

Research Article

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Crude oil, natural gas, and economic growth: impact and causality analysis in Caspian Sea region

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Abstract: The main objective of this study was to investigate the impact and causality of crude oil and natural gas on economic growth in the Caspian Sea region. Here, the study applies ordinary least square (OLS) method and Granger causality test using time series data from 1997 to 2015 to ascertain the impact and causality of crude oil and natural gas on economic growth. The results, according to the OLS method, evince that crude oil and natural gas have a significant impact on economic growth of the region. Alongside, considering causality test, gross domestic product (GDP) does Granger cause (unidirectional) crude oil price and export which denotes that GDP can help to forecast crude oil price and export; however, crude oil price and export cannot help to forecast GDP. Surprisingly, this direction is unlikely for GDP and natural gas. GDP and natural gas have unidirectional, but opposite causal relationship, i.e., natural gas price and export do Granger cause GDP which signify that natural gas price and export can help to forecast GDP; however, GDP cannot help to forecast crude oil price and export.

Keywords: Caspian Sea Region, European Union, Crude Oil, Natural Gas, Economic Growth

1 Introduction

Energy acts as lifeblood of the global modern economy, whereas oil and natural gas capture most of its area [Trench and Miesner, 2006, p. 10]. It is a crucial input for most of the goods and services and has an enormous impact on people's regular life. For these reasons, millions of people's living standards oscillate when the price of energy becomes unstable and unreasonable. As with people, countries in which economy totally or partially depends on energy also experience economic hardship with the lackadaisical behavior of energy prices. Importantly, the sluggish energy price has an enormous impact on economic growth of a country [Bayraktar et al., 2016, p. 14]. Various kinds of energy denominations have in our world such as crude oil, natural gas, coal, electricity, solar, and so on. Among them, crude oil and natural gas are the main driving forces, especially crude oil that has been dominating the energy market as a major commercial energy factor since the downturn of the coal, and also numerous studies suggest that it will be continuing its realm over the twenty-first century. In 2002, around 40% of the world energy mix was possessed by oil, whereas around 25% of the commercial energy by natural gas. However, reportedly, it will turn to 36.9% and 29.9% for oil and natural gas, respectively, in 2025 [Rahman, 2004, p. 8]. According to International Energy Agency (IEA), Key World Energy Statistics (KWES) 2016, on the one hand, crude oil accounted for 33.3% of the world¹ total primary energy supply in 2014. On the other hand, natural gas accounted for 21.2% of the

¹ World includes international aviation and international marine bunkers.

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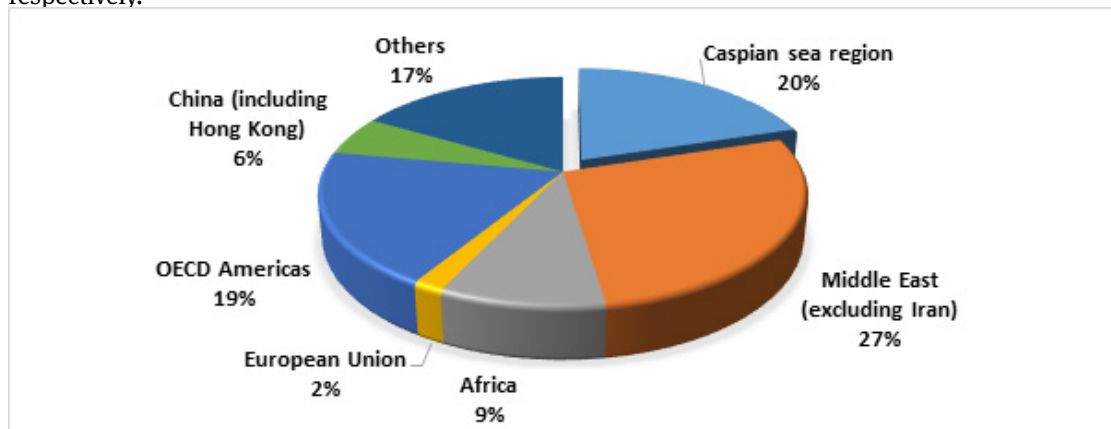
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world total primary energy supply. Now considering consumption, oil contributed 39.9% in the world final consumption in 2014, whereas natural gas only 15.1%. This consumption and supply depend on how much production oil and natural gas have all over the world.

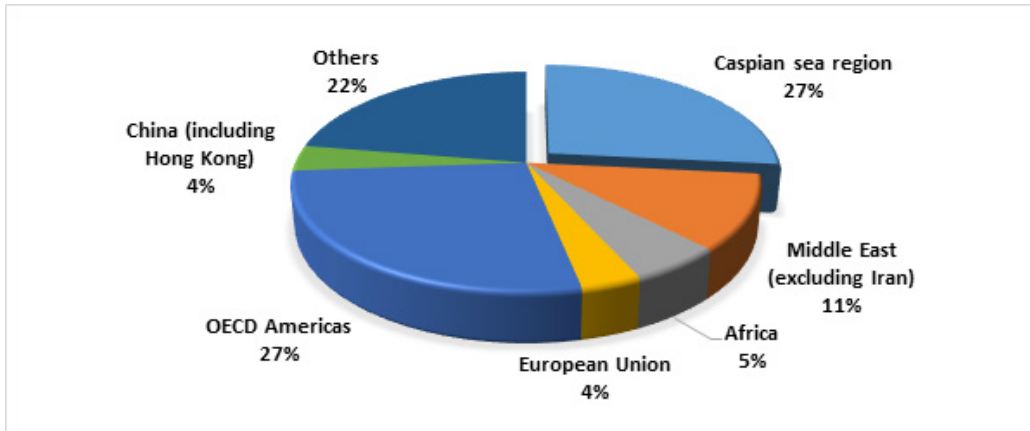
Crude oil and natural gas play an important role in the world economy. Most of the aspects of our lives are directly or indirectly related to the energy, especially, crude oil and natural gas. A study on China's macroeconomic performance found that oil price affects the economic growth significantly [Du et al., 2010, p. 9]. Economically, the abundance of crude oil and natural gas is a strength for a country because of its necessity in our regular life, e.g., transportation fuel, petroleum products, and so on. Therefore, it is a blessing for a country in that sense. According to Henry Kissinger, the former national security advisor of the USA, "Control oil and you control nations; control food and you control the people." Now, due to the ample demand for oil and gas, the reserve of these resources is declining day by day, although discovering new crude oil and natural gas field is continuing. Nonetheless, this demand for crude oil and natural gas leads the crude oil and natural gas affluent countries huge advantages for their economy; however, perhaps, it may no longer be same if there are no alternatives for it. Countries such as Kuwait, Saudi Arabia, Azerbaijan, Russia, and Kazakhstan are mostly depended on fuel economic growth [Hazarika, 2016, p. 1]. Most of the countries around the world satisfy their oil and gas needs from some specific regions or countries such as Persian Gulf, Caspian Sea, North America, South America, North Africa, and so on. Needless to say, the Persian Gulf and Caspian Sea region are strategically and geopolitically most important for the world's crude oil and natural gas demand because of their crude oil and natural gas cornucopia and geographical position. Historically, after the breaking up of the Soviet Union, the Caspian Sea region has been experiencing a substantial change; it is becoming internationalized to an extent not seen before, and a major reconfiguration of power and influence is taking place. Crumbling Russia's role and weakening influence in the Caucasus and in Central Asia since 1991 have opened the doors for external actors to engage in the region. In that continuation, the possibility for the exploitation of crude oil and natural gas in the region has raised the stakes of external actors [Jonson, 2001, p. 1].

