Petroleum Business Review, Vol. 8, No. 1, pp. 48–60, January 2024

Studying the Impact of Oil Shocks on the Sustainable Development of Petroleum Exporting Countries

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Highlights

- Raising oil revenues leads to higher inflation.
- Increasing oil prices has no impact on GDP.
- Raising oil prices increases income inequality.

Received: July 21, 2022; *revised:* July 25, 2023; *accepted:* October 29, 2023

Abstract

It is essential to carefully consider the management of underground resources, given their abundance and the significant role they have historically played in providing Iran with financial resources. However, oil shocks negatively affect the economy of petroleum-exporting countries due to fluctuating oil prices and their dependence on the global economy. This study examines whether oil shocks significantly impact the sustainable development of petroleum-exporting nations. Using econometric models and an autoregressive approach, it analyzes the effects of these shocks on OPEC countries from 2000 to 2019. The findings indicate that the resource curse afflicts these nations, with rising oil prices having no positive impact on their GDP. Moreover, increasing oil revenues result in higher inflation, slower urbanization, and growing inequality, as reflected in the Gini coefficient, all pointing to the presence of Dutch disease. In conclusion, policymakers are urged to focus on reducing investment risk and formulating realistic long-term plans centered on sustainability indicators to achieve more stable development. Oil shocks significantly influence the sustainable development of petroleum-exporting countries.

Keywords: Dutch disease, Oil shock, Resources, Sustainable development, VAR model

How to cite this article
Rasoulinezhad, E. and Rezaeian, M., Studying the Impact of Oil Shocks on the Sustainable Development of Petroleum Exporting Countries, Petroleum Business Review, Vol. 8, No. 1, p. 48–60, 2024. DOI: 10.22050/pbr.2023.352842.1272

1. Introduction

Since the end of the 19th century, economic literature has given much attention to the idea of sustainable development. According to sustainable development, addressing the demands of the present generation should not come at the expense of their potential to grow and develop. The subject of the environment and its significance for development was first brought up in 1972 at the United Nations Conference on the Human Environment (Goldin, 2018). In sustainable development, the concern is that natural resources extraction should not be carried out under the guise of attaining economic expansion in a method that puts an undue amount of strain on these resources. At the United Nations Conference on Environment and Development (Earth Summit) in 1997, the first sustainable development metrics were

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given for the evaluation of a few participating nations. There were three key justifications regarding the theory of sustainable development in general (Zahedi Mazandarani, 1977):

- The structural adjustment plans that were developed to address the 1980s global economic crisis were implemented with poor outcomes;
- The world's continuing, unabated rise in poverty, hunger, and inequality;
- Concerning environmental and natural resources degradation brought on by technology usage (ibid);

In recent decades, the subject of sustainable development has received less attention in emerging nations that export resources, particularly oil and gas, compared to the global level. The findings of this study and other studies indicate that Iran, one of the member of the Organization of the Petroleum Exporting Countries (OPEC), is not performing at its best in terms of the defined levels of indicators for sustainable development although sustainable development in these nations, particularly Iran, is crucial for the following reasons:

- Oil and gas are major sources of income in these countries. Due to their over-reliance on the oil and gas industries, these nations typically lack a vibrant private sector, making it impossible for them to support their economies through the manufacture of commodities in these industries, which also has little added value. By utilizing these resources excessively to meet their needs without taking into account its effects on the environment and the climate, these nations will endanger their future. Climate changes brought on by this problem pose severe hazards to these nations' agricultural industries and food supplies.
- Because they rely on oil and single-product economies, OPEC members and Iran may experience more severe economic repercussions from oil shocks. These shocks, which are externally produced as a result of changes in oil demand, can have an impact on several economic sectors both directly and through monetary and financial policies. They also have an impact on economic metrics like inflation, unemployment, and growth rates. More importantly, the degree to which these shocks and fluctuations can harm exporting nations' economies and development depends on some variables, including the speed of price changes, the extent to which the exporting nation is dependent on oil resources, the speed of reaction, and the range of tools available for an appropriate response to oil shocks. Therefore, the nations that export oil should focus more on sustainable development and lessen the reliance of their economies on these resources; therefore, their economies will be more stable, and the constraints the environment places on them will be minimized.
- However, because of their heavy reliance on natural resources and the direct injection of their profits into the economy, nations with large oil revenues frequently have structural economic problems like the Dutch disease and the curse of resources.
- The high reliance on oil resources makes it conceivable for the economies of the exporting nations to experience significant volatility due to demand-side sanctions. By lessening their reliance on these resources, petroleum exporting nations can strengthen their economic resistance and resilience. Accordingly, research demonstrates that enhancing the economy's flexibility and agility in petroleum exporting countries through the interconnections of various economic sectors with the global economy may strengthen the economy internally and minimize the impact of economic shocks, leading to proper and sustainable development (Rasoulinezhad, 2016).

