

Humbatova, Sugra Ingilab; Hajiyeve, Galib Bahram; Aliyeva, Leyla Zakir et al.

Article

The impact of oil exports on imports of agricultural machinery and equipment

International Journal of Energy Economics and Policy

Provided in Cooperation with:

International Journal of Energy Economics and Policy (IJEEP)

Reference: Humbatova, Sugra Ingilab/Hajiyeve, Galib Bahram et. al. (2023). The impact of oil exports on imports of agricultural machinery and equipment. In: International Journal of Energy Economics and Policy 13 (1), S. 335 - 351.

<https://econjournals.com/index.php/ijEEP/article/download/13719/7142/32092>.

doi:10.32479/ijEEP.13719.

This Version is available at:

<http://hdl.handle.net/11159/593882>

Kontakt/Contact

ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics
Düsternbrooker Weg 120
24105 Kiel (Germany)
E-Mail: [rights\[at\]zbw.eu](mailto:rights[at]zbw.eu)
<https://www.zbw.eu/>

Standard-Nutzungsbedingungen:

Dieses Dokument darf zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden. Sie dürfen dieses Dokument nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, aufführen, vertreiben oder anderweitig nutzen. Sofern für das Dokument eine Open-Content-Lizenz verwendet wurde, so gelten abweichend von diesen Nutzungsbedingungen die in der Lizenz gewährten Nutzungsrechte. Alle auf diesem Vorblatt angegebenen Informationen einschließlich der Rechteinformationen (z.B. Nennung einer Creative Commons Lizenz) wurden automatisch generiert und müssen durch Nutzer:innen vor einer Nachnutzung sorgfältig überprüft werden. Die Lizenzangaben stammen aus Publikationsmetadaten und können Fehler oder Ungenauigkeiten enthalten.

Terms of use:

This document may be saved and copied for your personal and scholarly purposes. You are not to copy it for public or commercial purposes, to exhibit the document in public, to perform, distribute or otherwise use the document in public. If the document is made available under a Creative Commons Licence you may exercise further usage rights as specified in the licence. All information provided on this publication cover sheet, including copyright details (e.g. indication of a Creative Commons licence), was automatically generated and must be carefully reviewed by users prior to reuse. The licence information is derived from publication metadata and may contain errors or inaccuracies.



<https://savearchive.zbw.eu/termsOfUse>



Impact of Oil Exports on Imports of Agricultural Machinery and Equipment

Sugra Ingilab Humbatova¹, Galib Bahram Hajiye², Leyla Zakir Aliyeva³, Natig Gadim-Oglu Hajiye^{4*}

¹Head of Department Economics, UNEC/Azerbaijan State University of Economics. Istiqlaliyyat Str. 6, Baku, AZ1001, Azerbaijan,

²Department Economics, UNEC/Azerbaijan State University of Economics. Istiqlaliyyat Str. 6, Baku, AZ1001, Azerbaijan,

³Department Economics, UNEC/Azerbaijan State University of Economics. Istiqlaliyyat Str. 6, Baku, AZ1001, Azerbaijan,

⁴Department Economics, UNEC/Azerbaijan State University of Economics. Istiqlaliyyat Str. 6, Baku, AZ1001, Azerbaijan, Center for Agricultural Research, Ministry of Agriculture, Baku, Azerbaijan. *Email: n.qadjiev2012@yandex.ru

Received: 14 September 2022

Accepted: 05 January 2023

DOI: <https://doi.org/10.32479/ijeep.13719>

ABSTRACT

The influence of the main export product on the main import product is the focus of any country. In this regard, since oil and oil products are the main export commodity of Azerbaijan, their impact on the import of machinery and equipment necessary for the development of the agricultural and agro-processing industries, which are the main imported products, was chosen as the subject of study. The purpose of the article was to assess the impact of the export of oil and oil products on the import of machinery and equipment necessary for the development of the agricultural sector and the agro-processing industry. The study used data for the period from 1999 to 2020. ARDL and ECM methods were applied and compared with FMOLS, DOLS and CCR as a validation. During the study, 9 hypotheses were proposed. All hypotheses have been proven to some extent. The results of the study show that, like all industries, the agricultural sector depends on the oil factor. Thus, the export of oil to the republic has a positive effect on imports and, of course, on the imports of many machineries and equipment necessary for the development of the agricultural sector, especially agricultural machinery for tillage and harvesting, equipment for the food industry and equipment for processing agricultural products. The overall result of the research was a recommendation to further acceleration of work aimed at diversifying the economy and developing the non-oil sector, similar to the results of other similar studies (researches investigating resource-exporting economies).

Keywords: Oil Export, Export oil Products, Agriculture, Import of Machinery and Equipment, FMOLS

JEL Classifications: Q02, Q17, Q37, O13, O24

1. INTRODUCTION

Azerbaijan is among the countries rich in natural resources. But agriculture and industry should be considered as key sectors of the economy that provide inputs and output for each other (Muhammad et al., 2021). According to the general economic law, as well as the theories of trade and foreign trade, each entity brings to the market those products that it has more of and the costs of which are absolute or relative. Instead, it imports products and services that it does not have and that are absolutely or relatively expensive to produce. Currently, Azerbaijan mainly supplies oil (crude oil) to the world market. It is true that in the

last 10-15 years, gas exports have also occupied an important place. However, the main export component for many years to come will be the export of oil. In 2020, the share of exports of crude oil is 68.18%, and the share of crude oil and oil products (kerosene for jet engines, heavy distillates or gas oils for other purposes, lubricants, petroleum coke, liquid fuels) is 70.31% was. The survey will examine the dependence of products on the export of crude oil, as well as crude oil and petroleum products: the share of imports of agricultural machinery for tillage and harvesting is 0.25%, the share of imports of equipment for processing agricultural products is 0.18%, and the share of imports of equipment for the food industry is 0.10%.

Moreover, the share of imports of other products in the same year was as follows: 11.5%-food, 2%-cars, 3%-drugs and medical supplies, 5.7%-products of ferrous metallurgy and engineering, 2%-forestry products, 1.8%-chemical industry products, 0.9%-household appliances, 2%-telephone sets for a mobile or other wireless communication network, etc. However, the strength of each state lies in the strength of its economy, which ensures its economic security. One of the main components of economic security, and I think the first one, is food security. Ensuring food security directly depends on the development of agriculture. In this regard, the diversification of the economy is one of the priorities in many resource-rich countries, so this issue has always been on the agenda in Azerbaijan. Growth of agriculture and food self-sufficiency, as we mentioned above, this research work was started by recognizing the dependence of agricultural development on the development of agriculture and the import of agricultural machinery for tillage and harvesting, equipment for processing agricultural products and equipment for food processing.

2. THE ROLE OF OIL ON THE WORLD ECONOMY

We would like to start the section dedicated to the role of oil in the world economy with the following quote: "In the grand tradition of epic storytelling, The Prize tells the panoramic history of oil and the struggle for wealth and power that has always surrounded oil. It is a struggle that has shaken the world economy, dictated the outcome of wars, and transformed the destiny of men and nations." (Yergin, 1991), "The Prize is as much a history of the modern world as of the oil industry itself, for oil has shaped the politics of the twentieth century and has profoundly changed the way we lead our daily lives." (Yergin, 1991). The large role of oil in the global economy should be taken for granted. Nature is made up of energy. All living beings consume and produce energy for their existence. In other words, they transfer energy from one form to another. Population growth and increased production and consumption (of products) and their diversity of substitute and complementary products have increased the demand for energy and its role in the economy, including in the global economy. Since the industrial revolutions, as in any field, the numerical and geometric series have increased and this process continues going up. From this perspective, the demand for oil began to increase rapidly from the late 19th century to the early 20th century. Politicians, government officials, the financial sector, as well as the real sector of the economy, as well as those who work there, including economists and researchers, began to be interested in this issue, and no matter what area they study, they studied the oil factor at least a few times. A clear proof of this can be the authors given in the literature review. The relevance of the oil price never loses its position for a moment: "With oil prices cascading to new highs over the past few years, the topic of energy prices has once again come to the fore" (Rogoff, 2006).

"There is now broad consensus among that oil price fluctuations impact global economic growth are somewhat less than they did two to three decades ago." (Rogoff, 2006). "The run -up of oil prices over the last decade resulted from strong growth of demand

from emerging economies confronting limited physical potential to increase production from conventional sources." (Hamilton, 2014), "Moreover, for reasons discussed later in the paper, the view that oil prices affect the economy through a channel other than the process of labor reallocation cannot be rejected." (Loungani, 1986). "It is widely accepted that fluctuations in the world price of oil have substantial real effects on the U.S. macroeconomy (e.g., Hamilton [1983], Loungani [1986], Shapiro and Watson [1988], Perron [1989])" (Keane and Prasad, 1996). In particular, the fact that the expression "My conclusion is that hundred-dollar oil is here to stay" (Hamilton, 2014) mentioned by Hamilton in 2014 is confirmed by "For example, analysts at the Bank of America warned on October 1, 2021, that oil could surge above \$100 in the event of a cold winter and spark inflation (Lee and Cho, 2021). This sentiment is common on Wall Street. Similar views have been expressed by other investment banks including Goldman Sachs, JP Morgan and Barclay. Likewise, BlackRock, the world's top asset manager, recently stated that there is a high probability of oil hitting \$100 a barrel. Despite these warnings, there has been no quantitative analysis of this scenario" in the article published by Kilian and Xiaoqing (2022), indicates the relevance of the oil factor not only in the world economy, but also in the world political arena as a whole.

3. LITERATURE REVIEW

The significance of oil resources to boost economy, to establish political power of the country and to strengthen its position for international relations commenced to surge up since the beginning of the XX century by arithmetic sequence and continued to go up by geometric sequence later. It is hard to find a scientist who neither touched the oil factor or did a fundamental research in the last 50-60 years. However, this trend commenced to be common since 90 s of XX century. For example, Forbes (1941), Parcher (1947), Cauley (1959), Wilson (1974), Allan and McLachlan (1976), Penrose (1976), Gavett (1977), Hassan (1978), Denisard and Disch (1981), Ahmed (1985), Hojman (1987), Wells (1988), Naanen (1988), Falola (1988), Majd (1989), Hanson et al. (1993), Auty and Warhurst (1993), Yazdanpanah (1994), Sachs and Warner (1995), Uri (1995), Uri (1996), Parker, (1997), Mohamed et al. (2009), Mohammadi and Jahan-Parvar (2011), Shaari et al., (2013), Mikayilov et al. (2020), (Mukhtarov et al., 2020) etc. In fact, these researches refer to oil price fluctuations and the influence of the price on the economy of oil-importing and exporting countries. The impact on the development of any field is limited only by researching the influence on the price of the products of this field. Our research work is not related with the oil prices but it covers the impact of the import of technology, machinery and equipment which indirectly influence on the development of agriculture. Meanwhile, since there is no literature about it, we are obliged to refer to the researches about the impact of oil price fluctuation on the agricultural products and food price fluctuation.

3.1. Oil Prices and the Impact of oil Production on the Economy and Agrarian Economy

Fardmanesh (1991) assessed the effect of Dutch oil boom disease for oil exporting countries as Venezuela, Nigeria, Indonesia, Ecuador, Algeria between 1966 and 1986. Based on research

findings, their structure changes due to the increase in the world prices and the influence of the costs of industrial products compared to agricultural commodities and oil prices. Both effects expand the manufacturing sectors of these countries and reduce their agricultural fields. Cost effects expand their non-tradable sectors, while world price effects can expand or reduce them. The opposite results were predicted for the oil collapse of the 1980 s.

Karbasi et al. (2009) Kobba Douglas studied the effect of energy factor on gross production of economy and agriculture using production function and ARDL method during 1981-2005 in Iran. Results show that the production elasticities of labor, capital and energy factors of Iran's agriculture sector are 0.36, 0.23 and 0.32, respectively. Beside, the production elasticities of labor, last year capital and energy factors of Iran's total economy are 0.55, 0.46 and 1.17, respectively. Both cases indicate that agriculture and overall economy are strongly dependent on energy factors.