Verily, the Caspian Sea region has a significant contribution in the world crude oil and natural gas production and export. For that reason, considering the production and export of crude oil and natural gas in 2015, the study divides the world into seven import parts to redefine the Caspian Sea region (considering Iran out of the Middle East). The world proportion of crude oil and natural gas production and export is given in the following paragraphs.

Graph 1.1 shows different regions' percentage of production of crude oil. Here, Caspian Sea region hold the second highest position among the regions. It exploited a significant amount (20%) of crude oil considering the world's crude oil production in 2015. Alongside, in the meantime, Middle East (excluding Iran) produced 27%, Organization for Economic Co-operation and Development (OECD) Americas 19%, Africa 9%, European Union 2%, China (including Hong Kong) 6%, and the rest of others produced 17%, respectively.

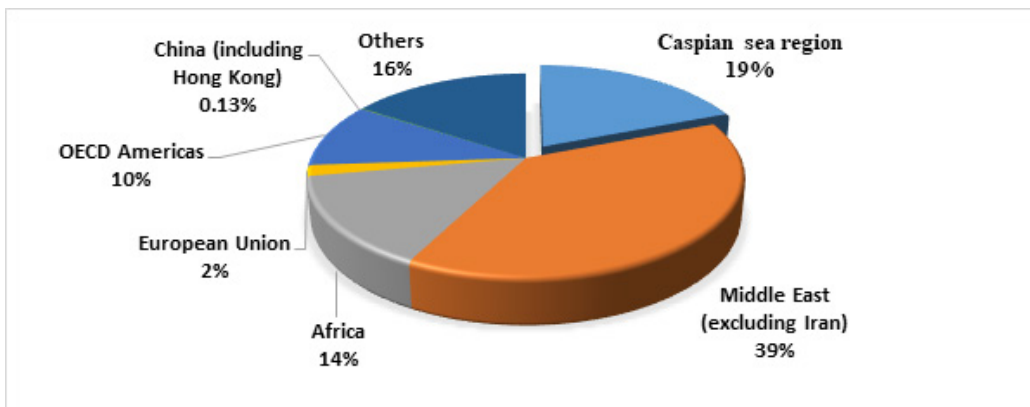


Graph 1.1. Percentage of crude oil production by region in 2015. Source: IEA (authors' computation)
Abbreviation: IEA, International Energy Agency



Graph 1.2. Percentage of natural gas production by region in 2015. Source: IEA (authors' computation)
Abbreviation: IEA, International Energy Agency

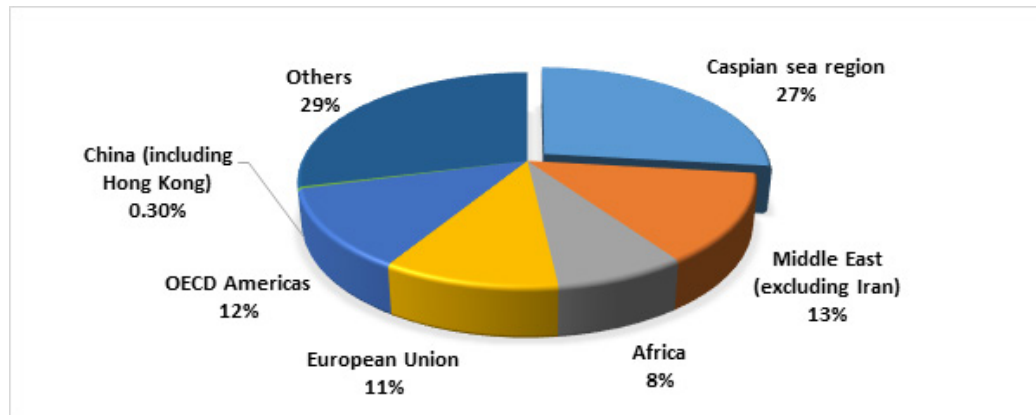
Graph 1.2 shows the proportion of producing natural gas of different regions in the world. As the graph shows, the Caspian Sea had the biggest part of the pie and became the topmost region which produced the highest amount of natural gas (around 27%) in 2015. In the meantime, OECD Americas became the second largest producer of natural gas. Importantly, the Middle East which is prominent for crude oil also produced a significant amount of natural gas that was around 11% of the total world production.



Graph 1.3. Percentage of crude oil export by region in 2015. Source: IEA (authors' computation)
Abbreviation: IEA, International Energy Agency

Graph 1.3 shows the percentage of the total export of crude oil by region in the world. It denotes that Middle East, the largest exporter of crude oil in the world, exported more than two-thirds of the world's total crude oil export, around 39%, in 2015. Significantly, the Caspian Sea region became the second largest exporter in that time and exported around 19% of the world's total crude oil. Here, it is noticeable that China (including Hong Kong) exported only 0.1364% which is nearly 0% of the world's total export of crude oil.

