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NEXUS BETWEEN EXCHANGE RATE AND CRUDE OIL PRICE: EVIDENCE FROM OIL PRODUCING AND EXPORTING COUNTRIES

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Abstract

This study examined the impact of persistent, continuous shocks and fluctuation in the exchange rate on oil price for major oil producing and exporting countries. The study employed the ARDL regression analysis for finding the impact of exchange rate on oil price, the bound and WALD test for nature of relation and Granger Causality approach for the causal relation. The study found the effective role of exchange rate fluctuation on oil price. The outcome of the bound and WALD tests shows that there is long-term correlation of exchange rate with price of oil. The granger causality approach found bi-causal relation running to and from exchange rate and oil price. Based on the findings, the study concluded that fluctuation in exchange rate has a considerable impact in changes in the price of oil and thus appreciation in exchange rate leads to an increase in the oil price internationally. Significant evidence shows that volatility in the exchange rate brings fluctuations in oil price that could damage the country's trade balance. Thus volatility in exchange rate can produce shocks that severely affect both exporting and importing oil countries. This volatility and shocks can also drastically affect the price level of oil that has economic impacts on various countries differently.

JEL CLASSIFICATION: F31, Q43, C32

KEYWORDS: OIL PRICE, EXCHANGE RATE, OIL PRODUCING, OIL EXPORTING COUNTRIES

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1. Introduction

The use of energy especially of crude oil and petroleum products are the need of today especially in this advanced technological and industrial era. Due to this, the demand for energy sources and for oil and petroleum products especially increases day by day. Most of the countries worldwide and specifically developing countries have either limited or do not have enough resources and are not capable to meet the oil demand requirements, so solely depend on the imports of oil form oil producing and exporting countries. However, if there is an increase in the price of oil or devaluation in the exchange rate, it raises the revenue of oil exporting countries and has adversely affected the oil importing countries by putting extra pressure on the trade and balance of payment.

As the exports and imports of goods between the countries depends on the exchange rate. Exchange rate is determined as the relative relationship of domestic to foreign price, or as the comparative price of the consumption goods basket among the home and world traded countries (Bergstrand, 1991; Lizardo & Mollick, 2010). In both cases, it is estimated that if the price of domestic consumer goods rises relative to that of commercially exportable goods, the real exchange rate may appreciate due to the increase in price of tradable or commercial commodities. In this context, a rise in the exported goods prices can leads to an appreciation in exchange rate, either through the income or substitution effect, or both (Koranchelian, 2005; Habib & Kalamova, 2007). In fact, by substitution effect, the supply of non-traded goods may falls further raising their prices, and thus led to appreciation in the exchange rate. Moreover, the increase in non-traded commodities demand contributes to the escalation of relative prices by income effect. Thus the basic two hypotheses which determine these effects are that resources are attracted by commodity sector and the demand for non-traded goods rises with an increase in income. Thus both exert an upward push on the exchange rate for imports of energy products like oil and petroleum products.

Exchange rate fluctuations on the real activity have been the focal point in the literature. It is generally observed that from the demand side, the devaluation or depreciation can enhance local production by inspiring net exports factor (Agenor, 1991; Alhajji, 2004). From the demand side, other factors (i.e. inflation, income, currency fluctuation, demand for loanable funds etc.) may also influence exchange rate fluctuations. The inflationary impact of the currency depreciation reallocates income from labors to producers

(Bahmani-Oskooee & Mirzaie, 2000; Cheng, 2008). However, the likelihood of depreciation can reduce aggregate demand's consumption element. In view of the fact that the labors are assumed with higher marginal propensity to consume than producers, so the aggregate consumption reduces due to currency devaluation (Bodart et al., 2012).

The fluctuation in exchange rate is mostly from both supply and demand side. Due to increase in overall supply side of goods in the economy, the sources of connection on a macro level between economy and the exchange rate become more complex. As the currency devaluation increases the imported input's cost, it adds to the cost of production and thereby limiting the overall growth and aggregate supply (Wang, Wu & Yang, 2013).

However, if the decline in imports of aggregate supply is less than increase in overall aggregate demand to offset the output gap, then depreciation can lead to a decline in local production. In such situation, the depreciation or devaluation is known as contraction, or else, it may be depression (Kilian, 2009).

1.1 Scope and Significance of the study

Since the 1990s, the relationship and association between exchange rate and crude oil price volatility have gained the interest of economist, policy makers and researchers. All of the countries of the world are involved in the trade of oil. Some of the countries are the exports of oil while some are the importers. However, the worlds are wholly or partially dependent on the crude oil. Whenever fluctuation in oil price occurs, it may have both positive and negative economic impacts on the exports and imports of oil leads to consistent effect on growth of different countries. Despite of the fact the exchange rate fluctuation has varying effect on the supply and demand of oil, it also leads erratic effect on oil price, currency fluctuation, trade balance, balance of payment, foreign reserve, consumption effect and having effect on related durable and non-durable goods. Therefore, most of countries tries to bring stability in the exchange rate to get rid of its adverse effect that might hit the required balance.

It is a fact that most of the countries worldwide trade in US dollars. But from past two decades, the US dollars have experienced shocks in their value that also affects the value of local currencies of many countries. These volatility shocks in US dollars also effect exchange rate directly or indirectly affects foreign trade of all the countries

either that are exporter's countries or importers (Zhang et al., 2008). Thus in the short run those countries that are oil importing needs to purchase more US dollars that will reduce the uncertainty and fluctuation effect of exchange rate as well as will refrain from the appreciation effect. Moreover, by purchasing more US dollars the countries will become denominated assets in the short run with higher foreign income that may reduce the import burden while importing the oil from oil exporting countries. As in the long run, higher foreign income will transfer into higher expenditures of imported goods. It is generally believed that in the oil-producing countries, the decline in value of the currency is retrenchment due to demand effect, restricted due to the occurrence of prices in the dollar of oil exports, is more than counter balanced by the negative effects of supply. In the past decade, however, Iran has seen a speedy rise in exports of oil. The expansionary impact is evident with regard to the expected continued depreciation in the long run.

