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Impact of Oil Price on Economic Growth of OECD Countries: A Dynamic Panel Data Analysis

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Abstract: Crude oil usage in (Organization for Economic Co-operation and Development) OECD countries has been significantly higher since the early 1970s and therefore, oil can be considered as one of the driving forces of the OECD economies. Moreover, oil prices have been frequently fluctuating over time, creating adverse economic and social impacts. The study examines the impact of oil price on the economic growth of 38 OECD countries over the period 2000–2020, through four channel variables such as real interest rate, exchange rate, government expenditure and investment. A dynamic panel data analysis based on Generalized Method of Moment (GMM) is employed to accomplish the objective of the study. The study confirms that there is a mixed impact of oil price on economic growth. More specifically, an increase in oil price positively affects economic growth only through interest rates while the oil price hike negatively affects economic growth through all other channel variables such as exchange rate, government expenditure and investment. Since the total negative effect of oil price on economic growth outnumbers the positive effect, the net impact of an oil price hike on economic growth is negative. Hence, the study strongly recommends applying appropriate polices to reduce oil price fluctuations while encouraging the use of country-specific renewable energy sources.

Keywords: oil price; economic growth; OECD countries; dynamic panel data analysis

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1. Introduction

Energy can be considered one of prominent factors which drives the global economy and energy is crucial for all three pillars of an economy such as agriculture, industry and service, irrespective of the nature of the country. It has been widely debated that the stock of non-renewable energy such as oil, coal and natural gas will end within a century and therefore, usage of alternative renewable energy sources has been rapidly increasing over time. Despite renewable energy sources such as wind power, solar power and nuclear power being in the limelight, oil has been playing a vital role in all sectors of the global economy [1]. Particularly, steady and higher economic growth in China, India and other industrial countries has created a massive demand especially for crude oil compared to other fossil fuels and therefore, the oil price has an enormous effect on such economies. However, the oil price has been recognized as one of the highly volatile prices in the current context [2]. Due to the volatile nature of the oil price, the benefits have been recognized of implementing appropriate energy price policies based on an oil price–growth nexus. Hence, numerous empirical investigations have been conducted by many scholars to model the oil price–growth nexus in the context of individual and groups of countries. Especially, historical investigation such as [3–6] clearly indicated the adverse impact of an oil price hike on the economic performance of countries.

The steady economic growth of any country is mainly driven by an expanded industrial sector. Similarly, crude oil is one of the key requirements for a successful industrial sector and therefore, an oil price hike initially affects the industrial sector followed by

economic growth. Figure 1 depicts the usage of fossil oil by the OECD countries over the period 1971–2015 while comparing it with the world's average. Oil usage in the OECD countries was approximately 2.5 times higher than the world's average over the period of 1971–2015 and this clearly indicates the importance of oil for the OECD countries. Particularly, oil usage in the OECD countries has been steadily increasing from 1982 to 2008. However, there is a slight decline in oil usage after 2009 and this downward trend might be due to the shift toward renewable energy sources. Nevertheless, the oil consumption of the OECD countries is remarkably higher than the rest of the world and hence, oil is one of the key driving forces of the economies of the OECD countries.

