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Asymmetric Transmission of Oil Price Fluctuations on the Value Added of Agricultural Sector Using NARDL Model and GAS Model

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ABSTRACT

Oil, as a primary source of energy, has a significant impact on promoting economic activities. Oil provides considerable part of the government's revenue sources. The price of oil has always fluctuated over the years due to various reasons including political, social, and economic developments in different countries. Since the price of oil affects different sectors of the economy, including agriculture, through the government budget and the revenue sources of the government, this study investigated the effect of OPEC oil price fluctuations on the value added of the agricultural sector from 1990 to 2019. The Generalized Autoregressive Score (GAS) Model estimated these fluctuations, while the Nonlinear Autoregressive Distributed Lag (NARDL) method estimated the long-term relationships. In addition to OPEC oil price fluctuations, variables such as the consumer price index, employment in the agricultural sector, and the trade openness degree were examined in the model. The results showed a negative effect of OPEC oil price fluctuations on the agricultural sector's value added. Furthermore, the trade openness had a positive effect on the agricultural value added in the long term. Results indicate that oil income is one of the most important issues that decline agricultural sector's value added, and the government should control this negative relation to develop agriculture as a vital part of the economy.

Keywords: GAS model, NARDL model, Trade openness.

INTRODUCTION

Oil price fluctuation is one of the most significant factors of the economy's fluctuation in oil-producing countries. Therefore, decreases and increases in oil prices have a large impact on oil export countries' economies. For this reason, the unusual fluctuations in the price of this product and the resulting uncertainty increase the price of other products and services and change the production benefits in the national and international markets. Due to the strategic position of oil in the economy of different countries, the resulting uncertainty can affect the economic performance of oil-importing and exporting countries in addition to the direct effects caused by price fluctuations (Sertaghi *et al.*, 2013).

As one of the main sources of funding, the price of oil and its fluctuations is one of the factors affecting the production fluctuations, especially in the oil exporting countries. These fluctuations can affect macroeconomic variables through different ways such as affecting the foreign exchange earnings. Further, oil revenues, as the main source of financial aid and subsidies, indirectly affect other economic activities (Brown and Yucel, 2002; Afarineshfar and Shahnazi, 2016). As a common commodity, it is evident that the oil

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price is affected by both supply and demand shocks, and the various types of oil price fluctuations will have different impacts on economic activity. These changes in the relationship between oil prices and the macro-economy reflect the evolution of the components of oil price shocks. Therefore, distinguishing the sources of oil price fluctuations is crucial to evaluate these effects (Zhang *et al.*, 2022). One of the most significant economic characteristics related to oil-rich countries is that a major part of the production and distribution mechanisms in these countries is affected by the amount of oil exports. Most of the OPEC countries as oil exporting countries are almost single-products in their export sector. In other words, oil sales in these countries are considered as the most critical export source or, at least, the most essential economic basis. Iran's economic growth is rapidly damaged by foreign impulses, such as the oil sanction, due to the sale of crude oil, lack of diversity in the product, government monopoly in the oil sales organization and, monopoly of purchase by customers (Tofigh and Matin, 2017). The agricultural sector as one of the components of revenue and production in most countries had the maximum share in national production and revenue until 1850. With the advancement of technology and the expansion of the industry and service sectors, the share of the agricultural sector in the national production gradually decreased in 1950 and the share of the agricultural sector in the gross national product decreased to 15-20% in most of the developed countries. However, the agricultural sector is still regarded as one of the most critical economic sectors in some developing countries such as Iran, which has a high share of the gross national product (Lohrasbi, 2006).

In Iran, the agricultural sector is more stable than other economic sectors and it is a reliable sector to solve one of the most important issues of Iran's economy, which is the single-product economy. According to the share of each economic sector in the GDP of Iran for ten years (from 2011 to 2020), the share of the agricultural sector in the GDP has been increasing year by year without being affected by political issues, weather, and other factors. Oon the other hand, the value added by the oil sector has fluctuated every year. Due to the high stability of the value added of agricultural sector, it can be a way to get out of the single-product economy through investment in this sector and cause growth in GDP (Central Bank of Iran, 2022). Regarding the potentials of this sector, the necessity of developing a strategy for the agricultural sector for optimal use of capacity is increasing every day. For this reason, efforts can be made to achieve these goals in this sector after determining the capability of the agricultural sector and its share in the gross domestic product.

Generally, while there is a high capacity for production, capital, employment and entrepreneurship should be created and waste of facilities should be avoided in other areas that have no reasonable returns. For this reason, special attention should be paid to agriculture as the axis of development Support, investment, technology, and planning should aim to assign a significant contribution in the 20-year perspective as the best country in the region in trade and export of agricultural products and providing the minimum needs of the countries (Ebrahimi and Salarian, 2009). Agriculture is highly essential in food production, non-oil exports, and job creation for the vast population. Due to the significance of food security and food supply in the future of the planet, all countries should consider this sector and its products, since the population of the earth will increase by 50% by 2050 according to the forecast made by the World Bank (2019). According to the reports published by the United Nations, food and water famine will cover many countries of the world due to the destruction and reduction of natural resources during recent years. Today, the food supply for the people and the possibility of cultivation and production of agricultural products in the future depends on the performance and planning of the countries (FAO, IFAD, UNICEF, WFP and WHO, 2018). The exogenous nature of oil price

fluctuations will transform the economy directly by affecting foreign exchange earnings, the government budget, etc. Since the agricultural sector is considered one of the most significant economic sectors in Iran, the fluctuations and oil prices will indirectly affect this sector through government subsidies, input prices, etc. Agriculture is an integral part of human life and its denial is neither possible nor desirable. Furthermore, it is impossible to continue the prevailing agricultural practices in terms of resources, costs, and environmental health (Weed, 1987). According to the effect of oil price fluctuations on the value added of the agricultural sector, this study examined the increase and decrease fluctuations of the oil price on the value added of the agricultural sector in Iran.