Thus, Saban et al. (2013) researched the effects of oil fluctuation on agricultural products based on the daily data between 01 January 1986-31 December 2005 and 01 January 2006-21 March 2011. They concluded that (test recently developed by Hafner and Herwartz, 2006) although there was no any risk transfer between oil and agricultural markets prior to crisis, while after crises oil market volatility is reflected in the agricultural markets except sugar. The impulse response analysis (GARCH) reveals that the shock is transferred to agricultural products after oil price fluctuation only after crisis. So, the transfer dynamics of the fluctuation significantly changes after food price crisis. Transferring risk after crisis turns into another aspect of dynamic mutual relations between energy and agricultural markets. They also concluded that the dependency has unbelievably increased among energy and agricultural markets recently.

Oyetade et al. (2016) used VECM and VAR methods and examined the relationship among agricultural export, oil export and output growth in Nigeria from 1981 to 2014. The study revealed that there is significant relationship between economic growth and the agricultural export and oil export. Based on the findings, government of the country is being advised to initiate new and redefined old policies that will diversify the export base.

Kakanov et al. (2018) provide a comprehensive analysis of the "resource curse" phenomenon, i.e. the negative impact of oil abundance on long-term economic growth, for a set of oil exporting countries. The empirical analysis relies on oil exporters between 1982 and 2012 and an error correction model (ECM). The paper provides robust evidence in favour of the resource curse hypothesis, and there is no evidence that higher quality institutions could mitigate the curse. Oil price shocks appear to have an asymmetric impact in the short run: The growth effect is positive when oil prices rise, while no statistically significant effect is observed when they fall. There is also indirect evidence that the impact of an oil price shock is partly offset by fiscal policies, particularly in countries with high oil dependence. In the long run, oil price volatility does not appear to have a statistically significant impact on GDP. Exchange rate regimes seem to play a role: Countries allowing their currencies to float seem to gain

from positive oil price shocks in the short run, but in the long run a fixed exchange rate regime is associated with higher GDP, probably owing to active stabilisation by sovereign wealth funds.

Before Abdlaziz et al. (2018) investigated the panel co-integration analysis of oil prices on agriculture in 25 oil-exporting countries between 1975 and 2004 during Dutch disease. The article fully modified OLS (FMOLS), dynamic (OLS) and (PMG) methods to examine the long-run effect of real oil price and real exchange rate on agriculture. The result of the Pedroni cointegration exposes the long-run relationship between the variables under study. Panel cointegration estimators show the negative and significant effect of oil price and exchange rate on agriculture value added. These results indicate the existence of the Dutch disease and de-agriculturalization in oil-exporting economies.

Ologunde et al. (2020) investigated the relationship between sustainable development and crude oil revenue (COR) in selected oil-producing African countries from 1992 to 2017 using the Pooled Mean Group (PMG) estimators on panel autoregressive distributed lag model (ARDL). In the panel analysis, the PMG estimator model has been seen as a good alternative to estimators such as DOLS and FMOLS. Empirical results revealed that there was no long-term relationship between COR and sustainable development. In other words, the results suggest that any changes to COR have a potential negative effect on sustainable development in the selected countries. This implies over-reliance on COR will impact the economies negatively in the long run. This finding, therefore, requires an immediate fiscal intervention on spending on sustainable development drivers such as education, health, agriculture cum adoption diversification policy. The findings proved once more that oil revenues in a long run will not be effective for sustainable development. Conversely, if the use of oil revenues is not adequately diversified and supported by government institutions, it will have a negative impact.

Abdlaziz et al. (2021) used ARDL method and researched the effect of revenue generated from oil on the added value of agricultural products in terms of the efficiency of real currency exchange among 25 oil-exporting countries during 1975-2014. The research concluded that revenue generated from oil directly and negatively affect the added value of agriculture in a long and short term. This impact is relatively strong in the major oil exporting countries but weak in the minor oil exporting countries. It can be inferred that in the long-run, the appreciation in real exchange rates exacerbate the negative marginal effects of oil revenue on agricultural value-added in all oil-exporting countries. However, the effects are different when considering MAOEC and MIOEC separately. When considering MAOEC, the contingent effect disappears (become insignificant) while in MIOEC, it is positive and statistically significant. Thus, in the long-run, the appreciation in real exchange rates diminishes the negative marginal effects of oil revenue on agricultural value-added in MIOEC. While oil revenue has a direct negative effect, its effect is also moderated by the variations in REERs in MIOEC in the long-run. Finally, in the short-run, fluctuations in the real exchange rate do not matter for the nexus of oil revenue and agriculture sector in these countries whether minor or MAOEC countries.

Aye and Odhiambo (2021) conducted a threshold analysis of the growth between oil prices and agriculture on a quarterly basis in South Africa from 01.1980 to 01.2020. They assessed the relations between oil price and agriculture using Tong (1983; 1990) and Hansen (2011) autoregression threshold model. The findings showed if the rice crude oil either in Dollars or in Rands will have significant negative effects on agricultural growth in South Africa.

Vasiljeva et al. (2022) used Panel Regression Model and studied the aims of sustainable development and crude oil market functioning features (oil price, oil production) of OPEC++ participating countries in 1992-2020. Findings reveal that reducing oil volume implied in OPEC+ and OPEC++ agreements will lead to stabilization of oil prices. However, it negatively affects sustainable development of countries. The reduction of oil production and export exert positive influence on the sustainable development of OPEC++ countries. The more the country developed the more positive effect it will be exerted or vice versa. This research reveals that in resource economies, a reduction in oil production and exports cannot have the same effect on sustainable development as in countries that do not produce oil, or are characterized by a higher level of economic development. This thesis is substantiated by the empirical confirm of the long-term adverse effect of the oil price growth on the realization of sustainable development goals. This effect is explained by the low level of economic diversification and the concept of “Dutch disease” as widely elucidated by scientists.

3.2. Impact of oil Prices on Agrarian Prices

Zhang et al. (2008) used VARMA model, Granger-Causality test and Johansen-Juselius models and studied the impact of oil prices on agricultural commodity prices on maize, soybeans and pork prices in China from January 2000 to October 2007. The results might heavily influence food prices in China to sharply increase biofuel production and crude oil prices.

Olayungbo (2021) analysed the causal link of oil and food prices in the sample countries that are both food importing and oil exporting economies, using ARDL panel method. The outcomes of the research encompassing annual data sets of 21 countries between 2001 and 2015 reveal that the short period analysis between oil prices and food prices is negative while positive effects exist in the long period. The causality result shows that causality runs from food prices to oil price. Thus, the result implies that appropriate agricultural policies that promote favourable food prices and alternative energy options should be pursued in the countries to ensure sustained food and oil supply.

Harri et al. (2009) studied cointegration relations among oil price, raw material price and exchange rate using VAR method. Their research encompassed the period from January 2000 to September 2008. Authors relied on concluded Johansen Trace Cointegration Test (Johansen, 1992; Johansen and Juselius, 1992) and concluded that some raw materials such as corn, cotton and soybean has relations with oil prices. However, wheat has no evidence. Also, exchange rates do play an important role in the linkage of prices over time.

Chen et al. (2010) analyzed the interactions between crude oil prices and wheat, maize, soybean prices. The empirical results taken by ARDL method reveal that the change in each grain price is significantly influenced by the changes in the crude oil price and other grain prices during the period extending from the 3rd week in 2005 to the 20th week in 2008. It implies that grain commodities are competing with the derived demand for bio-fuels by using soybean or corn to produce ethanol or bio-diesel during the period of higher crude oil prices in these recent years.

Ibrahim's (2015) research paper analyses the relations between food and oil prices for Malaysia from 1971 to 201 using ARDL model. The bounds test of the NARDL specification suggests the presence of cointegration among the variables. The estimated NARDL model affirms the presence of asymmetries in the food price behavior. Namely, in the long run, there is a significant relation between oil price increases and food price. Meanwhile, in the long run, the relation between oil price reduction and the food price is absent. Furthermore, in the short run, only changes in the positive oil price exert significant influences on the food price inflation. With the absence of significant influence of oil price reduction on the food price both in the long run and in the short run, the role of market power in shaping the behavior of Malaysia's food price is likely to be significant.

Olayungbo (2016) mainly focused on the causal link of oil and food prices in 39 developing and oil-exporting countries from 2001 and 2013, based on annual data and ARDL method. The cointegration test in several countries proved the presence of long term casual link between oil and food prices. The long term result exerted positive and significant influence of oil prices on food prices. However, the short term was positive but insignificant. Therefore, the author of the article concluded that oil price impacts on food price in a long run and implies to establish appropriate agricultural policies that promote favourable conditions to insulate economy from global crises as a result of oil fluctuations.

Fowowe (2016) conducted an empirical investigation of the effects of oil prices on agricultural commodity prices, based on the weekly data, in South Africa, from 2 January 2003 to 31 January 2014. Structural breaks cointegration tests showed no evidence of a long-run relationship between oil prices and agricultural commodity prices in South Africa. Nonlinear causality tests showed no evidence that agricultural commodity prices in South Africa respond to oil prices. The results show that agricultural commodity prices in South Africa are neutral to global oil prices.

Olasunkanmi and Oladele (2018) analyzed the impact of oil price shocks on agricultural commodity prices in Nigeria using monthly data on oil prices, maize, wheat and soybean and exchange rate from 1997 to 2016. Authors used dummy variables to capture periods of structural breaks in the selected agricultural commodity prices. Linear ARDL and Non-linear ARDL were estimated. Asymmetric test using Wald Statistics revealed evidence of asymmetries which imply the positive and negative shocks of the same magnitude and do not have equal impact on agricultural commodity prices. The study found significant positive oil price changes in all cases with the expected positive sign, implying that

increases in oil price lead to increases in agricultural commodities. Similarly, exchange rate showed positive significant relationship with agricultural commodities. It is concluded that oil price has overall positive relationship and significant effect on agricultural commodity prices. The study recommended that since oil price was important in agricultural commodities prices, efforts should be geared towards local development of the oil sector. It will bring about positive spillover effect on the agricultural sector and ensure food availability at affordable prices thereby improving standard of living and welfare.

Meyer et al. (2018) studied asymmetric analysis of oil price changes on food prices in oil-exporting developing countries between 2001 and 2014 using ARDL and NARDL method. They concluded that there is a positive and significant relationship between food and oil prices in a long run. Simultaneously, they concluded that there is no long-term relations between the reduction in oil price and food price. Authors recommended that oil-exporting developing countries should adjust their public policy schemes in such a way as to enable reductions in the oil price to trickle down to food prices. In addition, these countries should ensure the implementation of long-term agricultural policies aimed at insulating their economies from global food crises that may arise due to oil price increases.

Zmami and Ben-Salha (2019) used ARL and NARDL analysis and researched the impact of the Brent and West Texas Intermediate (WTI) oil prices on international food prices between January 1990 and October 2017. The findings confirm the presence of asymmetries since the overall food price is only affected by positive shocks on oil price in the long-run. While the dairy price index reacts to both positive and negative changes of oil price, the impact of oil price increases is found to be greater. The asymmetry is present for some other agricultural commodity prices in the short-run. They respond only to oil price decreases. They concluded that studies assuming the presence of a symmetric impact of oil price on food price might be flawed.

Chen et al. (2020) examined and compared samples how oil price impacts on food prices in high-and low-income oil-exporting countries before crisis (2000.01-2013.01) and during crisis (2013.02-2019.04). We found an inverse relationship between oil and food prices in the long run based on FMOLS, DOLS and Panel Granger Causality Test (PGCT). The story has been different during the crisis period: In low-income countries and all the countries combined, oil and food prices co-move in the long run. The findings also suggest that economic structure and uncertain events (crises) dictate the behaviour and relationship between food and oil markets. Food and oil prices may drift away in the short-run, but market forces turn them toward equilibrium in the long-run. Moreover, low-income countries are indifferent in both periods due to limited capacity to balance the increasing demand for and supply of food items.

Radmehr and Henneberry (2020) examined the relationship between food prices in Iran from March 1995 to February 2018. They used Pedroni co-integration tests, Panel ARDL, Pooled Mean Group (PMG), Dynamic Fixed Effect (DFE), Mean Group

(MG), Fully Modified Ordinary Least Square (FMOLS), Dynamic Ordinary Least Squares (DOLS), Impulse-Response Functions, Granger Causality methods (1969) and tests in their research. Results show that in both the short and the long-run, food prices would increase in response to an increase in energy prices. Findings also suggest that the appreciation of the United States Dollar (USD) in terms of the Iranian rial exerts a positive and significant impact on food prices in the long run.

