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**Article**

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# Impact of Oil Exports on Imports of Agricultural Machinery and Equipment

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**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 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). "T is widely accepted that fluctuations in the world price of oil have substantial real effectson 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 strenghten its position for international relations commenced to surge up since the beginning of the XX century by arithmetic sequence and contiunued 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 infuence 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 Venesuela, Nigeria, Indonesia, Eucador, 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. Tranferring 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 quaterly based 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 rices 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 an 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 form January 2000 to September 2008. Authors relied on concluded Johansen Trace Cointegration Test (Johansen, 1992; Johansen and Yuselius, 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, 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 countriesfrom 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 assymmetric analysis of oil price changes on food prices in oilexporting 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 Hetrosekadicity-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.

Kirikkaleli 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).

**Table 1: Data and internet resource**

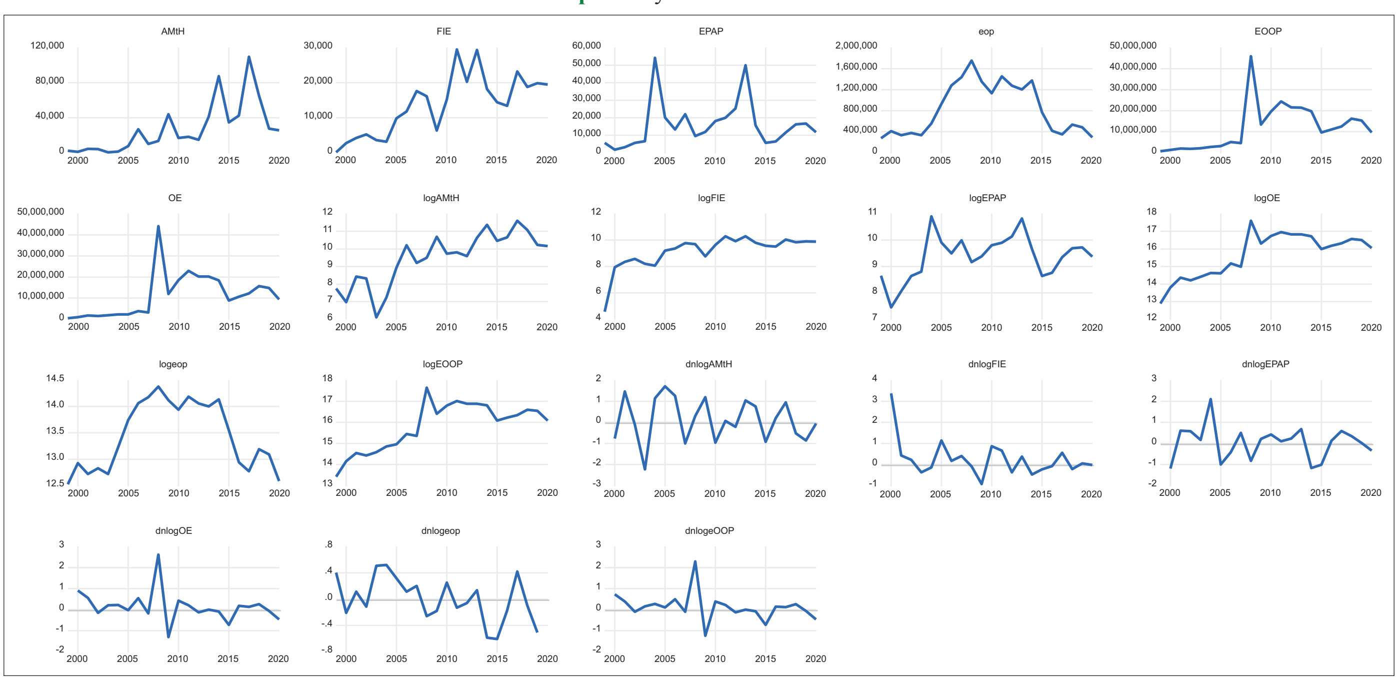
| | | |
|---|---|---|
| OE | Oil export (thousand manats) | www. stat.gov.az |
| EOOP | Export of oil and oil products (kerosene fuel for jet engines, heavy distillates or gas oils for other purposes, lubricating oils, petroleum coke, liquid fuel) (thousand manats) | www. stat.gov.az |
| EOP | Export 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 |