The oil price indirectly affects the economy of oil-exporting countries. Decrease and increase in oil prices impact oil revenues (Dutch disease). Also, the risk and uncertainty about oil revenues face the government budget with uncertainty. The increase and decrease in the oil price by affecting the amount of total demand and the price of inputs, increases the cost of production and the price of products (Ghaderzadeh and Ghosseiri, 2016). Therefore, oil price fluctuations can affect the investment in the agricultural sector through the government budget and decrease or increase it. In other words, the government's action to invest in the agricultural sector depends on the government's budget. Therefore, oil in Iran's economy changes the value added of the agricultural sector in different ways; first by influencing the investment in the agricultural sector and, secondly, by influencing the price of imported inputs and, consequently, affecting the price of agricultural products. Regarding these two influencing channels, based on the study of Dukohaki and Mousavi (2018), who investigated the fluctuation of oil price on the value added of economic sectors, the relationship between the fluctuation of oil price and the value added of the agricultural sector is negative. This means that by increasing the fluctuation of the oil price, the added value of the agricultural sector decreases. However, according to the study of Tarazkar and Sheikh Zainoddin (2019), in the short term and long term there is a positive relationship between the price of agricultural products and the increase in the oil price. It can be concluded that, eventually, the oil price will increase the value added to the agricultural sector with the increase in the price of agricultural products.

Therefore, in this study, we will estimate the increase and decrease of oil price fluctuations to check how this oil price fluctuations affects the value added to the agricultural sector. Does the value-added increase by the increase in oil price fluctuations or not? Also, does the reduction in oil price fluctuation have a positive effect on value-added or not? Because in most of the conducted studies, only the general investigation of oil price fluctuations on the value added of the agricultural sector is discussed, or they examine the impact of oil revenues on the value added of the agricultural sector (Dutch disease). However, in this study, our aim is to investigate the effect of both the increase and decrease of oil price fluctuation on the value added of the agricultural sector.

Shahabi *et al.* (2017) studied the direct and indirect effects of the growth of the agricultural sector from the abundance of natural resources during 1981-2014, using the method of simultaneous equations. Based on the results obtained from the estimation of the growth pattern in the agricultural sector, the direct effect of the abundance of natural resources on the agricultural sector is negative. Azeez (2018) evaluated the effects of oil price fluctuations on urban and rural food prices in Nigeria during 2000-2016. The variable was oil price volatility spillover effects on the prices of food in both pre-crisis and post-crisis periods. This study adopts the GARCH (1, 1)-TY model to evaluate the impulse response function and variance decomposition of these effects. Based on the results, total food prices and urban food prices react positively to oil price shocks in

the post-crisis periods, while rural food prices react negatively to oil price shocks. Furthermore, the reaction of urban food prices is more considerable in post-crisis periods since they are affected by oil price shocks. Dokohaki and Mousavi (2018) evaluated oil price fluctuations on the value added of agriculture, industry, and service sectors during period of 1976- 2011 by using the Autoregressive Distributed Lags (ARDL). The results indicated that the consumption variable of petroleum products in the service sector had a negative relationship with the value added of the service sector in the long term. Furthermore, the variable of oil price fluctuations had a positive relationship with the value added of the service sector in the long term. Further, the effect of oil price fluctuations on the value added of the agricultural sector is negative and the value added of the agricultural sector decreased by increasing oil price fluctuations. Ben Salah and Zamami (2019) studied the effect of Brent and West Texas Intermediate (WTI) oil prices on international food prices during 1990-2017. They estimate the ARDL model to analyze the impact of the Brent and WTI oil prices on international food prices between January 1990 and October 2017. The results showed the presence of an asymmetric relationship since food prices in the long term are only affected by positive shocks. The price dynamics of dairy products have exhibited asymmetric responsiveness to oil price fluctuations, with price increases following oil price rises being more pronounced than decreases during oil price declines. This suggests an upward stickiness in dairy pricing when influenced by energy market shocks.