Onour (2021) used Markov Switching Dynamic Regression-MSDR, Dynamic Conditional Correlation-DCC and Generalized Autoregressive Conditional Heteroskedasticity-GARCH models to research how the price changes between crude oil and food price (wheat, sugar, corn and fertiliser) from January 1988 to April 2018. The study suggests that when the oil prices increase during its low volatility, it leads to the reduction of food prices. On the contrary, when the oil prices increase during its high volatility, it leads to the increase of food prices. Dynamic Conditional Correlation-DCC of GARCH-reveals that the coefficients of oil price level are significantly and positively related to the conditional volatility of the price of food products. Thus, the volatility of the food prices is determined not by the volatility of the price of oil, but by the level of the oil price at the extreme points.

Kirikaleli and Darbaz (2021) studied the causal relationship between energy prices and food prices based on monthly data from 01.1980 to 01.2019. Their study attempts to utilize relatively newly developed methods, namely Toda-Yamamoto causality, Fourier Toda-Yamamoto causality, and spectral BC causality tests. The Toda-Yamamoto causality, Fourier Toda-Yamamoto causality test clearly reveals that there is bidirectional causality between the energy price index and food price indexes (grains, other food, and oils). On the contrary, tests showed a different result in terms of the relations between energy and oil. Both test reveals that there is a bidirectional causality between oil and energy. In order to widely research the causality between energy and food prices, spectral Granger causality method was used. The tests confirm the presence of causality in a long run between food price and energy prices.

Shokoohi and Saghaian (2022) used VAR panel model and analysed the effect of the causal link between food price and energy of oil-exporting and oil-importing countries. They relied on the annual data between 1974 and 2018 and concluded that the impact of oil prices on food prices is different in oil exporting and importing countries. This effect reduces first in oil-importing countries but then makes corrections over a period of time. However, for oil exporting countries, these effects are increasing and significant. In addition, the effects of real gross domestic product (GDP) and exchange rates on food prices are statistically significant in oil exporting countries. However, they do not directly affect the prices of food calories and fat in countries that import crude oil. These results prove that crude oil prices, incomes and exchange rate policies in oil exporting countries play an effective role in fighting starvation and food security.

4. DATA AND METHODOLOGY

4.1. Data Descriptions

The research used time series (2000-2020) to study the dependency import of agricultural machines for tillage and harvest, food industry equipment, some, equipment for processing agricultural products on oil export/export of oil and oil products. All indicators are in US dollar and taken from Azerbaijan Statistic Office (Table 1 and Graph 1).

4.2. Methodology

In this study, the assessment based on the ARDL model is carried out in five stages. First, as in every study, several stationarity tests are performed to check whether there is a 0 or 1 co-integration procedure between the variables used. Thus, there may be a co-integration relationship between variables that have this stationary characteristic (Pesaran et al., 2001). After that, the optimal residual of the model variables is determined using standard information criteria such as AIC (Akaike Information Criterion) and SIC (Schwartz Information Criterion). The third step is to check the co-integration using the bounds check method. Further, if the co-integration test indicates the presence

of a co-integrating relationship between variables, then an error correction model is evaluated to further confirm the co-integrating relationship, as well as the short-term influence of the independent variables on the dependent variables. Finally, the validity of the selected ARDL models is tested using two statistics: Cumulative sum of residuals (CUSUM) and cumulative sum of residual squares (CUSUMSQ).

Lingxiao et al. (2016) had mentioned such a fact that, According to some data, despite the ARDL model was proposed by Charemza et al. [1997] Pesaran et al. it was developed as a more applicable methodology by Pesaran et al. (2001) and Pesaran et al., 1999). It has several advantages over many other (e.g. Engle-Granger, Johansen, and Johansen and Juselius) cointegration methods. So, this method can be applied in solving problems with a small data coverage period. At the same time, this method allows analysis with I(0) and/or I(1) data, provided that I(2) is not present. Unlike the traditional method, it can use different lengths (lags) for different variables in the model. This significantly improves the fit of the model.

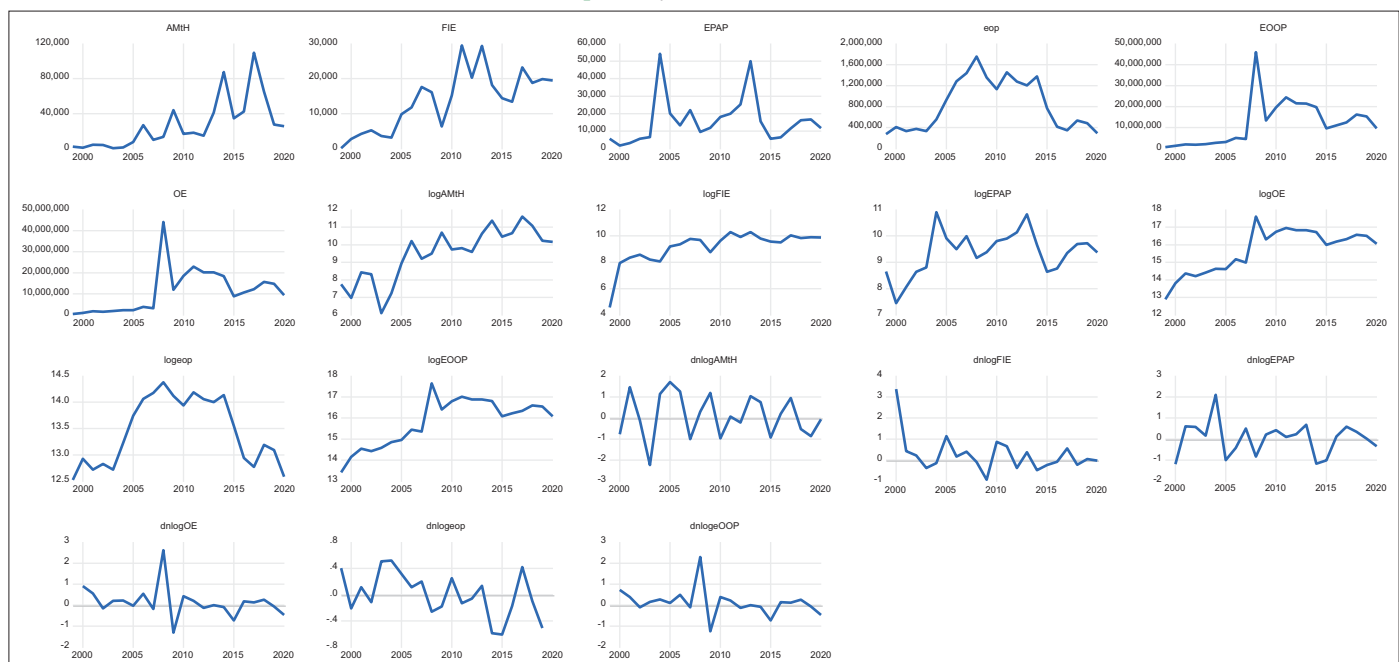
Estimation based on the ARDL model helps to overcome the endogeneity problem, and since the lagged indicators of the dependent variables are used as explanatory (independent) variables, it provides reliable results even in cases where the number of observations is small (Aliyev et al., 2016). Besides, instead of evaluating a system of equations, as in the Johansen method, only one equation is evaluated. If the ARDL model is applied, the long-term and short-term effect coefficients, including the error correction period coefficient (ETM), are also estimated here.

The sequential steps are as follows. First, based on the ARDL model, an unrestricted error correction model (ARDL-ECM) is constructed, which includes long-term and short-term

Table 1: Data and internet resource

OE	Oil export (thousand manats)	www. stat.gov.az
EOOP	Export of oil and oil products (kerosene fuel for jet engines, heavy distillates or gas oils for other purposes, lubricating oils, petroleum coke, liquid fuel) (thousand manats)	www. stat.gov.az
EOP	Export of oil products (kerosene fuel for jet engines, heavy distillates or gas oils for other purposes, lubricating oils, petroleum coke, liquid fuel) (thousand manats)	www. stat.gov.az
AMTH	Agricultural machines for tillage and harvest (thousand manats)	www. stat.gov.az
FIE	Food industry equipment (thousand manats)	www. stat.gov.az
EPAP	Equipment for processing agricultural products (thousand manats)	www. stat.gov.az

Graph 1: Dynamics of indicators



relationships between variables. Explanatory variables in formulas (1), (3) and (5)-Oil export, in formulas (2), (4) and (6)-Export of oil and oil products

4.3. URT-Stationary Time Series

Before using regression equation, we need to use URT to provide stability. This is important to determine the integration level and stationary for time series (variables) in modern empirical researches. So, using non-stationary time series causes wrong regression. That is why selecting the most appropriate model is important. The article used Augmented Dickey-Fuller, (ADF) (Dickey and Fuller, 1981), Phillips-Perron (PP) (Phillips and Perron, 1988), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) (Kwiatkowski et al., 1992) tests.

The following hypothesis was put forth in the research:

- H1₀: The increase in oil exports increases imports of agricultural machinery for tillage and harvesting
 H2₀: The increase in oil exports increases the imports of equipment for the food industry
 H3₀: The increase in oil exports increases the import of equipment for the processing of agricultural products
 H4₀: The increase in exports of oil and oil products increases imports of agricultural machinery for tillage and harvesting
 H5₀: The increase in the export of oil and oil products increases the import of equipment for the food industry
 H6₀: The increase in the export of oil and oil products increases the import of equipment for the processing of agricultural products
 H7₀: The increase in the export of petroleum products increases the import of agricultural machinery for tillage and harvest
 H8₀: The increase in the export of oil products increases the import of equipment for the food industry
 H9₀: The increase in exports of petroleum products increases imports of equipment for processing agricultural products

The following equations were used to study the impact of oil export/export of oil and oil products on import of agricultural machines for tillage and harvest, food industry equipment, some, equipment for processing agricultural products.

logarithmically

- AMTH=f(OE) (1)
 AMTH=f(EOOP) (2)
 AMTH=f(EOP) (3)
 FIE=f(OE) (4)
 FIE=f(EOOP) (5)
 FIE=f(EOP) (6)
 EPAP=f(OE) (7)
 EPAP=f(EOOP) (8)
 EPAP=f(EOP) (9)
 $LnAMTH = \beta_0 + \beta_1 LnOE + \varepsilon$ (10)
 $LnAMTH = \beta_0 + \beta_1 LnEOOP + \varepsilon$ (11)
 $LnAMTH = \beta_0 + \beta_1 LnEOP + \varepsilon$ (12)
 $LnFIE = \beta_0 + \beta_1 LnOE + \varepsilon$ (13)
 $LnFIE = \beta_0 + \beta_1 LnEOOP + \varepsilon$ (14)
 $LnFIE = \beta_0 + \beta_1 LnEOP + \varepsilon$ (15)
 $LnEPAP = \beta_0 + \beta_1 LnOE + \varepsilon$ (16)
 $LnEPAP = \beta_0 + \beta_1 LnEOOP + \varepsilon$ (17)
 $LnEPAP = \beta_0 + \beta_1 LnEOP + \varepsilon$ (18)