The need for OPEC member countries to pay greater attention to sustainable development may be argued for several reasons, all of which demonstrate that doing so can help these nations enjoy

sustainable growth and endure fewer economic upheavals and shocks. The current study aims to investigate the effects of oil shocks on the sustainable development of petroleum exporting countries and provides an answer to the question of whether or not existing oil can be a barrier to sustainable development in these countries, taking into account the discussion of sustainable development and using the indicators defined by the United Nations (SDG).

2. Literature review

Numerous studies have been conducted on the issue of oil and oil price changes and their effects on various economies as a result of this subject's significance for various nations. Iran has conducted a significant amount of research in this area as a result of its reliance on oil. The current research is divided into domestic and international categories.

2.1. Domestic research

Arslani (2008) examined the function and significance of oil and oil earnings in Iran's economy as well as their connection to macro variables. The collected data demonstrate that changes in the price of oil have an impact on the gross national product (GNP) and that these changes affect foreign currency earnings and government general budget revenues. Accordingly, as the price of oil rises, so does the foreign currency revenue from oil, which in turn raises overall foreign exchange receipts as well as the income for the government's general budget. Conversely, as the price of oil falls, so does the general income for the budget.

The paradigm and framework of sustainable development were identified and thoroughly defined by Najafi and Zahedi (2015) in their study entitled "The Conceptual Expansion of Sustainable Development". Finally, they offer proposals and outline the steps Iran must take to move toward sustainable development. Eghbali et al. (2004) examined the relationship between Iran's unstable oil exports and economic development using the classical production function (FEDER) and a self-regressive model with distributive breakdowns. They used several definitions of instability as a variable in their model and obtained varying outcomes. They also demonstrate in their first three models that the oil export instability variable has a detrimental impact on the rate of economic growth. The impact of the instability variable on economic growth is found to be minor but positive in the fourth model, while it is predicted to be negative in the fifth model for oil export instability.

Hadian and Parsa (2005) investigated the development of a variety of macroeconomic variables in Iran, including the gross domestic product, general price level, and employment level from 2004 to 2015. According to the findings, one of the key causes of changes in Iran's macroeconomic indicators is shocks to the oil price. They concluded that changes in oil prices account for 20% of changes in domestic output, 30% of changes in unemployment, and 60% of changes in general price levels.

Mehara and Niki Eskui (2015) sought to find structural shocks for four countries of Iran, Saudi Arabia, Kuwait, and Indonesia using the Blanchard and Quah technique in their study titled "Oil Shocks and their Dynamic Consequences on Macroeconomic Variables". They discovered that oil shocks are the primary cause of fluctuations in the economies of Iran and Saudi Arabia using yearly data from 1960 to 2003. Due to adequate action, the nations of Kuwait and Indonesia have been able to contain the negative impacts of oil shocks.

Fallahi and Peyghambari (2016) examined the interactions between changes in the price of the OPEC oil basket and the economic development of seven significant OECD nations between 1980 and 2005. They have determined that the impact of changes in the OPEC oil basket price on the level of nations' real GDP is only temporary using seasonal data and an auto-regression model. Additionally, there is a

one-way causal relationship between the growth rates of the real gross domestic product in each country and the growth rates of the OPEC oil basket.

Sadeghi and Abdullahi (2007) conducted a study entitled "Human Development in Iran" and examined the state of human development in Iran between 1986 and 2001. They found that the human development index at the provincial level varies greatly; in some provinces, it has increased, while it has dropped in others although human development has improved. This is because the provinces do not all have the same educational, welfare, and income facilities.

Mirfatah (2007), in a study titled "Effect of Oil Price Fluctuations on Economic Growth", examined the impact of oil price variations on economic growth using a non-linear specification for oil prices. The estimates from this research revealed that an increase in oil prices has a significant impact on Iran's economic growth, whilst an increase in oil prices has no effect.

