointegrated in order one I (1), it is considered that the variables have a long-run relationship and the VAR model becomes the VECM. VECM stands for the Vector Error Correction Model and changes in the values of the variables are the linear function of the change in the lag values of the variables and innovations. Loading or speed includes the coefficient of the error terms of the VAR equations which range from >−1 to <0 which means that the short-run shocks are temporary and adjusts to the long-run through many series of short-term adjustment. The VECM equation is presented below:

$$\Delta y_t = \prod y_{t-1} + B_0 + \sum_{i=1}^{P-1} B_i \Delta y_{t-1} + e_t \quad (3)$$

Here, Δy_t refers to the vector of the first difference of the selected variables. y_{t-1} indicates the vector of the error term and these are the one-period lag residuals of the VAR equations. B_0 and e_t state the vector of the deterministic constant and error term respectively. $\prod$ indicates the speed of the adjustment of the error terms toward the equilibrium. This study has performed the residual diagnostic test to confirm the stability and robustness of the study. These test statistics showed, there is no serial correlation and heteroscedasticity in the residuals. However, residuals are not normally distributed. This doesn't make the model unstable and the other two criteria confirm its stability.

The Impulse Response Function is displayed and narrated to show the response of the stock price to each of the variables. It presents how the target variables (RDSEX) respond to the one standard deviation shock to the selected variables.

The variance decomposition is presented to estimate the decomposition of the variance of the error of the stock price that comes from the shock to the variables. It presents the relative contribution of these variables including itself in the deviation of the endogenous variable.

4. RESULTS AND DISCUSSION

Table 3 exhibits the descriptive statistics of the selected variables including oil production, global real economic activity, real oil price, and real stock price. This descriptive analysis provides an

Table 3: Descriptive analysis

Particulars	OILPRO	GEA	ROILP	RDSEX
Mean	0.006250	−38.42724	4.250122	8.782046
Median	0.001716	−37.51309	4.220961	8.803664
Maximum	0.263452	116.6030	4.884181	9.022991
Minimum	−0.194159	−203.4912	2.964154	8.392403
SD	0.060655	60.58804	0.371659	0.134713
Maximum date	March-21	October-21	August-13	October-17
Minimum date	February-21	February-16	April-20	March-20
Observations	120	120	120	120

SD: Standard deviation, OILPROD: Oil production, GEA: Global real economic activity, ROILP: Real oil price, RDSEX: Real stock price. Source: Own calculation

understanding and summary of the time series that are used in the study. This descriptive analysis includes the measure of central tendency, a measure of dispersion, and several observations. For each of the variables, a total of 120 observations are collected for the study period from January 1, 2013, to December 31, 2022. The measure of the central tendency of the applied variables is explained by mean and median. The mean value depicts the average value of the variables in the specified study period. All variables have positive mean value except the global real economic activity (GEA) which refers to the average drop in the demand for industrial commodities. The median value splits up higher values and lower values. Standard deviation depicts the measure of dispersion. The standard deviation of the GEA is higher (60.588) than other variables and showing how scattered the observations are from the mean. This summary statistic also displays the maximum, and minimum values and their dates. The highest value of *OILPRO and GEA was reached in 2021. However*, the ROILP is maximum in 2013 and RDSEX in 20. Similarly, the lowest *OILPRO*, *GEA*, ROILP, and RDSEX are in 2021, 2016, 2020, and 2020 respectively.

Table 4 exhibits the result of the ADF test statistics for each of the four variables. All the variables are non-stationary in their levels I (0) and became stationary after the first difference I (1) that is they are integrated in the order one at a 1% significance level. As the ADF test result aligns with the condition.

Table 2 presents the output of the information criteria to determine the optimal lag order. This study has selected the lag order 5 according to the lowest AIC value using the generalized Vector Autoregressive Model.