Esmaili *et al*. (2020) evaluated the effect of exchange rate and oil price fluctuations on the trade balance of the Iranian agricultural sector with its eight trading partner countries using two linear and non-linear ARDL models. The purpose of this study was to investigate the effect of exchange rate and oil price fluctuations on trade balance of Iran's agriculture sector with its 8 major trading key commercial partners over the period 1998 to 2017, and examine also the existence of the J Curve in these countries. For methodology, linear and nonlinear ARDL models were utilized. The results showed that long-term oil price fluctuations had a positive effect in Turkey, Afghanistan, Germany, and India. The trade balance of Iran's agricultural products in these countries improved by increasing oil price fluctuations. However, the trade balance of the agricultural sector was reduced by increasing oil price fluctuations in Iraq, UAE, China, and Korea. Tarazkar and Sheikh Zainuddin (2019) studied the asymmetric effects of oil shock on the prices of agricultural products in Iran from 1976 to 2011 by using the autoregressive approach with Nonlinear Autoregressive Distributed Lag (NARDL). The NARDL model's examination revealed that agricultural commodity prices exhibit both short-term and long-term asymmetric behavior. This suggests that there is a positive and substantial correlation between the price of agricultural products and the rise in the price of oil, both in the short and long terms. In addition, a positive and significant relationship is the decrease in the price of oil and the price of agricultural products in the short and long term. Furthermore, the positive oil shock has a greater effect on agricultural product prices than the negative shock. Roman *et al*. (2020) studied the linkages between crude oil and food price. They used the data series covers the period between January 1990 and September 2020. The empirical results from the paper indicate that there are long-term relationships between crude oil and meat prices. The linkage of crude oil prices occurred with food, cereal, and oil prices in the short term. Furthermore, the linkages between the analyzed variables increased in 2006–2020. Tariq *et al*. (2020) investigated the effect of oil prices on futures and spot markets in agricultural products in Pakistan. They used 60 observations of seven agricultural variables traded in future and spot markets of Pakistan during 2012- 2017. Their methodology was Vector Error Correction mode. The findings revealed that the market of agricultural products in

Pakistan is sensitive to oil prices. The spot price of rice and sugar is considered representative of the price of agricultural products in future transactions (1 and 2-month futures exchange). The result of this study regarding the rice commodity market indicated that the price of oil considerably affects the future prices of rice and the price of crude oil can forecast the future price of rice in the short term. On the contrary, the price of crude oil did not affect the spot price of rice. Regarding the sugar commodity market, the results reported that oil cannot affect the price of sugar while the spot prices of sugar are greatly influenced by the price of oil.

Esmaeili *et al*. (2022) studied the effect of oil price impulse on the price of agricultural products in the cereal group during the periods of food crisis. The variables used in this study include corn Price Logarithm (PL), rice PL, soybeans PL, wheat PL, barley PL, real currency rate logarithm, crude oil PL, world oil production logarithm, world real economic activity logarithm and oil safety reserve logarithm. They used PVAR (Panel Vector Autoregression) method in their study. the results indicated that the total price of agricultural products oil shocks is indirectly affected by supply and demand shocks in addition to their direct effects. The price reaction of such products to oil shocks, total demand, and commodity markets in terms of direction, intensity, and pattern are similar and positive among oil exporting and importing countries. Umar *et al*. (2021) evaluated the relationship between oil price shock and agricultural commodity prices. They were estimated Granger causality (Granger Causality is a statistical hypothesis test used to determine whether one time series can predict another. It is based on the principle that if variable *X* "Granger-causes" variable *Y*, then past values of *X* should contain information that helps predict *Y* beyond what is contained in past values of *Y* alone), static connectedness, and dynamic rolling connectedness between different type of oil price shocks, agricultural commodity returns and volatility for the period of 2002–2020. Based on the results, oil price shocks are mainly caused by changes in the prices of cereals, live cattle and wheat, while supply shocks create more changes in the prices of cereals. Köse and Ünal (2022) studied "The effects of the oil price and temperature on food inflation in Latin America". They examined via a structural vector auto-regression model and panel Granger causality test, using monthly data between January 2003 and December 2020 for Latin American countries. According to their result, the oil price and temperature had an impact on food inflation. All results indicate that both monetary and fiscal policies are essential to control food prices. These countries can accomplish this by conventional policies or by radical institutional changes. Nevertheless, the oil price and temperature are external dynamics, and crucial in creating alternative policies to control food inflation. Ike *et al.* (2023) investigated “Oil price movements and agricultural production from heterogeneous sub-sectors: Analyzing the Dutch disease in an African resource-rich economy". Their study not only isolates the effect of oil price movements on agricultural production from heterogeneous sub-sectors in Nigeria but also tests for Dutch disease symptoms using annual data from 1970 to 2019. Their results from ARDL method indicated that, in the long run, oil price booms affect the food sector and the livestock sector heterogeneously. An increase in the oil price undercuts the production performance of the food sector.

The agricultural sector is considered one of the significant sectors of Iran's economy, playing a key role in food production, non-oil export, import, employment and foreign exchange. In addition, providing food security and the sustainability of soil can highly affect the performance of this sector. For this reason, it is significant to know the factors affecting this sector and the mechanism of these effects in the planning and policies. As Iran's economy is a single-product economy and oil has accounted for a large part of the budget and revenue during

recent years, the price of oil and its fluctuations have influenced other productive sectors of the economy, including the agricultural sector.

For this reason, this study focused on the effect of increase and decrease in oil price fluctuations on the value added of Iran's agricultural sector in the long term during 1990-2019. Therefore, this study has estimate how transmission of oil price fluctuations has affected the value added of the agriculture? Innovation of this article compared to others is: 1) Instead of using ARCH and GARCH models to estimate oil price fluctuation, GAS model has been applied. 2) We evaluate the impact of the increase and decrease in oil price fluctuation on the value added of the agricultural sector by the NARDL model.