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

**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:

$H1_0$: The increase in oil exports increases imports of agricultural machinery for tillage and harvesting

$H2_0$: The increase in oil exports increases the imports of equipment for the food industry

$H3_0$: The increase in oil exports increases the import of equipment for the processing of agricultural products

$H4_0$: The increase in exports of oil and oil products increases imports of agricultural machinery for tillage and harvesting

$H5_0$: The increase in the export of oil and oil products increases the import of equipment for the food industry

$H6_0$: The increase in the export of oil and oil products increases the import of equipment for the processing of agricultural products

$H7_0$: The increase in the export of petroleum products increases the import of agricultural machinery for tillage and harvest

$H8_0$: The increase in the export of oil products increases the import of equipment for the food industry

$H9_0$: 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:

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

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

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

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

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

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

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

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

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

In the formula, $\varepsilon_t$ is white noise; $\Delta$ is the first-order difference; $p$ is the lag order, which is usually calculated by AIC or SBC criterion; $\lambda_{1i}$ and $\lambda_{2i}$ is the long-term coefficient between variables; $\beta_{1i}$ and $\beta_{2i}$ is the short-term coefficient between variables. $\beta_0$ 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)

$$LnAMTH_t = \beta_0 + \lambda_1 LnOE_t + \varepsilon_t \tag{28}$$

$$LnAMTH_t = \beta_0 + \lambda_1 LnEOOP_t + \varepsilon_t \tag{29}$$

$$LnAMTH_t = \beta_0 + \lambda_1 LnEOP_t + \varepsilon_t \tag{30}$$

$$LnFIE_t = \beta_0 + \lambda_1 LnOE_t + \varepsilon_t \tag{31}$$

$$LnFIE_t = \beta_0 + \lambda_1 LnEOOP_t + \varepsilon_t \tag{32}$$

$$LnFIE_t = \beta_0 + \lambda_1 LnEOP_t + \varepsilon_t \tag{33}$$

$$LnEPAP_t = \beta_0 + \lambda_1 LnOE_t + \varepsilon_t \tag{34}$$

$$LnEPAP_t = \beta_0 + \lambda_1 LnEOOP_t + \varepsilon_t \tag{35}$$

$$LnEPAP_t = \beta_0 + \lambda_1 LnEOP_t + \varepsilon_t \tag{36}$$

Here $\beta_0$, $\lambda_1$ - 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

($H_0: \lambda_{1i} = \lambda_{2i} = 0$; $H_1: \lambda_{1i} \neq \lambda_{2i} \neq 0$) 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):

$$\Delta LnAMTH_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta LnAMTH_{t-1} + \sum_{i=0}^{p} \beta_{2i} \Delta LnOE_{t-i} + \varphi_1 ECT_{t-1} + \varepsilon_t \tag{37}$$

$$\Delta LnAMTH_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta LnAMTH_{t-1} + \sum_{i=0}^{p} \beta_{2i} \Delta LnEOOP_{t-i} + \varphi_2 ECT_{t-1} + \varepsilon_t \tag{38}$$

$$\Delta LnAMTH_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta LnAMTH_{t-1} + \sum_{i=0}^{p} \beta_{2i} \Delta LnEOP_{t-i} + \varphi_3 ECT_{t-1} + \varepsilon_t \tag{39}$$

$$\Delta LnFIE_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta LnFIE_{t-1} + \sum_{i=0}^{p} \beta_{2i} \Delta LnOE_{t-i} + \varphi_4 ECT_{t-1} + \varepsilon_t \tag{40}$$