4.4. ARDLBT (Autoregressive Distributed Lags Bounds Testing)

The equation (10-18) as an initial step to evaluate the mutual relationships between variables in the long and short term was presented in ARDL model (Pesaran et al., 2001) Equations (19-27)) as the following:

$$\Delta LnAMTH_t = \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta LnAMTH_{t-i} + \sum_{i=0}^p \beta_{2i} \Delta LnOE_{t-i} + \lambda_{1i} LnAMTH_{t-1} + \lambda_{2i} OE_{t-1} + \varepsilon_t \quad (19)$$

$$\Delta LnAMTH_t = \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta LnAMTH_{t-i} + \sum_{i=0}^p \beta_{2i} \Delta LnEOOP_{t-i} + \lambda_{1i} LnAMTH_{t-1} + \lambda_{2i} EOOP_{t-1} + \varepsilon_t \quad (20)$$

$$\Delta LnAMTH_t = \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta LnAMTH_{t-i} + \sum_{i=0}^p \beta_{2i} \Delta LnEOP_{t-i} + \lambda_{1i} LnAMTH_{t-1} + \lambda_{2i} EOP_{t-1} \quad (21)$$

$$\Delta LnFIE_t = \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta LnFIE_{t-1} + \sum_{i=0}^p \beta_{2i} \Delta LnOE_{t-i} + \lambda_{1i} LnFIE_{t-1} + \lambda_{2i} OE_{t-1} + \varepsilon_t \quad (22)$$

$$\Delta LnFIE_t = \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta LnFIE_{t-1} + \sum_{i=0}^p \beta_{2i} \Delta LnEOOP_{t-i} + \lambda_{1i} LnFIE_{t-1} + \lambda_{2i} EOOP_{t-1} + \varepsilon_t \quad (23)$$

$$\Delta LnFIE_t = \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta LnFIE_{t-1} + \sum_{i=0}^p \beta_{2i} \Delta LnEOP_{t-i} + \lambda_{1i} LnFIE_{t-1} + \lambda_{2i} EOP_{t-1} + \varepsilon_t \quad (24)$$

$$\Delta LnEPAP_t = \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta LnEPAP_{t-1} + \sum_{i=0}^p \beta_{2i} \Delta LnOE_{t-i} + \lambda_{1i} LnEPAP_{t-1} + \lambda_{2i} OE_{t-1} + \varepsilon_t \quad (25)$$

$$\Delta LnEPAP_t = \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta LnEPAP_{t-1} + \sum_{i=0}^p \beta_{2i} \Delta LnEOOP_{t-i} + \lambda_{1i} LnEPAP_{t-1} + \lambda_{2i} EOOP_{t-1} + \varepsilon_t \quad (26)$$

$$\Delta LnEPAP_t = \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta LnEPAP_{t-1} + \sum_{i=0}^p \beta_{2i} \Delta LnEOP_{t-i} + \lambda_{1i} LnEPAP_{t-1} + \lambda_{2i} EOP_{t-1} + \varepsilon_t \quad (27)$$

In the formula, ε_t is white noise; Δ is the first-order difference; p is the lag order, which is usually calculated by AIC or SBC criterion; λ_{1i} and λ_{2i} is the long-term coefficient between variables; β_{1i} and β_{2i} is the short-term coefficient between variables. β_0 free number. Ln - logarithm sign.

As the next step, the Engle-Granger (EG) co-integration test is applied. This test is mostly used to check long-term relationships (Menegaki, 2019, 2020). However, it also provides an opportunity to explore short-term relationships and identify interactions between variables. The regression equation is estimated for the variables in the first step of the EG co-integration test. Thus, the following equations for two variables are given (equations 28-25)

$$\text{LnAMTH}_t = \beta_0 + \lambda_1 \text{LnOE}_t + \varepsilon_t \quad (28)$$

$$\text{LnAMTH}_t = \beta_0 + \lambda_1 \text{LnEOOP}_t + \varepsilon_t \quad (29)$$

$$\text{LnAMTH}_t = \beta_0 + \lambda_1 \text{LnEOP}_t + \varepsilon_t \quad (30)$$

$$\text{LnFIE}_t = \beta_0 + \lambda_1 \text{LnOE}_t + \varepsilon_t \quad (31)$$

$$\text{LnFIE}_t = \beta_0 + \lambda_1 \text{LnEOOP}_t + \varepsilon_t \quad (32)$$

$$\text{LnFIE}_t = \beta_0 + \lambda_1 \text{LnEOP}_t + \varepsilon_t \quad (33)$$

$$\text{LnEPAP}_t = \beta_0 + \lambda_1 \text{LnOE}_t + \varepsilon_t \quad (34)$$

$$\text{LnEPAP}_t = \beta_0 + \lambda_1 \text{LnEOOP}_t + \varepsilon_t \quad (35)$$

$$\text{LnEPAP}_t = \beta_0 + \lambda_1 \text{LnEOP}_t + \varepsilon_t \quad (36)$$

Here β_0 , λ_1 - are regression coefficients, LnAMTH LnFIE and LnEPAP dependent variables as mentioned above, while LnOE, LnEOOP and LnEOP are independent variables, explanatory variables. ε - is error (is white noise), t -is time. After estimating the regression equation, the reliability of ε - is checked. When ε is stationary, it is said that there is a co-integrating relationship between the variables. Based on these, it is also proved that these equations (28-36) are long-term equations.

At the same time, ARDLBT checks for any dependencies between variables after the ECM is installed. The ARDL Boundary Testing Co-integration Method uses the Wald test (F-stat) to test for the presence of a long-term co-integration test between selected variables. Long-term interaction or co-integration

($H_0: \lambda_{11} = \lambda_{21} = 0$; $H_1: \lambda_{11} \neq \lambda_{21} \neq 0$) is checked. That is, the null hypothesis of the absence of this relationship is tested. The alternative hypothesis means the existence of co-integrating relationships between the variables. According to the F -test statistic, there are 2 types of bounds (upper and lower bounds) (Pesaran et al. 2001).

If the evaluation value of F -test statistics is less than the lower bound, there is no significant long-term mutual relations among variables. Otherwise, if F -test exceeds the upper bound, there is a long-term mutual relation. If the given statistics of F -test are within accepted values, the outcomes are uncertain.

Finally, ECM is evaluated using stationary variables, periodical lag, and white noise error ($ECT_{(t-1)}$). These variables are used to check cause and effect relations, in other words, to define the direction of power and dependency (equation (37-45)) (növbəti mərhələ, addım). Having established mutual relations, the next step will be

to evaluate the short and long term relations among variables. ECM was used to evaluate short term dependency (37-45):

$$\begin{aligned} \Delta \text{LnAMTH}_t &= \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta \text{LnAMTH}_{t-i} \\ &+ \sum_{i=0}^p \beta_{2i} \Delta \text{LnOE}_{t-i} + \varphi_1 ECT_{t-1} + \varepsilon_t \end{aligned} \quad (37)$$

$$\begin{aligned} \Delta \text{LnAMTH}_t &= \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta \text{LnAMTH}_{t-i} \\ &+ \sum_{i=0}^p \beta_{2i} \Delta \text{LnEOOP}_{t-i} + \varphi_2 ECT_{t-1} + \varepsilon_t \end{aligned} \quad (38)$$

$$\begin{aligned} \Delta \text{LnAMTH}_t &= \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta \text{LnAMTH}_{t-i} \\ &+ \sum_{i=0}^p \beta_{2i} \Delta \text{LnEOP}_{t-i} + \varphi_3 ECT_{t-1} + \varepsilon_t \end{aligned} \quad (39)$$

$$\begin{aligned} \Delta \text{LnFIE}_t &= \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta \text{LnFIE}_{t-i} \\ &+ \sum_{i=0}^p \beta_{2i} \Delta \text{LnOE}_{t-i} + \varphi_4 ECT_{t-1} + \varepsilon_t \end{aligned} \quad (40)$$

$$\begin{aligned} \Delta \text{LnFIE}_t &= \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta \text{LnFIE}_{t-i} \\ &+ \sum_{i=0}^p \beta_{2i} \Delta \text{LnEOOP}_{t-i} + \varphi_5 ECT_{t-1} + \varepsilon_t \end{aligned} \quad (41)$$

$$\begin{aligned} \Delta \text{LnFIE}_t &= \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta \text{LnFIE}_{t-i} \\ &+ \sum_{i=0}^p \beta_{2i} \Delta \text{LnEOP}_{t-i} + \varphi_6 ECT_{t-1} + \varepsilon_t \end{aligned} \quad (42)$$

$$\begin{aligned} \Delta \text{LnEPAP}_t &= \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta \text{LnEPAP}_{t-i} \\ &+ \sum_{i=0}^p \beta_{2i} \Delta \text{LnOE}_{t-i} + \varphi_7 ECT_{t-1} + \varepsilon_t \end{aligned} \quad (43)$$

$$\begin{aligned} \Delta \text{LnEPAP}_t &= \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta \text{LnEPAP}_{t-i} \\ &+ \sum_{i=0}^p \beta_{2i} \Delta \text{LnEOOP}_{t-i} + \varphi_8 ECT_{t-1} + \varepsilon_t \end{aligned} \quad (44)$$

$$\begin{aligned} \Delta \text{LnEPAP}_t &= \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta \text{LnEPAP}_{t-i} \\ &+ \sum_{i=0}^p \beta_{2i} \Delta \text{LnEOP}_{t-i} + \varphi_9 ECT_{t-1} + \varepsilon_t \end{aligned} \quad (45)$$

Table 2: Results of unified root tests

Model	Variable	ADF	PP	KPSS
With intercept only	At level form			
	<i>LnOE</i>	-2.111885	-2.620692	0.511051**
	<i>LnEOOP</i>	-2.395482	-2.395482	0.491440**
	<i>LnEOP</i>	-1.145315	-1.441392	0.175976
	<i>LnAMTH</i>	-1.812818	-1.529145	0.741095***
	<i>LnFIE</i>	-4.508987***	-6.010952***	0.662537**
	<i>LnEPAP</i>	-4.046870***	-2.367039	0.246016
	At First differencing			
	Δ LnOE	-6.800788***	-6.800788***	0.335760*
	Δ LnEOOP	-6.671246***	-6.671246***	0.363220*
	Δ LnEOP	-3.119722**	-3.125357**	0.539249**
	Δ LnAMTH	-5.825820***	-6.664843***	0.276569
	Δ LnFIE	-7.410029***	-15.52941***	0.343586*
	Δ LnEPAP	-3.730714**	-5.282537***	0.213513
With intercept and trend	At level form			
	<i>LnOE</i>	-2.261830	-2.166894	0.164158**
	<i>LnEOOP</i>	-1.032932	-1.818199	0.164772**
	<i>LnEOP</i>	-0.937024	-0.739019	0.168525**
	<i>LnAMTH</i>	-3.309202*	-1.529145	0.119574*
	<i>LnFIE</i>	-2.408524	-6.922448***	0.198260**
	<i>LnEPAP</i>	-2.858500	-2.455144	0.129803*
	At first differencing			
	Δ LOE	-7.310314***	-7.972479***	0.073724
	Δ LnEOOP	-7.201363***	-7.792329***	0.093597
	Δ LnEOP	-3.843482**	-3.572439*	0.101590
	Δ LnAMTH	-3.229580*	-8.997660***	0.276827***
	Δ LnFIE	-5.197627***	-23.45883***	0.104477
	Δ LnEPAP	-4.418839	-6.669006***	0.247333**
No intercept and no trend	At level form			
	<i>LnOE</i>	1.064828	0.753004	N/A
	<i>LnEOOP</i>	1.026733	0.990857	N/A
	<i>LnEOP</i>	-0.018981	-0.018981	N/A
	<i>LnAMTH</i>	0.887323	0.741095	N/A
	<i>LnFIE</i>	0.811147	0.801163	N/A
	<i>LnEPAP</i>	0.011546	0.263415	N/A
	At First differencing			
	Δ LOE	-6.700234***	-6.700234***	N/A
	Δ LnEOOP	-6.525613***	-6.574837***	N/A
	Δ LnEOP	-3.238435***	-3.244022***	N/A
	Δ LnAMTH	-5.731890***	-5.118680***	N/A
	Δ LnFIE	-5.197627***	-9.706088***	N/A
	Δ LnEPAP	-3.851689	-5.288212***	N/A
	<i>LnOE</i>			I (1)
	<i>LnEOOP</i>			I (1)
	<i>LnEOP</i>			I (1)
	<i>LnAMTH</i>			I (1)
	<i>LnFIE</i>			I (1)
	<i>LnEPAP</i>			I (1)

ADF denotes the Augmented Dickey-Fuller single root system respectively. PP Phillips-Perron is single root system. KPSS denotes Kwiatkowski-Phillips-Schmidt-Shin single root system. ***, **and * indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels respectively. The critical values are taken from MacKinnon (MacKinnon, 1996). Assessment period: 1999-2020. Legend: S-Stationarity; N/S-No Stationarity N/A-Not Applicable

Here, $\beta_0, \beta_{1i}, \beta_{2i}$ and $\varphi_1, \varphi_2, \varphi_3, \varphi_4, \varphi_5, \varphi_6, \varphi_7, \varphi_8, \varphi_9$ are coefficients. p is the optimal lag and ε is the white noise error of the model. They define the mutual relations among variables. The regression equation is evaluated for variables in the first stage of the *EG* cointegration test. For example, if there is the cointegration relations, this dependency is evaluated. If the cointegration is stable, then ECT_{t-1} is negative in terms of statistical significance. This coefficient is usually between -1 and 0 .

