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The impact of economic complexity and trade openness on gross domestic product growth in oil-producing countries

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Abstract

The present study aims to investigate the impact of economic complexity and degree of trade openness on gross domestic product growth in oil-producing countries. It applies a descriptive methodology along with a correlational research design. The relationship between the variables is analyzed using the data collected from the World Bank website and the international monetary fund. In other words, this research enjoys an ex post facto design, which is quasi-experimental. Moreover, it is categorized as a library, analytical, and causal study which is based on panel data analysis. All the oil-producing countries form the population of the study as a case study from 2006-2020, from which 10 countries are chosen as the statistical sample. The results of the study revealed that economic complexity and trade openness impact gross domestic product growth in a significant manner.

Keywords: Economic complexity, degree of trade openness, gross domestic product growth, oil-producing countries

Introduction

The concept of economic complexity was first raised and introduced by Harvard University researchers in 2008. This index indicates the rank of countries based on their production capability and eventually their export of "complex" products. Complex economies can apply a huge amount of relevant knowledge and produce a diversity of knowledge-based goods. However, simple economies enjoy less productive knowledge and the goods produced by them are simpler and require a smaller network of interactions. It should be noted that economic complexity needs an institutional environment to activate existing potential knowledge (Abdan et al., 2013).

The degree of trade openness is measured by the actual size of the imports and exports reported in a national economy, known as the Impex rate. This measure is currently used by most political economists to empirically analyze the impact of trade consequences on social and economic conditions of a country. The prosperity of a country depends on trade openness as one of the economic indicators (Stanka, 2010). Trade openness and globalization might be associated with a more efficient allocation of resources, more professional opportunities, higher productivity, and more variety of goods

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including frequent transfer of technology. (Dixit and Stiglitz 1977; Lancaster 1980; Ali Kavandi, Younes Nademi 1400). Considering what has been discussed so far, the present study is seeking to investigate the effect of economic complexity and trade openness on the gross domestic product growth in oil-producing countries. The main purpose of this research is to examine the impact of these variables on GDP growth from 2006 to 2020. Considering the purpose of the study, the macroeconomic variables are addressed here. The question raised in this study is "how do the macro-economic variables affect the gross domestic product growth?". To answer the mentioned question, the economic complexity, and degree of trade openness are examined in terms of their relationship with the GDP growth in oil-producing countries in the desired period. In other words, it tries to shed light on this issue which is considered the unknown aspect of the study.

Literature Review

The impact of economic complexity on gross domestic product growth

Applying diversification practices by the businesses or individuals in production could increase their capability and willingness to detect earnings and assets. Therefore, it leads to a low cost of capital through official resources and reduces export costs. When the export markets develop, access to efficient export markets could increase the cost of capital and decline the opportunity cost of continuing diversification practices. To put it differently, the export market development could increase credit facilities and motivation for performing activities related to economic complexity (Cheshmi & Abdolmaleki, 2013). In sum, endeavors to grow GDP could lead to the benefits attached to the export market development as well as the increase in complex economic activities. As the export market development declines the cost of official economic activities, the motivation to engage in more complex economic activities will be improved. The economic complexity index could play a crucial role in GDP growth if implemented within the terms of business. Hence, diversification is a significant factor in GDP growth. It makes private sector investment appeal to the suppliers and demanders, which is very important in developing export markets and if possible increasing fund flow and creating the required opportunities for GDP growth. The development of official investment institutions gradually allows the credits and monetary resources to cover all the applicants' needs and guide the economic units in the path of growth with maximum capacity. The development of private sector investment could automatically lead to competition between the investment institutions and therefore diversification in the products (Bakat and Philip, 2010).

One of the important economic sectors of the country that responds to the shocks of economic variables such as inflation rate, production growth is the industry sector.