Recently from current decades oil price has experienced many severe financial shocks. The crude oil price has experienced the fluctuation in price level throughout the history and that also leads to shut down and unemployment in many oil exporters countries (Zhang et al., 2008). Besides the truth that many of oil exporting countries especially of Gulf countries facing different wars since few decades, but the continuous fluctuation in the oil price is also harshly affected economic conditions of many these developing countries. During Iraq war in mid-eighties, non-oil exports to total exports ratio rose so quickly, mainly due to public sector investment in "strategic" sectors, together with the petrochemical industry. Until nowadays, exports petrochemical from state-owned companies have a greater share of exports of non-oil products. An increase in the ratio of non-oil exports to total exports come out to be indifferent to oil price (Zhang 2013).

The scope and significance of this study as follows. First, the increase in oil price may leads to rise in disposable income of exporters of oil, resulting in an increase in demand of other goods, indeed particularly those which are distinguished by high income and demand elasticity. Second, in view of substitution effect, high oil prices influence energy prices of other commodities like gas, coal, and electricity. Third, because of the inflationary pressure connected with increasing oil prices, the demand for the related capital could increase and thus increases the cost of oil production that exerts upward pressure on oil prices.

Moreover, oil is a major input for manufacturing and transportation of many commodities. Thus, rise in oil prices will definitely bring increase the cost of production, therefore affecting the prices of other goods. Keeping in

view all these reasons, fluctuations in oil prices might affect the prices of other goods, and as a result, perform a major role in the production, exports, imports, terms of trade, exchange rate and growth of the countries.

1.2 Problem Statement

Most of the studies focused on the exchange rate effects on the oil importing countries. Oil production and export decisions are to some extent independent of exchange rate fluctuation, however, the supply of oil might cause further fluctuations in exchange rate. Aggregate supply could be reduced due to rising costs of imported inputs as a result of the depreciation of the local currency. The persistent and continuous shocks and fluctuations in the crude oil price and real exchange rate creates instability at macro level in most of the countries as majority of the countries are oil-importing countries. Moreover, the appreciation in exchange rate results rise in the price of oil for importing though it may have progressive effect for oil-exporting countries. The fluctuation in exchange rate and increase in oil price may raise the economic growth, employment, industrial sector production, and etc., in oil-exporting countries that direct or indirect affects the whole economic, social and political conditions.

The arrangement of demand and supply streams signify the dependence of oil exports on changes in the money supply, exchange rate, government expenditure, and private expenditure. In the short-run, competition is determined by temporary exchange rate variations and, so forth, the response of the producers towards the fluctuation in the comparative prices of tradable and non-tradable commodities. For instance, the high value of the currency temporarily reduces demand for exports, and may be cause temporary reduction in the imports of goods such as oil and petroleum products too. However, in short run inexpensive cost of imports might raise the production supply. While in long-term, the sustained improvement or appreciation in the exchange rate requires a continuous adjustment in production supplies. Keeping in view the comparative potency of the cost channel and competitiveness, producers might raise or reduce production supplies according to the ongoing volatility in exchange rate in the long term.

From the last two decades, the countries worldwide experienced a lot of financial shocks and other disasters like macro-economic instability, political instability, global wars, changing global partnering, Covid-19 etc. Due to these external shocks accompanied by some internal shocks of many countries the oil production are affected. Moreover, these shocks lead to greater uncertainty, volatility and fluctuation

in the exchange rate that leads to a definite adverse effect on oil-importing countries. However, this study is going to investigate some different, and investigating the effect of exchange rate fluctuation on oil-exporting countries.

1.3 Objectives of the Study

This research study testing the following objectives

i. To examine the impact of fluctuation in exchange rate on oil price in major Oil producing and exporting Countries
ii. To determine the nature of relationship (short or long run) between exchange rate and oil price for major Oil producing and exporting Countries
iii. To investigate the causal relationship of exchange rate and oil price for major Oil producing and exporting Countries

1.4 Research Hypotheses

The following hypotheses are to be empirically tested in this research study

i. There isn't any impact of fluctuation in exchange rate on oil price in major Oil producing and exporting Countries.
ii. There short-run relationship exists between exchange rate and oil price in major Oil producing and exporting Countries
iii. There isn't any causal relationship between exchange rate and oil price in major Oil producing and exporting Countries.

2. Review of Past Literature

The policy makers and economist believe that volatility in oil price can produce shocks that severely affect both exporting and importing oil countries.

This volatility and shocks can also drastically affect real exchange rate that has economic impacts on various countries differently. Though enough number of literature exists on the relationship between the oil price and exchange rate, but the finding of these studies have ambiguous results. Some of the studies had found the positive and significant effect of variations in oil price on exchange rate while some have found inverse impacts. Moreover, most of these studies focused on the oil-importing countries, while this study investigating the relationship of exchange rate and oil price in context of

founder oil-exporting (OPEC) countries. A brief summary some of the past studies are given below.

2.1 On the Relation of Oil Price & Exchange Rate

Different researchers, economists and policy makers had attempted to empirically examine the relationship of crude oil price and exchange rate. In this regard, (Akram, 2004) investigated the impact of fluctuation in oil price and volatility in exchange rate for Norwegian and found that these two factors have inverse relation with each other. Moreover, the study of (Huang & Guo, 2007; Hasanov, 2010; Lizardo & Mollick, 2010; Reboredo, 2012; Beckman & Czudaj, 2013; Ghosh, 2011; Turhan et al., 2013) had found the significant inverse effect of volatility in crude oil price and exchange rate, while examine the relation of these two important factor across the various nations.

The fluctuation in oil and petroleum products in relation to volatility in exchange rate, its possible role and effect on product prices in controlling the movements in prices of goods and oil products has remained the keen interest in the literature. In this regard, (Chen & Rogoff, 2003) studied and observed the strong co-integration relations between volatility in oil price and exchange rate in three OECD members countries (New Zealand, Australia & Canada), that leads to an effective impact on other commodities where primary commodities were the considerable portion of their exports. Likewise, (Cashin et al., 2004) also found significant relation between real exchange rates and product prices in the long run for one-third of 58 nations relying on either directly or indirectly on oil and petroleum products during the period 1980-2002.