Using Equations 37-45, the following cause-and-effect relationships can be tested:

The Granger cause and effect relationship for the short run is evaluated using *F*-statistical or χ^2 -square statistical values by checking the statistical significance of the coefficients of all delayed first-order differences (all Δ LnOE_{t-1}, Δ LnEOOP_{t-1} and Δ LnEOP_{t-1}) together for each free variable (null hypothesis: $H_0: \beta_{2i} = 0, i = 1 \dots p$). The rejection of the null hypothesis suggests that LnOE, LnEOOP and LnEOP have short-term effects on LnAMTH LnFIE and LnEPAP.

Using the *t* test to check the Granger cause and effect relationship for the long run, the statistical significance of the coefficient

ECT_{t-1} is checked. The null hypothesis for this ($H_0: \varphi_1 = 0, \varphi_2 = 0, \varphi_3 = 0, \varphi_4 = 0, \varphi_5 = 0, \varphi_6 = 0, \varphi_7 = 0, \varphi_8 = 0$ and $\varphi_9 = 0$) needs to test. If, as a result, the null hypothesis is rejected, this long-run period shows that deviations from the equilibrium state have an effect on the dependent variable and will return to the equilibrium state over time.

A strong cause-and-effect relationship is, in fact, both a short-term and a long-term and-effect relationship. In other words, using the F-statistic or X^2 -square statistical values through the Wald test as a null hypothesis for each variable taken ($H_0: \beta_{2i} = \varphi_1 = 0, i = 1 \dots p,; H_0: \beta_{2i} = \varphi_2 = 0, i = 1 \dots p,; H_0: \beta_{2i} = \varphi_3 = 0, i = 1 \dots p,; H_0: \beta_{2i} = \varphi_4 = 0, i = 1 \dots p,; H_0: \beta_{2i} = \varphi_5 = 0, i = 1 \dots p,; H_0: \beta_{2i} = \varphi_6 = 0, i = 1 \dots p,; H_0: \beta_{2i} = \varphi_7 = 0, i = 1 \dots p,; H_0: \beta_{2i} = \varphi_8 = 0, i = 1 \dots p,; H_0: \beta_{2i} = \varphi_9 = 0, i = 1 \dots p,;$) hypotheses are tested.

4.5. FMOLS, DOLS and CCR

Fully Modified Ordinary Least Squares (FMOLS) (Phillips and Hansen, 1990), Dynamic Ordinary Least Squares (DOLS) (Stock and Watson, 1993), Canonical Cointegrating Regression (CCR) (Park, 1992) and analysis of the results of Engle-Granger analysis (Engle and Granger, 1987) are very useful in the research process (Musayev and Aliyev, 2017). Because reviewing the results several times through the ARDLBT co-integration approach allows for a more reliable analysis. Engle-Granger and Phillips-Ouliaris (Phillips and Ouliaris, 1990) cointegration tests were used to test for all regression equations evaluated using FMOLS, DOLS, and CCR.

4.6. Diagnostics

In this study, both the Breusch-Godfrey LM test (Breusch, 1978; Godfrey, 1978), (Breusch- Godfrey [BG] Test) the heteroscedasticity test, and the Breusch-Pagan-Godfrey test (Breusch and Pagan, 1979), as well as the Autoregressive Conditional Heteroskedasticity test (Bollerslev, 1986), test ARCH (Engle, 1982) and Ramsey RESET Test (Ramsey, 1969) (statistical) check the stability of the ARDL model. The J-B Normality test (Jarque and Bera, 1980; 1981; 1987) will be used to check the normal distribution of white noise error. The CUSUM and CUSUMSQ tests (Brown et al., 1975) are also used to investigate the stability of the ARDL model.

5. RESULTS AND DISCUSSION

5.1. Unit Root Tests Results

According to ADF, with intercept only- $LnFIE$ and $LnEPAP$ variables $I(0)$, with intercept and Trend- $LnAMTH$ variables $I(0)$ and No Intercept and No Trend-all variables $I(1)$ (Table 2).

According to PP test, with intercept only- $LnFIE$ variables $I(0)$, with intercept and trend $LnFIE$ variables $I(0)$ and No Intercept and No Trend-all variables $I(1)$ (Table 2).

The ADF, PP, and KPSS unit root test evaluation results suggest that the ARDL method and the ARDL boundary-test approach can be used to evaluate the short-term and long-term associations between variables (Table 3).

Table 3: VAR Lag Order Selection Criteria

	Lag	LogL	LR	FPE	AIC	SC	HQ
$F_{LnAMTH}=(LnAMTH/LnOE)$	0	-60.46620	NA	1.314626	5.949162	6.048640	5.970751
	1	-43.93246	28.34356*	0.399978*	4.755472*	5.053907*	4.820240*
$F_{LnAMTH}=(LnAMTH/LnEOOP)$	0	-58.58722	NA	1.099220	5.770211	5.869689	5.791801
	1	-41.74691	28.86910*	0.324817*	4.547324*	4.845759*	4.612092*
$F_{LnAMTH}=(LnAMTH/LnOPE)$	0	-55.36771	NA	0.808949	5.463591	5.563069	5.485180
	1	-31.11509	41.57592*	0.118003*	3.534770*	3.833205*	3.599538*
$F_{LnFIE}=(LnFIE/LnOE)$	0	-43.07461	NA	0.250878	4.292820	4.392299	4.314410
	1	-28.99204	24.14155*	0.096401*	3.332575*	3.631010*	3.397343*
$F_{LnFIE}=(LnFIE/LnEOOP)$	0	-40.70597	NA	0.200213	4.067235	4.166713	4.088824
	1	-26.42454	24.48244*	0.075489*	3.088052*	3.386487*	3.152820*
$F_{LnFIE}=(LnFIE/LnEOP)$	0	-40.04297	NA	0.187962	4.004093	4.103571	4.025682
	1	-18.32524	37.23040*	0.034905*	2.316690*	2.615125*	2.381458*
$F_{LnEPAP}=(LnEPAP/LnOE)$	0	-54.59248	NA	0.751375	5.389760	5.489238	5.411349
	1	-39.42262	26.00547*	0.260317*	4.325964*	4.624399*	4.390732*
$F_{LnEPAP}=(LnEPAP/LnEOOP)$	0	-52.48826	NA	0.614927	5.189358	5.288837	5.210948
	1	-37.07599	26.42104*	0.208182*	4.102475*	4.400910*	4.167243*
$F_{LnEPAP}=(LnEPAP/LnEOP)$	0	-41.54475	NA	0.216863	4.147119	4.246597	4.168708
	1	-23.85408	30.32686*	0.059097*	2.843246*	3.141681*	2.908014*

*Indicates lag order selected by the criterion, AIC: Akaike Information Criterion, SC: Schwarz Information Criterion

Table 4: Models

Model 1	$F_{LnAMTH}=(LnAMTH/LnOE)$	ARDL (1,1) C (AIC) (Automatic selection) Case 2: Restricted constant and no trend
Model 2	$F_{LnAMTH}=(LnAMTH/LnEOOP)$	ARDL (1,1) C (AIC) (Automatic selection) Case 2: Restricted constant and no trend
Model 3	$F_{LnAMTH}=(LnAMTH/LnEOP)$	ARDL (1,0) C (AIC) (Automatic selection) Case 2: Restricted constant and no trend
Model 4	$F_{LnFIE}=(LnFIE/LnOE)$	ARDL (1,1) C (AIC) (Automatic selection) Case 2: Restricted constant and no trend
Model 5	$F_{LnFIE}=(LnFIE/LnEOOP)$	ARDL (1,0) C (AIC) (Automatic selection) Case 2: Restricted constant and no trend
Model 6	$F_{LnFIE}=(LnFIE/LnEOP)$	ARDL (1,0) C (AIC) (Automatic selection) Case 2: Restricted constant and no trend
Model 7	$F_{LnEPAP}=(LnEPAP/LnOE)$	ARDL (1,0) C (AIC) (Automatic selection) Case 2: Restricted constant and no trend
Model 8	$F_{LnEPAP}=(LnEPAP/LnEOOP)$	ARDL (1,0) C (AIC) (Automatic selection) Case 2: Restricted constant and no trend
Model 9	$F_{LnEPAP}=(LnEPAP/LnEOP)$	ARDL (1,0) C (AIC) (Automatic selection) Case 2: Restricted constant and no trend

5.2. VAR Lag Order Selection Criteria

Optimal lags for variables are determined based on AIC, which are automatically selected by the ARDL method built into Eviews_12.

Table 5: Results from bound tests

Dependant variable	F-statistic	
Model 1	3.751896*	Cointegration
Model 2	3.860015**	Cointegration
Model 3	1.781248	No Cointegration
Model 4	23.99063***	Cointegration
Model 5	25.42706***	Cointegration
Model 6	15.98011***	Cointegration
Model 7	2.225163	No Cointegration
Model 8	2.242512	No Cointegration
Model 9	2.190050*	Cointegration

Significance								
n	I (0) Bound				I (1) Bound			
	10%	5%	2.5%	1%	10%	5%	2.5%	1%
1000	3.02	3.62	4.18	4.94	3.51	4.18	4.89	5.58
35	3.223	3.957		5.763	3.757	4.53		6.48
30	3.303	4.09		6.027	3.797	4.663		6.76

Given the use of annual data, the maximum lag initially applied to all variables is 1 (Tables 4 and 5).

5.3. Cointegration Testing Results

The results of the ARDL boundary test are given in Table 5. In all ARDL equations (models) test result indicates the existence of cointegration between the variables.

Table 5 shows whether there is a cointegration relationship between these variables. Thus, there is a long-term relationship. According to Narayan (2005), statistic is higher than upper bound at 5%.

5.4. ARDL Long Run and Short Run Results

Tables 6 and 7 presents the results of the long-term and short-term approach of ARDL.

5.5. Diagnostic Test Results

The (Table 8) presents the results of diagnostic tests ARDL models. The evaluation results of the Breusha-Godfrey (BG)

Table 6: ARDL long run form and bounds test long run coefficients

	Variable	Coefficient		
		Levels equation	Conditional error correction regression	ECM regression
Model 1	LnOE	1.025420***		
	C	-6.476714	-4.268601	
	LnAMTH(-1)		-0.659069**	
	LnOE(-1)		0.675822*	
	ΔLnOE(-1)		0.254467	0.254467
Model 2	CointEq(-1)			-0.659065**
	LnEOOP	1.131487***	0.750534*	
	ΔLnEOOP		0.269196	0.269196
	C	-8.311041	-5.512904	
	LnAMTH (-1)		-0.663323**	
Model 3	CointEq(-1)			-0.663323**
	LnEOP	1.535972***	0.451722	
	C	-6.476714	-3.200447	
	LnAMTH (-1)		-0.294095*	
	CointEq(-1)			-0.294095
Model 4	LnOE	0.457888***	0.380394**	
	C	2.027771	1.648582	
	LnFIE (-1)		-0.813002***	
	CointEq(-1)			-0.813002***
Model 5	LnEOOP	0.525588***	0.430817**	
	C	1.042357	0.854405	
	LFIE (-1)		-0.819686***	
	CointEq(-1)			-0.819686***
Model 6	LnEOP	0.355559	0.212386	
	C	4.734241	2.827896	
	LFIE (-1)		-0.597328***	
	CointEq(-1)			-0.597328***
Model 7	LnOE	0.267180	0.148136	
	C	5.219491	2.893913	
	LnEPAP (-1)		-0.554444*	
	CointEq(-1)			-0.554444*
Model 8	LnEOOP	0.300501	0.170415	
	C	4.650905	2.637536	
	LnEPAP (-1)		-0.567102*	
	CointEq(-1)			-0.567102**
Model 9	LnEOP	0.489244	0.292560	
	C	2.834459	1.694963	
	LnEPAP (-1)		-0.597984*	
	CointEq(-1)			-0.597984**