Zamanzadeh Nasrabadi (2008) studied the relationship between oil shocks and the economic development of OPEC member nations between 1970 and 2005 in the framework of a dynamic panel model. The study's findings demonstrate that the economic growth of OPEC member nations is strongly and significantly impacted by oil income shocks (except for the oil industry). The findings of this study suggest that negative shocks have a far higher and longer-lasting impact than the positive ones; in other words, this relationship is asymmetric.

Kamijani and Asadi Mehmandousti (2009) demonstrated that the dynamic effects of monetary policies and oil shocks on Iran's economic growth during 2013–2015 were both effective in Iran's economy. However, despite the impacts of oil shocks on liquidity, the monetary shock did not affect GDP.

According to Shahabadi and Heydari (2013), assessing the factors affecting this intensity in a sample of industrialized and developing nations between 1995 and 2006, the support of intellectual property rights has a positive and significant impact on the intensity of research and development (R & D). Indeed, it appears that the safer inventive enterprises feel and the more innovative activity develops, the greater the intellectual property protection is in a nation.

In a study entitled "Globalization and Sustainable Development", Dehshiri (2014) discussed how globalization might guarantee sustainable development. The author also contended that globalization and sustainable development are two complementary and interacting paradigms while investigating pessimistic beliefs regarding the detrimental consequences of globalization on sustainable development, perceiving these two factors as conflicting and mutual paradigms.

2.2. International research

The first study examining the impact of rising oil prices on real income may be attributed to Hamilton (1983), who titled the research "Oil and Macroeconomics after World War II". The American economy has been investigated in this research. In the periods 1948–1972 and 1973–1980, Hamilton found a statistically significant relationship between changes in oil prices and the increase in the real gross domestic product of the American economy. The study's final finding indicates a one-way causal relationship between oil price and production.

Dakhli and De Clercq (2004) studied the impact of human and social capital as drivers of innovative activity in 59 countries between 1995 and 1998. They used generalized confidence indices, industrial confidence, cooperative activity, and civil behavior norms as social capital, and the human development index (a composite index of life expectancy, educational attainment, and living standards) as a representative of human capital to study how capital affects innovation. Their findings indicated that human capital had a positive and significant influence on innovative activities.

In their 2005 research entitled "Oil Prices, Economic Activity, and Inflation: Evidence for Some Asian Countries", Cunado and Gracia delved into the changes in oil prices in six Asian nations between 1975 and 2002. In this study, the Granger causality test and the co-integration approach were both employed. The study's findings indicate a connection between the shock in oil prices and the inflation rates in Japan, Singapore, and Thailand. The causal relation between the oil shock and the economic development in Thailand, South Korea, and Japan is also established. Generally, uneven outcomes have been shown in the analyzed countries in response to changes in oil prices and inflation rates.

Olomola and Adejumo (2006) examined the impact of fluctuations in oil prices on production, inflation, the currency rate, and money supply using seasonal data in their work titled "Oil Price Shock and Macroeconomic Activity in Nigeria". Nigeria is analyzed from 1970 to 2003 in this study. The findings, which were obtained using the vector auto-regression model, show that changes in oil prices have a slight or no impact on the exchange rate but have a significant impact on inflation and production.

In an article titled "Oil Prices, Inflation, and Interest Rates in a Structural Co-integrated VAR Model for the G-7 Countries," Colongni and Manera (2007) examined the impact of changes in oil prices on macroeconomic variables like interest rate, exchange rate, money volume, inflation, and gross domestic product in (OECD) nations using the correction method, variance analysis technique, and stimulus-response function. The findings of this study suggest that changes in oil prices have a significant impact on key macroeconomic variables.

Ping and Qingchang (2008) studied how human capital affected innovation in China between 1990 and 2005. Their study's findings demonstrate that China's innovation has been driven by the integration of local research and development, while it is impossible to disregard the influence of foreign technology over domestic innovation. Additionally, they claim that foreign direct investment has expedited China's activity and growth while imports impede innovation.

In their study titled "Effect of Oil Price Shock on Iran's Economic Growth," Farzanegan and Markwardt (2009) used the vector auto-regression model approach to examine the relationship between the oil price shock and the key macroeconomic indicators of Iran between 1975 and 2006. The findings of this study indicate that the medium-term real effective exchange rate is altered by the positive oil price shock, which also enhances the value of the local currency. Only the early inflationary effects of the positive oil price shocks are noticeable, but actual import and domestic production per capita both rise significantly. They also concluded that negative shocks to the price of oil hurt Iran's economy more.