The instabilities in oil prices could be a major feature to consider in interpreting the performance of real exchange rates, assuming the associations among the oil and goods markets (Farooq, 2008; Cheng, 2008; Groen & Pesenti, 2010; Makin, 2013). The overriding character of oil among goods markets curtains from its price affecting prices of other commodities and many sectors of the economy as well (Chen et al., 2008; Aizenman et al., 2012; Bodart et al., 2012). Similarly, (Baffes, 2007) concluded that traverse of oil price fluctuation to prices of other goods could be clarified from both supply and demand side, however, the demand side factors are more active than supply side factor in determination of commodity prices. The elasticity or flexibility in the exchange rate to prices of oil and essential commodities are lesser as it mostly involves the substitution effect (Tokarick, 2008). The

flexibility in oil price mostly depended on contribution of both tradable and non-tradable commodities (Cashin et al., 2004), and sometimes it may be even greater if the production of non-traded goods is more labor-intensive relative to that of export commodities (Chen & Rogoff, 2003).

Oil prices throughout history have great influence over world commodity prices due to its immense importance as a fuel for both consumption and production. Some studies concentrated on the exchange rates affiliated oil producing economies, fluctuation in currency, and thus oil price shock probably produces fluctuation in the exchange rate. Korhonen and Juurikkala (2009) found statistical significance effect of the oil price on the exchange rates in the process of estimation of real exchange rate equilibrium for the set of nine OPEC nations. Likewise, in the investigations of (Koranchelian, 2005; & Zalduendo, 2006) illustrated that oil prices have effective role in the fluctuation and determination of exchange rate equilibrium, studying the relation of these two important factor for Venezuela and Algeria. Besides, it has also been found that oil prices could be a key cause of real disorders in exchange rate and commodity prices (Zhou, 1995). Some of the past literature in this regard generally concentrates on industrialized nations with an emphasis on the special role of oil in exchange rate determination. Therefore exporters of the commodities acknowledged slight consideration (Chen and Chen, 2007).

There were some studies found that fluctuation in exchange rate especially in US dollars had greatly affected the oil price (Kandil & Mirzaie, 2002; and Lizardo & Mollick, 2010). Moreover, there were some studies that had found a dominant role of exchange rate and oil price in the foreign trade of developed, oil exporting and OPEC countries but have a partial role in the case of developing countries (Vincent & Bertrand, 2011; Chen & Chen, 2007; Nikbakht, 2000; Arize et al., 2000).

2.2 On the Causal Relation of Oil Price & Exchange Rate

The importance of oil consumption and the effect of oil price through which the international trade channel affected (exchange rate) remained the focused in the literature. Numerous researchers were of the view that there are dominant role of exchange rate in fluctuation of oil price internationally. However, most of the investigator found that there are strong relation between exchange rate and oil price. In this regard many of the studies investigated the causal relation between exchange

rate and oil price (Arize et al., 2000; Breitung & Candelon, 2006; Nikbakht, 2010; Benhmad, 2012; Fratzscher et al., 2013; Bal & Rath, 2015; Bouoiyour et al., 2015).

There are some studies that absorbed the causal relation of oil price and exchange rate in the OPEC and developed countries, and most of the studies found strong co-integration and causal relation between these two important factors. Some of the well-known studies in this regard were of (Basher et al., 2012; Benhmad, 2012; Nouira et al., 2019; Suliman & Abid, 2020; Bouri et al., 2020) had found causal short as well as the long term association of oil price and exchange rate especially for oil exporting and OPEC countries. However, there were also some studies found that didn't observed any causal relation between these two variables in their investigation. Some of the past studies in this regard were (Wang et al., 2013; Parvar, 2010; Habib and Kalamova; 2007) didn't found any significant effect of volatility of crude oil price on real exchange as well as any causal relation between crude oil price and exchange rate of different countries.

Benhmad (2012) investigated the causality relationship of exchange rate in terms of US dollar and oil price for higher valued currencies and found bivariate causal relation of exchange rate and oil price on each other. Benassy-Quere et al., (2007) observed the causal and co-integration relation of oil price and dollar for China from USD peg and energy-intensive growth during 1974-2004. Bal and Rath (2015) examined the causality relation of oil price and exchange rate for China and India and found non-linear causal relation between the studied factors for both China and India. Bouoiyour et al., (2015) attempted to examine the causality relation of changes in oil price changes and fluctuation in exchange rate for Russia. The empirical findings revealed that bivariate causality relation existed between oil price and exchange rate in Russia. Wheras, (Chen and Chen, 2007) investigated causal relation of exchange rate and oil price for G7 member's countries and found that a significant causal relation exits between oil price and exchange rate.

Shahbaz et al., (2013) and Tiwari et al., (2013) investigated the relation of oil price and exchange rate for Romania and found that both non-linear and linear causal relation running from exchange rate and oil price. Nusair and Kisswani (2015) examined the causal relationship of exchange rate and oil price for Japan, Indonesia, Korea, Philippines, Malaysia, Singapore, and Thailand and findings of the study revealed that bidirectional relationship existed in oil price and exchange rate for Thailand and Malaysia, whereas, the

unidirectional relationship from oil price to exchange rates for Philippines, Korea, Singapore and Indonesia. However, the study didn't found any causal relationship of exchange rate and oil price for Japan. Tiwari and Albulescu (2016) investigated the causal relationship of oil price and exchange rate and found strong causal relation between these two factors in the short run for India.

Some of the recent studies (Alsamara et al., 2017; Nouira et al., 2019; Kilian and Zhou, 2019; Suliman and Abid, 2020) inspected the causal causal link of Intermediate crude oil price and real effective exchange rate index in terms of US dollars for trading partners. The bivariate two-way causal relation of both variables on each other was detected and concluded that these two variables have influential effect on each other. The fluctuation in exchange rate was remained significant in changes in crude oil price in countries worldwide.

3. Methodogical Framework

The area of this study is the selected major oil producing and exporting countries that are mainly consist of Muslim countries located in Asia (Western Asia). Due to the production and exporting of an important natural resource and need of the world, some of these countries were considered the strong political and economic regions of the Middle East. But due to global wars, disasters and strategic changes, the influence of these major oil producing and exporting countries are also changing. OPEC was and has an oil export country and it exports oil to many countries. Moreover, the rapid fluctuation in international currencies (exchange rate) is also observed from the last decade. All these major changes in the global environment and exchange rate have severely affected the price in oil price. The changes in oil price and exchange rate leads to an increase in cost of production and transportation of oil that have an adversely affected economically, politically and socially the countries worldwide. Moreover, most of the institutions, industries and economic zones that are either directly or indirectly depended on oil have also affected.

