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## Article

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## The Impact of Oil Prices on the Food Inflation in Kazakhstan

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### ABSTRACT

This paper assesses empirically the effects of real oil price shocks on the food inflation in Kazakhstan for the monthly period 2004-2019 by using a VAR model. Standard unit root tests do not yield reliable results in the presence of breaks. In this regard, Zivot and Andrews (1992) has been tested with the help of unit root test. Food prices have been proven to be  $I(1)$  according to the Zivot and Andrews (1992) test, while  $I(0)$  is according to the ADF test. In subsequent steps, the causality test of the variables was performed. According to the test, there is a double-chance causality between oil prices and food prices. The short-term effect of the variables is investigated with the help of the VAR model. As a result, crude oil prices have an indirect impact on food prices.

**Keywords:** Kazakhstan, Oil Prices, Food Prices, Inflation, VAR Model, Unit-Root Test

**JEL Classifications:** E64, L66, P44, Q41

### 1. INTRODUCTION

In the last decade, food and oil price changes in the world market began to affect the socio-economic development and stability of the world countries. The most controversial of them is the increase in the agricultural commodity and food prices. Especially after the financial crisis of 2008, expansionist monetary policies followed by Central Banks (CB) of western countries, the integration of commodity markets with the financial system, and the increased demand of developing countries for key inputs contributed greatly to the increase in good and commodity prices.

Literature shows a steep increase in food prices in the international market from 2009 on, and especially after the financial crisis of 2008. Moreover, increased fertilizer, chemical goods, and energy prices also contribute to the increase in food prices. Because fertilizer and chemical goods production require big amounts of energy.

How much the oil price affects food prices? Many scientists worked on this question. Agricultural and livestock products are

especially affected by the oil price. Fertilizer, chemical goods, and transportation are inputs for agriculture and livestock production. Thus, an increased oil price causes an indirect increase in food prices.

This effect is explained with two mechanisms: the first mechanism works through increases in the input costs, and the second mechanism works through agricultural goods which are used as input in the production of alternative energy sources like biofuel. The study of Olson et al. (2014) explains the effect of the oil price on food prices with the listing of food companies in the stock market. Yet other authors also explain the effect of the oil price on food prices with the financialization.

In the study of Avalos (2014), the answer to this question is investigated through structural testing. This model consists of oil and food (corn and wheat) prices. As a result, they found a long-term relationship between oil and food prices. The study of Yanikkaya et al. (2015) is titled "Is the Food Price Inflation Transmission Rate Changed?". This study analyzed the transmission effect of oil

price on the inflation via Expanded Phillips Curve Method. They concluded that the changes in the production process in Turkey and rapid increases in oil price increase the transmission to inflation.

In their study, Abdlaziz et al. (2016) analyzed the relationship between the oil price and food prices using Non-Linear ARDL Analysis and by including variables regarding oil prices, GDP, food prices and real exchange rates. Results showed a long-term effect of the oil prices and real exchange rates on the food prices. The study of Lucotte (2016), also analyzed the relationship between oil price and food prices (wheat, meat, rice, corn, and dairy products). Results of this study showed a long-term relationship between oil price and food prices, especially after 2008.

Altıntaş (2016), in his study titled “Asymmetrical Effect of Oil Price on Food Prices: a NARDL Model Implementation for Turkey,” analyzed this effect by including variables such as food prices, oil price, energy prices, and real income. Empirical results showed a significant asymmetrical transmission from oil price to food prices. They found significant coefficients both on the negative and positive sides regarding the effect of oil price on food prices.

Scientists working on the relation between the oil price and food prices mostly prefer VAR and ARDL techniques for time series analysis. But scientists working on the long-term relationship mostly use VECM model. Recently ARCH models are preferred to estimate volatility.

Pal and Mitra (2017), have suggested that devaluates the association between crude oil prices and world food price indices, within general space and time, and then within the combined time-frequency sphere. To incorporate both the time and frequency features of the data, we used a wavelet method that has shown that the world food prices, along with the prices of cereals, vegetable oils, and sugar, co-move with and are led by crude oil prices, results that remain relevant from the short-run policy perspective. The outcome of Toda–Yamamoto causality confirmed the spillover of crude oil price changes to the world food price index also in the long run.