2.3. Distinguishing feature

The distinction between this research and other investigations, according to the evaluation of prior studies, will be in analyzing the state of sustainable development indicators in OPEC petroleum exporting countries and determining the impact of changes in the world oil price on these indicators.

The sustainable development goals (SDG Indicators) issued by the United Nations are the indicators examined in this study.

3. Methodology

The auto-regression vector approach was employed in the current study to examine the correlations between the research variables. The features of the society under study caused the type of data utilized in the research to be taken into account as panel data. One technique for predicting and examining the relationships between variables in time series data is the VAR approach.

The purpose of the VAR model is to determine the connection between some univariate time series and concurrent equations, as follows:

$$y_{1,t} = C_1 + A_{1,1}y_{1,t-1} + A_{1,2}y_{2,t-1} + e_{1,t} \quad (1)$$

$$y_{2,t} = C_2 + A_{2,1}y_{1,t-1} + A_{2,2}y_{2,t-1} + e_{2,t} \quad (2)$$

Since there are many endogenous variables involved in this approach (VAR), it is unnecessary to distinguish between endogenous and exogenous variables. Instead, we treat all model variables as endogenous. However, the previous values of the model's endogenous variables and those with lags from all other endogenous variables are used to explain each endogenous variable. The VAR technique simultaneously analyzes time series for multiple forecasts.

The following are the properties of this prediction technique:

- This approach is straightforward and functions as a simultaneous system where all variables are regarded as endogenous;
- In the VAR technique, each variable's value is stated as a linear function of the variables' historical values;
- The outcomes of sophisticated models of simultaneous equations often outperform the forecasts made using this technique (Khajehpour and Karbasi, 2014).

3.1. Studying variables

The following data are utilized in this study:

3.1.1. Urbanization development

Urbanization is a term that describes how many people live in cities compared to how many live in villages; the pace of urbanization describes the more people live in cities compared to the fewer people living in villages.

3.1.2. Gini coefficient

A statistical measure between zero and one is called the Gini coefficient. When the Gini coefficient is zero, the income distribution is perfectly equal and each person or household has precisely the same income or expenditures. However, when all of the money is allocated to just one individual or class, the Gini coefficient is an indicator of total inequality in the distribution of income or costs. The Lorenz curve serves as the geometric foundation for the definition of the Gini coefficient.

3.1.3. Gross domestic product

It measures the value of goods and services generated during a specific period in a specific geographic region.

3.1.4. Oil price

The price of oil is seen as an independent exogenous variable based on worldwide pricing and the supply and demand for oil in international markets.

3.1.5. Inflation

It is the relentless and egregious rise in pricing. In other words, an increase in prices is considered inflation if it affects all items (or the majority of them) and continues over time rather than occurring suddenly (Shakri, 2010).

3.1.6. Risk of investment

The financial investment risk index has been utilized in this study to quantify the risk of investment.

4. Findings

4.1. Studying data stationery using unit root test

First, the stationary of the variables should be examined to see whether the study model and estimate are valid. When choosing the appropriate model and examining the behavior of the variables, the stationary of the variables aids in achieving the intended outcomes. Even if no logical connection exists between the independent and dependent variables, if the variables of our estimated model are unstable, the coefficients obtained in the causal model may be large and result in incorrect regression. The Levin–Lin–Chu (LLC) test is one of the tests we may use to identify the significance of variables in panel models.

The absence of a unit root is the null hypothesis in this test, while the alternative hypothesis is that at least one-panel member is stationary.

H0: A unit root exists and the concerned variable is non-stationary;

H1: A unit root does not exist and the concerned variable is stationary.

Table 1

The results of the LLC unit root test

Variable	Standard level		First-order difference	
	T-statistics	P-value	T-statistics	P-value
Gini coefficient	–2.18	0.0145	–3.23	0.0006
GDP	–6.799	0.0000	–1.73	0.0416
Risk of investment	–10.8928	0.0000	–13.87	0.0000
Oil price	–4.4585	0.0000	–3.04	0.0012
Urbanization	2.2352	0.9873	–5.1164	0.0000
Inflation	–1.9049	0.0284	–1.3737	0.0848

The test's findings demonstrate that all of the variables are stationary at the standard level, with the first-order difference of the variables revealing that other variables besides urbanization also gained statistical significance.