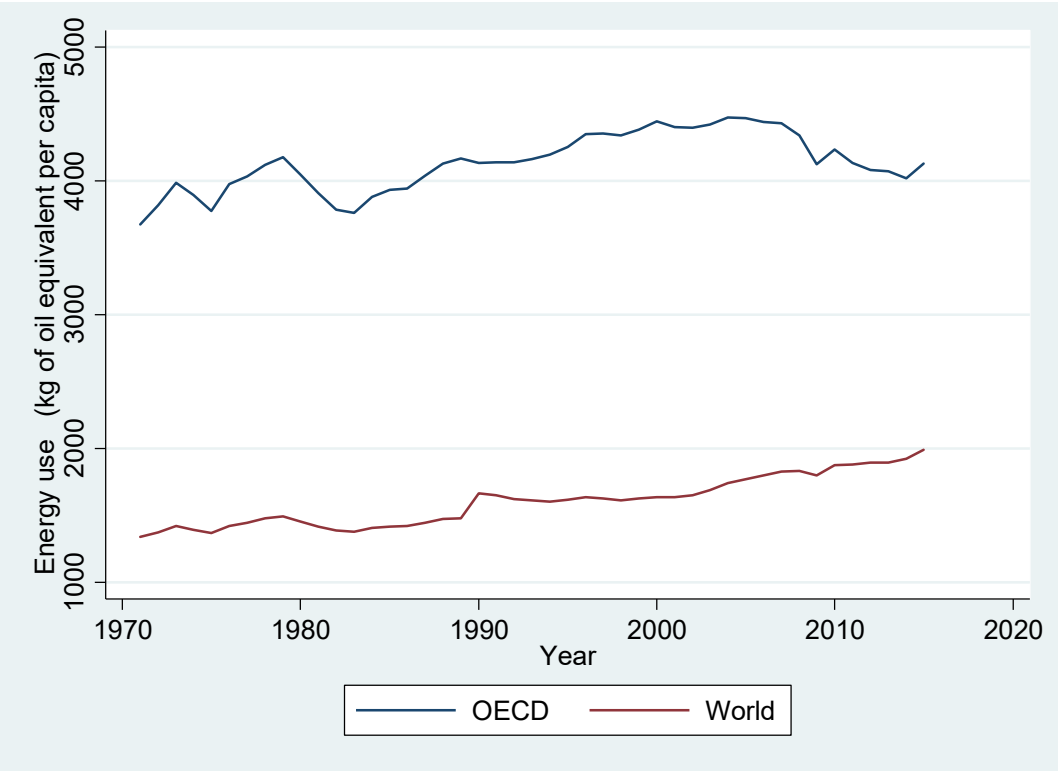

Figure 1. Energy use (kg of oil equivalent per capita) by the OECD countries. Source: Created by the authors based on the data from World Development Indicators.

Furthermore, Figure 2 illustrates the leading oil-demanding sectors in the OECD countries by 2020. According to Figure 2, the road sector accounted for the largest amount of oil demand in 2020, highlighting that 48.6% of oil demand was demanded for the usage of motor vehicles. Apart from that, petrochemicals demanded 16.2% followed by residential/commercial/agriculture (9.8%) and aviation (4.4%) sectors, respectively. Moreover, electricity generation, marine bunkers and rail and domestic waterways sectors collectively represented only 8.5% of total oil demand in the OECD countries. The sector-wise distribution of oil demand also emphasizes the importance of oil as an energy source to the OECD countries.

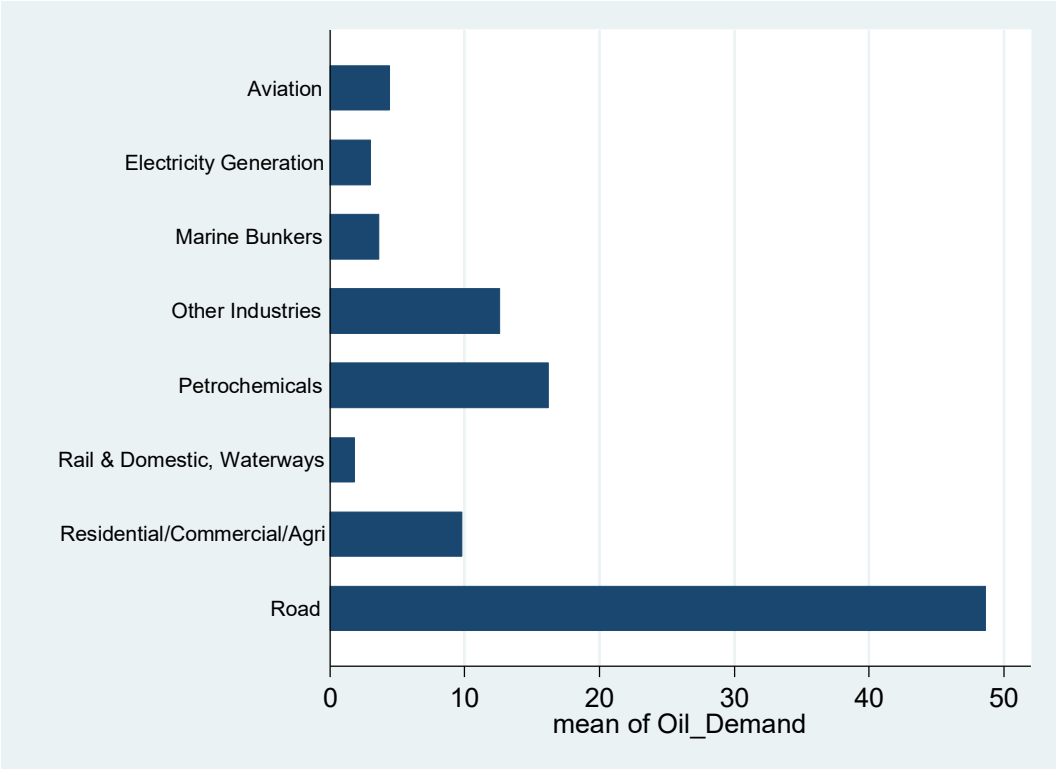

Figure 2. Sector-wise distribution of oil demand in the OECD countries (2020). Source: Created by authors based on the data from World Development Indicators.