Baimaganbetov et al. (2019), in this study, the long-term relationship between oil price and regional real income per capita of 14 regions of Kazakhstan and 2 cities with special status has been investigated for 2008-2015 period by using Westerlund cointegration test (2007). The existence of CSD between the states that formed the panel was examined with LMadj test where deviation was corrected by Pesaran and Yamagata, and it was decided that CSD was among the regions tested in the analysis. In the analysis, the existence of unit root in the series was analyzed by using CADF test taking into account the CSD in the series and it was seen that the series were not stable at the level and became static when the first differences were taken.

## 2. FUNDAMENTAL FACTORS EFFECTIVE ON THE OIL PRICE

We can list the factors affecting the oil production under two groups. These are structural and secondary factors. Structural

factors are effective in the long-term, whereas secondary factors are more effective in the short-term (Tsoskounoglou et al., 2008).

The most important structural factor is the supply-demand equilibrium. But in the short-term, geopolitical risks, financial speculations, crises, natural disasters, and value of the dollar are more effective. But these short-term factors are transitory, not permanent (Solak, 2012).

Fundamental factors affecting the oil price are as follows (Tsoskounoglou et al., 2008):

- Global oil demand
- Current production capacity
- World’s proven reserves
- Global economic growth rate
- Exchange rate
- Investments in the oil sector
- Financial speculations
- Geopolitical risks.

### 2.1. Supply Effect

In the first quarter of the 20th century, there were 10 oil producing countries. These were USA, Russia, East India, Romania, Austria-Hungary, Japan, Canada, Germany, and Peru. Half of the total production is produced just by the USA and Russia (Zysin and Sergeev, 2008).

According to Table 1, today the majority of production is performed by a couple of countries. According to the data of BP (2019), 17.9% is being produced by the USA, 12.4% by Saudi Arabia, 12.1% by the Russian Federation, 5.9% by Canada, and 5.0% by Iraq.

We can discuss the oil-producing countries under two groups, OPEC and non-OPEC. According to the BP (2020) data, OPEC members are currently producing 37.6 % of total supply. Countries in this group are Angola, Algeria, Ecuador, Islamic Republic of

**Table 1: Crude Oil Production (by Country)**

2019 global oil production			
S. No	Country	Daily production (thousands of barrels per day)	Global share (%)
1	U.S.A.	17045	17.9
2	Saudi Arabia	11832	12.4
3	Russian Federation	11540	12.1
4	Canada	5651	5.9
5	Iraq	4779	5.0
6	The United Arab Emirates	3998	4.2
7	People’s Republic of China	3836	4.0
8	Islamic Republic of Iran	3535	3.7
9	Kuwait	2996	3.1
10	Brazil	2877	3.0
11	Nigeria	2109	2.2
12	Mexico	1918	2.0
13	Norway	1731	1.8
14	Angola	1417	1.5
15	Venezuela	918	1.0
Total			79.8

Source: BP Statistical Review of World Energy 2020

Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, and the United Arab Emirates.

## 2.2. Demand Effect

Although the demand for oil products increases every year, it is expected for the share of oil to drop among the energy consumption. This drop is caused by the increased production of clean energy, such as natural gas and renewable energy. Every country demand oil, and only some produce. Thus, we can analyze the oil demand by region, as well as OECD membership (Aydin, 2014, p. 77).

According to Table 2, daily global oil consumption in 2019 was 100.9 million barrels. According to BP (2020) data, oil demand increased by 1.1% compared to 2018. According to the table above, the biggest demand came from the Asia-Pacific region including China and India. The consumption of this region is 36.5 million barrels/day and amounts to 36.2% of global consumption. North America Region including the U.S.A. comes second. This region consumes 24,6 million barrels/day and this amounts to 24.4% of the global consumption. Europe region consumes 15,3 million barrels/day and this amounts to 15.2% of the global consumption. Middle East region consumes 9.4 million barrel/day and this amounts to 9.3% of the global consumption. Central and Southern America region consumes 6.7 million barrels/day and this amounts to 6.6% of the global consumption. Lastly, Africa region consumes 4.09 million barrels/day and this amounts to 4.1% of the global consumption.

Total daily consumption of the OECD countries is 47.4 million barrel and this amounts to 47% of the global consumption, whereas the total daily consumption of non-OECD countries is 53,5 million barrels and this amounts to 53% of the global consumption.