4.2. Co-integration

We will examine the co-integration in the model after confirming the consistency of the variables using the unit root test (which was carried out in the previous section) and before describing the model in vector auto-regression models. The Pedroni test is one of the techniques we employ to examine convergence in panel models.

Co-integration tests were implemented into many models by Pedroni (1999). Two categories are used to group these tests. Panel v-statistics, panel statistics, panel PP-statistics, and panel ADF-statistics are included in the first category, which is based on the intra-dimensional approach. The second group, consisting of three groups ρ, group PP, and group ADF statistics, is based on the inter-dimensional method. The opposing hypothesis is predicated on the presence of the co-integration vector between the variables, whereas the null hypothesis for both groups assumes that under the null hypothesis, ε_{it} is non-stationary and that there is no long-term association between the model's variables. We aim to find the co-integrated model variables. If this outcome is achieved, the VAR model can be executed.

4.3. Determining model's optimum lag section

The size of the model's optimum lag section has to be established before the co-integration model can be estimated. The significance of this issue is that it can show that the erroneous sentences have a normal distribution, are independent of one another, and do not have a sequential correlation.

Table 2

The results of the panel model's optimum lag test

Lag	CD	J	J-Pvalue	MBIC	MAIC	MQIC
1	0.9999968	128.8412	0.0747975	–411.3074	–86.15881	–218.2564
2	0.999999	87.22373	0.1068354	–273.542	–56.77627	–144.8413
3	0.999999	34.57003	0.5366019	–145.8128	–37.42997	–81.46248

As shown, the optimal lag for the model is 1. As a consequence, we run the co-integration test and the VAR model with a single lag. The CD statistic has the largest number for a lag of 1 in this test, or the test statistics have the lowest number in this lag, depending on the AIC statistic, while the J-Pvalue is more than 5 percent, thus the model optimum lag is 1.

Table 3

The results of the co-integration test

P-Value	T-statistics	Test statistics
0.0000	5.0294	Modified Philips-perron t
0.0210	2.0342	Phillips-perron t
0.0034	2.7045	Augmented Dicky-Fuller test

In this test, the alternative hypothesis denotes the presence of co-integration whereas the null hypothesis indicates the absence of co-integration. The results demonstrate that the null hypothesis is not accepted, and that there is a significant long-term relationship between the variables.

4.4. Granger causality test

This test is used to establish the causal connection between a time series and several factors. In this test, we check to see whether a previous process is what leads to a future process, i.e. if a variable's past values can be used to determine its cause and forecast its future. Two linear regressions are employed in the Granger test to identify causality (Granger, 1969):

$$Y(T) = \sum_{i=1}^{L} \propto \mathrm{iY(t-i)} + \varepsilon 1(\mathrm{t})$$

$$Y(T) = \sum_{i=1}^{\infty l} \alpha i Y(t-i) + \sum_{i=1}^{L} \beta \mathrm{iX(t-i)} + \varepsilon 1(\mathrm{t})$$

It is significant to note that the variables' stationary state must be guaranteed for this test. The acceptance or rejection criteria for this test is 95%. Hypothesis H0 is ruled out if the P-value is less than 5%. Hypothesis H0 is accepted if the value is higher than 5%..

Now that the variables do not include the unit root, so we can run the test.

4.5. Results of causality test

Table 4

The results of the causality test

		Dependent variable					
	Casualty variable	GDP	Gini	Risk	Oil	ub	inf
Independent variable	GDP	----	Not available	Available	Available	Not available	Not available
	Gini	Available	----	Available	Available	Not available	Available
	Risk	Available	Not available	-----	Available	Not available	Not available
	Oil	Available	Not available	Available	-----	Not available	Available
	ub	Available	Not available	Available	Not available	-----	Not available
	inf	Available	Available	Available	Available	Available	-----
	Co-integration	Available	Available	Available	Available	Available	Available

4.6. Impulse-respond function

The time of an impulse's effect is studied by analyzing the impulse-respond functions. These functions examine how a variable impulse standard deviation affects other model variables. In other words, this function illustrates how a shock to one of the internal variables in the vector auto-regression model might have an impact on the system.

The response of the investment risk variable (risk) and the Gini coefficient to a standard deviation shock in oil price can be described as follows:

4.6.1. Gini

The variable first experiences a positive change, but after a few times, it begins to trend downwards. Almost in the middle of the period, the variable experiences a negative change, and it then continues to

experience negative changes but with less strength. Therefore, the shift is positive in the short term but negative in the medium and long term.