3.1 Methodology of the Study

Now a day's most of the countries favors flexible exchange rate. Exchange rate depends and affected by a variety of variables that are infamously difficult to forecast or predict. However, the oil price depends upon the domestic and international demand for oil as well as available supply, cost and production of oil. Moreover, the oil price also depends upon the terms of trade and exchange rate. This research study aims to empirically evaluate the nexus of exchange rate and crude oil price in oil-exporting and producing countries.

For empirical examination the oil price (OP) is assumed as dependent variable whiles the exchange rate (ER), oil exports (OX) and Oil Production (OQ) as independent variables. The theoretical relations of the variable is expressed in the form of

$$OP = f(ER, OX, OQ) \tag{3.1}$$

The simple econometric model that expresses the relationship between dependent variable and explanatory variables is

$$OP_{it} = \alpha_0 + \alpha_1 ER_{it} + \alpha_2 OX_{it} + \alpha_3 \Delta OQ_{it} + \mu_t \tag{3.2}$$

In methodology, the ARDL Regression & co-integration regression technique is applied to examine the impact of fluctuation of exchange rate on oil price in major oil producing and exporting countries. The ARDL bound testing and WALD test is applied to investigate the objective & hypothesis 2nd that is nature (short or long) relation between the main studying variables. The Granger Causality test be apply for finding the causal relation between exchange arte and oil price and for empirical examination of objective and hypothesis 3rd of this study. For the regression analysis and regressors effects, the ARDL model is in the form of

$$\Delta OP_{it} = \alpha_0 + \sum_{t-1}^{n} \alpha_1 \Delta ER_{it} + \sum_{t-1}^{n} \alpha_2 \Delta OX_{it} + \sum_{t-1}^{n} \alpha_3 \Delta OQ_{it} + \mu_t \tag{3.3}$$

The above model with optimal number of lag will be in the form of

$$\Delta OP_{it} = \alpha_0 + \sum_{k-1}^{p} \alpha_1 \Delta ER_{it} + \sum_{K-1}^{p+1} \alpha_2 \Delta ER_{it} + \sum_{k-1}^{p} \alpha_3 \Delta OX_{it} + \sum_{K-1}^{p+1} \alpha_4 \Delta OX_{it} + \sum_{K-1}^{p} \alpha_5 \Delta OQ_{it} + \sum_{k-1}^{p+1} \alpha_6 \Delta OQ_{it} + \mu_{it} \tag{3.4}$$

In the above model (K-1) and (p+1) is the number of optimal lag that is to be regressed by applying ARDL as Vector Auto-Regressive (VAR) model.

In order to look at the causal relation of exchange rate, oil price and other important variables selected in this study, the Granger causality equations for analysis are

$$\Delta OP_{it} = \sum_{k=1}^{n} \beta_1 ER_{it} + \sum_{j=1}^{n} \beta_2 OX_{it} + \sum_{X=1}^{n} \beta_3 OQ_{it} + \mu_i \quad (3.5a)$$

$$\Delta ER_{it} = \sum_{k=1}^{n} \beta_1 OP_{it} + \sum_{j=1}^{n} \beta_2 OX_{it} + \sum_{X=1}^{n} \beta_3 OQ_{it} + \mu_i \quad (3.5b)$$

$$\Delta OX_{it} = \sum_{k=1}^{n} \beta_1 ER_{it} + \sum_{j=1}^{n} \beta_2 OP_{it} + \sum_{X=1}^{n} \beta_3 OQ_{it} + \mu_i \quad (3.5c)$$

$$\Delta OQ_{it} = \sum_{k=1}^{n} \beta_1 ER_{it} + \sum_{j=1}^{n} \beta_2 OX_{it} + \sum_{X=1}^{n} \beta_3 OP_{it} + \mu_i \quad (3.5d)$$

3.2 Data Description

The quarterly time series data are used and regressed to analyse the nexus between exchange rate and oil price for selected major oil-exporting and producing countries. For regression analysis, the time periods of the study is from 2000-2021.

The data are collected from various international sources includes the Global economy, World Economy, World Bank, World Development Index (WDI) and International Monetary Fund (IMF).

4. Analysis & Explanation of Results

Different techniques are applied to regress variables data for finding the nexus of oil price and exchange rate, the impact of fluctuation in exchange rate on oil price, the nature of relation short vs long between these two variables and the causal relation for major oil producing and exporting countries. For empirical investigations of the study objectives and hypotheses, the Histogram and Normality test will be applied to find the descriptive analysis and normality of the variables data. For findings the order of integration and unit root, the Augmented Dicky-Fuller and Phillips Perron (PP) unit tests are applied.

On the basis of unit root tests outcome, the Auto Regressive Distributed lag (ARDL) model is regressed to examine the nexus and impact of fluctuation in exchange rate on oil price and for empirical investigation of 1st objective. For nature of relation either short or long term, and for examination of 2nd objective, the ARDL bound and WALD tests are applied. For findings the co-integration, speed of adjustment and long run impact of independent variables including exchange rate on oil price, the ARDL co-integration and long form analysis are conceded.

The Granger Causality test is used to enquire the causal relation exchange rate and oil price as well as with other included variables. The stability and diagnostic tests for serial correlation, specification bias, auto-correlation and Hetroskasdacity are also applied.

4.1 Statistical Description of the Study

The Histogram and Jaque-Bera test are applied for descriptive statistical analysis, normality of the variables data and model. The summarize results obtained is given in below table (1).

Table 1. Normality Test and Statistical Description	
Mean	3.648634
Median	74.68719
Maximum	1232.736
Minimum	6.187348
Std. Dev.	543.7862
Skewness	0.256715
Kurtosis	1.736148
Jarque-Bera	0.587219
Probability	0.368214
Observations	41

Source: authors own calculations (2022).

The above table (1) shows that the probability value of Jarque-Bera test is (0.368214), above the significance level at (1%, 5% & 10%), guiding the normality of the variables data and model. The statistical description of the data shows that the mean value of the sample data is approximately four (3.648), near to zero. The average maximum value is approximately 1166. The Skewness value is positive and very close to zero. These statistics shows that overall data used is acceptable and fit for further analysis.