## 2.3. Geopolitics

Geopolitics term originally is a military term. But today the term implies the geographical interactions and consequent power struggles. The main aim of the geopolitical studies is to determine the geostrategy of nations (Khanna, 2011). The geopolitics of energy focuses on the regions with rich energy resources and analyzes supply-demand relation in the energy market, transportation of energy products, pipelines, and the surrounding geography (Avalos, 2014).

In the 19<sup>th</sup> century, the industrial revolution turned oil into a strategic product. Thus, energy producing countries gained

strategic importance. So global powers began to form strategies to control the production and transportation of this resource for their energy security. So, regions with rich oil fields gained strategical importance and a global struggle began to control these regions (Karadağ, 1991).

Energy sources are not uniformly distributed throughout the world. For a region to be defined as important in terms of energy geopolitics, that region should have the potential of supplying a significant portion of the world demand. Recent technological developments led to the discovery of new oil fields and this forces us to review the geopolitics of energy. During this review, we should remember that the geopolitics of energy includes the regions with fossil resources as well as regions used for transportation (Sevim, 2012).

Short-term events such as instability, war, and terror attacks in the oil exporting countries may limit the access of oil products to the world market and this may lead to speculations as well as volatility in oil price. Increased geopolitical risks cause a concurrent increase in insurance costs, therefore in the oil price. Hence the geopolitical risks exert medium and long-term effects on the oil price. Geopolitical risks may also cause a decrease in international investments in the affected regions. Thus, production costs in these regions rise as a result of the old technology used in the production process (Tsoskounoglou et al., 2008).

Fundamental factors affecting the food prices are as follows (Tsoskounoglou et al., 2008):

- Population growth and urbanization
- Increased consumption
- Oil price
- Oil inventory
- Changes in exchange rates
- Local policies.

## 3. METHODS

### 3.1. Zivot-Andrews Test

Zivot and Andrews (1992) criticized Perron's (1989) assumptions regarding externalities. Perron's study is based on the study of Nelson and Plosser (1982), hence used the dataset from Nelson and Plosser (1982). Perron (1989) refuted the unit root null hypothesis for the series used by Nelson and Plosser (1982) by accepting only 1 time-break. In his study, Perron (1989) accepted the Great Depression (1929), and oil price shock (1973) as externalities.

**Table 2: Daily Oil demand by region (thousands of barrels per day)**

Region	2018	2019	Difference (%)	Global Share (%)
North America	24823	24670	-0.6	24.4
Central and South America	6648	6694	0.7	6.6
Europe	15350	15311	-0.3	15.2
CIS	4158	4228	1.7	4.2
Middle East	9174	9416	2.6	9.3
Africa	3988	4098	2.8	4.1
Asia Pacific	35753	36541	2.2	36.2
Total	99894	100959	1.1	100
OECD countries	47720	47428	0.6	47
Non-OECD countries	52174	53531	2.6	53

Source: BP Statistical Review of World Energy 2020

This means that the time-break was known beforehand. Zivot and Andrews (1992) used this externality assumption as the starting point for their study. Zivot and Andrews (1992), claimed that problems arise during the pretests of Perron methodology when the breaking point is chosen based on previous observations. ZA argued that the test method they developed prevents data loss and therefore it is more appropriate than Perron test (Zivot and Andrews, 2002).

Test procedure developed by Zivot and Andrew failed to refute four null hypotheses out of ten null hypotheses refuted by the Perron method at 5% significance level. This means that the results of this method are less conclusive.

Zivot and Andrews (1992), incorporated the breaking point into their model as an internal variable unlike Perron (1989) who used it as an external variable. Unlike the Perron method, which uses the breaking point as a variable known beforehand, ZA estimated the breaking point. To estimate the breaking point, they use their data as the dependent algorithm. Therefore ZA (1992) turned the conditional unit root test of Perron (1989) based on a structural break in a known time into an unconditional unit root test (Zivot and Andrews, 2002). ZA (1992) stated that the static trend alternative hypothesis should be weighted most to estimate the breaking point.