Table 5 displays the Johansen cointegration test output. When the trace or max test statistic value is greater than the critical value of 0.05, the null hypothesis is rejected. According to the trace statistics, the trace value is greater than the critical value of 0.005 rejecting the null hypothesis r = 0 and r ≤ 1. This statistic refers that there is at most 2 cointegrating equation and most of two the variables have a long-run relationship. According to the max statistics, the max value of 32.99364 is greater than the critical value of 27.58434. Hence, rejecting the null hypothesis r = 0 and accepting the alternative hypothesis r = 1. Thus, the Max statistic shows that at most one variable presents a long-run relationship. When Trace and Max's statistics show different results, any of the results can be taken. This study has taken the result of the Trace statistics.

Table 4: Augmented dickey fuller tests

Variables	Levels	First difference	I (d)
ADF test statistic			
OILPRO	−2.389952	−6.005322***	I (1)
GEA	−2.661373	−10.09546***	I (1)
ROILP	−2.280564	−8.586966***	I (1)
RDSEX	−2.423586	−10.13666***	I (1)

***Specify a 1% level of statistical significance. Source: Own calculation. ADF: Augmented Dickey-Fuller, OILPROD: Oil production, GEA: Global real economic activity, ROILP: Real oil price, RDSEX: Real stock price

Table 5: Johansen's cointegration test statistics

H_0	H_A	Eigenvalue	λ_{Trace}	0.05	λ_{Max}	0.05
r=0	r=1	0.251301	63.74162**	47.85613	32.99364**	27.58434
r≤1	r=2	0.168031	30.74798**	29.79707	20.97141	21.13162
r≤2	r=3	0.054153	9.776568	15.49471	6.346841	14.26460
r≤3	r=4	0.029637	3.429727	3.841465	3.429727	3.841465

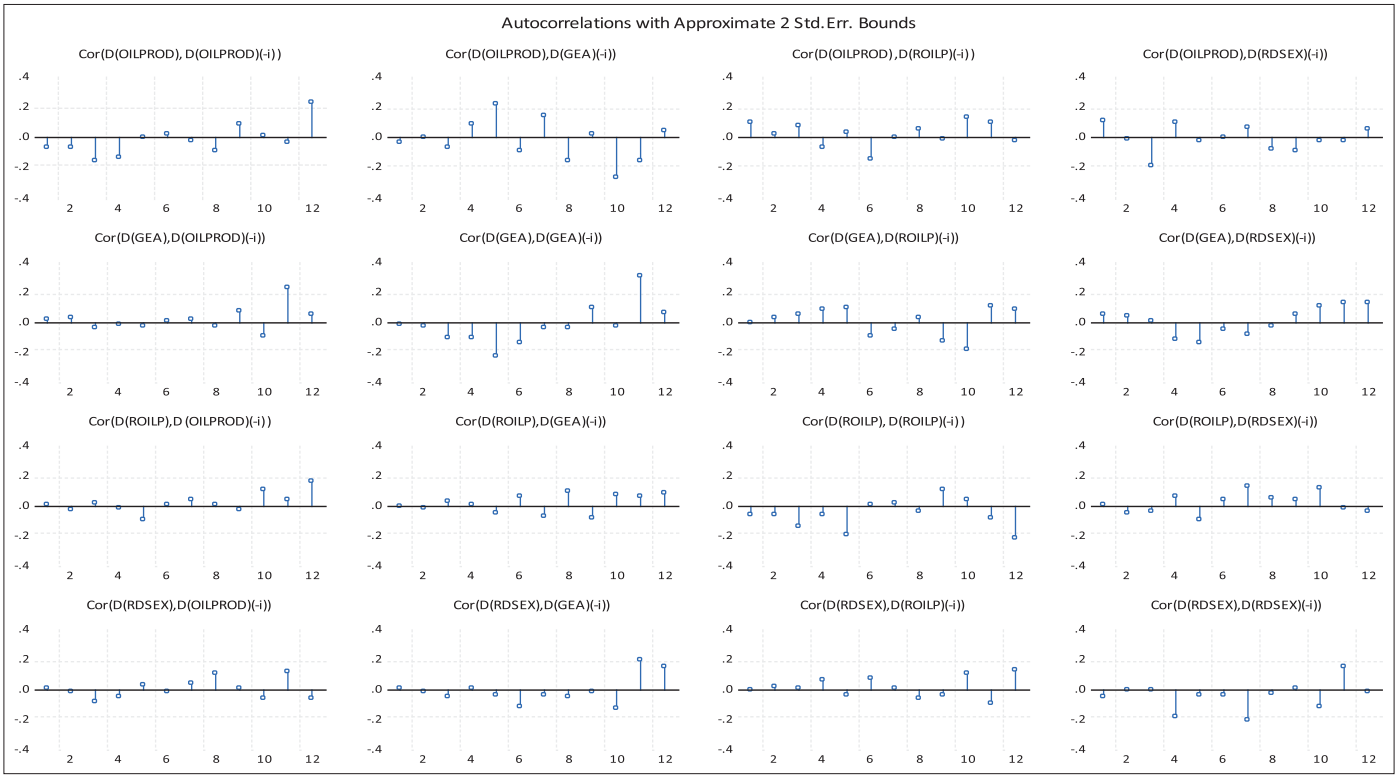
**The level of statistical significance at 5%. Source: Own calculation. Here, the number of cointegrating vectors is denoted by "r". R=0 refers there is no cointegrating vector, r≤1 refers there is at most 1 cointegrating equation and r≤2 refers there is a maximum of 2 cointegrating equations