Summary of research background is presented in Table 1:

MATERIALS AND METHODS

In our study, we evaluated the short-term and long-term effects of fluctuations in OPEC oil prices, employment in the agricultural sector, degree of trade openness, and the consumer price index on the value added of the agricultural sector by using the autoregressive distributed lag during 1990-2019. To choose variables and estimate our model, we have reviewed the study of other researchers such as: Tarazkar and Sheikh Zeinodin (2019), Afarineshfar and Shahnazi (2016) and Dokohaki and Mousavi (2018). In our study, the general logarithmic form is shown in Equation (1):

$$LAgri = \alpha + \beta_1 \text{Lopec}^{+} + \beta_2 \text{Lopec}^{-} + \beta_3 Lbr + \beta_4 LDgree + \beta_5 Lcpi + u_t \quad (1)$$

Where, LAgri represents the value added of the Agricultural sector and Lopec^{-} represents decrease in oil's fluctuation and Lopec^{+} indicate increased oil fluctuation. In addition, Lbr, LDgree, and Lcpi indicate the employment in the agricultural sector, the degree of trade openness, and the consumer price index. The degree of trade openness is obtained by Equation (2) (Amini and Lotfipour, 2014):

$$\text{Dgree} = \frac{\text{IM} + \text{EX}}{\text{GDP}} \quad (2)$$

Where, IM shows the amount of Import, EX is the amount of Export, and GDP indicates the Gross Domestic Product of the agricultural sector.

Based on the available studies, the effect of consumer price index and oil price fluctuations on the value added of the agricultural sector is expected to be negative in the long term. Furthermore, the degree of trade openness is expected to have a positive effect on the value added of the agricultural sector. In this study, the GAS method was used to estimate the increase and decrease in oil price fluctuations using OXmetrics7 software. In addition, the estimation of the final model of ADRL and NARDL was conducted in EViews7 software.

Generalized Autoregressive Score Model (GAS)

In traditional models, the GARCH method (Bolerslow, 1986) is used to estimate uncertainty and volatility which is rooted in the ARCH method presented by Engel (1982). One of the weaknesses of the ARCH method is its sensitivity to outliers (Muler and Yohai, 2008), and its use in defining table-valued parameter models in a wide variety of multivariate and multivariate time series settings is considered one of the practical features of the GAS framework. This model is related to the category of observation-based models, which includes well-known models such as the GARCH method where the conditional distribution of the ARCH and GARCH methods is used. Assume in the GAS method (p,q) that Y_t is a k-dimensional random vector at time t with conditional distribution:

$$Y_t | Y_{1:\,t-1} \approx p(Y_t\,;\,\theta_t) \quad (3)$$

Where, $Y_{1:\,t-1} \equiv (Y_1^T, \ldots, Y_{t-1}^T)^T$ and Yt-1 values represent the p created by the time

Table 1. Summary of research background.

No.	Reference	Subject	Methodology	Variable	Results
1	Ike *et al.* (2023)	Oil price movements and agricultural production from heterogeneous sub-sectors: Analysing the Dutch disease in an African resource-rich economy. (During 1970- 2019)	ARDL dynamic Granger causality techniques	Oil price and food sector	An increase in domestic production has a weak predictive content for oil price booms, it is because of the strong linkage between domestic livestock production and the global livestock market.
2	Köse and Ünal (2022)	The effects of the oil price and temperature on food inflation in Latin America. (During January 2003 and December 2020)	SVAR and panel Granger causality test	Oil price, temperature and food inflation	Oil price and temperature had an impact on food inflation.
3	Esmaeili *et al.* (2022)	The Impact of Oil Price Fluctuation on the Price of Agricultural Products Considering the Food Crisis Periods.	PVAR Method	Agriculture product price, real currency rate, crude oil price, world oil production, world real economic activity	The total price of agricultural products is indirectly affected by oil shocks supply and demand shocks in addition to their direct effects.
4	Umar *et al.* (2021)	Return and volatility transmission between oil price shocks and agricultural commodities. (During 2002-2020)	Granger causality, static connectedness, and dynamic rolling connectedness	Different type of oil price shocks, agricultural commodity returns	Oil price shocks are mainly caused by changes in the prices of cereals, live cattle and wheat, while supply shocks create more changes in the prices of cereals.
5	Tariq *et al.* (2020)	Oil and Agricultural Commodity Markets of Pakistan: Looking for a Preferable Trading Avenue. (During 2012-2017)	Vector Error Correction model	Oil price and 60 observations of seven 7 agricultural variables traded in Futures and spot markets of Pakistan	The market of agricultural products in Pakistan is sensitive to oil prices. The spot price of rice and sugar is considered representative of the price of agricultural products in future transactions
6	Roman *et al.* (2020)	The Linkages between Crude Oil and Food Prices. (During January 1990 and September 2020)	Data series	Crude Oil and Food Price	There are long-term relationships between crude oil and meat prices. The linkage of crude oil prices occurred with food, cereal, and oil prices in the short term
7	Ben Salah and Zamami (2019)	Does Oil Price Drive World Food Prices? Evidence from Linear and Nonlinear ARDL Modeling. (During January 1990 and October 2017)	ARDL model	Brent and West Texas Intermediate (WTI) oil prices and international food prices	The price of dairy products has reacted to quickly changes in oil prices while the effect of the increase in oil prices has been higher than the reduction. they only react to the reduction in oil prices

Table 1 Continued…

Continued of Table 1. Summary of research background.