Null hypotheses of ZA (1992) for the three models are as follows:

$$y_t = \mu + y_{t-1} + e_t$$

Here, the term  $y_t$  expresses the unit root process without a structural break in the null hypothesis. An alternative hypothesis is the one that  $y_t$  series with a static trend after a 1-time break in the trend function at an unknown time.

In their study, Zivot and Andrews (1992) followed the ADF testing procedure used by Perron (1989). They used the following regression equations in order to test the null hypothesis.

$$y_t = \hat{\mu}^A + \hat{\theta}^A DU_t(\hat{\gamma}) + \hat{b}^A t + \hat{a}^A y_{t-1} + \sum_{j=1}^k \hat{c}_j \Delta \hat{y}_{t-j} + \hat{e}_t$$

$$y_t = \hat{\mu}^B + \hat{\theta}^B t + \hat{\gamma}^B DT^*(\hat{\gamma}) + \hat{a}^B y_{t-1} + \sum_{j=1}^k \hat{c}_j^B \Delta \hat{y}_{t-j} + \hat{e}_t$$

$$y_t = \hat{\mu}^C + \hat{\theta}^C DU(\hat{\gamma}) + \hat{b}^C t + \hat{\gamma}^B DT_t^*(\hat{\gamma}) \hat{a}^B + \hat{a}^C y_{t-1} + \sum_{i=1}^k \hat{c}_i^C \Delta \hat{y}_{t-i} + \hat{e}_t$$

$$\begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} = \frac{1}{(1-b_{12}b_{21})} \begin{bmatrix} 1 & -b_{12} \\ -b_{21} & 1 \end{bmatrix} \begin{bmatrix} \epsilon_{yt} \\ \epsilon_{zt} \end{bmatrix}$$

In other words, for  $a=1$ , the value that decreases t value is selected as the breaking point. This means that the t statistic developed for the  $a=1$  null hypothesis is the smallest among all possible breaking points.

Here, let us assume  $\hat{\gamma}_{inf}^i$  model provides such a diminishing value:

$$t_{a'}^{\hat{\gamma}} = \left| \widehat{\gamma}_{inf}^i \right| = \inf_{\gamma \in \Lambda} t_{a'}^{\hat{\gamma}}(\gamma) \quad i = A, B, C$$

The critical value of  $\inf_{\gamma \in \Lambda} t_{a'}^{\hat{\gamma}}(\gamma)$  for a given dimension of the left tail test is wider (more negative) than the critical value calculated by Perron using the fixed breaking fraction value ( $\gamma$ ). The critical value of Zivot and Andrews (1992) for Model (A) is 24% wider than the critical value of Perron at the 5% significance level, whereas it is 23% wider at the 1% significance level (absolute values). A similar situation is also true for Model (B) and Model (C). Moreover, one should look to the statistical significance level of  $c_j$  coefficient in order to estimate the delay count, “k.”

In the ZA testing, we must first estimate Model (C). Then we chose the appropriate model based on the significance level of DU and DT dummy variables. If both dummy variables are found significant, then Model (C) is estimated; if only DU variable is found significant, then Model (A) is estimated; and if only DT variable is found significant, then Model (B) is estimated. Although there is no consensus on which model is more appropriate; researchers mostly prefer Model (A) and Model (C) (Jones and Olson, 2013).

In the decision phase,

$$\inf_{\gamma \in \Lambda} t_{a'}^{\hat{\gamma}}(\gamma) < k_{inf,a}$$

is taken as the unit root null hypothesis. Thus, we can say that the series has a probable structural rupture in an unknown point in time and has a static trend. (If the absolute value of the calculated t statistic is bigger than the Zivot and Andrews’s critical value, then the unit root null hypothesis is refuted).

Zivot and Andrews (1992) testing approach diverges from Perron (1989) in two aspects. First, the breaking point assumed as an externality in the Perron approach is calculated through the chosen equation in the Zivot and Andrews approach.

Another difference is that ZA approach excludes the structural break under the null hypothesis. Therefore,  $D(T_B)$  dummy variable we found in Model (A) and Model (B) is not included in the regression equations of the ZA approach.

ZA test with internal break uses the whole sample and defines a different dummy variable for every breaking point in time. Minimum t statistic of ZA has its own critical asymptotic theory and critical value. Because the critical values of ZA are more negative than the ones calculated by Perron (1989), they fail to refute the null hypothesis (Pesaran, 2007).