***, **and * indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels respectively

Table 7: ARDL Model Coefficients and Error Correction (short run) Model Coefficients

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
ARDL Model Coefficients									
$\Delta \text{LAMSPH}(-1)$	0.438156	-0.378287	-0.257236						
LnAMTH	0.777951**	0.739981**	0.365617						
$\Delta \text{LnFIE}(-1)$				-0.083396	-0.079313	0.079536			
LnFIE				0.719639**	0.729209**	2.098201*			
$\Delta \text{LnEPAP}(-1)$							-0.377008	-0.388330	-0.412628**
LnEPAP							0.663988*	0.690056**	0.734310***
$\Delta \text{LnOE}(-1)$	-0.421102			0.307727			0.139243		
LnOE	-0.896512*			-0.514774**			-0.349554*		
ΔLnEOOP		0.505829			0.358594*			0.169177	
LnEOOP		-0.903057			-0.561093**			-0.410863*	
ΔLnEOP			1.185385			2.582399*			0.760492*
LnEOP			0.269124			-0.432789			-0.773122**
C	6.870748	7.451061*	-6.964471	1.480554	2.195647	-2.434146	-0.656771	0.121305	3.650428
Error correction (short run) model coefficients									
$\Delta \text{LnAMTH}(-1)$	0.258497	0.236574	0.034610						
$\Delta \text{LnFIE}(-1)$				0.049710	0.050084	0.003597			
$\Delta \text{LnEPAP}(-1)$							1.119368	0.238784	0.075561
ΔLnOE	0.333109			0.342681			-0.045879		
ΔLnEOOP		0.338116			0.404603			0.077118	
ΔLnEOP			-0.464981			0.469303			1.152788**
$\text{ECT}(-1)$	-0.762258**	-0.752911**	-0.435943*	-0.425991	-0.434167	-0.224612	-0.693659	-0.728018**	-0.501391
C	0.049154	0.057562	0.126156	0.085676	0.086523	0.117271	-0.355747	0.075142	0.095505

***, ** and * indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels respectively

Table 8: Diagnostic test results

(LM Version)						
	Normality Test (Jarque-Bera) JB	Ramsey RESET Test (t-statistic)	Heteroskedasticity Test: ARCH χ^2	Breusch-Godfrey Serial Correlation LM Test: χ^2 -Godfrey	R ²	D_W (Durbin and Watson, 1971)
Model 1	1.224725 0.542069	0.330103 0.8557	0.933627 0.3339	1.841800 0.6059	6.197778 0.0457	1.605904
Model 2	0.812776 0.666052	0.202762 0.6585	1.016455 0.3267	0.586274 0.6322	5.543846 0.0625	1.621157
Model 3	1.628936 0.442875	0.049230 0.9613	1.28915 0.2562	2.316050 0.3141	6.990971 0.0303	2.040432
Model 4	1.078476 0.583193	0.167417 0.8690	0.164925 0.6847	0.642026 0.7254	1.584374 0.4529	1.767814
Model 5	1.498941 0.472617	0.599753 0.5566	0.300864 0.5833	0.167146 0.9198	1.524040 0.4667	1.761928
Model 6	1.483941 0.476175	1.521044 0.1466	0.052111 0.8194	0.797585 0.6711	0.964306 0.6175	1.516300
Model 7	4.729595 0.093968	0.996138 0.3332	0.461718 0.4988	1.812288 0.4041	0.402796 0.8176	1.713526
Model 8	4.929361 0.085462	0.980808 0.3505	0.463229 0.4970	1.735417 0.4299	0.388795 0.8233	1.704314
Model 9	2.315623 0.314173	1.164187 0.2605	0.546938 0.4596	0.440996 0.8021	0.832911 0.6594	1.620687
(F-version)						
	Normality Test (Jarque-Bera) JB	Ramsey RESET test (t-statistic)	Heteroskedasticity Test: ARCH χ^2	Breusch-Godfrey Serial Correlation LM Test: χ^2 -Godfrey	CUSUM -5%- Significance	CUSUM Squares -5%- Significance
Model 1	N/A N/A	0.108968 0.8557	0.881410 0.3602	0.544773 0.6583	3.140294 0.0726	NO/STB
Model 2	N/A N/A	0.450292 0.6585	1.069027 0.3012	1.968954 0.5789	2.690116 0.1005	STB
Model 3	N/A N/A	0.002424 0.9613	1.240173 0.2801	1.115634 0.3493	3.992265 0.0392	STB
Model 4	N/A N/A	0.583193 0.8690	0.149667 0.7034	0.283831 0.7562	0.652824 0.5339	NO/STB
Model 5	N/A N/A	2.313575 0.1466	0.047022 0.8308	0.355317 0.7058	0.385035 0.6866	STB

(Contd...)

Table 8: (Continued)

(F-version)							
	Normality Test (Jarque-Bera) JB	Ramsey RESET test (t-statistic)	Heteroskedasticity Test: ARCH χ^2 Breusch-Pagan -Godfrey		Breusch-Godfrey Serial Correlation LM Test: χ^2	CUSUM -5%- Significance	CUSUM Squares -5%- Significance
Model 6	N/A	0.359703	0.274913	0.072209	0.626019	STB	STB
	N/A	0.5566	0.6065	0.9306	0.5473		
Model 7	N/A	0.992292	0.425367	0.850054	0.156447	STB	NO/STB
	N/A	0.3332	0.5225	0.4438	0.8565		
Model 8	N/A	0.961984	0.429789	0.810750	0.150906	STB	NO/STB
	N/A	0.3505	0.5218	0.4701	0.8611		
Model 9	N/A	1.355331	0.506084	0.193052	0.330404	STB	NO/STB
	N/A	0.2605	0.4860	0.8261	0.7234		

Legend: N/A—not applicable

Table 9: FMOLS, DOLS, CCR results

		ECT						
		ADF/PP/KPSS	Constant,	None	Cointegration test			
		Constant	Linear trend		Engle-granger		Phillips-ouliaris	
					tau-statistic	z-statistic	tau-statistic	z-statistic
Fully modified least squares (FMOLS) model 1								
LnOE	1.046239***	-3.400593**	-3.565238*	-3.491362**	-3.515337	-15.81280*	-3.595956*	15.65971*
C	-6.873767		/-3.459461*	/-3.471604**				
		/-3.377370**	/0.088016	/NA				
		/0.291222						
Dynamic Least Squares (DOLS) Model 1								
LnOE	1.021486**	-3.506559**	-2.593759	-3.614446**	-3.515337	-15.81280*	-3.595956*	15.65971*
C	-6.483761		/-2.636657	/-2.666470***				
		/0.249483	/0.076145	/NA				
Canonical Cointegrating Regression (CCR) Model 1								
LnOE	1.022723***	-3.377050**	-3.572648*	-3.463885***	-3.515337	-15.81280*	-3.595956*	15.65971*
C	-6.485915		/-3.469738*	/-3.444711***				
		/0.316647	/0.095819	/NA				
Fully Modified Least Squares (FMOLS) Model 2								
LnEOOP	1.129642***	-3.329914**	-3.552468*	-3.422214***	-3.463146	-15.61670*	-3.538296	-15.37764*
C	-8.339050*		/-3.444193*	/-3.406179***				
		/0.350799*	/0.095838	/NA				
Dynamic Least Squares (DOLS) Model 2								
LnEOOP	1.090805**	-3.434369**	-4.040568**	-3.536943***	-3.463146	-15.61670*	-3.538296	-15.37764*
C	-7.709306		/-2.630002	/-2.630002**				
		/0.270089	/0.081285	/NA				
Canonical Cointegrating Regression (CCR) Model 2								
LnEOOP	1.112419***	-3.315639**	-3.560446*	-3.405181***	-3.463146	-15.61670*	-3.538296	-15.37764*
C	-8.051949		/-3.453153*	/-3.389483***				
		/0.368576*	/0.094674	/NA				
Fully Modified Least Squares (FMOLS) Model 3								
LnEOP	0.964938	-0.374984	-5.672266***	-1.911749*	-1.664038	-5.414288	-1.486104	-4.005651
C	-3.442063		/-3.563247*	/-1.899691				
		/0.568694*	/0.189162**	/NA				
Dynamic Least Squares (DOLS) Model 3								
LnEOP	0.764643	-3.413986*	-4.531977**	-3.564921***	-1.664038	-5.414288	-1.486104	-4.005651
C	-0.656505		/-3.529474*	/-2.486933**				
		/0.513690*	/0.203279**	/NA				
Canonical Cointegrating Regression (CCR) Model 3								
LnEOP	0.955588	-0.384108	-4.531977**	-3.564921***	-1.664038	-5.414288	-1.486104	-4.005651
C	-3.315966		/-3.529474*	/-2.486933**				
		/0.569060*	/0.203279**	/NA				
Fully Modified Least Squares (FMOLS) Model 4								
LnOE	0.668487***	-3.665603**	-3.575042*	-3.757350***	-5.852699***	-19.94189**	-5.747203***	-21.24732**
C	-1.221358		/-3.541948*	/-3.731707***				
		/0.074228	/0.065945	/NA				
Dynamic Least Squares (DOLS) Model 4								
LnOE	0.587495***	-3.200695**	-3.271756	-3.302636***	-5.852699***	-19.94189**	-5.747203***	-21.24732**
C	0.087824		/-3.230606	/-3.180695***				
		/0.127244	/0.148553**	/NA				

(Contd...)

Table 9: (Continued)

		ECT						
		ADF/PP/KPSS	Constant,	None	Cointegration test			
		Constant	Linear trend		Engle-granger		Phillips-ouliaris	
					tau-statistic	z-statistic	tau-statistic	z-statistic
Canonical Cointegrating Regression (CCR) Model 4								
LnOE	0.694851***	-3.647987**	-3.541163*	-3.726898***	-5.852699***	-19.94189**	-5.747203***	-21.24732**
C	-1.651258	/-3.622489**	/-3.512098*	/-3.704120***				
		/0.071203	/0.070880	/NA				
Fully Modified Least Squares (FMOLS) Model 5								
LnEOOP	0.724840***	-3.595773**	-3.532172*	-3.688874***	-5.960226***	-19.72316**	-5.794529***	-21.20400**
C	-2.206813	/-3.569391**	/-3.500643*	/-3.665041***				
		/0.102105	/0.077382	/NA				
Dynamic Least Squares (DOLS) Model 5								
LnEOOP	0.643457***	-3.123235**	-3.249566	-3.223659**	-5.960226***	-19.72316**	-5.794529***	-21.20400**
C	-0.885514	/-3.094699**	/-3.180010	/-3.198027***				
		/0.154493	/0.098994	/NA				
Canonical Cointegrating Regression (CCR) Model 5								
LnEOOP	0.752123***	-3.575065**	-3.484857*	-3.654104***	-5.960226***	-19.72316**	-5.794529***	-21.20400**
C	-2.654781	/-3.552405**	/-3.458111*	/-3.633079***				
		/0.086225	/0.078184	/NA				
Fully Modified Least Squares (FMOLS) Model 6								
LnEOP	0.707742*	0.726708	-3.913367**	-1.729487*	-4.488710**	-11.89573	-4.249363**	-13.90564
C	-0.183563	/-1.359080	/-3.902905**	/-1.610176*				
		/0.613763**	/0.140339*	/NA				
Dynamic Least Squares (DOLS) Model 6								
LnEOP	0.605905	-2.523809	-6.628713***	-2.873278***	-4.488710**	-11.89573	-4.249363**	-13.90564
C	1.210699	/-2.491924	/-3.625185*	/-2.604883				
		/0.428426*	/0.053282	/NA				
Canonical Cointegrating Regression (CCR) Model 6								
LnEOP	0.690821*	0.622450	-3.973163**	-1.761538*	-4.488710**	-11.89573	-4.249363**	-13.90564
C	0.052131	/-1.381783	/-4.008038**	/-1.645268*				
		/0.615926**	/0.204611**	/NA				
Fully Modified Least Squares (FMOLS) Model 7								
LnOE	0.370517	-3.192297**	-7.134574***	-3.282213***	-4.397300**	39.00430	-3.222841	-14.19595
C	3.586580	/-3.186362**	/-3.169118	/-3.279390***				
		/0.103842	/0.093332	/NA				
Dynamic Least Squares (DOLS) Model 7								
LnOE	0.267673	-2.921928*	-2.990193	-3.005515***	-4.397300**	39.00430	-3.222841	-14.19595
C	5.273381	/-2.923892*	/-2.966415	/-3.042713***				
		/0.124968	/0.092160	/NA				
Canonical Cointegrating Regression (CCR) Model 7								
LnOE	0.361871*	-3.199855**	-7.137866***	-3.293618***	-4.397300**	39.00430	-3.222841	-14.19595
C	3.729702	/-3.193932**	/-3.165550	/-3.290642***				
		/0.102271	/0.094338	/NA				
Fully Modified Least Squares (FMOLS) Model 8								
LnEOOP	0.433238*	-3.219633**	-3.856414**	-3.297065***	-4.468147**	37.18923	-3.259090	-14.37847
C	2.515873	/-3.215193**	/-3.226043	/-3.297065***				
		/0.102954	/0.087110	/NA				
Dynamic Least Squares (DOLS) Model 8								
LnEOOP	0.330868	-3.000813*	-5.017293***	-3.086052***	-4.468147**	37.18923	-3.259090	-14.37847
C	4.194978	/-2.966592*	/-2.883205*	/-3.051855***				
		/0.104173	/0.082360	/NA				
Canonical Cointegrating Regression (CCR) Model 8								
LnEOOP	0.421377*	-3.229783**	-7.079487***	-3.312208***	-4.468147**	37.18923	-3.259090	-14.37847
C	2.711781	/-3.225267**	/-3.222187	/-3.310967***				
		/0.100432	/0.088313	/NA				
Fully Modified Least Squares (FMOLS) Model 9								
LnEOP	0.748635*	-5.341432***	-5.372415***	-5.409250***	-5.965476***	37.06536	-3.089732	-13.30914
C	-0.690143	/-3.417547**	/-3.266516	/-3.461294***				
		/0.291744	/0.084094	/NA				
Dynamic Least Squares (DOLS) Model 9								
LnEOP	0.647075*	-2.950706*	-3.623109*	-3.107270***	-5.965476***	37.06536	-3.089732	-13.30914
C	0.751157	/-2.897965*	/-3.122914	/-2.986254				
		/0.390208*	/0.056550	/NA				
Canonical Cointegrating Regression (CCR) Model 9								
LnEOP	0.744569	-5.373339***	-5.403455***	-5.435724***	-5.965476***	37.06536	-3.089732	-13.30914
C	-0.635086	/-3.425220**	/-3.287299*	/-3.466128***				
		/0.291807	/0.084086	/NA				