No.	Reference	Subject	Methodology	Variable	Results
8	Esmaili *et al.* (2020)	The impact of exchange rate fluctuations and oil prices on the trade balance of Iran's agricultural sector: curve approach J. (During period 1998 - 2017)	Non-linear ARDL models	Exchange rate and oil price fluctuations of Iran and trade balance of Iran's agriculture sector with its 8 major trading partners	Long-term oil price fluctuations had a positive effect in Turkey, Afghanistan, Germany, and India. The trade balance of Iran's agricultural products in these countries improved by increasing oil price fluctuations
9	Tarazkar and Sheikh Zainuddin (2019)	The Impacts of Asymmetric Oil Shocks on Agricultural Commodity Price: Application of Nonlinear Autoregressive Distributed Lags (NARDL) Approach. (During 1976-2011)	Autoregressive approach with Nonlinear Autoregressive Distributed Lag	Oil's price shock, agricultural commodity prices	There is a Positive and substantial correlation between the price of agricultural products and the rise in the price of oil
10	Azeez (2018)	Oil price volatility spillover effects on food price in Nigeria. (During 2000-2016)	GARCH (1, 1)-TY model	Oil price volatility spillover and prices of food	Total food prices and urban food prices react positively to oil price shocks in the post-crisis periods while rural food prices react negatively to oil price shocks.
11	Dokohki and Mousavi (2018)	Investigating the impact of oil price fluctuations on the added value of different economic sectors in Iran. (During 1976-2011)	ARDL model	Oil price fluctuations, value added of agriculture, industry, and service sectors	The effect of oil price fluctuations on the value added of the agricultural sector is negative and the value added of the agricultural sector decreased by increasing oil price fluctuations.
12	Shahabi *et al.* (2016)	Investigating the effects of abundance of natural resources (oil) on the added value of the agricultural sector. (During 1981- 2014).	Method of simultaneous equations	Growth of the agricultural sector, abundance of natural resources	Growth pattern in the agricultural sector, the direct effect of the abundance of natural resources on the agricultural sector is negative.

series up to time t, θl shows a vector of time series parameters with density function p depending on Y_{t-1}. The time series parameters θ_t are created by the conditional distribution scalable score function and its first-order function are as follows:

$$\theta_{t+1} = k + As_t + B\theta_t \quad (4)$$

Where, k, A, and B are the matrix of coefficients, and the scaling score functions s_t is as follows:

$$s_t = s_t\nabla_t + B\theta_t \quad (5)$$

$$\nabla_t = \frac{\delta lnp(r_t;\theta_t)}{\delta\theta_t} \quad (6)$$

$$s_t = \eta_t(\theta_t)^{-\gamma} \quad (7)$$

$$\eta_t(\theta_t) = E_{t-1}[\nabla_t\nabla_t^T] = -E_{t-1}[\frac{\delta^2 lnp\ (r_t;\theta_t)}{\delta\theta_t\delta\theta_t^T}] \quad (8)$$

Where, γ is a number from the set {0, 1.2, and 1}. The value of s_t changes the time series parameters from θ_t to θ_{t+1}, which is similar to the well-known Newton-Raphson algorithm (Chen and Zhu, 2019).

NARDL Method

The Nonlinear Autoregressive Distributed Lag (NARDL) was first proposed by Shin *et al*. (2011), and later developed by Shin *et al*. (2014). The NARDL approach is considered as an extension of the ARDL model, and is considered as the advantages of this method. In this method, it is possible to estimate the model regardless of whether all of the variables have a co-integration degree I(1) or a combination of zero I(0) and one I(1) (Pesaran *et al*., 2001). This approach can be used in small samples in addition to the possibility of entering independent and dependent variable intervals in the model (Pesaran and Shin, 1999; Narayan *et al.*, 2004).

In addition to the above-mentioned factors, the NARDL approach provides the possibility to simultaneously study the presence of nonlinear and asymmetric relationships in the short and long term unlike the ARDL method (Yip and Lin, 2017). Furthermore, asymmetric relationships can exist in the long or short term or in both. Hence, the effect of positive and negative shocks of independent variables on the dependent variable can be evaluated by separating the short and long-term (Ariz *et al*., 2017). The NARDL model can be indicated as follows (Shin *et al*., 2011):

$$y_t = \beta^+ X_t^+ + \beta^- X_t^- + u_t \quad (9)$$

Where, β^+ and β^- represent the long-term coefficients of the model and X_t can be separated into positive and negative changes in the form of the following equation:

$$x_t = x_0 + x_t^+ + x_t^- \quad (10)$$

Where, x_0 shows the initial value of x_t. In addition, x_t^+ and x_t^- represent the partial sums of positive and negative changes in x_t, respectively, which can be presented as follows:

$$x_t^+ = \sum_{i=1}^{t} \Delta x_t^+ = \sum_{i=1}^{t} \text{Max}\,(\Delta x_t, 0) \quad (11)$$

$$x_t^- = \sum_{i=1}^{t} \Delta x_t^- = \sum_{i=1}^{t} \text{Min}\,(\Delta x_t, 0) \quad (12)$$

Shin *et al*. (2011) combined the linear ARDL (p,q) model presented by Pesaran and Shin (1999) and Pesran *et al.* (2001) to present the NARDL (p,q) as follows:

$$\Delta y_t = \alpha_0 + \rho y_{t-1} + \theta^+ x_{t-1}^+ + \theta^- x_{t-1}^- + \sum_{i=0}^{\rho-1} \varphi_i \Delta y_{t-i} + \sum_{i=0}^{q} (\pi_i^+ \Delta x_{t-i}^+ + \pi_i^- \Delta x_{t-i}^-) + e_t \quad (13)$$

Where, $\theta^+ = -\rho\beta^+$ and $\theta^- = -\rho\beta^-$ are established.