Standard VAR model is good at analyzing the relations in a group of economic variables. Yet VAR method has no economic background and therefore is very controversial. Therefore, results obtained from VAR method may not be applicable to the economic theory.

Therefore, we modified the VAR model as follows:

$$y_t = b_{10} - b_{12} z_t + \gamma_{11} y_{t-1} + \gamma_{12} z_{t-1} + \epsilon_{y_t}$$

$$z_t = b_{20} - b_{22} y_t + \gamma_{21} y_{t-1} + \gamma_{22} z_{t-1} + \epsilon_{z_t}$$

This equation is the structural representation of VAR model. In order to reduce the equation, we calculated the following equations:

$$y_t + b_{12} z_t = b_{10} + \gamma_{11} y_{t-1} + \gamma_{12} z_{t-1} + \epsilon_{y_t}$$

$$b_{21} y_t + z_t = b_{20} + \gamma_{21} y_{t-1} + \gamma_{22} z_{t-1} + \epsilon_{z_t}$$

When this equation is expressed with the reduced coefficient, we reach to the following equation:

$$y_t = b_{10} + \gamma_{11} y_{t-1} + b_{12} (b_{20} + b_{21} y_t) + \gamma_{12} z_{t-1} + \epsilon_{y_t}$$

$$z_t = b_{20} + b_{21} (b_{10} + \gamma_{11} y_{t-1} + b_{12} z_{t-1} + \epsilon_{y_t}) + \gamma_{22} z_{t-1} + \epsilon_{z_t}$$

$$y_t = a_{10} + a_{11} y_{t-1} + a_{12} z_{t-1} + e_{1t}$$

$$z_t = a_{20} + a_{21} y_{t-1} + a_{22} z_{t-1} + e_{2t}$$

Dependent variables,  $e_{1t}$  and  $e_{2t}$ , calculated from these equations are the estimation errors for the next period. When VAR model is used for estimation, estimation errors are not significant. If information that is more detailed is needed and our aim is to estimate the future, then we use:

$$\begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} = \frac{1}{(1 - b_{12}b_{21})} \begin{bmatrix} 1 & -b_{12} \\ -b_{21} & 1 \end{bmatrix} \begin{bmatrix} \epsilon_{y_t} \\ \epsilon_{z_t} \end{bmatrix}$$

### 3.2. DataSet

In this test, we used monthly values between 2004:01 and 2019:12. Data is collected from the Kazakhstan Central Bank database and EIA database. Food prices are based to 2010 prices (100) and seasonality is removed. Lastly, volatilities caused by exchange rate and seasonal changes are removed from the oil price.

### 3.3. Unit Root Tests

In this study, we performed two unit root tests. These are the expanded Dickey Fuller, Zivot and Andrews (1992) tests.

As seen above in Table 3, food prices look static according to the results of normal ADF unit root testing. Nevertheless, ZA unit root testing showed a contrary result. This may be explained with the break in 2007.

According to Table 4 above, integration order of the variable oil price is I (1). In other words, oil price variable contains unit root and its first order difference is taken, it becomes static.

Figure 1, above, shows the response of food prices to an oil price shock. As seen in the figure, there is a significant positive relationship between the oil price and food prices in the first two periods. This proves a positive relationship between these variables. As a result, we can foresee that oil price and food prices move in the same direction. In other words, if oil price rises so food prices. This relation loses its significance in the following periods, so this means that an oil price shock is effective on food prices just for 4 months.

Figure 2, shows the response of the oil price to food prices. As seen in the figure, there is a significant positive relationship between the oil price and food prices in the first three periods. This proves a positive

Figure 1: The response of food prices to the oil price

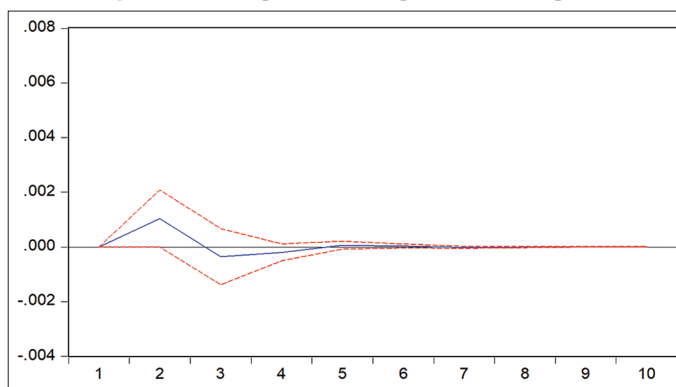


Table 3: Results of unit square testing

Variables	ADF test		Zivot-Andrews test	
	Statistics	Probability	Statistics	Probability
Food prices				
Intercept	-5.471	0.000	-6.097	0.165
Trend and intercept	-5.472	0.001	-5.552	0.4132
None	0.0367	0.6923	-7.723	0.731