Most of the existing empirical analyses have addressed the oil price–growth nexus based on the direct relationship between oil price and economic growth. However, the oil price initially affects the key determinants of economic growth and thereafter, the impact of the oil price hike is transferred to the economic growth through such determinants. Thus, the impact of oil price on economic growth should be analyzed through various channels which have a direct relationship with economic growth. The present study attempts to overcome the weakness in measuring the direct relationship between oil price and economic growth by applying a novel method proposed by [7]. Frimpong et al. [7] has confirmed that the real impact of oil price on economic growth should be calculated through the impact on the channel variables which have a direct relationship with the economic growth. However, the Frimpong et al. [7] analysis focused only on the economic community of West African states. Hence, the novelty of the present study is the examination of the impact of oil price on economic growth through an indirect transmission mechanism which includes the number of channel variables directly related with economic growth. Thus, the study analyzes the impact of the oil price on channel variables and then, the impact of channel variables on economic growth and ultimately, the impact of oil price on economic growth is quantified as a combined effect of the two aforementioned effects. Therefore, the main objective of the current study is to examine the impact of the oil price hike on economic growth of the OECD countries, aligning with the framework of [7]. Apart from that, the present study eliminates methodological weaknesses attached to both time series and cross-sectional analyses by employing dynamic panel data analysis based on the Generalized Method of Moment (GMM). Cross–sectional analyses suffer from endogeneity and omit variable biases while the results of the time-series analyses cannot be generalized. Apart from that, estimators of Ordinary Least Squares (OLS) and Fixed Effects models are biased and inconsistent due to the endogenous nature of dynamic growth regressions. Hence, dynamic panel data analysis based on the GMM method is one of the best suited models to eliminate the methodological weaknesses in the literature. The findings of the study

confirms that there is a mixed impact of oil price on economic growth. More specifically, an increase in oil price enhances economic growth only through the interest rate while reducing economic growth through all other channel variables, such as exchange rate, government expenditure and investment.

The rest of the paper can be outlined as follows. The next section critically evaluates the existing body of knowledge on the oil price–growth nexus. After that, the methodology adopted in the study is elaborated followed by the results and discussion sections. The conclusions and recommendations of the study are indicated in the final section of the paper.

2. Literature Review

The relationship between oil prices and economic growth has been historically investigated by scholars such as [3–6] and most of the historical studies emphasized that energy price can affect economic activities through both supply and demand sides. Especially, Rasche & Tatom [6] and Okonjo-Iweala [8] highlighted that an increase in unrefined oil prices may lead to a shortage of energy and thereby, an oil price increase affects economic growth through the supply side. In fact, the oil price crisis in the 1970s led to the movement called 'limits to growth' and also a stream of ecological economics [9]. As Cleveland et al. [10] indicated, the ecological economists have empirically proven that a low oil price can positively affect economic growth by increasing labor productivity. Aligned with this historical argument between the oil price and economic growth, Ayres and Warr [11] also observed that oil price reduction essentially spurs economic growth, and this argument was also empirically confirmed by [4]. Empirical literature has addressed the link between the oil price and economic growth in terms of both oil-exporting countries and -importing countries. Scholars such as [12–14] indicated that an oil price hike positively affects the economic growth of oil-exporting countries. According to [15], an oil price hike essentially increases the income of such countries, leading to higher consumption and investment followed by higher economic growth. In contrast, scholars such as [16–18] stated that an increase in oil price drastically affects the economic growth of oil-importing countries. However, the majority of empirical works such as [4], Bjørnland [19], Refs. [9,20,21] emphasized that an increase in oil price adversely affects economic growth irrespective of the nature of the country.

Lee and Ni [22] recognized that energy prices influence economic activities mostly through households' and firms' consumption expenditure, as consumers' demands are highly responsive to an oil price hike. Similarly, Similarly, Kilian [23] and Kilian and Park [24] also confirmed the notion of [22] and mentioned that the oil price can have an adverse effect on economic growth not only through the production cost but via the consumptions of households and firms as well. In fact, Hamilton [25] in the context of the United State of America (USA), confirmed that an oil price hike accounts for lower demand for automobiles and consequently, the automobile sector is adversely affected. Moreover, Kilian [23] stressed that the oil price can affect economic growth through household expenditure based on five effects such as the income effect, uncertainty effect, precautionary effect, durable effect and reallocation effect.

The volatility of the oil price and its effect on real production have been addressed by scholars such as [19,26–28]. According to Okonju [28], oil prices frequently fluctuate, and this volatile nature of oil prices is not desirable for economic activities. Similarly, Refs. [19,26,27] also concluded that volatile oil prices create a significant adverse impact on economic growth irrespective of the nature of countries. However, El-Anshasy et al. [29] argued that the negative impact of oil price fluctuation can be mitigated through effective and appropriate fiscal policies, while [30] examined the possibility of reducing the impact of oil price volatility on economic growth through established financial institutions.