$$\Delta LnFIE_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta LnFIE_{t-1} + \sum_{i=0}^{p} \beta_{2i} \Delta LnEOOP_{t-i} + \varphi_5 ECT_{t-1} + \varepsilon_t \tag{41}$$

$$\Delta LnFIE_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta LnFIE_{t-1} + \sum_{i=0}^{p} \beta_{2i} \Delta LnEOP_{t-i} + \varphi_6 ECT_{t-1} + \varepsilon_t \tag{42}$$

$$\Delta LnEPAP_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta LnEPAP_{t-1} + \sum_{i=0}^{p} \beta_{2i} \Delta LnOE_{t-i} + \varphi_7 ECT_{t-1} + \varepsilon_t \tag{43}$$

$$\Delta LnEPAP_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta LnEPAP_{t-1} + \sum_{i=0}^{p} \beta_{2i} \Delta LnEOOP_{t-i} + \varphi_8 ECT_{t-1} + \varepsilon_t \tag{44}$$

$$\Delta LnEPAP_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta LnEPAP_{t-1} + \sum_{i=0}^{p} \beta_{2i} \Delta LnEOP_{t-i} + \varphi_9 ECT_{t-1} + \varepsilon_t \tag{45}$$

**Table 2: Results of unified root tests**

| Model | Variable | ADF | PP | KPSS |
|---|---|---|---|---|
| With intercept only | At level form | | | |
| | *LnOE* | −2.111885 | −2.620692 | 0.511051** |
| | *LnEOOP* | −2.395482 | −2.395482 | 0.491440** |
| | *LnEOP* | −1.145315 | −1.441392 | 0.175976 |
| | *LnAMTH* | −1.812818 | −1.529145 | 0.741095*** |
| | *LnFIE* | −4.508987*** | −6.010952*** | 0.662537** |
| | *LnEPAP* | −4.046870*** | −2.367039 | 0.246016 |
| | At First differencing | | | |
| | ΔLnOE | −6.800788*** | −6.800788*** | 0.335760* |
| | Δ*nLEOOP* | −6.671246*** | −6.671246*** | 0.363220* |
| | Δ*LnEOP* | −3.119722** | −3.125357** | 0.539249** |
| | Δ*LnAMSTH* | −5.825820*** | −6.664843*** | 0.276569 |
| | Δ*LnEFI* | −7.410029*** | −15.52941*** | 0.343586* |
| | Δ*LnEPAP* | −3.730714** | −5.282537*** | 0.213513 |
| With intercept and trend | At level form | | | |
| | LnOE | −2.261830 | −2.166894 | 0.164158** |
| | *LnEOOP* | −1.032932 | −1.818199 | 0.164772** |
| | *LnEOP* | −0.937024 | −0.739019 | 0.168525** |
| | *LnAMTH* | −3.309202* | −1.529145 | 0.119574* |
| | *LnFIE* | −2.408524 | −6.922448*** | 0.198260** |
| | *LnEPAP* | −2.858500 | −2.455144 | 0.129803* |
| | At first differencing | | | |
| | ΔLOE | −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 | | | |
| | LnOE | 1.064828 | 0.753004 | N/A |
| | *LnEOOP* | 1.026733 | 0.990857 | N/A |
| | *LnEOP* | −0.018981 | −0.018981 | N/A |
| | *LnAMTH* | 0.887323 | 0.741095 | N/A |
| | *LnFIE* | 0.811147 | 0.801163 | N/A |
| | *LnEPAP* | 0.011546 | 0.263415 | N/A |
| | At First differencing | | | |
| | ΔLOE | −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 |
| LnOE | | | | I (1) |
| *LnEOOP* | | | | I (1) |
| *LnEOP* | | | | I (1) |
| *LnAMTH* | | | | I (1) |
| *LnFIE* | | | | I (1) |
| *LnEPAP* | | | | 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 $X_i$-square statistical values by checking the statistical significance of the coefficients of all delayed first-order differences (all $\Delta LnOE_{t-i}$, $\Delta LnEOOP_{t-i}$ and $\Delta LnEOP_{t-i}$) together for each free variable (null hypothesis: $H_0$: $\beta_{2i} = 0, i = 1\ldots p$). 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 $X_i$-square statistical values through the Wald test as a null hypothesis for each variable taken ($H_0$: $\beta_{2i} = \varphi_1 = 0$,i= 1…$p$,; $H_0$: $\beta_{2i} = \varphi_2 = 0$,i= 1…$p$,; $H_0$: $\beta_{2i} = \varphi_3 = 0$,i= 1…$p$,; $H_0$: $\beta_{2i} = \varphi_4 = 0$,i= 1…$p$,; $H_0$: $\beta_{2i} = \varphi_5 = 0$,i= 1…$p$,; $H_0$: $\beta_{2i} = \varphi_6 = 0$,i= 1…$p$,; $H_0$: $\beta_{2i} = \varphi_7 = 0$,i = 1…$p$,; $H_0$: $\beta_{2i} = \varphi_8 = 0$,i = 1…$p$,; $H_0$: $\beta_{2i} = \varphi_9 = 0$,i = 1…$p$,;) 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 |