Graph 1.4 shows the proportion of natural gas export by region in the world. As the highest producer of natural gas, the Caspian Sea region also exported the highest amount of natural gas in 2015 which was almost one-third of the world's total natural gas export. Alongside, interestingly, most of the other regions exported proportionately similar amounts of natural gas (considering production) in the same year. Here, as with crude oil export, China (including Hong Kong) exported nearly zero amount of natural gas—around 0.3073%—in 2015.



Graph 1.4. Percentage of natural gas export by region in 2015. Source: IEA (authors' computation)
Abbreviation: IEA, International Energy Agency

The Caspian Sea is a landlocked body of water between Europe and Asia surrounded by five littoral (coastal) countries—the southwest by Azerbaijan, south by Iran, northeast by Kazakhstan, southeast by Turkmenistan, and the northwest by Russia—border inland sea. The region contains large volumes of crude oil and natural gas reserves in both offshore deposits in the Caspian Sea and onshore fields in Caspian basin. As with reserve, it exploits a significant volume of crude oil and natural gas. The US Energy Information Administration (EIA) estimated (2012) that the Caspian basin area contains approximately 48 billion barrels of oil and 285 trillion cubic meters of gas in proven or probable reserves. Amid this reserve, 75% of crude oil and 67% of natural gas situated within 100 miles of coastal area. In addition, the US Geological Survey (USGS) estimated that the Caspian Sea region has a mean of approximately 20 billion barrels of undiscovered² oil resources and 243 trillion cubic feet of undiscovered natural gas resources. It is also estimated that around 61% of undiscovered oil and 81% of natural gas are located in the south of Caspian basin. On the other hand, the production of crude oil in Caspian basin area approximately 2.6 million per day is accounted for 3.4% of the world supply. As with crude oil, it produced approximately 2.5 billion cubic feet per year.

Due to the abundance of crude oil and natural gas reserve, their economy mostly depends on these two denominations. Simply put, they export a huge amount of crude oil and natural gas to other countries. In the region, Russia is the biggest exporter in European Union energy market. According to European Commission, in 2007, the European Union imported around 185 million tons of crude oil and 100.7 million tons of oil equivalents of natural gas which accounted for 32.6% and 38.7% of total oil and natural gas import of European Union, respectively.

On the other hand, China is also a large importer which imports a significant amount of crude oil and natural gas from the Caspian Sea region; it is mainly because of their domestic energy demand. According to Caspian report, China imports natural gas from Turkmenistan through Central Asia–China Gas Pipeline which started in 2006 and accounts for around 40 billion cubic meter natural gas per year. Recently, in 2013, they signed a new agreement by which China imports 25 billion cubic meter natural gas, totally 65 billion cubic meters, and it will continue until 2020. Along with European Union and China, Turkey is also an important importer for the Caspian Sea region. According to Central Intelligence Agency (CIA) Factbook, Turkey consumes more oil and natural gas than its production; its consumption is growing day by day. It already imports a significant amount of gas from Russia and has a good relationship with other Caspian region's countries. Importantly, some significant Caspian region's gas pipelines enter European Union markets through Turkey such as Trans-Anatolian Natural Gas Pipeline (TANAP), Baku–Tbilisi–Ceyhan Pipeline, and so on. For that reason, Turkey becomes an important player for the energy market in the Caspian Sea region. Finally, Japan, India, and Pakistan also import from the Caspian region; their

² Undiscovered resources mean the resources technically recoverable

demand is increasing day by day. In that continuation, the proposed Trans-Afghanistan Pipeline—which will transport natural gas from Caspian region's Turkmenistan through Afghanistan to Pakistan and then India—will adjoin Caspian region with India and Pakistan. Now considering all the countries' significant demand for crude oil and natural gas, Caspian Sea is becoming a more important player in the world energy market.

Although the Caspian Sea region has an enormous amount of crude oil and natural gas reserve and its contribution in the world energy market, there is no such study that explains the impact of crude oil and natural gas on economic growth in the Caspian Sea region. On the other hand, most of the studies about Caspian countries consider individual variable of crude oil and natural gas rather than using most prominent variables together which insinuates an ambiguity for accurate findings of the region. This study deals with these two conspicuous problems and evaluates, on the one hand, the impact and causality of crude oil and natural gas on economic growth in the region, and on the other hand, it considers most important variables of crude oil and natural gas—reserve, export, production, and price rather than using just one variable. For these reasons, the main objective of this study was to investigate the impact and causality of crude oil and natural gas on economic growth in the Caspian Sea region.

2 Literature review

Energy plays a key role in our regular life where crude oil and gas are the important energy resources which influence a country's as well as region's economy. This study analyzes the impact and causality of crude oil and natural gas on economic growth in the Caspian Sea region. Surprisingly, no studies in academia have ever investigated the region (considering five countries together) before. This absence of unanalyzed Caspian Sea region recognizes the research as a unique study in the academic arena. However, there are some studies conducted on the impact of crude oil and natural gas on economic growth in the Caspian Sea region's countries individually as well as other countries and region. Now, to evince a conspicuous academic contribution on the region's energy and economic relationship, some of the conducted studies are mentioned in the following paragraphs.

Balcilar et al. [2017, pp. 12–20] studied the impact of oil price on South African gross domestic product (GDP) growth. The study found that, under the low growth regime, the oil price has a predictive content for real GDP growth. Besides, it is also found that the higher growth regime will be long lived compared to the low growth regime.

Bayat et al. [2017, p. 823] examined whether energy consumption is an important factor for economic growth in Brazil, Russia, India, China, and South Africa (BRICS) countries or not. To do so, the study applied panel data analysis considering the period from 1990 to 2013 and found that conservation hypothesis in Russia, feedback hypothesis in Brazil, and neutrality hypothesis in other countries are valid.

Bayraktar et al. [2016, pp. 33–43] analyzed the impact of oil prices on current account deficit and growth in the fragile-five countries (Brazil, Indonesia, South Africa, India, and Turkey). The results showed a significant relationship of oil prices with both GDP and current account deficit—a positive correlation between oil price and GDP and negative relationship between oil price and current account deficit.