This sector due to its critical role in the life cycle of society and is one of the most important industries that add value in the economy of any country. (sivash saleh ziabari,2021)

Recently a number of experimental and theoretical researches have addressed the relationship between economic complexity index and export market development. Some concluded that detection of the incomes leading to export cost reduction is the starting point for the investigation of the relationship between diversification and export market development. When the diversification practices are applied by the businesses or individuals, their capability and willingness to detect earnings and assets will increase and therefore the export costs will decrease. As the result of GDP growth, more efficient intermediaries get into the market which lower the export cost. Briefly, GDP growth is positively correlated with economic complexity index (Mohammadi et al., 2014). Financial development improves financial markets, some governments persuade further development to faster financial development. Assuming the significance of financial development in a country's growth process and sustainable development, it may render vital advantages including the optimal resources' allocation, production factors' efficiency, reducing trade obstacles' costs, and access to inexpensive inputs. Hence, developing financial sectors may improve economic growth and employment. It may also increase real competitors in the internal market, and this can in turn motivate manufacturers to enhance efficiency and productivity. (Tayebeh shahriyar, 2023)

The impact of trade openness on gross domestic product growth

Another aspect of financial development is the role of the domestic financial system in cross border transfer of financial resources. It addresses the impact of openness in financial markets on the entry and exit of capital, appropriate currency regimes, and the limitations of asset exchanges or the financial instruments of foreigners and citizens.

The political and legal atmosphere plays a significant role in the quality of the services provided by financial institutions. In some developing countries, for instance, the banks do not wish to increase loans because the inefficient judicial systems or the corrupted political institutions get in the way of paying the loans off. The quality of the legal institutions, property rights, bureaucracy, and the government's accountability affect the financial system. So, the institutional environment is considered as one of the aspects of financial development. Therefore, development in banking, financial, and monetary dimensions can't ensure financial development and the degree of development in bank regulations and supervisions, financial market openness, and the institutional environment of the society matter a lot.

Economic value added is obtained by multiplying the difference between the rate of return and the cost of capital in the amount of capital (Arvin Rostami, 2022).

Background of the Study

In a study carried out by Antedeniti and Franco (2021), the relationship between economic complexity and economic growth is investigated. The panel data of 117 developing and developed countries (from 1995-2016) was used to estimate the regression model. The results showed a

positive correlation between two variables in developed countries but no correlation was found between them in the case of developing countries.

In a similar study, Sadeghi et al (2020) investigated the impact of economic complexity and financial development on economic growth. They collected their required data from 79 countries from 1996 to 2014. They concluded that economic complexity and financial development have a significant effect on the economic growth.

Zobeyri and Motmeni (2019) examined the relationship between human capital and economic complexity in Iran during 2010-2016. The data processing revealed no significant correlation between elementary admission rate and economic complexity. Moreover, there was no significant relationship between the research & development expenditure of GDP and the economic complexity index; and Johonsen's test showed no cointegration between the variables. However, the government's expenditure on higher education was detected as a significant factor affecting economic complexity; and its ratio to GDP was cointegrated with economic complexity. The causality direction found between these variables is one way, i.e., higher education expenditures lead to economic complexity. Evaluating the immediate response revealed that the main economic complexity occurs after three years. It also showed that a 10 percent growth in higher education expenditure could lead to an 11 percent growth in the economic complexity index.

Fazeli and Khodaparast (2020) investigated the effect of financial development and economic complexity on economic growth through a fixed effects model in 17 oil-producing countries during 2000-2016. It applies the variables of financial credit to GDP as the financial development indicator and the economic complexity index, proposed by Harvard University and MIT. Gross capital accumulation, human capital, trade openness, and rule of law are also considered as the variables of the study. Based on the results obtained, the financial development index has a significantly positive effect on economic growth. Even though the countries under investigation rely substantially on oil production considering their export portfolio and consequently possess low economic complexity, the financial development index has a significantly positive impact on economic growth. The need for more complexity in export is confirmed. The oil-producing countries could benefit from their competitive advantage, i.e. their access to enormous sources of gas and oil, to promote economic complexity as well as export complexity. To do so, they could invest in oil and gas downstream industries which produce more complex goods.

Khodabakhshi Parizi et al (2014) in his research entitled the impact of waste of agricultural products on various economic aspects concluded that the policy of macro policies , practical strategies to prevent losses from government and raising public awareness in waste reduction should be considered more , they also concluded that given the strategic importance of agriculture sector in the GDP of the country and the value of non-oil-experts and employment in the

country , the waste reduction could increase crop and garden yields as well as creating employment , development of non-oil-exports and creating food security(Sharif Fallah, 2018).

Methods and Methodology

Considering theoretical foundations and experimental studies including Sadeghi et al (2020), the following formula can be achieved:

(1) $GDPRit = \beta 0 + \beta 1 ECIit + \beta_2 OPENit + \varepsilon it$

In which,

GDP is gross domestic product growth; retrieved from the World Bank data

ECI is Economic complexity index; retrieved from the World Bank data.