The model is evaluated by using the NARDL approach as follows. First, NARDL (p,q) is evaluated by using the Ordinary Least Squares (OLS) method and determining the optimal lag based on one of the Akaike or Schwarz -Bayesian criteria. Then, the presence of asymmetric co-integration relationship between independent and dependent variables (x_t^- and x_t^+ and y_t) is assessed. In this regard, it is necessary to use the bound test and the modified value of the F statistic provided by Pesaran *et al*. (2001) and Shin *et al*. (2011), namely, $= \theta^- = \theta^+ = 0$.

This test has two upper and lower critical bounds. If the calculated values of the F statistic are more than the upper bound, there is a long-term equilibrium relationship and a convergence between the variables of the model. If there is a co-integration relationship, it is possible to evaluate whether the relationships are symmetrical or asymmetrical in the short and long terms using the Wald test (Athanasenas *et al*.,

2014). In order to evaluate the presence of asymmetric relationships in the long term, it is necessary to confirm the following null hypothesis:

$$H_0: -\frac{\theta^+}{\rho} = -\frac{\theta^-}{\rho} \quad (14)$$

The null hypothesis mentioned below should be confirmed to check the presence of asymmetric relationship in a long term (Tarazkar and Sheikh Zainuddin, 2019):

$$H_0 = \sum_{i=1}^{q} \pi_i^+ = \sum_{i=1}^{q} \pi_i^- \quad (15)$$

First, oil price fluctuation values were calculated using the GAS method and OXmetrics software. Then, the obtained fluctuation values were considered as an independent variable and its stability and other independent variables were studied. After evaluating the degree of stationary, since it was proved that the degree of stationary of the variables was zero and one, the ARDL method was used to estimate the long-term and short-term relationship.

RESULTS

Estimation of Oil Price Fluctuations

Oil price fluctuations were modeled using the GAS method, the results of which are shown in Table 2. Based on the results, the residual term of the oil price variable is abnormal and has ARCH effects since the GAS method has no limitation in estimating the fluctuations of abnormal variables, and the presence of ARCH effects is confirmed (Bagherzade *et al.*, 2020). The evaluation of the stationary test of variables are in Table 2.

In Table 2, the normality of the OPEC oil price is evaluated, and the result shows the variable is not normal. Therefore, the first condition for estimating the GAS model is accepted. Also, the arch result indicates that the oil price has fluctuated, so, the second condition is accepted too. In the next step, the stationary value of the variable is estimated to check whether the oil price is stationary or not. If it will be stationary in the first difference, all conditions to use GAS will be met.

Checking the Stationary of Variables

If the studied variables are non-stationary, the regression and the statistical inference will be incorrect. In addition, sometimes it is possible that the R^2 level is high despite the non-stationary of the variables, in which case the results will be misleading. In order to prevent such an occurrence of the stationary of the variables, the Augmented Dickie-Fuller and Phillips-Perron tests were used (Table 3).

As shown in Tables 3, some variables are stationary in level and others are stationary in the first difference. According to the results of ADF test degree, Opec is not stationary at the level. But the results of P-P shows that Opec is stationary at the level and follows an I (0) process. Also, according to results of the ADF test, dgree is stationary at the level. But the results of P-P shows that dgree is not stationary at the level and follows an I (1) process. Also, according to the ADF and P-P tests, agri, lbr and cpi follow an I (1) process. Due to the theories, the results of ADF and PP are mixed and indicated that all of the variables did not have the same integration at that level, therefore, the ARDL method will be used to estimate the long-term relationship.

Bound Test

Bound test or F test examines the presence of a long-term relationship between the

Table 2. Descriptive results of oil price variable.

	Normality test					
variable	Kurt	skw	jarquebera	Std. dev	Mean	Arch
L(Opec)	1.68*	5.53*	22.16*	13.63	-1.89	25.25*

*: Denotes significance levels at 10%. Source: Research findings.

Table 3. The results of the Phillips-Perron and Augmented Dickey Fuller Static Test.

	Phillips-Perron		Augmented Dickey Fuller	
Variables	In level	First difference	In level	First difference
L(agri)	-0.39	-6.64*	-2.78	-6.19*
L(Opec)	-1***	-	0.72	-4.13*
L(lbr)	-1.75	-5.24*	-1.77	-5.23*
L(dgree)	-0.85	-4*	-4.53*	-
L(cpi)	-0.78	-2.16**	-2.55	-3.38***

***, **, *: Denote significance levels at 1, 5 and 10%, respectively. Source: Research findings.

Table 4. The results of the F-Bounds test.

F-statistic	Signif	1 %	2.5%	5%	10%
5.29	I(0)	3.06	2.7	2.39	2.08
	I(1)	4.15	3.73	3.38	3

Source: research findings.

Table 5. The results of long-run NARDL model estimation.