| | *CointEq*(−1) | | | −0.659065** |
| Model 2 | LnEOOP | 1.131487*** | 0.750534* | |
| | ΔLnEOOP | | 0.269196 | 0.269196 |
| | *C* | −8.311041 | −5.512904 | |
| | LnAMTH (−1) | | −0.663323** | |
| | *CointEq*(−1) | | | −0.663323** |
| Model 3 | 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 | | | | | |
| ΔLAMSPH(−1) | 0.438156 | −0.378287 | −0.257236 | | | | | | |
| LnAMTH | 0.777951** | 0.739981** | 0.365617 | | | | | | |
| ΔLnFIE(−1) | | | | −0.083396 | −0.079313 | 0.079536 | | | |
| LnFIE | | | | 0.719639** | 0.729209** | 2.098201* | | | |
| ΔLnEPAP(−1) | | | | | | | −0.377008 | −0.388330 | −0.412628** |
| LnEPAP | | | | | | | 0.663988* | 0.690056** | 0.734310*** |
| ΔLnOE(−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 | | | | | |
| ΔLnAMTH(−1) | 0.258497 | 0.236574 | 0.034610 | | | | | | |
| ΔLnFIE (−1) | | | | 0.049710 | 0.050084 | 0.003597 | | | |
| ΔLnEPAP(−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** |
| 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 $\chi^2$ | Heteroskedasticity Test: Breusch-Pagan -Godfrey | Breusch–Godfrey Serial Correlation LM Test: $\chi^2$ | $R^2$ | D_W (Durbin and Watson, 1971) |
| Model 1 | 1.224725 | 0.330103 | 0.933627 | 1.841800 | 6.197778 | 0.646149 | 1.605904 |
| | 0.542069 | 0.8557 | 0.3339 | 0.6059 | 0.0457 | | |
| Model 2 | 0.812776 | 0.202762 | 1.016455 | 0.586274 | 5.543846 | 0.650395 | 1.621157 |
| | 0.666052 | 0.6585 | 0.3267 | 0.6322 | 0.0625 | | |
| Model 3 | 1.628936 | 0.049230 | 1.28915 | 2.316050 | 6.990971 | 0.614363 | 2.040432 |
| | 0.442875 | 0.9613 | 0.2562 | 0.3141 | 0.0303 | | |
| Model 4 | 1.078476 | 0.167417 | 0.164925 | 0.642026 | 1.584374 | 0.673077 | 1.767814 |
| | 0.583193 | 0.8690 | 0.6847 | 0.7254 | 0.4529 | | |
| Model 5 | 1.498941 | 0.599753 | 0.300864 | 0.167146 | 1.524040 | 0.688020 | 1.761928 |
| | 0.472617 | 0.5566 | 0.5833 | 0.9198 | 0.4667 | | |
| Model 6 | 1.483941 | 1.521044 | 0.052111 | 0.797585 | 0.964306 | 0.598539 | 1.516300 |
| | 0.476175 | 0.1466 | 0.8194 | 0.6711 | 0.6175 | | |
| Model 7 | 4.729595 | 0.996138 | 0.461718 | 1.812288 | 0.402796 | 0.266452 | 1.713526 |
| | 0.093968 | 0.3332 | 0.4988 | 0.4041 | 0.8176 | | |
| Model 8 | 4.929361 | 0.980808 | 0.463229 | 1.735417 | 0.388795 | 0.267996 | 1.704314 |
| | 0.085462 | 0.3505 | 0.4970 | 0.4299 | 0.8233 | | |
| Model 9 | 2.315623 | 1.164187 | 0.546938 | 0.440996 | 0.832911 | 0.396399 | 1.620687 |
| | 0.314173 | 0.2605 | 0.4596 | 0.8021 | 0.6594 | | |
| (F-version) | | | | | | | |
| | Normality Test (Jarque-Bera) JB | Ramsey RESET test (t-statistic | Heteroskedasticity Test: ARCH $\chi^2$ | Heteroskedasticity Test: Breusch-Pagan -Godfrey | Breusch–Godfrey Serial Correlation LM Test: $\chi^2$ | CUSUM –5%– Significance | CUSUM Squares –5%– Significance |
| Model 1 | N/A | 0.108968 | 0.881410 | 0.544773 | 3.140294 | STB | NO/STB |
| | N/A | 0.8557 | 0.3602 | 0.6583 | 0.0726 | | |
| Model 2 | N/A | 0.450292 | 1.069027 | 1.968954 | 2.690116 | STB | STB |
| | N/A | 0.6585 | 0.3012 | 0.5789 | 0.1005 | | |
| Model 3 | N/A | 0.002424 | 1.240173 | 1.115634 | 3.992265 | STB | STB |
| | N/A | 0.9613 | 0.2801 | 0.3493 | 0.0392 | | |
| Model 4 | N/A | 0.583193 | 0.149667 | 0.283831 | 0.652824 | STB | NO/STB |
| | N/A | 0.8690 | 0.7034 | 0.7562 | 0.5339 | | |
| Model 5 | N/A | 2.313575 | 0.047022 | 0.355317 | 0.385035 | STB | STB |
| | N/A | 0.1466 | 0.8308 | 0.7058 | 0.6866 | | |