ADF denotes the Augmented Dickey–Fuller single root system respectively. PP Phillips–Perron is single root system. KPSS denotes Kwiatkowski–Phillips–Schmidt–Shin single root system. ***, ** and * indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels respectively. The critical values are taken from MacKinnon (MacKinnon, 1996). ***, ** and * indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels respectively

Table 10: Granger cause and effect analysis evaluation results (Probability). Wald test

	Short-term period			Long-term period			Strong impact		ADF unit root test	
	$\Delta LOE/\Delta LOPE/\Delta LOPE$			ECT-1			ECT-1		With intercept only/with intercept and trend/no intercept and no trend	
	Chi-sq.	F-st.	t-st.	t-st.	Chi-sq.	F-st.	Chi-sq.	F-st.		
Model 1	0.2535	0.2703	0.2703	0.0040	0.0008	0.0040	0.0036	0.0140	-3.430079**/-4.043842**/-3.515337***	
Model 2	0.2892	0.3049	0.3049	0.0038	0.0007	0.0038	0.0032	0.0133	-3.378422**/-4.020006**/-3.463146**	
Model 3	0.5496	0.5586	0.5586	0.0437	0.0277	0.0437	0.0801	0.1135	-4.551039***/-6.436482***/-4.88710***	
Model 4	0.0820	0.1012	0.1012	0.1533	0.1339	0.1533	0.1862	0.2174	-5.808720***/-5.618156***/-5.852699***	
Model 5	0.0557	0.0738	0.0738	0.1395	0.1200	0.1395	0.1371	0.1695	-5.928473***/-5.694647***/-5.960226***	
Model 6	0.1898	0.2095	0.2095	0.2555	0.2371	0.2555	0.0902	0.1241	-4.551039***/-6.436482***/-4.88710***	
Model 7	0.8590	0.8611	0.8611	0.3381	0.3242	0.3381	0.4153	0.4333	-4.479018***/-5.470089***/-4.397300***	
Model 8	0.7454	0.7496	0.7496	0.0084	0.0037	0.0084	0.0109	0.0289	-4.533128***/-5.634898***/-4.478147*	
Model 9	0.0089	0.0195	0.0195	0.0926	0.0724	0.0926	0.0004	0.0049	-5.904042***/-6.134051***/-5.965476***	

ADF denotes the Augmented Dickey–Fuller single root system respectively. ***, ** and * indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels respectively. The critical values are taken from MacKinnon (MacKinnon, 1996)

method confirmed that our ARDL model had no problems with sequential correlation. The results of the Breusha-Pagan-Godfrey (BFG) and ARCH methods later confirmed that heteroscedasticity was not a problem. According to the Ramsey RESET test, that the model is well defined. The table shows the total amount of recursive balances (CUSUM) and the squares of recursive balances (CUSUMQ) indicating that the ARDL model is constant during the sampling period (CUSUM). However, while CUSUM was stable in all models, CUSUMQ was unstable in models 1, 4, 7, 6, and 9.

5.6. FMOLS, DOLS, CCR and Engle-Granger Analysis Results

FMOLS, DOLS, CCR cointegration methods and analysis of the results of Engle-Granger analysis are very useful in our study (Tables 9 and 10). This is because the revision of the results obtained with the ARDLBT co-integration approach with the application of these methods allows for a more reliable analysis.

Another feature that indicates a cointegration relationship between the variables is that the white noise errors obtained from the estimates are stationary. Table 10 shows the results of the stationary test by applying single root tests ADF, PP and KPSS on the white noise error of each long-run equation evaluated by FMOLS, DOLS and CCR. Based on these results, although in many models the white noise errors are stationary and thus again confirm the existence of a co-integrating interaction, in some models this situation is not fully confirmed. This result does support the results of the Engle-Granger and Phillips-Ouliaris cointegration tests given above.

Short-term and long-term cause-and-effect relationships can be more clearly analyzed using the Granger cause and effect relationship using the Engle-Granger cointegration method. It was confirmed that long-term interaction exists in models 1, 2, 3, 8 and 9, and strong causality between variables exists in models 1, 2 and 8 (Table 10).

6. CONCLUSION AND POLICY IMPLICATIONS

Oil is the main export product of Azerbaijan. Imports are dominated by machinery and equipment, modern equipment and technologies.

In one of our previous studies, we noted that food and agricultural products have a special weight, which is no less important among imported goods. Undoubtedly, reducing the import of food and agricultural products (saving foreign exchange) and ensuring food security, diversifying the economy to increase self sufficiency, developing the non-oil sector, agriculture and agro-processing, which have a large share in this sector. It is recommended to increase the import of many machinery and equipment necessary for the sustainable development of agriculture, especially agricultural machinery for tillage and harvesting, equipment for the food industry, equipment for processing agricultural products.

In the study, it was confirmed that there are long term interactions and strong cause and effect relationships between the import of the mentioned products (machinery, equipment and machinery necessary for the agricultural and agro-processing sector) and the export of oil and oil products. Since the domestic market, especially the food market, is highly dependent on exports and world prices, in order to increase the supply of the agricultural-food market with local products, studies on economic diversification and stimulation of the agricultural sector, studies on the dependence of imports of oil and oil products on exports of oil and oil products, examine imports machinery and equipment, mechanical engineering, the increase should be of paramount importance.

REFERENCES

- Abdlaziz, R.A., Naseem, N.A.M., Slesman, L. (2018), Dutch disease effect of oil price on agriculture sector: Evidence from panel cointegration of oil exporting countries. *International Journal of Energy Economics and Policy*, 8(5), 241-250.
- Abdlaziz, R.A., Naseem, N.A.M., Slesman, L. (2021), Oil revenue and agriculture value-added in oil-exporting countries: Does the role of real exchange rate matter? *International Journal of Energy Sector Management*, 16(1), 171-190.
- Ahmed, A.S. (1985), Oil and development: the experience of the petroleum producing countries of the third world/petrol et developpement: L'experience des economies petrolieres du tiers monde. *Savings and Development*, 9(3), 325-357.
- Aliyev, K.H., Dehning, B., Nadirov, O. (2016), Modelling the impact of fiscal policy on non-oil GDP in a resource rich country: Evidence