Benedictow et al. [2013, pp. 400–410] analyzed the effects of fluctuations in oil price and economic policy factors in Russia. The study found that although a large variation in oil price is responsible for the vulnerability of Russian economy, its economic growth is significant when there is an absence of oil price growth.

Ftiti et al. [2016, p. 11] examined the linkage between crude oil prices and economic growth for four Organization of the Petroleum Exporting Countries (OPEC member countries; United Arab Emirates, Kuwait, Saudi Arabia, and Venezuela). The results evinced that the vacillation of crude oil prices in the global business cycle and/or financial crisis affects the relationship between oil and economic growth in OPEC member countries.

Hasan [2017, p. 393] studied the nature of the dissemination of international energy price shocks to diverse sectors in the Australian stock market. Here, he applied the multivariate generalized autoregressive

conditional heteroscedasticity (MGARCH) approach and found statistically significant dynamic movement of volatility in price returns of crude oil, coal, and natural gas and different Global Industry Classification Standard (GICS) sector indices on the Australian stock exchange.

Idrisov et al. [2015, p. 257] analyzed the impact of the world oil price on economic growth (in terms of output) in Russia. They found that, considering the classical model, there is no impact of global oil prices on the long-term economic growth in Russia while the price increases constantly, but the price can predetermine the short-term transitional trends from one long-term equilibrium to another.

Jiménez-Rodríguez and Sánchez [2005, pp. 1, 5, 8] analyzed oil price shock and real GDP growth in some OECD countries. The results indicated that oil price has a negative impact on GDP growth considering oil-importing countries. In terms of exporting countries, oil price also negatively impacts on GDP growth except for UK and Norway where this relationship varied.

Kiani and Pourfakhraei [2010, p. 7764] illustrated a system dynamic model of Iranian oil and gas sector for production and consumption policy. The results showed that the export of gas will reach around 500 or 620 million cubic meters per day considering various scenarios, and export revenue may touch up to 500 billion USD by 2025.

Parvin Hosseini and Tang [2014, p. 427] examined the effects of oil and non-oil exports on economic growth in Iran. They found that oil export has an inverse effect on economic growth in Iranian economy.

Reynolds and Kolodziej [2008, p. 271] studied the relationship between oil production and GDP of former Soviet Union (FSU) during the transition period of 1987–1996. The econometric analysis found that the decline of GDP in Soviet and former Soviet during the 1980s to 1990s does not Granger cause the decline in oil production, but there is a Granger cause when the pair is opposite, in other words, the decline in oil production did Granger cause the fall of GDP.

Sama and Tah [2016, p. 510] determined the impact of energy consumption on economic growth in Cameroon. The study used generalized method of moment technique by applying secondary time series data. It is found, along with other findings, that GDP, population growth rate, and petroleum prices have a positive relationship with petroleum consumption. Furthermore, the empirical result revealed that the rate of inflation and economic growth are positively related.

Tamba [2017, pp. 275, 277–281] investigated a causal relationship between crude oil production and economic growth in Cameroon. Here, the author found that there is no causal relationship between the production of crude oil and economic growth in Cameroon.

Umar and Kilishi [2010, pp. 29, 41–44] analyzed the volatility of crude oil price and its impact on the Nigerian economy. They found that crude oil price has a significant impact on GDP, money supply, and unemployment except for consumer price index (CPI).

Zarra-Nezhad et al. [2016] inspected and elucidated the long memory property in OPEC oil prices. To obtain the expected findings, they used daily oil price time series for the period from March 15, 2011, to April 22, 2014, by applying R/S, MRS, and Geweke and Porter-Hudak (GPH) tests to estimate the fractional differencing parameter. Here, the results affirmed the existence of long memory property in the time series of OPEC oil prices.

3 Methodology

3.1 Data Collection and Calculation

The study considers secondary data sources for analyzing the Caspian Sea region. For analyzing the data, it uses time series data of 19 years from 1997 to 2015. Here, the research analyzes crude oil, natural gas, and GDP. The crude oil and natural gas each have been defined by four variables. Crude oil considers reserve, export, production, and price of crude oil; natural gas likewise considers reserve, export, production, and price of natural gas. In this study, GDP represents the economic growth. Here, the IEA, US EIA, and Index Mundi are the main sources for collecting crude oil and natural gas time series data, and the World Bank is for the GDP.

The Caspian Sea is surrounded by five countries: Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan. The time series data for each country are available, but the data for the Caspian Sea as a whole are absent which have influenced researchers to arrange the concrete data for the Caspian Sea region by accumulating five countries' data. For constructing time series data for economic analysis, the study sums the five countries' data by using Microsoft Excel Sum Function:

$$\text{SUM}(\text{number1}, [\text{number2}, \dots, \text{number}_n])$$

3.2 Test for Stationarity: Unit Root Test

For time series data, especially for regression, it is vital to test whether the time series is stationary or not. In other words, it can be said that whether the data have a unit root or not. The use of nonstationary time series data may lead to spurious regression [Stock and Watson, 1989, p. 3]. In the spurious regression, the value of R^2 could be high when two variables trending overtime even though they are not related. The result from the spurious regression may influence to take a wrong decision. On the other hand, the use of nonstationary data in a regression model may invalidate the standard assumptions for asymptotic analysis. According to Granger and Newbold [1974, para. 5], the use of nonstationary variables in a regression implies that R^2 values and t -statistics no longer follow the usual distributions and they can be enthusiastically inflated. There are some varieties of powerful test tools to ensure stationarity—such as augmented Dickey–Fuller (ADF) test, Phillips–Perron test, generalized least square (GLS)-detrended Dickey–Fuller (DF) test, and so on. Among these tests, the study considers the ADF test because of its clarity and robustness in adjusting the serial correlation between the error terms.