Table 6 shows the impact of oil price shock arising from different sources on the stock price based on the vector error correction model (VECM). All the selected variables in this model are statistically significant at a 5% level. Here, the coefficient of the error correction term (ECT) is negative −0.156795 and meets the condition to fall between the range of $-1 < \prod < 0$. This refers that the deviation of the stock price from the long-run equilibrium in the previous period due to the short-run shock in the oil price will be adjusted at a speed of 15.67% and statistically significant at a 1% level of significance. The difference between the long run and short run is 15.67% and it will be corrected within 1 month. This model has used optimum lag order of 5 for each of the variables. However, the VECM is estimated with lag order four (p-1). In addition, the RDSEX is significantly negatively affected by the lag value up to 4 lag of itself at a 1% significance level. That is in the short run 1% change in the D(RDSEX[−1],2) is associated with a 0.583662 decrease in the stock price (RDSEX) holding other things constant. Similarly, the lag value of oil production (OILPROD) has a negative and statistically significant impact on the real stock price (RDSEX) at a 1% significance level since the economy is highly dependent on crude oil in the short run. A 1% change in the lag value of oil production will decrease the real stock price by 2.323212.

Furthermore, the lag value of global real economic activity (GEA) has a positive impact and significant impact on the real stock price (RDSEX) at a 5% significance level to the shock. 1% in the D(GEA[−2],2) I associated with a 0.000486 increase in the real stock price in the short run. Lastly, crude oil price (ROILP) shock has a positive and statistically significant impact on the real stock price in the short run at a 1% significance level. A 1% change in the (ROILP) results in a 0.1479 increase in the stock price in the short run. The adjusted R square is 0.6277 that is can explain 62.77% of the target variable RDSEX. The Durbin-Watson stat value is close to 2 and refers to no serial correlation in the residuals.

Figure 2 graphically shows the residuals of the model which is within around 2 standard error bounds. This indicates that the residuals of the model are free from serial correlation.