Kilian and Lewis [31] found that an oil price hike affects economic growth through inflation. According to Kilian and Lewis [31], the oil price leads to an increase in the general price level of a country and consequently, inflationary pressure affects the economic activities of a country. Similarly, Nordhaus [32] stated that an oil price hike mainly affects

headline inflation rather than core inflation and therefore, households can be affected. However, Kilian [33] had argued that sometimes the ultimate effect of an oil price hike may create deflationary pressure due to discouraged consumers' demand. However, Bernanke et al. [34] has argued that the oil price affects economic growth not just through higher inflation but via higher interest rates. According to Bernanke et al. [34], central banks increase interest rates to control inflationary pressure and thereby, the economic growth can be affected as the higher interest rate declines investment. Therefore, Bernanke et al. [34] and Hamilton and Herrera [35] also stressed that an oil price hike may cause economic recession as well.

Taking more recent empirical analyses into account, Mo et al. [36] investigated the impact of the oil price on the economic growth of Brazil, Russia, India, China, and South Africa (BRICS) countries by employing the Wavelet-based Quantile-on-Quantile method. Mo et al. [36] observed mixed results in the context of BRICS countries and highlighted that the impact of oil price on economic growth is highly diverse due to different types of oil price policies and therefore, impact can vary across time periods, countries and quantiles. Apart from that, Liaqat [37] examined the impact of the oil price on the economic growth of Pakistan over the period 1972–2020 using the Autoregressive Distributed Lag (ARDL) model. Liaqat [37] observed that an oil price hike adversely affects both short and long runs while increasing the inflationary pressure in the economy. However, Liaqat [37] applied a conventional time series analysis and therefore, the results cannot be generalized. Unlike the time series analysis of Liaqat [37], Akinsola & Odhiambo [38] employed a panel-Auto Regressive Distributive Lag (Panel ARDL) model to observe the relationship between economic growth and oil price in seven Sub-Saharan African (SSA) countries. Despite Liaqat [37] having confirmed that the oil price adversely affects economic growth both in the short and long run, Akinsola & Odhiambo [38] stressed that the oil price has no significant impact on economic growth during the short term. However, Akinsola & Odhiambo [38] and Bjørnland [19] emphasized that the oil price negatively affects the economic growth of SSA countries during the long term. Işık et al. [39] have proposed a composite model which incorporates both the Armey Curve (AC) and Environmental Kuznets Curve (EKC) to reinvestigate the EKC for 7 US states. However, this study has specifically focused on golden level spending which minimizes CO_2 emission which is required for a lower level of environment degradation. Despite Işık et al. [39] being theoretically important in terms of Environmental Economics, they have limited relevance in terms of quantifying the impact of oil price on economic growth.

Despite a great deal of literature highlighting that the oil price significantly and negatively affects economic growth, there are a number of studies which have ended up with conflicting findings. A study by Chang and Wong [40] which focuses on the oil price–growth nexus in Singapore found that there is no statistically significant relationship between oil price and economic growth and also, with other macroeconomic variables such as inflation and unemployment, while Olomola and Adejumo [41] and Oriakhi and Osaze [42] have confirmed a positive relationship between oil price and economic growth in the context of Nigeria. Similarly, Hamilton (2003) [43] also indicated that oil price changes may have a positive impact on economic activities rather than negative impacts. Especially, Jiménez-Rodríguez and Sanchez [9] stated that an increasing oil price has a more substantial impact on the economic performance of OECD countries compared to the effect of a falling oil price. Apart from that, Maalel and Mahmood [44] found an asymmetric effect of the oil price on economic growth in the context of the Gulf Cooperation Council, while Odhiambo [45] highlighted that the impact of the oil price on economic growth varies across countries, over time and also based on the sample selected. The same notion was highlighted by Mo et al. [36] in the context of BRICS countries. Under this scenario, the current study revisits the oil price–growth nexus, providing more rigorous and updated empirical evidences to the conflicting findings in the literature.

3. Methodology

3.1. Data and Conceptual Framework

The study is mainly based on secondary data collected from 38 OECD countries over the period 2000–2020. The detail of each variable and related data sources are explained in the operationalization in the next section. The present study believes that the impact of an oil price hike on economic growth can occur through several channels rather than in its direct effect. The oil price associates with the number of key macroeconomic variables in the economy, and such macroeconomic variables have a direct relationship with economic growth. Consequently, the conceptual framework proposed by Frimpong et al. [7] was utilized with few modifications. Figure 3 below indicates the conceptual framework used for the study.