OPEN is trade openness; retrieved from the World Bank data.

All the oil-producing countries form the population of the study as a case study from 2006-2020, from which 10 countries are chosen as the statistical sample.

Results

Table 1 presents descriptive statistics including the number of observations, minimum, maximum, mean, standard deviation, and variance.

Table 1. Descriptive Statistics

Variable	N of Observations	Min.	Max.	Mean	Variance	Standard Deviation
Economic complexity	150	-.31	1.68	.5919	.266	.52618
Trade openness	150	22.11	176.11	64.75	1515.77	38.9329
Gross domestic product growth	150	10.52	15.86	12.7894	1.763	1.32761

The number of observations equals 150. The values for minimum, maximum, mean, variance and standard deviation are also calculated. The highest variance and standard deviation belong to the trade openness variable which implies that trade openness among the oil-producing countries is more variable. While the variance and standard deviation for economic complexity are the lowest so the countries have less variability in terms of the economic complexity index.

Normality of statistical data

Skewness is a measure of the asymmetry of the probability distribution. Positive kurtosis means the peak of the distribution is higher than the normal distribution curve while negative kurtosis is the opposite. Overall, if the skewness and kurtosis are not in the interval of (-2, 2), the distribution of the data is not considered normal. Table 2 shows the skewness and kurtosis of the data.

Table 2. Skewness and Kurtosis of the Data

	Skewness		**Kurtosis**		
Variable	N of Observations	Std. Error	Statistic	Sts. Error	Statistics
Economic complexity	150	.394	-.577	.198	.351
Trade openness	150	.394	1.357	.198	1.348
Gross domestic product growth	150	.394	.601	.198	.713

As shown in table 2, the skewness and kurtosis for economic complexity index are 0.351 and 0.577 respectively, which indicates a normal distribution.

After checking the normality of the data distribution considering its skewness and kurtosis, the Shapiro-Wilk or the Kolmogorov-Smirnov test is used to ensure the normality of the distribution. In the null hypothesis, a normal distribution is assumed with an error of 0.05. Therefore, if the test statistic is ≥ 0.05, the null hypothesis won't be rejected, i.e., the data distribution is normal. In the normality test, the statistical hypothesis is as follows:

- If the P-value is less than %5, then the null hypothesis will be rejected, i.e., the data distribution can't categorize as normal, poisson, exponential, or uniform type. The results of the Shapiro-Wilk and the Kolmogorov-Smirnov tests are presented in table 3.

Table 3. Normality of the Distribution

Variable	**N of Observations**	**Shairo-Wilk**		**Kolmogorov-Smirnov**	
		Statistic	**Std. Error**	**Statistic**	**Std. Error**
Economic complexity	150	.000	.963	.000	.168
Trade openness	150	.000	.851	.000	.163
Gross domestic product Growth	150	.000	.902	.000	.150

As seen it table 3, the P-value is larger than %5, which confirms the null hypothesis regarding the normal distribution of the data. In other words, the data is normally distributed.

Checks for Stationarity

To check the panel data stationarity, a combination unit root test such as the Levin-Lin Chu test is used. The null hypothesis of this test assumes non-stationary data with t-distribution. Levin, Lin, and Chu argue that using a combination unit root test is more powerful than cross-sectional unit root tests in the case of panel data. The null stationary hypothesis in this test assumes that the time series contains a unit root, which is against the alternative non-stationary hypothesis. The result of the Levin-Lin Chu test is provided in table 4.

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Table 4. Results of Unit Root Test

Variable	Statistic	Sig.	Result
Economic Complexity	-5.35	.0000	Stationary
Trade openness	-3.04	.0012	Stationary
Gross domestic product growth	-2.38	.0087	Stationary

As seen in the table above, the result of the Levin-Lin Chu test is significant for all the variables (P<0.05), which indicates the stationarity of the data. Therefore, the Levin-Lin Chu test assumes that using unit root test in panel data prevents fabricating the regression. It also assumes that using a combination unit root test is more powerful than cross-sectional unit root tests in the case of panel data.

Research Model Estimation

In F-Limmer test, the null hypothesis assumes a pooled data model while the alternative hypothesis indicates a panel data model. The results of the F-Limmer test is provided in table 5.