Figure 2: Autocorrelation test



Source: Own calculation

Table 6: Estimated results of the vector error correction models

Variables	Coefficient	SE	t-statistics
ECT (∏)	−0.156795	0.041498	−3.778369***
D (RDSEX[−1], 2)	−0.583662	0.089952	−6.488601***
D (RDSEX[−2], 2)	−0.360144	0.094576	−3.807974***
D (RDSEX[−3], 2)	−0.448302	0.091715	−4.887971***
D (RDSEX[−4], 2)	−0.374924	0.080580	−4.652789***
D (OIL PROD[−1], 2)	−2.323412	0.566079	−4.104393***
D (OIL PROD[−2], 2)	−2.060306	0.422403	−4.877579***
D (OIL PROD[−3], 2)	−1.550453	0.251223	−6.171628***
D (OIL PROD[−4], 2)	−0.593750	0.096566	−6.148665***
D (GEA[−2], 2)	0.000486	0.000236	2.059835**
D (GEA[−3], 2)	0.000719	0.000231	3.109261***
D (ROILP[−1], 2)	0.147896	0.050384	2.935388***
D (ROILP[−2], 2)	0.184545	0.043919	4.201896***
Constant	−0.001649	0.004551	−0.362324
R^2	0.683698		
Adjusted R^2	0.627686		
Durbin-Watson stat	2.064585		

**, ***Specify 1% and 5% levels of statistical significance respectively. Source: Own calculation. OILPROD: Oil production, GEA: Global real economic activity, ROILP: Real oil price, RDSEX: Real stock price, ECT: Error correction term, SE: Standard error

This study has employed residual diagnostic tests for the Vector Error Correction Model to check the stability and robustness of the model. Table 7 represents model residual diagnostic results. It includes the residual auto-correlation check, heteroscedasticity check, and normality check are performed. This study has performed VECM residual serial correlation test (LRE statistic and Rao F-statistics) and accepts the null hypothesis that there is no serial correlation in the residual. Similarly, the residual heteroscedasticity test (Chi-square = 378.1762) with (P = 0.0752)

Table 7: Vector error correction model residual diagnostic tests output

Diagnostic tests of	Test statistics	P-value
Serial correlation LM test	LRE statistics Rao F-statistic	No serial correlation
Heteroscedasticity test	Chi-square	Free from ARCH effect
Normality	Jarque-Bera	Not normality distributed

Source: Own calculation

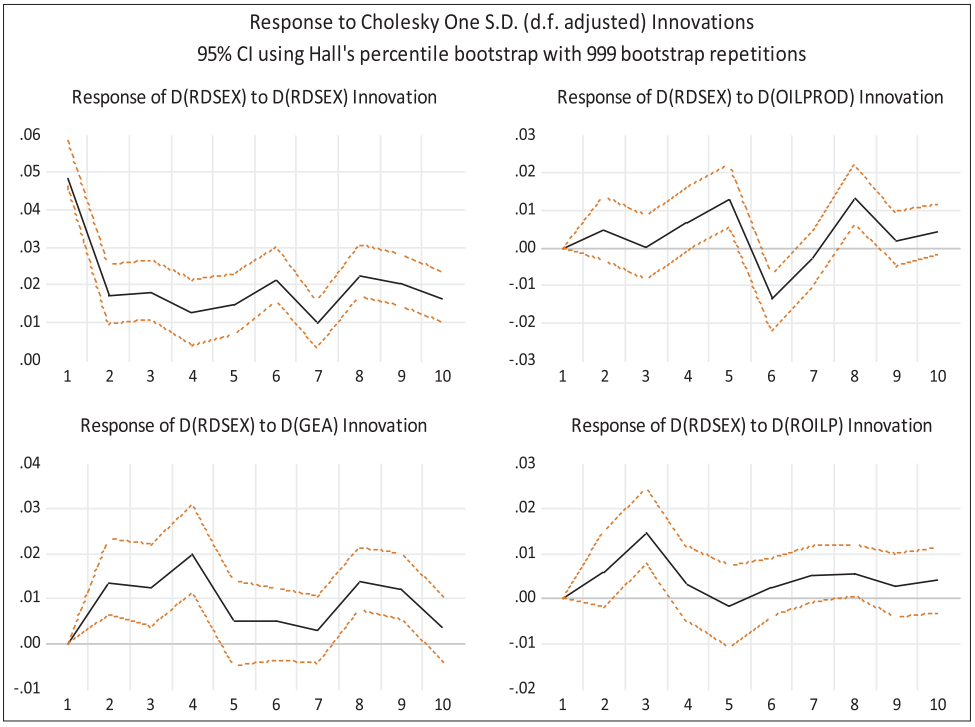
and normality test (129.7053) with (P = 0.0000) referring that the VECM residuals are free from heteroscedasticity and not normally distributed. The non-normality problems do not invalidate the model, as the improvement of the model is possible.