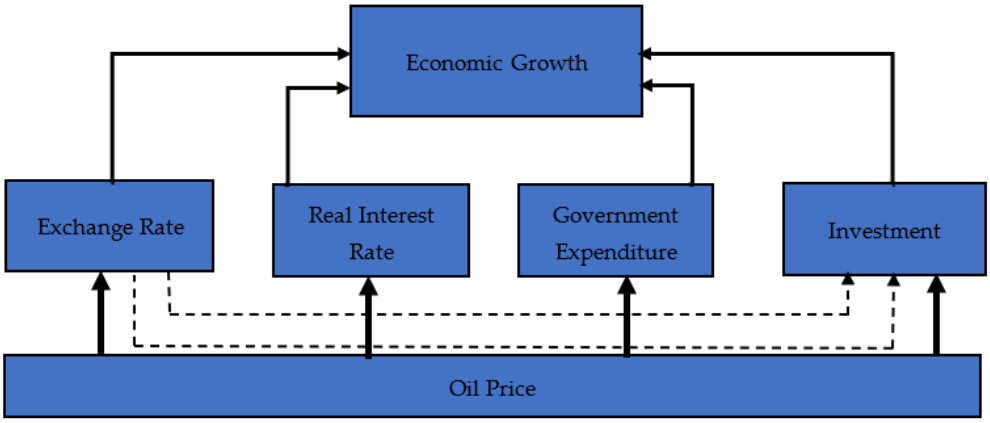

Figure 3. Conceptual Framework. Source: Created by authors based on Frimpong et al. [7].

According to the framework, four main channel variables were recognized based on Frimpong et al. [7]. In fact, Frimpong et al. [7] used five channel variables, such as exchange rate, interest rate, government consumption, inflation and investment. However, the present analysis does not consider inflation as a channel variable, as inflation highly correlated with some of the independent variables in the regression model.

A higher oil price leads to an increased exchange rate (depreciate), especially in oil-importing countries, as an oil price hike increases the demand for foreign currencies. The depreciated exchange rate may worsen the trade balance followed by the economic growth of the importing country. Similarly, the depreciated exchange rate can also affect investment as well. Apart from that, an increased oil price results in higher inflationary pressure and thereby, a lower real interest rate. The lower real interest rate may lead to capital outflows and therefore, both investment and economic growth are affected. Government expenditure is one of the crucial components of economic growth. An oil price hike certainly increases the government expenditure and therefore, the allocation of resources for other economic activities is restricted. Hence, an oil price hike can affect economic growth through increased government expenditure as well. Investment is one of the crucial determinants of economic growth, and a higher oil price adversely affects investments and thereby, economic growth as well. In fact, an oil price hike essentially increases the cost of production and therefore, the investments are discouraged. Under this scenario, the aforementioned conceptual framework can be applied and the effect of the oil price on economic growth can be quantified through the transmission mechanism of channel variables such as exchange rate, real interest rate, government expenditure and investment.

The present study initially examines the impacts of each variable (except oil price) on economic growth followed by the impact of oil price on each channel variable. After that, the impact of the oil price on economic growth is calculated by considering the combined effects of oil price on channel variables and the effects of channel variables on economic growth.

3.2. Operationalization and Empirical Model

The operationalization related to the conceptual framework highlighted in Figure 3 is indicated in Table 1 below. In addition to the variable highlighted in the conceptual framework, openness is also considered as a control variable as indicted in the operationalization.

Table 1. Operationalization of the Research.

Variable Name	Description	Source
Log of RGDP	Logarithm of Real Gross Domestic Production	World Development Indicators
Log Oil Price	Logarithm of Annual Average Oil Price	Organization for Economic Co-operation and Development Petroleum database (https://data.oecd.org/energy/crude-oil-import-prices.htm, accessed on 3 July 2022)
Log Real Interest Rate	Logarithm of Real Interest Rate	World Development Indicators
Log Gov. Expenditure	Logarithm of Government Expenditure	World Development Indicators
Log Exchange Rate	Logarithm of Exchange Rate (USD)	World Development Indicators
Log Investment	Logarithm of Total (Private & Public Investment)	World Development Indicators
Log Inflation	Logarithm of Consumer Price Index	World Development Indicators
Log Openness	Logarithm of Total Trade	World Development Indicators

Source: Created by authors.

The oil price–growth nexus has been examined by a great deal of literature; however, most of the studies have an in-built methodological weakness, hence leading to wrong conclusions and policy implications. Specifically, cross-sectional analyses [9,44,46] which take averages of data series hinder the time-series variation in variables. Similarly, most of the cross-sectional analyses suffer from endogeneity and omitted variable biases. Apart from that, the results of time-series analyses [47–49] cannot be generalized, as such analyses focus only on one country's scenario. Additionally, estimators of conventional Ordinary Least Squares (OLS) and Fixed Effects models are biased and inconsistent due to the endogenous nature of dynamic growth regressions. Hence, the current studies attempt to minimize the methodological issues attached to the literature by employing dynamic panel data analysis based on the Generalized Method of Moment (GMM). The GMM dynamic panel data technique developed by Arellano and Bond [50] and Arellano and Bover [51] can be used to control the unobserved country-specific effects by introducing the difference of the regression equation Yüncü [52]. This approach eliminates country-specific omitted variable bias and the endogeneity problem by introducing appropriate instruments (Levine, 2003 [53]).