Variables	coefficient	Std. error	t-statistic
L(dgree)	0.19**	0.08	2.3
L(lbr)	0.56***	0.14	4.03
L(opec_pos)	-0.41***	0.12	-3.42
L(opec_neg)	-0.33***	0.01	-3.19
L(cpi)	0.79***	0.25	3.12
C	2.01**	0.87	2.31

*** and **: Denote significance levels at 1% and 5%, respectively. Source: research findings.

independent and dependent variables. Table 4 shows the results of the bound test.

Since the calculated F statistic (5.29) is greater than the upper limit values, the presence of a long-term relationship is confirmed. The upper and lower bounds are measured by I (0) and I (1).

Estimation of Long-Term Relationship

After confirming the long-term relationship between the independent and dependent variables, the long-term NARDL model was estimated to evaluate the long-term relationship between the variables. The results of long-run NARDL are presented in Table 5.

As shown in Table 5, OPEC oil price fluctuations have a negative effect on the value added of Iran's agricultural sector, however, other factors—such as trade openness, the consumer price index, and agricultural sector employment—exhibit a positive long-term impact on the value added of Iran's agricultural sector. An increase in the value added of the agricultural sector due to the increased consumer price index can be justified due to the increasing trend of both variables (value added of the agriculture and consumer price index), over the period 1970-2019. These results are in contrast with Esmaeili *et al.* (2022) and Tarazkar and Sheikhzeinuddin (2019), in whose study oil price fluctuations had a positive effect on agricultural products price. However, our results are aligned with Dokohki and Mousavi (2018) and Shahabi *et al.* (2016).

Estimation of ECM Error Correction Pattern

Table 6 represents the results of the long-term error correction model related to the effect of oil price fluctuations and the value added of the agricultural sector.

Table 6. Estimating ECM.

Variables	coefficient	Std.error	t-statistic
D(L(agri(-1)))	0.56	0.18	0.3
D(L(agri(-2)))	0.44**	0.17	2.51
D(L(dgree))	-0.49***	0.11	-4.29
D(L(dgree(-1)))	-0.44***	0.11	-4.01
D(L(lbr))	0.5**	0.18	2.75
D(L(cpi))	-0.13	0.13	-1.02
D(L(opec_neg))	0.23***	0.04	5.2
D(L(opec_neg(-1)))	0.17***	0.03	4.9
ECM(-1)	-0.71***	0.24	-5.88
R^2 = 0.71	$\bar{R}^2$ = 0.58	D-W=2.4	

***, **, *: Denote significance levels at 1, 5 and 10%, respectively; Source: Research findings.

Table 7. The resul1ts of the Diagnostic Tests.

Autocorrelation Test (Breusch-Godfrey)			Heteroscedasticity Test (ARCH Test)		
	Statistics	Prob		Statistics	Prob
CHSQ	1.98	0.23	CHSQ	3.95	0.46
F (2,5)	10.62	0.68	F (1,21)	4.35	0.49

Source: research findings.

As shown in Table 6, the coefficient of ECM is negative and statistically significant at the 0.01 level. In addition, the value of the ECM coefficient is equal to -0.71. Based on the above-mentioned theories, the coefficient value should be between 0 and -1, which is why the result is acceptable. In other words, 0.57% of the imbalance for one period is adjusted in the next period. The adjustment speed is equal to $\frac{1}{0/71} = 1/4$. In other words, its adjustment will take approximately 17 months.

Autocorrelation and Heteroscedasticity

It is necessary to ensure that the results of the model are correct. For assurance about our model efficiency, autocorrelation and heteroscedasticity should be checked. Therefore, in Table 7 results of these tests are reported.

According to the results of Table 7, there are no autocorrelation and heteroscedasticity, which confirms the truth of the estimation model.

Model Stability Tests

In this step, in order to ensure the stability of the regression, CUSUM and CUSUMQ tests were estimated. According to theory, the estimated statistical values is drawn between two critical values at the 5% level, the null hypothesis, that discuss the regression is stable, is accepted. The results are shown in Figure 1.

According to the results shown in Figure 1, the null hypothesis is accepted and our NARDL model is stable.

DISCUSSION

Based on the results obtained from the estimates, in the long term, the degree of trade openness has a positive effect on the value added of the agricultural sector. In other words, the value added of the agricultural sector increases by 0.19% in the long term with each unit change in the trade openness. In addition, a positive relationship was observed between the value added of the agricultural sector and employment in the agricultural sector. In other words, the value added of this sector increases by 0.56% with each unit increase in employment in the agricultural sector in the long term. Further, the obtained results indicated that the

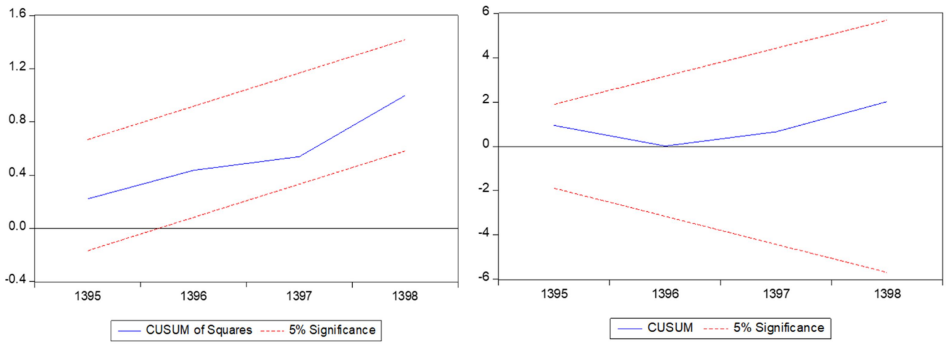

Figure 1. CUSUM and CUSUMQ Test to estimate the stability of NARDL model (Source: Research findings).

consumer price index has a positive relationship with the value added of the agricultural sector. Due to the upward trend of value added in Iran's agricultural sector over the years, as well as the growing trend of the consumer price index, such a result is not far from expected.