Figure 3 shows the impulse response function of real stock prices to oil shocks. It indicates the response of stock price to one SD shock to itself. There is a sharp decline in the stock price over period one to period two while remaining in the positive region. Then it reached a steady state at period 7 and further fluctuates.

It exhibits a positive response of stock price to one SD shock in demand shock as well as oil price shock which is similar to the VECM output. However, it shows that the one SD supply shock also has a positive impact on stock price opposite to the model output in the short run.

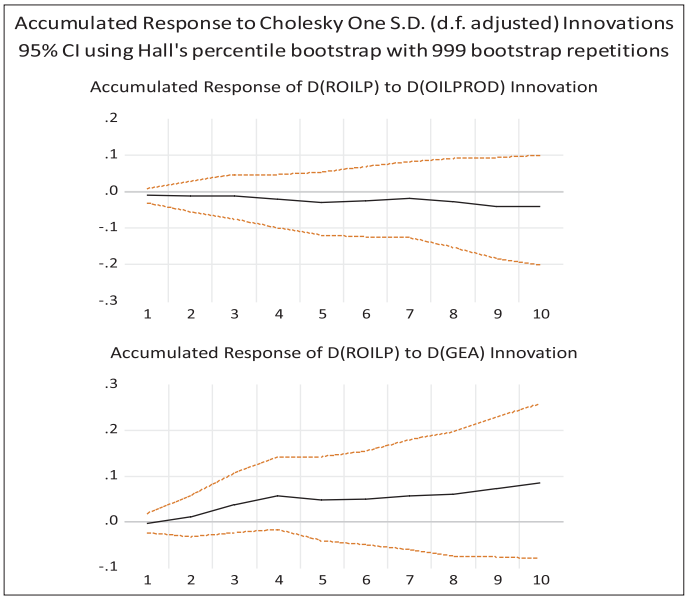
Figure 4 presents the impulse response function of oil prices to demand and supply shocks. It exhibits a negative response of oil price to one SD shock in demand shock and also shows that the oil

Figure 3: Responses of real stock prices to oil shocks



Source: Own calculation

Figure 4: Responses of real oil price to the sources of innovations



Source: Own calculation

price responds positively to the one SD supply shock in the short run. This outcome is in line with economic theories. However, the response of the oil price to different sources shocks is steadily referring to inefficiencies in the global oil market.

This study has performed variance decomposition to explain the change in the interest variable that is caused by other variables. It is a useful tool to forecast the changes of one variable that is created by the other variables and identify the relative importance of each source of shock. Table 8 shows the variance decomposition result for the real stock price (RDSEX) for the time horizon of 10 months. Variance decomposition in month 1 refers that there is no contemporaneous effect of oil production (OILPROD), global economic activity (GEA), or real oil price (ROILP) on the real stock price and is 100% explained by RDSEX itself. The variation in the real stock price is affected by the shock itself both in the long run and short run. However, over time the effect of these shocks is increasing on the stock price. Oil production explains at most 9.33%, global economic activity explains at most 17.57% and real crude oil price explains at most 6.92% of the variation in the real stock price respectively. The variation in the real stock price is mainly affected by its shock and demand-side shock. However, it is slightly explained by supply-side shock. Therefore, the demand side shock of oil price has a greater impact on the variation of the real stock price.