Aligning with GMM dynamic panel analysis, the panel growth regression can be expressed as follows:

$$logy_{i,t} = \gamma + \alpha logy_{i,t-1} + \acute{\beta} X_{i,t} + \acute{\delta} C_{i,t} + \mu_i + e_{t,i} \quad (1)$$

In Equation (1), $logy_{i,t}$, the dependent variable of the growth regression, is the logarithm of Real Gross Domestic Product (RGDP) for country i at time t. Similarly, $logy_{i,t-1}$ is the logarithm of the lag of RGDP. $X_{i,t}$ is the vector of channel variables, while $C_{i,t}$ is the vector of control variables. μ_i in Equation (1) indicates the unobserved country-specific fixed effect while $e_{t,i}$ is the random error term.

The Equation (1) can be written as Equation (2) below by getting the difference of Equation (1) in order to capture the growth rate.

$$\Delta logy_{i,t} = \gamma + (\alpha - 1) logy_{i,t-1} + \acute{\beta} X_{i,t} + \acute{\delta} C_{i,t} + \mu_i + e_{t,i} \quad (2)$$

$\Delta logy_{i,t}$ in Equation (2) indicates the economic growth rate for country i at time t. The growth Equation (2) empirically estimates the impact of channel variables and other control variables on economic growth.

The next step is to examine the impact of the oil price on channel variables as the impact of the oil price on economic growth is calculated as a combined effect of both the impact of the oil price on channel variables and the impact of channel variables on economic growth. Hence, Equation (3) is empirically estimated to capture the impact of the oil price on channel variables.

$$logX_{i,t} = \varnothing + \mu logOP_{i,t} + \acute{\varphi}C_{i,t} + \mu_i + u_{t,i} \quad (3)$$

In Equation (3), $logX_{i,t}$ represents all the channel variables considered, $logOP_{i,t}$ indicates the oil price for country $\boldsymbol{i}$ at time t, and $C_{i,t}$ shows the vector of control variables. Apart from that, μ_i in Equation (1) indicates the unobserved country-specific fixed effect while $u_{t,i}$ is the random error term.

Both Equations (2) and (3) are empirically estimated using GMM dynamic panel data analysis. Aligned with [54], the lag values of the independent variables are used as instruments of each model to address the endogeneity issue. The overall accuracy and consistency of the models are tested using the Sargan and Serial Correlation testes. The Sargan test of over-identifying restrictions used to test the overall validly of the moment condition and the instruments, while the Serial Correlation test is carried out to check whether the error terms are serially correlated.

4. Results and Discussion

4.1. Descriptive Analysis

The descriptive analysis of the considered variables is indicated in Table 2. The log transformation of all the variables is considered mainly due to two reasons. The first is that the log transformation of the variables allows one to interpret the estimated coefficients as elasticities, and therefore, a meaningful interpretation can be documented. Secondly, the log transformation of the variables reduces unnecessary variation and fluctuation of the variables and smoothens the data series. The Table 2 indicates the summary statistics of all variables highlighting mean, standard deviation and minimum and maximum values. The number of observations is 760 each for all variables considered in the study.

Table 2. Summary Statistics of the Variables.

Variables	Mean	Standard Deviation	Minimum	Maximum
Log Oil Price	4.02	0.38	3.12	5.23
Log Interest Rate	1.92	0.32	1.65	2.34
Log Gov. Expenditure	32.45	4.12	27.32	39.21
Log Exchange Rate	7.23	0.67	−0.32	9.62
Log Investment	37.21	2.01	28.64	41.92
Log Inflation	4.21	0.52	2.05	8.75
Log Openness	5.75	0.37	4.23	8.27
Log Growth	3.53	0.72	1.23	5.73

Source: Calculated by authors based on World Bank data.

According to the standard deviation of the summary statistics, all the variables have less variation from their mean values except both log of government expenditure and log of investment, which have slightly higher standard deviations compared to other variables.

4.2. GMM Panel Data Results on Growth Model and Channel Variables

The results of the growth equation and other channel equations are presented in Table 3 below. The second column of Table 3 indicates the estimated coefficients of the growth equation. According to the lag growth variable (Growth (−1)) the current growth rate

mainly depends on the GDP of the previous year. The estimated coefficient indicates that a 1% increase in previous economic growth rate increases the present growth rate by 0.6564%. The interest rate has negatively associated with the growth and more specifically, a 1% increase in the interest rate reduces the growth by 0.0434%. A higher interest rate reduces the investment and thereby, the growth decreases. Similarly, both government expenditure and exchange rate also negatively link with economic growth, reporting coefficients of −0.0062 and −0.0023, respectively. In fact, an increase in exchange rate (depreciation of domestic currency) essentially increases the prices of imports and therefore, production processes which depend on importing inputs are discouraged. Consequently, economic growth is adversely affected by the increased exchange rate.

Table 3. Results of the GMM Dynamic Panel Data Analysis.