ADF

In the case of DF test, the time series may create autocorrelation problem; for that reason, DF have developed a new test called ADF test. ADF test is the most prominent unit root test tool to ensure stationarity of time series data. Considering the nature of the test, it is similar to DF test, except lag difference. ADF test considers a lag difference for explained variables to regulate the autocorrelation problems. This ADF test has three shapes: (i) only intercept, (ii) trend and intercept, and (iii) no trend, no intercept.

$$\Delta Y_t = \beta_0 + \gamma Y_{t-1} + \sum_{i=1}^p (\delta_i \Delta Y_{t-i}) + \varepsilon_t \dots\dots\dots \quad (\text{i})$$

$$\Delta Y_t = \beta_0 + \beta_1 T + \gamma Y_{t-1} + \sum_{i=1}^p (\delta_i \Delta Y_{t-i}) + \varepsilon_t \dots \quad (\text{ii})$$

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{i=1}^k (\alpha_i \Delta Y_{t-i}) + \varepsilon_t \dots\dots\dots \quad (\text{iii})$$

In the abovementioned equations, β_0 represent intercept and t signifies a trend. Here, $Y_{t-1} = Y_{t-1} - Y_{t-2}$, $Y_{t-2} = Y_{t-2} - Y_{t-3}$ and so on. Alongside, in the equation, $\sum_{j=1}^p (\delta_j \Delta Y_{t-j})$ demonstrates the lag differences and ε_t is the pure white noise error term. The null hypothesis assumes that there is a unit root in the time series, in other words, the time series is nonstationary. Subsequently, the alternative hypothesis denotes that there is no unit root in the time series which means that it is stationary. The ADF test examines γ to ascertain whether the time series is stationary or not.

$$H_0 : \gamma = 0$$

$$H_1 : \gamma \neq 0$$

If p -value is $>5\%$, then the study is failed to reject null hypothesis which means that there is a unit root in the time series data which denotes the data are nonstationary.

3.3 Regression Analysis

Regression analysis is to ascertain the linear relationship between two or more variables. In other words, it is a method of predictive modeling statistical technique which inspects the relationship between dependent and independent (explanatory) variables. The study considers ordinary least square (OLS) regression method to analyze the impact between dependent and independent variables.

3.4 OLS

According to Pohlman and Leitner [2003, p. 119], OLS method is a statistical technique to ascertain the relationship between a dependent and an accumulation of explanatory variables, with an error or disturbance term. The error term and linear consolidation of independent variables explain the dependent variable. The important feature of OLS is it minimizes the sum of squared disturbance or error for all variables when calculating parameter values [Campbell and Campbell, 2008, p. 6].

$$Y = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_n X_n + \varepsilon \quad (\text{iv})$$

where Y is an observed random variable, and it is also called dependent or response variables. Subsequently, X is the observed nonrandom variable (also named conditioning or predictor or explanatory or independent variable). Alongside, α is a slope parameter, which explains the status of an observed random variable in the absence of explanatory variables. On the other hand, β represents intercept parameter; it explains the magnitude and direction of a linear relationship. Finally, ε denotes unobserved random variable or error or disturbance term. It captures the amount of variation which is unpredicted by slope and intercept parameters.

Here, in this study, OLS regression method considers GDP as a dependent or predictor variable and crude oil and natural gas—reserve, export, production, and price—as independent or explanatory variables. The OLS methods are as follows:

$$\text{GDP} = \alpha_0 + \beta_1 (\text{COR}) + \beta_2 (\text{COPRO}) + \beta_3 (\text{COEX}) + \beta_4 (\text{COP}) + \varepsilon \quad (\text{v})$$

$$\text{GDP} = \alpha_0 + \beta_1 (\text{NGR}) + \beta_2 (\text{NGPRO}) + \beta_3 (\text{NGEX}) + \beta_4 (\text{NGP}) + \varepsilon \quad (\text{vi})$$

where COR is the crude oil reserve, COPRO is the crude oil production, COEX is the crude oil export, COP is the crude oil price, NGR is the natural gas reserve, NGPRO is the natural gas production, NGEX is the natural gas export, and NGP is the natural gas price. Alongside, β_1 , β_2 , β_3 , and β_4 represent the sensitivity of GDP growth rate to crude oil and natural gas—reserve, production, export, and price, respectively. In the linear regression, the null hypothesis assumes that explanatory variables for crude oil and natural gas do not have an impact on the dependent variable. On the other hand, alternative hypothesis assumes an opposite relationship—explanatory variables for crude oil and natural gas do have an impact on the dependent variable. The hypothesis is as follows:

$$H_0: b_1 = b_2 = b_3 = b_4 = 0$$

$$H_1: b_1 = b_2 = b_3 = b_4 \neq 0$$

If p -value is $>5\%$, then the study is failed to reject null hypothesis, in other words, there is no impact of explanatory variables on the dependent variable. On the other hand, if p -value is $<5\%$, then the study rejects null hypothesis which means that the explanatory variables have an impact on the dependent variable.

3.5 Granger Causality Test

The study also applies the Granger causality test to ascertain the causal relationships between the variables. Through this test, it tests the causal relationship between GDP and each explanatory variable for crude oil—reserve, export, production, and price. Subsequently, it also examines the causality between GDP and each explanatory variable for natural gas—reserve, export, production, and price. The general formula for Granger causality is as follows:

$$X_t = \alpha_1 X_{t-i} + \beta_1 Y_{t-i} + \epsilon_t \quad (\text{xiii})$$

$$Y_t = \alpha_2 Y_{t-i} + \beta_2 X_{t-i} + \mu_t \quad (\text{xiv})$$

In the equation, ϵ_t and μ_t are the serially correlated random vectors which have zero mean and finite covariance matrix. Here, α_1 and α_2 are the coefficients of X and Y , respectively. Alongside, β_1 and β_2 are the coefficients of Y and X , respectively. The (X, Y) is a pair for Granger causality test. Finally, $(t-i)$ is the lag period which means the number of years of lag for the X and Y variables. For Granger causality test, the study considers eight pairs of variables.

Pairwise causality is as follows: (GDP, crude oil reserve), (GDP, crude oil export), (GDP, crude oil production), (GDP, crude oil price), (GDP, natural gas reserve), (GDP, natural gas export), (GDP, natural gas production), and (GDP, natural gas price)

Now, considering the hypothesis, the null hypothesis is X does not Granger cause Y and vice versa. On the other hand, the alternative hypothesis is X Granger causes Y and vice versa. The hypothesis is as follows:

$$H_0: b_1 = b_2 = 0$$

$$H_1: b_1 = b_2 \neq 0$$

If the p -value is $>5\%$, then the study is failed to reject the null hypothesis. It means that X does not Granger cause Y and vice versa. On the other hand, if the p -value is $<5\%$, then the study rejects null hypothesis which denotes that X Granger causes Y and vice versa.