Table 5. The results if F-Limmer Test

Test	Statistic	Sig.	Result
F-Limmer test	376.68	.0000	panel data

The result of F-Limmer test rejects the null hypothesis and confirms the alternative one. In other words, the model fits the data is the panel data. Although the null hypothesis assumes a pooled data model, the result of the test confirms the panel model to best fit the data. After running F-test and finding the appropriate model, which is panel data model, the Hausman test should be applied to determine the effects model. The Hausman test distinguishes between fixed effects vs. random effects specifications. The null hypothesis in Hausman test assumes the random effects model specification. The result of the Hausman test is presented in table 6.

Table 6. The Results of Hausman Test

Test	Statistic	Sig.	Result
Hausman test	13.26	.0000	Fixed effect

The P-value for the Huasman test is significant (<0.05), which leads to the rejection of the null hypothesis considering the random model specification. Thus, the alternative assumption, i.e. the use of fixed effects model, is confirmed. In other words, the model contains fixed effects and doesn't change through time. To determine if there is

any correlation in residuals, the Pesaran cross-sectional dependency test is used. The Breusch-Pagan is used to test for heteroscedasticity in linear regression model. It tests whether the variance of the residuals obtained from linear regression is dependent on explanatory variable. This test is among the simplest ones in this regard. The results of the Pesaran dependency and Breusch-Pagan tests are provided in table 7.

Table 7. The Results of the Pesaran Cross-Sectional Dependency and Breusch-Pagan Tests

Test	Statistic	Sig.	Result
Breusch-Pagan Test	.0000	165.26	Heteroscedastic
Pesaran Dependency Test	.0000	12.67	Correlation in residuals

The result of Breusch-Pagan Test (table 7) rejects the null hypothesis considering the variance homoscedasiticity. So the research model has a heteroscedastic variance. The P value is significant in Pesaran Dependency test, which rejects the null hypothesis and confirms the cross-sectional dependence (correlation in residuals).

As there is a significant correlation between the residuals and the heteroscedastic variance in the regression, the feasible generalized least square (GLS) could be used to estimate the coefficients of the model. The GLS, compared to the ordinary last square, is more efficient in showing the greatness of the F statistic. In other words, the variance of the response ratio estimated through the GLS is x-times less than the OLS. Moreover, the 95 percent confidence interval will be narrower for different linear forms in the final unit model. Overall, since the data exhibits heteroscedasticity (non-constant variance) and auto-correlation, GLS is used to estimate the model.

Data Analysis

Table 8 contains the results of model estimation regarding the impact of the financial development and economic complexity on gross domestic product growth in oil-producing countries, including the United Arab Emirates, Iran, Kuwait, Saudi Arabia, Russia, Canada, Mexico, America, Argentina, and Brazil during 2006-2020.

Table 8. The Results of Model Estimation

Variable	Coefficient	T test	Sig.	Result
Y-intercept	12.43	424.87	.0000	Significant
Economic complexity	.09	7.17	.0000	Significant
Trade openness	.003	1.56	.0119	Significant

As the results in table 8 show, the variables of financial development, economic complexity, human capital, and the degree of trade openness have a significant impact on gross domestic product growth in oil-producing countries ($P<0.05$). Considering

the results of model estimation, the final research model is estimated as follows:

(2) $GDPR_{it} = 12/43 + 0/09*ECI_{it}$ $0/003*OPEN_{it} + \varepsilon_{it}$

Based on the model (2), an increase in one unit of economic complexity generates a 0.09 rise in GDP growth. The results indicate that the increase in economic complexity leads to a rise in GDP growth and, therefore economic growth in the oil-producing countries. Moreover, owing to diversification in the production and export in the United Arabia Emirate, Iran, Kuwait, Saudi Arabia, Russia, Canada, Mexico, America, Argentina, and Brazil, it is expected that the economic complexity index meets the desired level and increase the gross domestic product in the mentioned countries. It means that these countries, thanks to their productivity rate are considered more complex in their economy and can have a variety of products. Conforming to this interpretation, the countries such as the United Emirates Arabia, Iran, Kuwait, Saudi Arabia, Russia, Canada, Mexico, America, Argentina, and Brazil enjoy more economic growth because of their higher economic complexity, which reveals the positive impact of economic complexity on the rate of economic growth. Thus, economic complexity through knowledge results in saving resources, improving the quality of production institutions, and the creation of production structures, which altogether accompany the diversification in production, cost savings, more earnings, and economic growth. The results of the study reveal a significantly positive relation between economic complexity and gross domestic product growth in oil-producing countries, which confirms the research hypothesis.