4.2 Unit Root Tests

It is commonly known as that mostly time series data suspects unit root, spurious relation, and serial correlation. This study also consists of time series data, therefore the Augmented Dicky-Fuller and Phillips Perron tests are applied to know the unit root, order of integration and spurious relation in the data. The t-stat values of both the tests are shown in the table (2).

Table 2. ADF & PP Tests Values

Variables	**ADF Test Values**		**PP Test Values**	
	At I(0)l	**At I(I)**	**At I(0)**	**At I(I)**
Oil Price (OP)	-3.757316	-4.562482	-3.938362	-5.429241
Exchange Rate (ER)	-1.136205	-3.684972	-1.297328	-4.609540
Oil Exports (OX)	-1.327618	-3.843943	-1.528763	-4.876406
Oil Production (OQ)	-3.475146	-4.786708	-3.862185	-5.295317

The results of unit root (ADF and PP) tests depicted in above table (2) revealed that the variables exchange rate and oil exports are non-stationary at I(0), whereas, oil price and oil production are stationary. For further stationarity of the variables, the PP and ADF tests are applied at 1st difference and the outcome of both tests confirms that the included variables are stationary at I(1). Further, the result didn't find any spurious relation, out liars and any other serious problem in the data.

4.3. Regression Analysis of the Variables

With reference to results of ADF test, the ARDL regression analysis is carried by regressing the oil price in relation with exchange rate alongside with the other independent variables that are oil exports and oil production for major oil producing and exporting countries to empirically analyse the impact of fluctuation in exchange rate on oil price as assumed of objective 1st of this study. The results of the variables regression obtained by estimators of each independent variable and their significant values (assumed in model in the form of t-stat and prob.) are shown in below table (3).

Table 3. ARDL Regression Analysis {Dependent Variable: LOG(OP)}

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LOG(OP(-1))	0.168531	0.042935	3.925173	0.0002
LOG(ER)	0.424130	0.091845	4.617892	0.0000
LOG(OX)	0.236873	0.052203	4.537618	0.0000
LOG(OX(-1))	0.321794	0.112841	2.851729	0.0214
LOG(OQ)	0.113716	0.023982	4.741629	0.0000
LOG(OQ(-1))	0.136053	0.039186	3.471961	0.0016
C	0.268536	0.216867	1.238251	0.3418
R-squared	0.874706	Durbin-Watson stat		2.035404
Adjusted R-squared	0.856038	Prob(F-statistic)		0.000000

Economists showed a great deal of interest and attempted to investigate energy markets because of the current oil price shocks. Likewise, the ongoing increase in the global economic imbalances leads to great devotion of economic analysts in studying exchange rate issues. In spite of these concurrent proceedings, slight concentration has been given to investigate the relationship of oil prices and exchange rates for oil producing and exporting countries. This study examines the relation between these two important variables. The regression result obtained given in table (3) revealed that the model outcomes are stable, consistent and acceptable as the value of R^2, Adj. R^2, DW stat and Prob. F-stat. values are satisfactory and didn't shows any sort of problem.

Uncertainty and volatility in exchange rate and its possible effect on oil prices are complex phenomenon and policy makers should have full awareness of the foreign exchange and oil markets especially of domestic and international demand and supply of oil. It might be essential to execute some procedures that support firms to rely more on new energy sources in such way that changes in oil prices may not be the main cause of real exchange rate volatility. Besides that, some steps have to be implemented for the improvement of exporting firms. In addition encouraging energy efficiency instead of energy intensity may decrease costs of production. Due to some global shocks and financial crises the exchange rate and oil price affect severely that leads to an adverse effect on all countries especially on developing countries. The above result of ARDL analysis shows that there significant and positive impact of exchange rate on oil price in major selected oil producing and exporting countries. The result indicated that one percent fluctuation and volatility in exchange rate leads to approximately forty-two percent change in the oil price in the same direction. As oil is the most important factor and its demand and supply is not only on domestic but also on international way, that's why any sort of fluctuation in exchange rate will have definite effect on price especially during exports and imports of oil. The empirical findings of this study as shown in above table (3) are consistent with the theoretical as well as empirical literature (Hasanov, 2010; Ghosh, 2011; Novotny, 2012; Reboredo, 2012; Beckman & Czudaj, 2013; Turhan et al., 2013).

Further, the study also regressed the variables oil exports and oil production to examine its impact on oil price. As predicted the study found significant effect of oil production and oil exports via fluctuation in the exchange rate on

oil price. As the exports of a country are imports for other countries, so whenever, the appreciation in exchange rate occurs it make the imports expensive and brings increase in the oil price. The studies of (Momani, 2006; Habib & Kalamova, 2007; Jahan-Parivar & Mohammadi, 2008; Bjornland, 2008; Korhonen & Juurikkala, 2009; Adeniyi et al., 2012; Oluwatosin, 2012; Wang et al., 2013) also found the significant effect of oil exports via exchange rate in the variation of oil price for various countries.

Moreover, as the oil price rises due to fluctuation in the exchange rate, it become the motivating factor for exporting countries to earn more, so the oil production will be increase. This finding is consistent with the theoretical literature of the objective of producers and of supply law. In the past studies of (Aghion et al., 2006; Bodart et al., 2012) have also the same findings.

4.4. Nature of Relation between Exchange Rate & Oil Price

To examine the 2nd objective and long-run relation of oil price and the exchange rate for oil producing and exporting countries during 2000-20216, the ARDL bound and WALD tests are applied and the results of bound is given in table (4), whereas, that WALD test in table (5).

Table 4. ARDL Bounds Test

Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k	I0 Bound (5%)	I1 Bound (5%)
F-statistic	5.257163	7	2.32	3.5

The F-stat. value of ARDL bound test is greater from the value of I(0) and I(1) bound at 5% significance level, shows that there is long run relation between oil price and exchange rate in oil producing and exporting countries. The outcome of bound test is consistent to the earlier studies of (Camarero et al., 2002; Joyce & Kamas, 2003; Nusair & Kisswani, 2015) which found the strong the association of oil price and exchange rate as well as significant effect of exchange rate on oil price in the long run.