4 Findings and analysis

In this chapter, the study illustrates the empirical results after conducting the tests and analyzing the results. Here, first, it analyzes the stationarity level of the time series data through ADF test. Second, the study discusses about regression analysis—the impact of crude oil and natural gas on economic growth in the Caspian Sea region. Finally, it analyzes the pairs of variables through Granger causality test.

4.1 Unit Root Test Results for Stationarity

The study tested the time series data by using ADF to ascertain the stationarity of the data. It found the stationarity of all variables, which is considered in the study, at first difference and considering three lag length except one variable, crude oil production, which is stationary at first difference, but it considered six lag length.

Table 1: ADF test results

| Variables | t-ADF statistic | Critical (1%) | Critical (5%) | Con. |
|-----------|-----------------|---------------|---------------|---------|
| GDP | -2.065634* | -2.708094 | -1.962813 | S. (D1) |
| COR | -3.567248* | -3.920350 | -3.065585 | S. (D1) |
| COPRO | -2.965859** | -2.792154 | -1.977738 | S. (D1) |
| COP | -3.245009* | -3.886751 | -3.052169 | S. (D1) |
| COEX | -1.976553* | -2.708094 | -1.962813 | S. (D1) |
| NGR | -4.768303** | -3.886751 | -3.052169 | S. (D1) |
| NGPRO | -3.965802** | -3.886751 | -3.052169 | S. (D1) |
| NGP | -5.384605** | -3.886751 | -3.052169 | S. (D1) |
| NGEX | -4.875451** | -3.886751 | -3.052169 | S. (D1) |

Source: Eviews (authors' computation)

Note: *Stationarity at 5% level of significance; **indicating stationarity at 1% level of significance

Abbreviations: ADF, augmented Dickey–Fuller; COEX, crude oil export; COP, crude oil price; COPRO, crude oil production; COR, crude oil reserve; GDP, gross domestic product; NGEX, natural gas export; NGP, natural gas price; NGPRO, natural gas production; NGR, natural gas reserve

The results of unit root test (ADF) of the economic variables, ADF test statistics, critical values at different percentage, and the level of stationarity are summarized in Table 1. The null hypothesis of this test is nonstationary; for that reason, the notion of this test is to reject the null hypothesis. Actually, the null hypothesis is rejected when the p -value is £0.05 (5% level of significance). Another way of rejecting the null hypothesis is the t -value. In this case, the null hypothesis is rejected when the t -value is greater than critical values. It is important to say that the test considers only absolute value (no negative sign). Therefore, considering the values of the unit root test, the findings of stationarity assure that there is no variable used in this analysis which has unit root in its time series data, in other words, all the variables are stationary—some are at 1% level and others are at 5%.

4.2 Regression Analysis

The study conducted the OLS method considering crude oil, natural gas, and GDP. Its results are summarized in Table 2.

Table 2: Regression analysis of GDP and crude oil variables

| Dependent variable: GDP | | | | |
|---|-------------|----------------|----------------|--------|
| Method: Least squares | | | | |
| Included observations: 18 after adjustments | | | | |
| Variable | Coefficient | Standard error | t -statistic | Prob. |
| C | 4.60E+10 | 4.32E+10 | 1.064925 | 0.3063 |
| COR | 3.85E+09 | 2.87E+09 | 1.338145 | 0.2038 |
| COPRO | -92,240,264 | 1.12E+08 | -0.824405 | 0.4246 |
| COP | 1.86E+10 | 2.31E+09 | 8.062539 | 0.0000 |
| COEX | 423,908.5 | 1,376,989 | 0.307852 | 0.7631 |
| R^2 | | 0.893604 | | |
| Adjusted R^2 | | 0.860867 | | |
| F -statistic | | 27.29624 | | |
| Prob(F -statistic) | | 0.000003 | | |

Source: Eviews (authors' computation)

Abbreviations: COEX, crude oil export; COP, crude oil price; COPRO, crude oil production; COR, crude oil reserve; GDP, gross domestic product; Prob, probability

Table 2 summarizes different measurements for interpreting regression model of GDP and crude oil variables. Here, the coefficient of crude oil reserve 3,850,000,000 indicates that one unit increase in crude oil reserve leads to an increase in GDP by 3,850,000,000 units holding other variables fixed, but this interpretation is statistically insignificant because of p -value which is >5%. This same interpretation is suitable for other independent variables considering GDP which are also statistically insignificant except crude oil price. The coefficient value of crude oil price is significant—one-unit increase in crude oil price leads to an increase in GDP by 18,600,000,000 units holding everything else fixed. Now, considering probability value of F -statistics, it rejects the null hypothesis which means that independent variables jointly impact the dependent variable, GDP, because the p -value of the corresponding F -statistic is <5%. Finally, to measure how strong the data are to the fitted regression line, the R^2 value of 89.36% means that 89.36% variation in GDP can be explained by the independent variables—crude oil reserve, production, price, and export.

Table 3: Regression analysis of GDP and natural gas variables

| Dependent variable: GDP | | | | |
|---|-------------|----------------|---------------------|--------|
| Method: least squares | | | | |
| Included observations: 18 after adjustments | | | | |
| Variable | Coefficient | Standard error | <i>t</i> -statistic | Prob. |
| C | 9.00E+09 | 5.94E+10 | 0.151532 | 0.8819 |
| NGR | -9.10E+08 | 9.56E+08 | -0.952607 | 0.3582 |
| NGPRO | 255,242.5 | 56,828.79 | 4.491430 | 0.0006 |
| NGP | -2.72E+10 | 4.06E+10 | -0.668511 | 0.5155 |
| NGEX | -131,583.6 | 107,041.2 | -1.229280 | 0.2408 |
| <i>R</i> ² | 0.721312 | | | |
| Adjusted <i>R</i> ² | 0.635562 | | | |
| <i>F</i> -statistic | 8.411799 | | | |
| Prob (<i>F</i> -statistic) | 0.001407 | | | |

Source: Eviews (authors' computation)