Moreover, an increase in one unit of trade openness generates a 0.0003 rise in GDP growth. It shows that the more the ratio of the sum of exports and imports to GDP, the more the GDP growth will be. The results confirm the research hypothesis in terms of the existence of a significant positive correlation between the degree of trade openness and GDP growth.

Generally, politicians and economic analysts can utilize the economic complexity index to compare the oil-producing countries including the United Emirates Arabia, Iran, Kuwait, Saudi Arabia, Russia, Canada, Mexico, America, Argentina, and Brazil. So, relying on conventional models in determining economic growth is far from reality. Therefore, apart from production factors and capital, the main reason for economic growth in oil-producing countries is knowledge, which could appear in production through the work of experts. This new concept in economic growth could raise a country's competitive rank at both national and international levels.

The nations are seeking to increase their trade openness to have more production and investing in private sectors could help in this regard because it might lead to production stability and stimulate financial markets in the oil-producing countries. Considering the effect of fiscal expansion, the government's borrowings lead to rising interest rates which offsets the simulative effects. When the fiscal expansion policy considers borrowing from the public (the bonds issued by the governments), foreign, or monetary debs, the

interest rates rise across the markets because it creates a huge demand for credit in financial markets and consequently fiscal stimulus. Investing in roads, bridges, and so on as a fiscal stimulus could increase economic growth and trade openness, which increases national production and earnings.

Based on the results in table 8 and model 2, it can be concluded that financial development and economic growth has a significant effect on GDP growth in the oil-producing countries during 2006-2020., which is confirmed considering the null hypothesis and F statistic. In addition, the coefficient of determination result (R square method) shows that 99 percent of the changes in GDP growth is predicted by economic complexity and trade openness.

7. Conclusion

The present study aimed to investigate the effect of economic complexity and trade openness on GDP growth in oil-producing countries including the United Emirates Arabia, Iran, Kuwait, Saudi Arabia, Russia, Canada, Mexico, America, Argentina, and Brazil during 2006-2020 through using panel data. Generally, the effect of these factors on GDP growth is the subject of this study. The result of the F-Limmer test confirmed the panel model. The results also confirmed the existence of fixed effects, non-consistent variance, and the correlation in residuals. Finally, the feasible generalized least square was used to estimate the effect of explanatory variables on GDP growth in oil-producing countries.

Considering the research hypothesis, economic complexity has a significant effect on GDP growth in oil-producing countries. It can be concluded that economic complexity indicates utilizing technology and innovation in production procedures, which could create the opportunities to use potential capacities, save resources, optimally allocate resources, reduce production costs, increase productivity and diversification and finally increase GDP growth.

Human capital has a significantly positive effect on GDP growth in oil-producing countries. The results reveal that the increase in human capital creates opportunities to attract specialists towards production, which flourishes the production practices and exchanges in different markets. It also increases the export and import ratio and the degree of trade openness and economic growth in oil-producing countries. As it was previously mentioned, this study investigated the effect of economic complexity and trade openness on GDP growth in oil-producing countries and the relationships between the explanatory variables were estimated through a panel model. After determining the variables through panel model specification and checking data stationarity, feasible GLS was used to estimate the research model. The results of the study confirm the research hypothesis regarding the significant relationship between economic complexity, trade openness, and GDP growth. In conclusion, depending on the outlooks and policies taken to promote GDP growth in oil-producing countries as one of the economic elements, it is required to take diversification into account, especially in oil products (as well as production and development infrastructures) and pursue appropriate policies to strengthen and reinforce them in

the long term. Moreover, GDP growth in oil-producing countries showed that the rise in oil export value has increased economic growth and created prosperity in the financial market, which leads to GDP growth in oil-producing countries.

Therefore, the data analysis revealed a high degree of diversification in the portfolio of the countries under investigation thanks to their high competitiveness in final capital and consumption goods, which can affect their economic growth. To make it short, by owning more complicated and diversified products in its export portfolio, a country can gain more power in international economic interactions and, in other words, a more resistive economy. However, a simple economy that relies on a single product not only makes the country and its economy more vulnerable but also paves the way for the interference of foreign countries in internal affairs.

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