For further testing and confirming the outcome of ARDL bound test, the Wald test is applied to examine the either there is any long run relation exits

between these two important variables and the result of WALD test is given in table (5).

Table 5. Wald Test Analysis

Null Hypothesis: C(2)=C(3)=C(4)=0

Test Statistic	Value	df	Probability
F-statistic	6.843723	(7, 30)	0.0000
Chi-square	49.75396	7	0.0000

The result of WALD test also shows the consistent outcome with bound test and indicates the long-run relation between the studied important factors in oil producing and exporting countries during 2000 to 2021 and thus rejecting the null hypothesis.

4.5 Co-integration & Long-Term Analysis

Most of the researchers and theories suggest confirming co-integration and co-integrating vector among the variables especially when some the variables show their stationarity at I(1) and posits the long term association. Therefore, in this study the ARDL co-integration test is run to check the co-integration especially between exchange rate and oil price and the results is shown in the table (6).

Table 6. ARDL Cointegrating & Long Run Analysis

Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ER)	0.385235	0.112734	3.417182	0.0025
DLOG(OX)	0.216142	0.045605	4.739438	0.0000
DLOG(OQ)	0.137893	0.037759	3.651893	0.0014
CointEq(-1)	-0.537184	0.128626	-4.176316	0.0000
Cointeq = LOG(OP) - (0.4361*(ER) + 0.2367*LOG(OX) + 0.1936 *LOG(OQ)				
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(ER)	0.436148	0.115745	3.768163	0.0016
LOG(OX)	0.236754	0.051826	4.568176	0.0000
LOG(OQ)	0.193605	0.051909	3.729676	0.0017
C	0.251602	0.203417	1.236873	0.3865

As from co-integration test results it is clear that has strong co-integration and co-integrating vector between oil price and exchange rate in oil producing and exporting countries during 2000-2021. Therefore for further analysis, the ARDL long run analysis is conducted to examine the effect of exchange rate on oil price.

It is well well-known from the theory that a country exporting oil may face appreciation in the exchange rate (fall in exchange rates) with an increase in oil prices and vice versa. In a comparison of countries with self-sufficiency in oil and one dependent on oil import, the earlier would carry an appreciation as the oil price rise relative to the other country other things being ceteris paribus. More commonly, the currencies of the countries that have the oil reserves to some extent appreciate comparative to countries that don't have oil reserves at all. In oil exporting countries the literature generally observed the correlation and long run association between exchange rate and oil price. Similarly, this study also found significant effect of exchange rate fluctuation

in oil price variation and consistent results to earlier studies of (Chaodhuri & Daniel, 1998; Bahmani-Oskooee & Mirzaie, 2000; Breitung & Candelon, 2006). From, the outcome it can be stated, a rise in oil prices is absorbed towards an appreciation of the exchange rate.

4.6 Diagnostic and Stability Analysis

There are some important assumptions of regression analysis. If these assumptions are violated then it gives wrong and biased results. To check the reliability of the above results and models different diagnostic and stability analysis test were applied. They are discussed one by one below in details.

One of the assumptions of regression analysis, that random term or error term must be independent of each other and didn't serially correlated with each other or past values (i.e. U ≠ Uj). If it did, it gives wrong regression analysis and biased results. To check the serial correlation in the regression model applied in this study, we applied Busch-Godfrey Serial Correlation LM test and in table (4.7) the results is given.

Table 7. Correlation Test Results

F-statistic	0.372816	Prob. F(2,7)	0.6572
Obs*R-squared	0.532717	Prob. Chi-Square(2)	0.7075

The results of Busch-Godfreyserial correlation LM test show that the model we regressed for empirical analysis of this study is free from serial correlation proving that random or error term is independent of each other. Secondly, the results of the test drawn in the table (7) also show that the model does not contain any sign of spurious relation and auto-correlation.

There is also one of the assumptions that variance of the error term as well as in explanatory variables must be constant. If the variance between the two or more random term or between the two or more explanatory variables is not constant, then it makes the standard error large that make the overall model and estimator value of the variables insignificant. For this purpose, we applied Breusch-Pagan-Godfrey Heteroskedasticity test and the results of the test are drawn in below table (8).

Table 8. Heteroskedasticity Test Results

F-statistic	2.321200	Prob. F(2,9)	0.1538
Obs*R-squared	4.083505	Prob. Chi-Square(2)	0.1298
Scaled explained SS	2.014789	Prob. Chi-Square(2)	0.3652

The results in above table show that the model didn't suffer from Heteroskedasticity and the variance among the random term variables are constant as the probability and Chi-square are more than 5%.

4.7 Causality Analysis

To examine the causal relation between oil price and the exchange rate in oil producing and exporting countries and for testing of 3rd objective of the study, the Pair-Wise Granger Causality test is applied and in table (4.9) the outcome is given.

Table 9. Causality Regression Results

Variables	*OP*	*ER*	*OX*	*OQ*
OP	---	0.0012	0.0255	0.0267
ER	0.0416	---	-0.0018	0.1749
OX	0.0316	-0.0174	---	0.0482
OQ	0.0054	0.2715	0.0372	---

The result of causality test shown in above table (9) indicates that there is a bi-variate causal relation between oil price and exchange rate in oil producing and exporting countries. This means that both exchange rate and oil price are strongly dependent on each other. Fluctuation in one variable will affect the other macroeconomic variable. The finding of this study regarding the causal relation between these two important variables is consistent to the earlier literature of (Breitung & Candelon, 2006; Benhmad, 2012; Tiwari & Albulescu, 2016; Nouira et al., 2019). Further, the study also found bi-causal relation of oil production and oil exports with oil price.Further, the study didn't found any causal relation between exchange rate and oil production, however, found bi-directional relation between oil exports and exchange arte

and is consistent with the theoretical and empirical literature of (Habib & Kalamova, 2007; Korhonen & Juurikkala, 2009; Wang et al., 2013; Beckmann & Czudaj, 2013).