4.6.2. Risk

When compared to shock, the investment risk variable is negative in the short term. However, over the medium and long term, this negative reaction has turned positive.

4.7. Stability test of panel-VAR model

One of the variables is out of range, according to the model's stability test. Therefore, the model is stable at a 90% level of confidence. Tests of the model's stability reveal that it is stable to an acceptable degree.

5. Discussion and conclusions

We can execute the vector regression model based on the panel data after conducting the reliability and convergence tests of the variables, which are necessary for the model. The $p > z$ statistic indicates whether the variable is significant or not. Therefore, the statistic below 5% reflects the model's significance. Another variable that is more significant than one variable may be determined by comparing the variables and coefficients concerning one another. Therefore, one of the best outcomes is produced by the GDP variable, which is a reliable dependent variable.

We can draw the following conclusions from the explanation of the model's variable coefficients:

- According to the model's results, all factors in the explanation of the GDP variable—aside from the price of oil—have positive and significant relationships. The GDP and the oil price variable have a negative and significant relationship.
- Although the price of oil is rising, as shown by the interpretation of the price coefficient on GDP, the government's oil revenues are increasing. However, because the nations that export oil lack the institutions needed to fully use these profits, it is nearly impossible for these revenues to have a significant influence on the development of those nations or generate long-term economic growth in such nations. The outcomes support the impact of the resources curse in these nations.
- The lack of a significant relationship between the urbanization variable and the variables of GDP and oil price in the explanation of the urbanization variable demonstrates that oil profits cannot contribute to the growth of urbanization. Further, this variable has a negative relationship with the inflation variable, which shows that an increase in inflation will harm the growth of urbanization. Since the price of oil has a positive and significant effect on inflation, an increase in the price of oil in this way can harm this variable.
- The study's findings indicate that the size of the economy does not significantly affect the fair distribution of income, as shown by the Gini coefficient. However, there may be a correlation between it and the price of oil. Therefore, as the size of the economy and oil revenues increase, the Gini coefficient rises and widens the class gap. As a result, an increase in income does not necessarily imply an improvement in the living conditions of society's citizens, and this can be attributed to the inefficient structure and rent-seeking nature of governments in oil-exporting nations.
- The research's findings indicate a significant and positive relationship between inflation and oil prices, demonstrating that oil-exporting nations' oil profits immediately enter the economy when they arrive, leading to the Dutch disease and inflation owing to inadequate infrastructure.

- The estimated model's results show that there is a negative and substantial relationship between investment risk and oil price. This negative relationship between oil price and investment risk demonstrates that rising oil prices warrant investing in the oil and gas industry, which lowers investment risk. However, it is noteworthy that nothing about this relates to sustainable development since growth and development inevitably slow down as a result of the resources curse (an industry's expansion relative to other economic sectors).

6. Policy recommendations

- Considering the United Nations' methodology for directing the indicators of sustainable development in various nations, the Islamic Republic of Iran's policymakers and economic managers should focus more on these indicators because of economic sanctions, the spread of COVID-19, and other economic turbulences. A documented long-term strategy and a distinct doable vision are essential.
- Given the current economic circumstances in Iran and the inflationary stagnation that has taken place, the obtained results indicate that the size of the economy (GDP) has a significant impact on the sustainable development index. Utilizing more efficient monetary and financial policies and raising the proportion of non-oil revenues in Iran's economic growth as opposed to oil incomes can be a positive step in line with production growth and the use of Iran's prospective production potential.
- Based on the findings, it is possible to identify investment risk as a barrier to sustainable development. The danger of investing in Iran has risen recently as a result of the situation in the Middle East, sanctions, and currency volatility in Iran. Consequently, it is recommended that the government should smooth the path toward lowering investment risk in Iran's economy using policies and programs such as increased support for foreign investors, development, and more effective special economic zones; tax support; and subsidies for production and investment.
- To achieve sustainable growth in Iran's economy, it is crucial to strengthen the economy's resilience through enhancements to the market infrastructure, increased resilience to external shocks, and financial market volatility, among other things.

Nomenclature

LLC test	Levin–Lin–Chu test
OPEC	Organization of the Petroleum Exporting Countries
VAR	Vector auto-regression model

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