Abbreviations: GDP, gross domestic product; NGEX, natural gas export; NGP, natural gas price; NGPRO, natural gas production; NGR, natural gas reserve; Prob, probability

The column of coefficient shows the value of each independent variable (Table 3) where, among four, three variables have a negative sign—natural gas reserve, price, and export. Here, the coefficient value of natural gas reserve is -910,000,000 which indicates that one-unit increase in natural gas reserve leads to a decrease in GDP by 910,000,000 units holding everything else fixed. The same interpretation goes for other variables which have a negative sign. However, natural gas production has a different interpretation: the coefficient value of the variable explains that one-unit increase in natural gas production leads to an increase in GDP by 255,242 units holding everything else fixed. It is important to say that only natural gas production is statistically significant whereas the others are insignificant. Now, considering *F*-statistics, all independent variables jointly influence GDP; it is because of the *p*-value which is <5%. Finally, *R*² value of 72.13% indicates that approximately 72% variation in GDP can be explained by natural gas reserve, production, price, and export.

4.3 Granger Causality Analysis

In this finding and analysis part, the study illustrates and discusses Granger causality of paired variables of crude oil and natural gas in the Caspian Sea region. The findings and analysis are discussed in the following paragraphs.

Table 4: Granger causality test of GDP and crude oil price

| Pairwise Granger causality tests | | | |
|----------------------------------|------|---------------------|-------|
| Sample: 1997–2015 | | | |
| Lags: 2 | | | |
| Null hypothesis: | Obs. | <i>F</i> -statistic | Prob. |
| COP does not Granger cause GDP | 16 | 3.66813 | 0.06 |
| GDP does not Granger cause COP | | 4.06009 | 0.04 |

Source: Eviews (author' computation)

Abbreviations: COP, crude oil price; GDP, gross domestic product; Prob, probability

As summarized in Table 4, crude oil price does not Granger cause GDP, but GDP does Granger cause crude oil price because the *p*-value is <5% which proves its statistical significance. This causality test shows a unidirectional causal relationship between GDP and crude oil price. However, the direction turned to

bilateral if the study would have considered 10% level of significance.

Table 5: Granger causality test of GDP and crude oil export

| | | | |
|----------------------------------|------|-------------|-------|
| Pairwise Granger causality tests | | | |
| Sample: 1997–2015 | | | |
| Lags: 2 | | | |
| Null hypothesis: | Obs. | F-statistic | Prob. |
| COEX does not Granger cause GDP | 16 | 0.58534 | 0.573 |
| GDP does not Granger cause COEX | | 4.93429 | 0.029 |

Source: Eviews (author' computation)

Abbreviations: COEX, crude oil export; GDP, gross domestic product; Prob, probability

As summarized in Table 5, a unidirectional causal relationship has been found between GDP and crude oil export which is significant at 2.9% probability, because the p -value is <5%. It indicates that GDP affects crude oil export, but crude oil export does not affect GDP. In other words, GDP Granger causes crude oil export; however, crude oil export does not Granger cause GDP.

Table 6: Granger causality test of GDP and natural gas price

| | | | |
|----------------------------------|------|-------------|-------|
| Pairwise Granger causality tests | | | |
| Sample: 1997–2015 | | | |
| Lags: 3 | | | |
| Null hypothesis: | Obs. | F-statistic | Prob. |
| NGP does not Granger cause GDP | 15 | 4.47730 | 0.040 |
| GDP does not Granger cause NGP | | 0.19680 | 0.895 |

Source: Eviews (author' computation)

Abbreviations: GDP, gross domestic product; NGP, natural gas price; Prob, probability

As summarized in Table 6, a unilateral causal relationship can be seen between natural gas price and GDP which is statistically significant at 5% level; it means that natural gas price does affect GDP, but GDP does not affect the natural gas price. By simply putting, the natural gas price can help to forecast GDP, but GDP cannot help to forecast natural gas price.

Table 7: Granger causality test of GDP and natural gas export

| | | | |
|----------------------------------|------|-------------|-------|
| Pairwise Granger causality tests | | | |
| Sample: 1997–2015 | | | |
| Lags: 5 | | | |
| Null hypothesis: | Obs. | F-statistic | Prob. |
| NGEX does not Granger cause GDP | 13 | 38.1912 | 0.025 |
| GDP does not Granger cause NGEX | | 1.80252 | 0.394 |

Source: Eviews (author' computation)

Abbreviations: GDP, gross domestic product; NGEX, natural gas export; Prob, probability

Examining the results of Table 7, the causality relationship has been found between natural gas export and GDP which is statistically significant. Noticeably, this is the single most interesting finding to emerge from the test which is similar to crude oil price and GDP pair—crude oil price does Granger cause GDP.

5 Discussion

The findings of the study show a robust impact of the crude oil and natural gas on economic growth in the Caspian Sea region. It concludes that crude oil variables jointly have a significant impact on economic growth, GDP, in the Caspian Sea region; it rejects the null hypothesis. Surprisingly, among crude oil variables, only crude oil price has a significant individual impact on economic growth, and the rest of the variables do not have an individual impact, but jointly they have. Therefore, any change (increase or decrease) in crude oil variables—reserve, production, price, and export—jointly would affect the economic condition of the region. Therefore, individually, only crude oil price can affect the economic growth in the region. Likewise, natural gas variables also jointly have a significant impact on economic growth, GDP, in the Caspian Sea region; it also rejects the null hypothesis. Here, among natural gas variables, only natural gas production has a significant individual impact on economic growth where other variables do not have. Therefore, the takeaway of the findings is that any adjustment in natural gas variables—reserve, production, price, and export—will mutually affect the economic position of the region. But, considering individual variable, only natural gas production has an influence on the Caspian Sea region's GDP.

Now, the findings of the Granger causality test have been illustrated above only those which have at least one unidirectional Granger cause. Here, Table 4 summarizes that GDP does Granger cause crude oil price; it rejects the null hypothesis because the probability value is statistically significant at 5% level of significance. Now, if the study had considered 10% level of significance, then the opposite direction—crude oil price does Granger cause GDP—could have been statistically significant. Alongside, the findings also mention that GDP does Granger cause crude oil export which explains how GDP affects crude oil export. It denotes that movements in GDP do affect the movements in crude oil export, but it is incompatible with the opposite direction.