However, our focused relation in this study is that of exchange rate and oil price and the results of the study obtained for Granger causality test for causal relation found significant and successful bi-directional relation between oil price and exchange rate for the period of 2000-2021, proving that these two variables are strongly connected with each other in case of major oil producing and oil exporting countries. Furthermore, on the contrary to the reverse causality, it is assumed that fluctuations in both the exchange rate and oil prices may be responsive to any other concurrent factors. One of these factors may be the monetary policy. Since oil is a durable good, its supply and price will be sensitive to not only the present monetary policy but also anticipated future. Similarly, determine the exchange rate determination is also affected by both present and projected monetary policy. So, one should suppose the determination of both oil prices and exchange rates together.

5.1 Conclusion

The aim of this study is to examine the impact, nature of relation and causal association of oil prices and exchange rate for major oil producing and exporting countries during 2000-2021. For this, the study employed various techniques in the methodology. For findings the impact of fluctuation in exchange rate in oil price that is 1st objective of the study, the ARDL short run analysis was carried. For analyzing the nature of relation and satisfying the 2nd objective, the ARDL bound and WALD tests are applied. For investigating the causal relation and for 3rd objective of this study, the Granger Causality approach is regressed.

The ARDL regression analysis for the impact of fluctuation in exchange rate shows that variation in the exchange rate leads to changes in the oil price in oil producing and exporting countries during the studied period of time. The factors and elements that establish the real exchange rate and cost of energy consist the real price of oil that let these countries to compose estimates of the cost accounts for exporting companies for future production (Vincent and Bertrand, 2011). Foreign trade volumes of developing countries are greatly affected by energy costs and currency exchange policies, therefore, the fluctuation in exchange rate has been the main concern and have dominance

effect in the macroeconomic indicators for developing countries by fluctuations in prices of oil.

Regressing for 2nd objective and nature of relation, the outcome of the ARDL bound and co-integration tests indicated the long-term association of exchange rate and the price of oil. Moreover, the WALD test also identifies the long run relation between oil price and the exchange rate for the study of period analysis. The ARDL long form indicated the long term significant association of exchange rate and oil price.

Another objective (3rd) of study was regarding the causal relation and the study found bi-variate relation running from and to exchange rate and oil price. The correlation of oil price and exchange rate may be complicated more than that shows by the trade effects. A number of transmission ways can support this causality relation between these two important factors. Firstly, as oil denominated in US dollars, depreciation of dollar may direct to a rise in oil demand from economies of currencies other than the dollar, which in return could cause a rise in the prices of oil. Second, if in case the oil-producing economies have targeted revenue from exports in their currency to finance the deficit in their government budget, and then with the depreciated dollar they may cut oil supplies in order to raise the price to attain their goal through export earnings. A third reason might be, investors probably would increase demand for merchandise when the dollar depreciates as hedge evade inflation. This may lead to increasing trend in oil prices.

5.2 Limitation of the Study

As the current study was done at aggregate level, it would be better if a detail study is conducted at disaggregate level.

Further, there is also need of the study that tests the application of Marshall linear theorem that will add to literature.

References

Agenor, P.R. (1991), *Output, Devaluation, and the Real Exchange Rate in Developing Countrie,* Weltwirtschaftliches Archive, 127, 18-41.

Aizenman, J., Edwards, S. & Riera-Crichton, D. (2012), *Adjustment Patterns to Commodity Terms of Trade Shocks: The Role of Exchange Rate*

and International Reserves Policies, Journal of International Money and Finance 31, 1990-2016.

Akram, Q.F. (2004), *Oil Prices and Exchange Rates: Norwegian Evidence*, Econometrics Journal, 7(2), 476-504.

Alhajji, A.F. (2004), *The Impact of Dollar Devaluation on the World Oil Industry: Do Exchange Rates Matter?* Journal of International Money and Finance, 17, 299-316.

Alsamara, M., Mrabet, Z., & Dombrecht, M. (2017), *Asymmetric Responses of Money Demand to Oil Price Shocks in Saudi Arabia: A non-linear ARDL approach*, Applied Economics, 49(37), 3758-3769.

Arize, A.C., Osang, T., & Slottje, D.J. (2000), *Exchange-Rate Volatility and Foreign Trade: Evidence from Thirteen LDC's*, Journal of Business & Economic Statistics, 5(2), 10-17.

Baffes, J. (2007), *Oil Spills on Other Commodities*, Resources Policy, 32, 126-134.

Bahmani-Oskooee, M., & Mirzaie, A. (2000), *The Long-run Effects of Depreciation of the Dollar on Sectoral Output*, International Economic Journal, 14, 51-61.

Bal, D.P., & Rath, B.N. (2015), *Nonlinear Causality between Crude Oil Price and Exchange Rate: A Comparative Study of China and India*, Energy Economics, 51, 149-156.

Basher, S.A., Haug, A.A., & Sadorsky, P. (2012), *Oil prices, exchange rates and emerging stock markets*, Energy Economics, 34(1), 227-240.

Beckmann, J., & Czudaj, R. (2013), *Oil Prices and Effective Dollar Exchange Rates*, International Review of Economics and Finance, 27(C), 621-636.

Benassy-Quere, E., Mignon, V., & Penot, A. (2007), *China and the relationship between the Oil Price and the Dollar*, Energy Policy, 35(11), 5795-5805.

Benhmad, F. (2012), *Modelling nonlinear Granger Causality between the Oil price and U.S. dollar: A Wavelet Based Approach*, Economic Modelling, 29(15), 1505-1514.

Bergstrand, J.H. (1991), *Structural Determinants of Real Exchange Rates and National Price Levels: Some Empirical Evidence*, American Economic Review, 81(1), 325-334.

Bodart, V., Candelon, B., & Carpantier, J.F. (2012), *Real Exchanges Rates in Commodity Producing Countries: A Reappraisal*, Journal of International Money and Finance, 31, 1482-1502.

Bouoiyour, J., Selmi, R., Tiwari, A.K., & Shahbaz, M. (2015), *The nexus between oil price and Russia's real exchange rate: Better paths via unconditional vs conditional analysis*, Energy Economics, 51, 54-66.

Bouri, E., Kachacha, I. & Roubaud, D. (2020), *Oil market conditions and sovereign risk in MENA oil exporters and importers*, Energy Policy, 137, 111-127.

Breitung, J., & Candelon, B. (2006), *Testing for Short and Long-run Causality: A Frequency Domain Approach*, Journal of Econometrics 12, 363−378.