- from Azerbaijan. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 64, 1869-1878.
- Allan, J.A., McLachlan, K.S. (1976), Agricultural development in Libya after oil. *African Affairs*, 75(300), 331-348.
- Auty, R., Warhurst, A. (1993), Sustainable development in mineral exporting economies. *Resources Policy*, 19(1), 14-29.
- Aye, G.C., Odhiambo, N.M. (2021), Oil prices and agricultural growth in South Africa: A threshold analysis. *Resources Policy*, 73, 102196.
- Bollerslev, Tim. (1986), Generalized Autoregressive Conditional Heteroskedasticity. *Journal of Econometrics*, 31 (3): 307-327
- Breusch, T.S. (1978), Testing for autocorrelation in dynamic linear models. *Australian Economic Papers*, 17, 334-355.
- Breusch, T.S., Pagan, A.R. (1979), A simple test for heteroskedasticity and random coefficient variation. *Econometrica*, 47(5), 1287-1294.
- Brown, R.L., Durbin, J., Evans, J.M. (1975), Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society: Series B (Methodological)*, 37(2), 149-163.
- Cauley, T.J. (1959), Oil and agriculture: Compared and contrasted. *The Southwestern Social Science Quarterly*, 40(2), 139-146.
- Charemza, W.W., Deadman, D.F. (1997), *New Directions in Econometric Practice: General to Specific Modelling, Cointegration and Vector Autoregression*. United Kingdom: Edward Elgar.
- Chen, D., Gummi, U.M., Lu, S.B., Muazu, A. (2020), Modelling the impact of oil price fluctuations on food price in high and low-income oil exporting countries. *Agricultural Economics Czech*, 66, 458-468.
- Chen, S.T., Kuo, H., Chen, C.C. (2010), Modeling the relationship between the oil price and global food prices. *Applied Energy*, 87(8), 2517-2525.
- Denisard, C.O.A., Disch, A. (1981), Oil prices, agricultural production and changes in real income in Brazil. *Luso-Brazilian Review*, 18(1), 77-116.
- Dickey, D.A., Fuller, W.A. (1981), Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica*, 49, 1057-1072.
- Durbin, J., Watson, G.S. (1971), Testing for serial correlation in least squares regression. III. *Biometrika*, 58(1), 1-19.0
- Engle, R.F. (1982), Autoregressive conditional heteroskedasticity with estimates of the variance of United Kingdom inflation. *Econometrica*, 50(4), 987-1007.
- Engle, R.F., Granger, C.W.J. (1987), Co-integration and error correction: Representation, estimation, and testing. *Econometrica*, 55(2), 251-276.
- Falola, T. (1988), Review of state, oil, and agriculture in Nigeria, by M. Watts. *African Economic History*, 17, 203-203.
- Fardmanesh, M. (1991), Dutch disease economics and oil syndrome: An empirical study. *World Development*, 19(6), 711-717.
- Forbes, G. (1941), Oklahoma oil and Indian land tenure. *Agricultural History*, 15(4), 189-194.
- Fowowe, B. (2016), Do oil prices drive agricultural commodity prices? Evidence from South Africa. *Energy*, 104, 149-157.
- Gavett, E.E. (1977), Energy policy and research in agriculture. *American Journal of Agricultural Economics*, 59(5), 1083-1086.
- Godfrey, L.G. (1978), Testing against general autoregressive and moving average error models when the regressors include lagged dependent variables. *Econometrica*, 46, 1293-130.
- Granger, C.W.J. (1969), Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, 37, 424-438.
- Hafner, C.M., Herwartz, H. (2006), Volatility impulse responses for multivariate GARCH models: An exchange rate illustration. *Journal of International Money and Finance*, 25(5), 719-740.
- Hamilton, J.D. (1983), Oil and the macroeconomy since World War II. *Journal of Political Economy*, 91(2), 228-248.
- Hamilton, J.D. (2014), *The Changing Face of World Oil Markets*. No. w20355. Cambridge, USA: National Bureau of Economic Research.
- Hansen, B.E. (2011), Threshold autoregression in economics. *Statistics and its Interface*, 4, 123-127.
- Hanson, K., Robinson, S., Schluter, G. (1993), Sectoral effects of a world oil price shock: Economywide linkages to the agricultural sector. *Journal of Agricultural and Resource Economics*, 18(1), 96-116.
- Harri, A., Nalley, L., Hudson, D. (2009), The relationship between oil, exchange rates, and commodity prices. *Journal of Agricultural and Applied Economics*, 41, 501-510.
- Hassan, M.F. (1978), Agricultural development in a petroleum-based economy: Qatar. *Economic Development and Cultural Change*, 27(1), 145-167.
- Hojman, D.E. (1987), The dutch disease as a challenge to the conventional structuralist-dependency paradigm: Oil, minerals and foreign loans in Latin America. *Boletín de Estudios Latinoamericanos y Del Caribe*, 42, 39-53.
- Ibrahim, M.H. (2015), Oil and food prices in Malaysia: A non-linear ARDL analysis. *Agricultural and Food Economics*, 3, 28-35.
- Jarque, C.M., Bera, A.K. (1980), Efficient tests for normality, homoscedasticity and serial independence of regression residuals. *Economics Letters*, 6(3), 255-259.
- Jarque, C.M., Bera, A.K. (1981), Efficient tests for normality, homoscedasticity and serial independence of regression residuals: Monte Carlo evidence. *Economics Letters*, 7(4), 313-318.
- Jarque, C.M., Bera, A.K. (1987), A test for normality of observations and regression residuals. *International Statistical Review*, 55(2), 163-172.
- Johansen, S. (1992), A Representation of Vector Autoregressive Processes Integrated of Order 2. *Econometric Theory* 8, 188-202.
- Johansen, S., Juselius, K. (1992), Testing Structural Hypotheses in a Multivariate Cointegration Analysis of the PPP and the UIP for UK. *Journal of Econometrics*, 53, 211-44.
- Kakanov, E., Hansjörg, B., Lilas, D. (2018), *Resource Curse in Oil Exporting Countries*. OECD Economics Department Working Papers 1511. Berlin: OECD Publishing.
- Karbasi, A.R., Fahimifard, S.M., Jahany, H.R. (2009), Studying the effect of energy factor on Iran's agriculture sector and total economy production. *Iranian Economic Review*, 14(23), 1-17.
- Keane, M.P., Prasad, E.S. (1996), The employment and wage effects of oil price changes: A sectoral analysis. *Review of Economics and Statistics*, 78(3), 389-400.
- Kilian, L., Xiaoqing, Z. (2022), The impact of rising oil prices on US inflation and inflation expectations in 2020-23. *Energy Economics*, 113, 106228.
- Kwiatkowski, D., Phillips, P., Schmidt, P., Shin, Y. (1992), Testing the null hypothesis of stationarity against the alternative of a unit root. *Journal of Econometrics*, 54(1-3), 159-178.
- Kirikaleli, D., Darbaz, I. (2021), The causal linkage between energy price and food price. *Energies*, 14, 4182.
- Lingxiao, W.A.N.G., Peculea, A.D., Xu, H. (2016), The relationship between public expenditure and economic growth in Romania: Does it obey Wagner's or Keynes's Law? *Theoretical and Applied Economics*, 23(3), 41-52.
- Lee, J., Cho, H.C. (2021), Impact of Structural Oil Price Shock Factors on the Gasoline Market and Macroeconomy in South Korea. *Sustainability*, 13, 2209. <https://doi.org/10.3390/su13042209>
- Loungani, P. (1986), Oil shocks and the dispersion hypothesis. *Review of Economics and Statistics*, 58, 536-539.
- Mackinnon, J.G. (1996), Numerical distribution functions for unit root and cointegration tests. *Journal of Applied Economics*, 11(6), 601-618.
- Majd, M.G. (1989), The oil boom and agricultural development: A reconsideration of agricultural policy in Iran. *The Journal of Energy and Development*, 15(1), 125-140.
- Menegaki, A.N. (2019), The ARDL method in the energy-growth nexus field; Best implementation strategies. *Economics*, 7, 105.

- Menegaki, A.N. (2020), *A Guide to Econometric Methods for the Energy-Growth Nexus* (Enhanced Edition). Netherlands: Elsevier.
- Meyer, D.F., Sanusi, K.A., Hassan, A. (2018), Analysis of the asymmetric impacts of oil prices on food prices in oil-exporting, developing countries. *Journal of International Studies*, 11(3), 82-94.
- Mikayilov, J.I., Mukhtarov, S., Mammadov, J. (2020), Gasoline demand elasticities at the backdrop of lower oil prices: Fuel-subsidizing country case. *Energies*, 13, 6752.
- Mohamed F.A., Hameed, A., Amna, A. (2009), The Impact of Petroleum Prices on Vegetable Oil Prices: Evidence from Co-integration tests. In: *International Borneo Business Conference on Global Changes: Corporate Responsibility*, Organized by the School of Business and Economics of University Malaysia Sabah (UMS) and the Faculty of Economics and Business of Universities Malaysia Sarawak (UNIMAS). p.15-17.
- Mohammadi, H., Jahan-Parvar, M.R. (2011), Oil prices and real exchange rates in oil-exporting countries: A bounds testing approach. *The Journal of Developing Areas*, 45, 313-322.
- Muhammad, K., Muhammad, A., Dilawar, K., Hassan, Taj, Allayarovş P., Azeem, A. (2021), Agricultural exports, financial openness and ecological footprints: An empirical analysis for Pakistan. *International Journal of Energy Economics and Policy*, 11, 256-261.
- Mukhtarov, S., Aliyev, S., Zeynalov, J. (2020), The effect of oil prices on macroeconomic variables: Evidence from Azerbaijan. *International Journal of Energy Economics and Policy*, 10(1), 72-80.
- Musayev, A., Aliyev, K.H. (2017), Modelling oil-sector dependency of tax revenues in a resource rich country: Evidence from Azerbaijan. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 65, 1023-1029.
- Naanen, B. (1988), Review of state, oil, and agriculture in Nigeria, by M. Watts. *The International Journal of African Historical Studies*, 21(3), 529-530.
- Narayan, P.K. (2005), The saving and investment nexus for China: Evidence from cointegration tests. *Applied Economics*, 37(17), 1979-1990.
- Olasunkanmi, O.I., Oladele, K.S. (2018), Oil price shock and agricultural commodity prices in Nigeria: A Non-Linear Autoregressive Distributed Lag (NARDL) approach. *African Journal of Economic Review*, 6(2), 74-92.
- Olayungbo, D., Hassan, W. (2016), Effect of oil price on food price in developing oil exporting countries: A panel ARDL. *OPEC Energy Review*, 40, 397-411.
- Olayungbo, D.O. (2021), Global oil price and food prices in food importing and oil exporting developing countries: A panel ARDL analysis. *Heliyon*, 7(3), e06357.
- Ologunde, I.A., Kapingura, F.M., Sibanda, K. (2020), Sustainable development and crude oil revenue: A case of selected crude oil-producing African Countries. *International Journal of Environmental Research Public Health*, 17, 6799.
- Oluwatoyese, O.P., Applanaidu, S.D., Abdulrazak, N. (2016), Agricultural export, oil export and economic growth in Nigeria: Multivariate co-integration approach. *International Journal of Environmental and Agriculture Research*, 2(2), 64-72.
- Onour, I. (2021), Dynamics of crude oil price change and global food commodity prices. *Finance and Economics Review*, 3(1), 38-50.
- Parcher, L.A. (1947), Oil and agriculture. *The Southwestern Social Science Quarterly*, 28(3), 244-252.
- Park, J.Y. (1992), Canonical cointegrating regressions. *Econometrica*, 60, 119-143.
- Parker, A.A. (1997), What happens to the world: When the oil runs out. *ReNew: Technology for a Sustainable Future*, 61, 46-49.
- Penrose, E. (1976), Africa and the oil revolution: An introduction. *African Affairs*, 75(300), 277-283.
- Pesaran, M., Shin, Y. (1999), *An Autoregressive Distributed Lag Modeling Approach to Cointegration Analysis*. United Kingdom: Cambridge University Press. DAE Working Paper no 9514.
- Pesaran, M.H., Shin, Y.I., Smith, R.J. (2001), Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16, 289-326.
- Phillips, P.C., Ouliaris, S. (1990), Asymptotic properties of residual based tests for cointegration. *Econometrica*, 58(1), 165-193.
- Phillips, P.C.B., Hansen, B.E. (1990), Statistical inference in instrumental variables regression with I (1) Processes. *Review of Economics Studies*, 57, 99-125.
- Radmehr, R., Henneberry, R.S. (2020), energy price policies and food prices: Empirical evidence from Iran. *Energies*, 13, 4031.
- Ramsey, J.B. (1969), Tests for specification errors in classical linear least squares regression analysis. *Journal of the Royal Statistical Society, Series B*, 31(2), 350-371.
- Ramsey, J.B. (1974), Classical model selection through specification error tests. In: Zarembka, P., editor. *Frontiers in Econometrics*. New York: Academic Press. p.13-47.
- Rogoff, K. (2006), *Oil and the Global Economy*, Manuscript. United States: Harvard University.
- Saban, N., Erdem, C., Soytas, U. (2013), Volatility spillover between oil and agricultural commodity markets. *Energy Economics*, 36, 658-665.
- Sachs, J.D., Warner, A.M. (1995), *Natural Resource Abundance and Economic Growth*. Cambridge: National Bureau of Economic Research.
- Shaari, M.S., Pei, T.L., Rahim, H.A. (2013), Effects of oil price shocks on the economic sectors in Malaysia. *International Journal of Energy Economics and Policy*, 3, 360-366.
- Shokooi, Z., Saghaian, S.H. (2022), Nexus of energy and food nutrition prices in oil importing and exporting countries: A panel VAR model. *Energy*, 255(1), 124416.
- Tong, H. (1983), *Threshold models in non-linear time series analysis*. New York: Springer.
- Tong, H. (1990), *Non-linear time series: A dynamical system approach*. New York: Oxford University Press.
- Uri, N.D. (1995), The impact of crude-oil price volatility on agricultural employment in the United States. *The Journal of Energy and Development*, 20(2), 269-288.
- Uri, N.D. (1996), The impact of crude oil price volatility on agricultural employment in the United States. *Energy and Environment*, 7(1), 57-74.
- Vasiljeva, M.V., Ponkratov, V.V., Vatutina, L.A., Volkova, M.V., Ivleva, M.I., Romanenko, E.V., Kuznetsov, N.V., Semenova, N.N., Kireeva, E.F., Goncharov, D.K., Elyakova, I.D. (2022), Crude oil market functioning and sustainable development goals: Case of OPEC++-participating Countries. *Sustainability*, 14, 4742.
- Wells, J.C. (1988), Review of state, oil and agriculture in Nigeria, by M. Watts. *American Journal of Agricultural Economics*, 70(1), 215-216.
- Wilson, R.R. (1975), Petroleum for U. S. Agriculture. *American Journal of Agricultural Economics*, 56(5), 888-895.
- Yazdanpanah A. (1994), *Oil Prices and Agricultural Policy in Iran*. Food and Agricultural Policy Research Institute (FAPRI) Publications (archive only). Iowa: Center for Agricultural and Rural Development (CARD) at Iowa State University. p.94-123.
- Yergin, D. (1991), *The prize: The epic quest for oil, money and power*. New York: Simon and Schuster.
- Zhang, Q., Reed, M.R. (2008), Examining the Impact of the World Crude Oil Price on China's Agricultural Commodity Prices: The case of Corn, Soybean, and Pork (No. 1368-2016-108438). No 6797. In: 2008 Annual Meeting. Dallas, Texas: Southern Agricultural Economics Association.
- Zmami, M., Ben-Salha, O. (2019), Does oil price drive world food prices? Evidence from linear and non-linear ARDL modeling. *Economies*, 7, 1-18.