Source: Calculated by authors

Table 4: Results of unit root testing

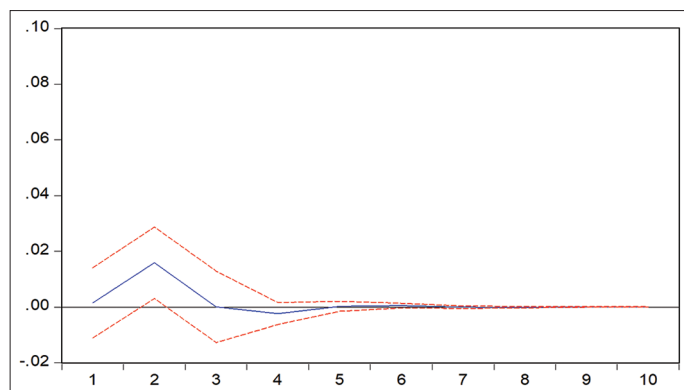
Variables	ADF test		First difference	
	Statistics	Probability value	Statistics	Probability value
Oil Prices				
Intercept	-1.222	0.662	-1.222	0.662
Trend and Intercept	-2.688	0.244	-2.688	0.244
None	-0.042	0.666	-0.042	0.666

Source: Calculated by authors

**Table 5: Results of the variance differentiation**

Period	S.E	Food prices	Oil price
1	0.006207	100.0000	0.000000
2	0.007613	98.03829	1.961714
3	0.007972	96.52257	3.477430
4	0.008035	95.89424	4.105764
5	0.008042	95.73957	4.260426
6	0.008044	95.72125	4.278749
7	0.008045	95.72207	4.277926
8	0.008045	95.72214	4.277857
9	0.008045	95.72166	4.278336
10	0.008046	95.72140	4.278601

Source: Calculated by authors

**Figure 2: The response of the oil price to food prices**

relationship between these variables. As a result, we can foresee that oil price and food prices move in the same direction. This relation loses its significance in the following periods, so this means that an oil price shock is effective on food prices just for five months.

According to Table 5 above, all variations in food prices in the first period can be explained by itself. This ratio proves that food prices variable is external. As the number of periods increase, explanatory power diminishes and becomes static after the 4th period. After the 4th period, the oil price can only explain 4% of the variability in food prices.

## 4. CONCLUSION

Oil is a strategic product as it is used in many sectors such as transportation and energy. Hence, any change in the oil price affects the macroeconomic indicators of both exporting and importing countries such as growth, exchange rate, and inflation. These affects may vary according to the development level of the relevant country and her status as an exporter or importer.

The effect of oil price changes on food price is explained with two mechanisms: The first mechanism works through the increased input costs and the second one works through the increased demand to the agricultural products used as inputs for alternative energy production.

Scientists working on the relation between the oil price and food prices mostly prefer VAR and ARDL techniques for time series analysis. On the other hand, scientists working on the long-term

relation mostly prefer the VECM model. But recently ARCH models gained popularity to calculate the volatility.

We can list the factors affecting the oil production under two groups. These are structural and secondary factors. Structural factors are effective in the long-term, whereas secondary factors are more effective in the short-term. The most important structural factor is the supply-demand equilibrium. But in the short-term, geopolitical risks, financial speculations, crises, natural disasters, and value of the dollar are more effective. But these short-term factors are transitory, not permanent.

Results show a significant positive relationship between the oil price and food prices in the first two periods. This proves a positive relation between these variables. As a result, we can foresee that oil price and food prices move in the same direction. In other words, if oil price rises so food prices. This relationship loses its significance in the following periods, so this means that an oil price shock is effective on food prices just for 4 months.

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