*(Contd...)*

**Table 8:** ***(Continued)***

| (F-version) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Normality Test (Jarque-Bera) JB | Ramsey RESET test (t-statistic | Heteroskedasticity Test: ARCH $\chi^2$ | Heteroskedasticity Test: Breusch-Pagan -Godfrey | Breusch–Godfrey Serial Correlation LM Test: $\chi^2$ | 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 | Constant, Linear trend | None | Cointegration test: Engle-granger tau-statistic | Engle-granger z-statistic | Phillips-ouliaris tau-statistic | Phillips-ouliaris 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 | /−4.072880** | /−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 | /−3.354440** | /−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* | /−3.311078** | /−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 | /−2.561552 | /−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 | /−3.297145** | /−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 | /−1.746914 | /−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 | /−2.398603 | /−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 | /−1.751631 | /−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 | /−3.636387** | /−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 | /−3.055910** | /−3.230606 | /−3.180695*** | | | | |
| | | /0.127244 | /0.148553** | /NA | | | | |

*(Contd...)*

**Table 9:** ***(Continued)***

| | | ECT | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | ADF /PP /KPSS | Constant, Linear trend | None | Cointegration test | | | |
| | | | | | Engle-granger | | Phillips-ouliaris | |
| | | Constant | | | 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 ΔLOE/Δ*LOOPE*//Δ*LOPE* | | | Long-term period ECT-1 | | | Strong impact ECT-1 andΔLOE/Δ*LOOPE*/ /Δ*LOPE* | | ADF unit root test With intercept only/with interceptand 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***/−.488710*** |
| 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***/−4.488710*** |
| 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 obtaine 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.

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