On the other hand, considering natural gas and GDP, natural gas price and export do have Granger cause GDP; it is also statistically significant at 5% level because both models reject the null hypothesis. It is notable that the models are significant when they consider lag difference 3 and 5 for the natural gas price and natural gas export, respectively. Therefore, the findings of this study suggest that an oscillation in natural gas price and export affect the GDP in the Caspian Sea region which means that the fluctuation of natural gas price affects GDP in the region; the understanding is same for natural gas export.

It is noteworthy that the Granger causality test did not find any significant causality relationship between crude oil and natural gas reserve and GDP and crude oil and natural gas production and GDP. For that reason, these relationships have not been discussed in the study.

6 Conclusion and recommendation

6.1 Introduction

As discussed earlier, the Caspian Sea region is one of the oldest regions of oil production in the world. Alongside, it is an important strategic participant in the world energy market. Noticeably, due to the abundance of crude oil and natural gas reserve, it has got international attention and become a significant strategic partner in international politics [Yergin, 2012, p. 44]. According to EIA, the Caspian basin has (proved and probable reserves) approximately 48 billion barrels of oil and 292 trillion cubic feet of natural gas which illustrates how strategically important the region is to the world energy market. This reserve also shows how much strength the region has considering the other regions, e.g. Persian Gulf. In addition, the strategic location—between Asia and Europe—of the region possesses a crucial place on the world map. Therefore, the abundance of crude oil and natural gas has brought the region as a crucial and significant player to the world energy market, especially to the Eastern (China, India, Pakistan) and Western countries, especially the European Union. For that reason, the main objective of the study was to investigate the impact and causality of crude oil and natural gas on economic growth in the Caspian Sea region.

6.2 Significance of the empirical results

Despite possessing the abundance of energy resources, there is no such research that has analyzed and evaluated the energy impact on economic growth in the Caspian Sea region., in other words, no study has been conducted which evinces the Caspian Sea region's economic growth and its energy resources, especially crude oil and natural gas. However, there are some studies that have been taken place in the academic arena which evaluated specific country or countries of a region's energy position instead of the whole region (Caspian Sea region). For example, Benedictow et al. [2013, pp. 400–410] analyzed the effects of fluctuations in oil price and economic policy factors in Russia. Ftiti et al. [2016, p. 11] examined the linkage between crude oil prices and economic growth for four OPEC member countries (United Arab Emirates, Kuwait, Saudi Arabia, and Venezuela). Idrisov et al. [2015, p. 257] analyzed the impact of world oil price on economic growth (in terms of output) in Russia. Parvin Hosseini and Tang [2014, p. 427] examined the effects of oil and non-oil exports on economic growth in Iran. Reynolds and Kolodziej [2008, p. 271] studied the relationship between oil production and GDP of the FSU during the transition period of 1987–1996. Tamba [2017, pp. 275, 277–281] investigated a causal relationship between crude oil production and economic growth in Cameroon.

Currently, regarding impact analysis, this research's empirical results comply with some previous studies' results, simply put, the study has a similar result—crude oil price has a significant impact on economic growth—as with some previous studies [Umar and Kilishi, 2010; Benedictow et al., 2013; Bayraktar et al., 2016; Ftiti et al., 2016]. However, there is a study [Jiménez-Rodríguez and Sánchez, 2005] that found an opposite empirical result—oil price negatively impacts on GDP growth in OECD countries except for UK and Norway. On the other hand, considering causality analysis, two previously conducted studies' [Reynolds and Kolodziej, 2008; Tamba, 2017] findings bolster the research findings, in other words, the study has found similar findings as other two studies found before—no causal relationship between crude oil production and economic growth.

In a nutshell, there are two noticeable observations that had never been conspicuously evaluated in any research: i) analyzing impact and causal relationship among crude oil, natural gas, and economic growth in the Caspian Sea region and ii) considering reserve, export, production denomination along with the price of crude oil and natural gas for the region. Here, deliberately, the research has considered both observations and found some vibrant findings that evince the significance of the empirical results of the study in both the academic and professional arena.

6.3 Recommendations

Currently, considering the analysis and the takeaways from the study, the researchers endeavor to illustrate some effective potential ways that the countries can consider for the further economic development of the region.

First, the countries of the region should introduce a proportionately equal playground where everyone can exercise their economic right properly. To do so, Russia and Iran should begin the process by resolving the regional energy-related disputes—especially the legal status of Caspian Sea or Lake—among them, then they can gently patronize Azerbaijan, Kazakhstan, and Turkmenistan to come together and endeavor to develop the region in a most sophisticated way. Nevertheless, for the development of the region, the countries should start a negotiation by keeping the differences aside and develop a common platform such as the OPEC.

Second, due to the huge demand of crude oil and natural gas of Eastern and Western countries, they should develop a common energy market strategy and policy—for instance, setting reasonable crude oil and natural gas price standard, sharing developed technologies for energy drilling and refining among them, and establishing a mutual military base in the region for avoiding any unexpected critical situation—for the region where five countries of the region can experience a win–win situation.

Finally, since the pipelines play an important role in supplying the crude oil and natural gas, all five

countries should prepare relatively an effective manifesto—i) any pipeline from Caspian basin should have mutual participation of all five countries in the order that they can enjoy proportionately equal benefit from the pipeline, ii) the amount of crude oil and natural gas of offshore drilling from the Caspian Sea should be divided proportionately among five countries, and iii) the cost of all offshore drilling should bear by five countries proportionately—for this pipeline policy by considering other internal disputes.

6.4 Final remarks

In summary, the study has endeavored to discuss the energy scenario of the region and ensure the research objectives through some empirical and descriptive analysis. Here, it found, on the one hand, some findings that evince the strong economic condition of the region. On the other hand, there are some other findings that ascertain some loopholes in the region where the countries of the region should concentrate rigorously. Finally, although the findings of the study have conspicuously fulfilled the research objective and the recommendations have elucidated the possible steps which the region should consider, nothing will be changed or developed if the countries of the region do not keep their differences aside and begin the negotiation process among them as soon as possible. Otherwise, the Caspian Sea region might experience severe economic impediments in the near future as the Middle East.

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