Camarero, M., Ordez, J., & Tamarit, C. (2002), *An analysis of the transmission mechanism of monetary policy in Spain using a structural cointegrated VAR approach*, Applied Economics, 34, 2201- 2212.

Cashin, P., Cespedes, L. & Sahay, R. (2004), *Commodity Currencies and the Real Exchange Rate*, Journal of Development Economics 75, 239-268.

Chaodhuri, K., & Daniel, C. (1998), *Long-Run Equilibrium Real Exchanger Rates and Oil Prices*, Economic Letters, 58(2), 231 - 238.

Chen, S.S., & Chen, H.C. (2007), *Oil Prices and Real Exchange Rates*, Energy Economics, 29(3), 390-404.

Chen, Y.C., & Rogoff, K. (2003), *Commodity Currencies*, Journal of International Economics, 60, 133-160.

Cheng, K. C. (2008), *Dollar Depreciation and Commodity Prices.* International Monetary Fund (IMF) Working Paper No. 23, Pp. 72-75.

Farooq, A. (2008), Commodity *Prices, Interest Rates, and the Dollar*, Norges Bank Working Paper No. 2008/12.

Fratzscher, M., Schneider, D. & Van-Robays, I. (2013), *Oil Prices, Exchange Rates and Asset Prices*, CESifo Working Paper Series No. 4264.

Ghosh, S. (2011), *Examining Crude Oil Price-Exchange Rate Nexus for India during the Period of Extreme Oil Price Volatility*, Applied Energy, 88(5), 1886-1889.

Groen, J., & Pesenti, P.A. (2010), *Commodity Prices, Commodity Currencies and Global Economic Developments*, NBER Working Papers no. 15743.

Habib, M.M., & Kalamova, M.M. (2007), *Are there Oil Currencies? The real Exchange Rate of Oil Exporting Countries*, European Central Bank Working Paper Series No. 839.

Hasanov, F. (2010), *The Impact of Real Oil Price on Real Effective Exchange Rate: the Case of Azerbaijan*, DIW Berlin, Discussion Paper No. 1041.

Huang, Y., & Guo, F. (2007), *The Role of Oil Price Shocks on China's Real Exchange Rate*, China Economic Review, 18(4), 403-416.

Joyce, J., & Kamas, L. (2003), *Real and Nominal Determinants of Real Exchange Rates in Latin America: Short-run Dynamics and Long-run Equilibrium*, The Journal of Development Studies, 39(6), 155-182.

Kandil, M., & Mirzaie, A. (2002), *Exchange Rate Fluctuations and Disaggregated Economic Activity in the US: Theory and Evidence*. Journal of International Money and Finance, 21, 1-31.

Kilian, L. (2009), *Not all Oil Shocks are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market*. American Economic Review, 99(3), 1053-1069.

Kilian, L., & Zhou, X. (2019), *Oil prices, exchange rates and interest rates*, CESifo Working Paper Series, No. 7484.

Koranchelian, T. (2005), *The Equilibrium Real Exchange Rate in a Commodity Exporting Country: Algeria's Experience*, IMF Working Paper No. 05/135.

Korhonen, I., & Juurikkala, T. (2009), *Equilibrium Exchange Rates in Oil Exporting Countries*, Journal of Economics and Finance, 33, 71-79.

Lizardo, R.A., & Mollick, A.V. (2010), *Oil Price Fluctuations and U.S. Dollar Exchange Rates*, Energy Economics, 32(2), 399-408.

Makin, A. (2013), *Commodity Prices and the Macro-economy: An Extended Dependent Economy Approach*, Journal of Asian Economics, 24, 80-88.

Nikbakht, L. (2010), *Oil Prices and Exchange Rates: the Case of OPEC*, Business Intelligence Journal, 3(1), 83-92.

Nouira, R., Hadj, A.T., & Rault, C. (2019), *Oil Price Fluctuations and Exchange Rate Dynamics in the MENA Region: Evidence from non-causality-in-variance and asymmetric non-causality tests*, The Quarterly Review of Economics and Finance, 73, 159-171.

Novotny, F. (2012), *The Link between the Brent Crude Oil Price and the US Dollar Exchange Rate*, Prague Economic Papers, 2, 220-232.

Nusair, S.A., & Kisswani, K.M. (2015), *Asian Real Exchange Rates and Oil Prices: A co-integration Analysis under Structural Breaks*, Bulletin of Economic Research, 67(1), 1-25

Reboredo, J.C. (2012), *Modelling Oil Price and Exchange Rate Co-Movements*, Journal of Policy Modeling, 34(3), 419-440.

Suliman, M.H., & Abid, M. (2020), *The impacts of oil price on exchange rates: Evidence from Saudi Arabia*, Energy Exploration & Exploitation 38(5), 2037-2058.

Tiwari, A.K., & Albulescu, C.T. (2016), *Oil Price and Exchange Rate in India: Fresh evidence from continuous wavelet approach and asymmetric, multi-horizon Granger-causality tests*, Applied Energy, 179, 272-283

Tiwari, A.K., Mutascu, M.I., & Albulescu, C.T. (2013), *The Influence of the International Oil Prices on the Real Effective Exchange Rate in Romania in a Wavelet Transform Framework*, Energy Economics, 13, 34-47.

Turhan, I., Hacihasanoglu, E., & Soytas, U. (2013), *Oil Prices and Emerging Market Exchange Rates*, Emerging Markets Finance and Trade, 49(S1), 21-36.

Wang, Y., Wu, C., & Yang, L. (2013), *Oil Price Shocks and Stock Market Activities: Evidence from Oil-Importing and Oil-Exporting Countries*, Journal of Comparative Economics, 41(4), 1220-1239.

Zalduendo, J. (2006), *Determinants of Venezuela"s Equilibrium Real Exchange Rate*, IMF Working Paper No. 06/74.

Zhang, Y. (2013), *The Link between the Price of Oil and the Value of the US Dollar*, International Journal of Energy Economics and Policy, 3(4), 341-351.

Zhang, Y., Fan, Y., Tsai, H., & Wei, Y. (2008), *Spillover Effect of US Dollar Exchange Rate on Oil Prices*, Journal of Policy Modelling, 30 (6), 973-991.

Zhou, S. (1995), *The Response of Real Exchange Rates to Various Economic Shocks*, Southern Economic Journal, 61 (4), 936-954.