5. CONCLUSION

The purpose of this study is to identify the impact of crude oil price shock on the real stock price of the Dhaka Stock Exchange. Since the oil price is a key force for economic activity and growth, it has a significant impact on the stock market. This study is conducted for the period of 2013:01-2022:12. The variables selected for the analysis are real stock price, global real economic activity index, real oil price, and percentage change in crude oil production. The variables are estimated under the vector error correction model. After performing the analysis under the VEC model, this study confirms that the impact of the crude oil price shock on the real stock price defers based on whether the shock is driven by the supply side shock or demand side shock argued by Kilian and Park (2009). This study detects that the shock in global oil production which refers to the supply of crude oil negatively affects the real

Table 8: Variance decomposition output for real stock price

Period	SE	D (RDSEX)	D (OILPROD)	D (GEA)	D (ROILP)
1	0.048462	100.0000	0.000000	0.000000	0.000000
2	0.053738	91.59545	0.759166	6.411066	1.234314
3	0.059773	83.04054	0.613690	9.421683	6.924087
4	0.064706	74.70555	1.549961	17.57749	6.166998
5	0.0067834	72.79296	5.0141116	16.52174	5.671184
6	0.072610	72.24317	7.774999	14.90221	5.079623
7	0.073611	72.17613	7.700822	14.68498	5.438068
8	0.079497	69.91905	9.334486	15.59590	5.150559
9	0.083036	70.17732	8.607247	16.37520	4.840233
10	0.084879	70.82058	8.502761	15.81875	4.857911

Source: Own calculation. OILPROD: Oil production, GEA: Global real economic activity, ROILP: Real oil price, RDSEX: Real stock price, ECT: Error correction term, SE: Standard error

stock price at a 1% significance level in the short run. The supply shock which is increasing the crude oil price can result from the difference between stable oil supply and elasticity of demand. On the other hand, a shock to the global real economic activity which refers to the demand for crude oil has a significant positive impact on the real stock price in the short run. The demand shock increases the crude oil price is accounted for the expansion of global economic activity and precautionary demand for crude oil. Lastly, the aggregate shock to the oil price increases the real stock price significantly at a 1% level of statistical significance in the short run. These findings of the study are supported by some research by (Gupta and Modise, 2013; Effiong, 2014; Marashdeh, 2017; Cunado and Gracia, 2014; Kilian and Park, 2009). They obtained similar results in their study of oil price shock and the stock market. The outcomes of the analysis can differ based on whether the country is an oil-importing or exporting country. Unlike the result of this study, Cong et al. (2008) found no significant impact on the real stock price in china.

The variance decomposition result shows the relative contribution of the different sources of shocks to the variation in the real stock price. In the 1st month, the variation in real stock price is 100% explained by its shock. However, over time other shocks became important. The demand side shock (GEA) is relatively more important to the oil price shock since it has the highest contribution of around 17.57% to the variations in the real stock price followed by a supply shock. Thus, aggregately the oil price shock explains around 27% variation in the real stock price. Due to constraints with DSEX, this study is capable of incorporating a small number of observations while suggesting another researcher include a longer study period to get more accurate results for the long-run impact.

The main contribution of the study is that demand-side shock and supply-side shock of oil prices have different impacts on the real stock price of the oil-importing country Bangladesh. It shows supply side shock has a negative impact and demand side shock has a positive impact on real stock price respectively. The relative importance of the demand side shock is more to explain the variation in stock price. It highly helps policymakers and also investors to develop and implement decisions appropriately.

As a direction for future research, one can take into account whether the country is an oil-importing or exporting country and does that change the findings of the study. Another direction of research may focus on SARC countries and present comparisons between findings. Finally, one can also include some economic policy in the model and estimate its impact on a single economy or group of economies.

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