	Channel Variables				
	Growth	**Real Interest Rate**	**Exchange Rate**	**Gov. Expenditure**	**Investment**
Growth (−1)	0.6564 *** (4.5901)				
Log Oil Price		−0.0322 ** (−2.5320)	0.0231 ** (2.3402)	0.2781 *** (4.2510)	−0.0061 * (−2.0021)
Log Real Interest Rate	−0.0434 ** (−2.5786)		−0.0043 ** (−2.2101)		−0.0352 ** (−2.4012)
Log Gov. Expenditure	−0.0062 * (−2.0238)				
Log Exchange Rate	−0.0023 *** (−3.2101)			0.0012 (0.9878)	
Log Investment	0.0322 ** (2.3021)	−0.0021 (−0.2788)	−0.0076 * (−1.9897)	0.0028 * (2.0087)	
Log Inflation	0.0023 * (2.0352)	−0.0032 ** (−2.2872)	0.0023 (1.0023)		
Log Openness	0.0067 ** (2.5630)				0.0045 * (2.0183)
Observations	760	760	760	760	760
Sargan Test [1] (p-Value)	0.3245	0.4524	0.3082	0.4962	0.2878
Serial Correlation [2] (p-Value)	0.4615	0.6328	0.5282	0.6296	0.4212

Source: Calculated by the authors based on World Bank data. [1] Sargan Test has the null hypothesis that the over-identifying restrictions are valid. [2] Serial Correlation Test has the null hypothesis of error terms that are not serially correlated. *** Significant at 1% ** Significant at 5% * Significant at 10%.

Apart from that, both inflation and openness also indicate a positive relationship with growth. More specifically, a 1% increase in inflation and openness may increase the growth by 0.0023% and 0.0067%, respectively. The estimated coefficients of the growth equation are consistent with the studies such as Bleaney at al. [55], Barro et al. [56], Barro & Sala-i-Martin [57], Anaman [58] and Asheghian [59].

Empirical estimation of the channel variables is indicated in the 3rd to 6th columns in Table 3. The 3rd column highlights the impact of the oil price on real interest rate and confirms that all three variables—oil price, investment and inflation—negatively affect the real interest rate. Specifically, a one percent increase in oil price may decrease the real interest rate by 0.0322. In fact, the inflationary pressure created by an oil price hike essentially reduce the real interest rate. It is proven by the coefficient estimated for inflation and it reveals that a one-percent increase in inflation reduces the real interest rate by

0.0032 percent. However, investment has not been a significant factor of the real interest rate in the equation estimated for the real interest rate.

According to the exchange rate equation estimated in column 4, the oil price increases (depreciates) the exchange rate. More specifically, a one-percent increase in oil price causes the exchange rate to depreciate by 0.0231 percent and the relationship is statistically significant at a five-percent level. When the oil price is increasing, the demand for foreign reserves increases and consequently, exchange may depreciate based on the market forces for the exchange rate. Apart from that, the interest rate is negatively associated with the exchange rate, which is also statistically significant at a five-percent level. The negative relationship between the interest rate and exchange rate can be mainly justified through capital and investment inflows. The higher interest rate attracts more foreign investment and capital flows and hence, the exchange rate appreciates due to increasing the supply of foreign reserves.

The last column in Table 3 indicates the investment equation, which elaborates the impact of oil prices on investment. According to the results, the oil price negatively associates with investment and a one percent increase in the oil price decreases investment by 0.0061%, and the relationship is statistically significant. Crude oil is one of the crucial factors in all investment sectors and therefore, the oil price hike essentially discourages investment activities. Similarly, interest rates are also negatively associated with investment, reflecting how a higher interest rate is not favorable for investments. In fact, a higher interest rate increases the cost of capital and therefore, investors are discouraged. Apart from that, openness increases the investment and a one-percent increase in openness may increase the investment by 0.0045 percent.

4.3. Estimation of the Impact of Oil Price on Economic Growth

According to the estimated results, Table 4 summarizes the impact of the oil price on channel variables and economic growth. As indicated in the conceptual framework, the study quantifies the impact of oil price on economic growth through different channels as an indirect effect. Therefore, the second column of Table 4 indicates the effect of oil prices on channel variables, while column 3 summarizes the impact of channel variables on economic growth. The 4th column indicates the impact of oil price on economic growth as a combined effect of both column 2 and 3. In fact, the effect of the oil price on economic growth is the product of the effect of the oil price on channel variables and the effect of channel variables on economic growth.

Table 4. Effect of Oil Price on Channel Variables and Economic Growth.

Channel Variables	Effect of Oil Prices on the Channel Variables	Effect of Channel Variables on Economic Growth	Effect of Energy Prices on Economic Growth
Interest Rate	−0.0322	−0.0434	0.00139
Exchange Rate	0.0231	−0.0023	−0.000053
Govt. Expenditure	0.2781	−0.0062	−0.001724
Investment	−0.0061	0.0322	−0.000196
Total Negative Effect			−0.001973
Total Positive Effect			0.00139
Total Net Effect			−0.000583

Source: Calculated by authors based on data analysis.