Moreover, there is an increasing trend between the producer and consumer price index. The consumer price index has surpassed the producer price index in some years. In general, the effect coefficient of the consumer price index is more than the producer price index. Eventually, the results of the relationship between oil price fluctuations and the value added of the agricultural sector indicated that increase and decrease fluctuations of OPEC oil prices have had the same effect on the value added of the agricultural sector in Iran, while it caused the decreased in the agricultural value added in the long term.

One of the ways of oil price fluctuations affecting the value added of Iran's agricultural sector is through clienteles of Iranian agricultural products. Persian Gulf countries are one of the main clienteles of Iran's agricultural products, and as oil exporters, they are affected by oil price fluctuations. In this way the fluctuation of oil prices has an effect on the income of those countries, as well as their purchasing power, and this will affect the amount of export and sale of Iran's agricultural products and reduce it. Due to the significance of oil in Iran's economy and its effect on the government budget through oil revenues, oil price fluctuations have caused uncertainty and risk in the revenue sources of the government. In this regard, oil price fluctuations have caused the development and support policies of the government towards the production sectors, including the agricultural sector. In other words, investing in the following infrastructure of the agricultural sector and the like has faced risk and uncertainty:

- water transfer projects, reservoirs,
- power transmission and other infrastructures,
- policies for the guaranteed purchase of agricultural products,
- guaranteed prices for agricultural products,
- technical and credit assistance,
- subsidies on production inputs

Based on the results, the following suggestions are presented:

The presence of a negative effect of both increases and decreases in oil price fluctuations on the value added of the agricultural sector in the long term shows the large effect of oil on the economy.

The agricultural sector holds significant potential for both food security and employment generation. As a stable economic sector with consistent value-added benefits, agriculture remains resilient even amid political-economic challenges. Shifting focus from oil to agriculture would provide multiple advantages: it would reduce government budget vulnerabilities caused by oil price fluctuations, strengthen domestic production capabilities, and minimize dependence on imported raw materials. This strategic transition would ultimately drive sustainable

economic development across the country. Investment in knowledge-based companies is one of the ways to transfer from traditional agriculture to mechanized agriculture. In addition, an appropriate platform for investment in the agricultural sector was provided with the help of knowledge-based companies in different fields of agriculture such as animal husbandry, agriculture, and biotechnology. Consequently, production in this sector and the value added of the agricultural sector increased, which resulted in the improved government budget and economic status.

- Since OPEC oil price fluctuations can't be controlled, the government should find a practical solution to increase the value added of the agricultural sector simultaneously with the decrease and increase of such fluctuations in the OPEC oil price, and try to prevent a decline in the value added of the agricultural sector. One of these ways is subsidies and government aid on the imported inputs and agricultural poisons, etc., to reduce the production costs of farmers and increase exports by eliminating export tariffs on agricultural products.

One of the export markets of Iran's agricultural products is the oil-exporting countries of the Persian Gulf. Fluctuations in oil can affect their purchasing power, therefore, it is suggested that agreements be concluded between Iran and the countries of the region, whereby agricultural export can be made. This would lead to higher export of agricultural goods that have a comparative advantage.

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انتقال نامتقارن نوسانات قیمت نفت بر ارزش افزوده بخش کشاورزی با استفاده از مدل NARDL و مدل GAS

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چکیده

نفت به عنوان منبع اولیه انرژی تاثیر بسزایی در ارتقای فعالیت های اقتصادی دارد. نفت بخش قابل توجهی از منابع درآمدی دولت را تامین می کند. قیمت نفت در طول سالیان متمادی به دلایل مختلف از جمله تحولات سیاسی، اجتماعی و اقتصادی کشورها همواره در نوسان بوده است. از آنجایی که قیمت نفت بر بخش‌های مختلف اقتصاد از جمله بخش کشاورزی از طریق بودجه دولت و منابع درآمدی دولت تأثیر می‌گذارد، این مطالعه به بررسی تأثیر نوسانات قیمت نفت اوپک بر ارزش افزوده بخش کشاورزی از سال ۱۹۹۰ تا ۲۰۱۹ پرداخته است. روابط طولانی مدت علاوه بر نوسانات قیمت نفت اوپک، متغیرهایی مانند شاخص قیمت مصرف کننده، اشتغال در بخش کشاورزی و درجه باز بودن تجارت در مدل مورد بررسی قرار گرفت. نتایج حاکی از تأثیر منفی نوسانات قیمت نفت اوپک بر ارزش افزوده بخش کشاورزی بود. علاوه بر این، باز بودن تجارت تأثیر مثبتی بر ارزش افزوده کشاورزی در بلندمدت داشت. نتایج حاکی از آن است که درآمد نفت یکی از مهمترین موضوعاتی است که ارزش افزوده بخش کشاورزی را کاهش می دهد و دولت باید این رابطه منفی را کنترل کند تا کشاورزی به عنوان بخش حیاتی اقتصاد توسعه یابد.