As indicated by Table 4, the oil price positively affects economic growth through some of the channel variables and negatively affects other channel variables. Hence, the oil price has a mixed impact on economic growth. Specifically, the oil price positively associates with economic growth only through the interest rate channel. As Table 4 indicates, a one-percent increase in oil price increases the economic growth by 0.000139 percent through

the interest rate channel. A higher oil price reduces interest and a lower interest rate accelerates the economic growth by encouraging investments. However, the impact of the oil price on economic growth through all other channel variables is negative. Thus, the total negative impact of the oil price increase on economic growth is 0.001973 while the positive impact is 0.00139. Consequently, the net effect of the oil price hike on economic growth is negative (−0.000583). More specifically, a one-percent increase in oil price drops economic performance by 0.000583 percent. The findings of the current study are also in line with the studies such as Arshad et al. [60], Bhattacharya & Bhattacharya [61], Hsing [62] and Bouzid [63] related to Pakistan, India, Germany and Tunisia, respectively.

Figure 4 above clearly illustrates the impact of the oil price on economic growth through different channel variables. As Figure 4 indicates, the highest negative impact of the energy price on economic growth has come through government expenditure followed by investment. Moreover, Figure 4 also visualizes the total negative and positives effects related to each channel variable along with the total net effect of the oil price on economic growth.

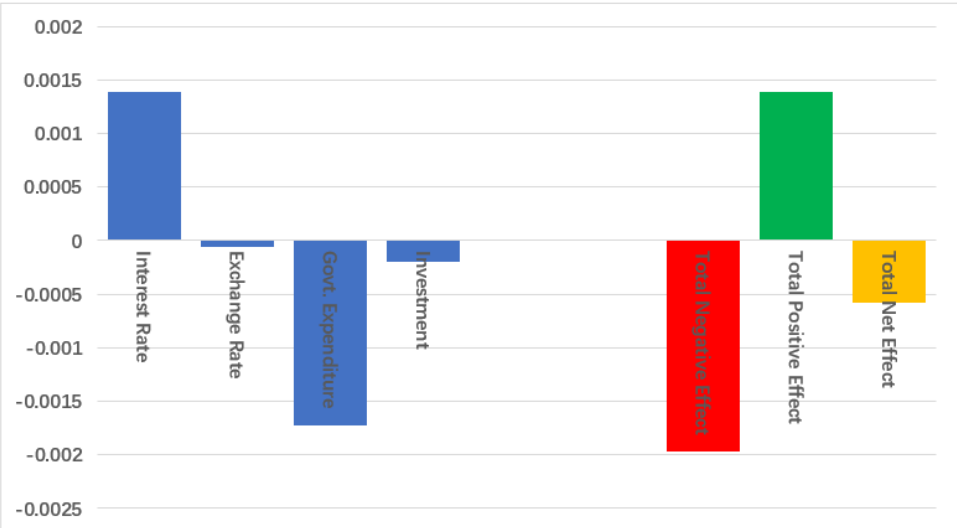

Figure 4. Impact of Oil Price on Economic Growth. Source: Created by authors based on data analysis.

5. Conclusions and Recommendations

The present study examines the impact of the oil price on the economic growth of OECD countries. The study considered 38 OECD countries based on the availability of data and secondary data mainly collected from the World Development Indicators of the World Bank over the period 2000–2020. The study examined the impact of oil price on economic growth through four channel variables: real interest rate, exchange rate, government expenditure and investment. The empirical models are estimated using GMM panel data analysis which includes the lag of the independent variables as instruments. According to the estimated growth equation, the economic growth of the previous year, interest rate, government expenditure, exchange rate, investment, inflation and openness are recognized as the key factors for economic growth in the considered countries. Moreover, the study confirms that the oil price negatively affects the channel variables such as interest rate and investment, while being positively associated with both exchange rate and government expenditure.

The effect of the oil price on economic growth has been calculated by taking the product of the effect of oil prices on the channel variables and the effect of channel variables on economic growth. The estimated results reveal that there is a mixed impact of oil price on economic growth. More specifically, an increase in the oil price positively affects economic growth only through the interest rate, while the oil price hike negatively affects economic growth through all other channel variables such as the exchange rate, government

expenditure and investment. Since the total negative effect of the oil price on economic growth outnumbers the positive effect, the net impact of the oil price hike on economic growth is negative, and it elaborates that a one-percent increase in oil price drops economic performance by 0.000583 percent. Since the economic growth is affected bythe oil price hike through different channels, the study strongly recommends applying appropriate polices to reduce oil price fluctuations while encouraging the use of country-specific renewable energy sources.

The main limitation of the present study is that the study has only focused on the OECD countries and therefore, the findings may not be applicable to some developing countries. Moreover, the study has used only four channel variables based on the availability of data. Therefore, the study recommends future studies to consider a world-wide analysis, incorporating more channel variables into the model. Furthermore, it is suggested to develop a composite index for energy prices which allows the capture of the impact of overall energy prices on economic growth.

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