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RELATIONSHIP BETWEEN ENERGY AND FOOD PRICES IN THE EURO AREA

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Abstract. Over the past five years, global economic developments have been accompanied by a number of challenges. After a period of economic development, the global economy is facing a significant challenge caused by the COVID-19 crisis. There have been factory closures, border closures and supply chain disruptions. All this is reflected in the EU and the euro area. This was followed by a period of recovery and accelerating inflation. The war on the territory of Ukraine is also having a significant impact on inflationary processes. This further jeopardises the supply of energy resources and their prices begin to rise at a very high rate. The shock of rising energy prices has also been reflected in sharp increases in food prices. In the euro area, there have been periods when food prices have risen by more than 17% on an annual basis and energy products by almost 60% in some months. All these developments highlight the need to examine the links between energy and food prices. This is necessary in order to be able to take quick decisions in the event of new volatility in energy prices. The aim of the study is to establish a causal relationship between the dynamics of energy and food prices and the time lag over which food prices react to increases in energy prices. A correlation analysis is carried out and a causal relationship between the two indicators is established by regression analysis at different time lags. The hypothesis tested is that, over the last five years, there has been a strong month-to-month correlation between energy prices and food prices with a lag of six months. For the purpose of regression analysis and hypothesis testing, monthly data for food inflation and inflation for the group Electricity, gas and other fuels have been used. The data are taken from the structure of the Harmonised Index of Consumer Prices published by Eurostat. The detailed regression analysis shows that there is a statistically significant linear relationship between the price indices of the two product groups with a lag of six months. The Granger causality test confirms the results of the dynamic, correlation and regression analysis. The results of the test show not only the existence of a causal relationship, but also the ability of energy price changes to predict food price dynamics. All this leads to the conclusion that in periods of significant changes in energy prices, food prices can be expected to follow similar dynamics within six months. This relationship could be used both for forecasting and for taking specific economic measures.

Keyword: food prices, energy prices, causal relationships.

JEL Classification: C13, E31, E37, O13

1. Introduction

Over the past five years, the global economy has faced a number of significant challenges. The emergence of the COVID-19 pandemic has brought to the fore the issue of meeting the food needs of the population. In parallel, a number of supply chains have been disrupted, borders closed and the free movement of goods restricted, with factories being shut down. These processes are also having a direct impact on the economies of the euro area. The recovery of the economies from the COVID-19 pandemic has been accompanied by inflationary processes that are not being contained by the central banks. Moreover, the European Central Bank initially adopted a considerably more cautious approach to inflation-fighting measures than the US Federal Reserve (Borisova, 2021). During the recovery of economies from the COVID-19 pandemic, there was a notable surge in energy prices. This trend was followed by rising food prices. This negative process intensified after the start of the war in Ukraine. During this period, energy commodity indices reached historic highs. Prices for natural gas, petroleum products and electricity have been rising since the start of the war in Ukraine, with average increases in the euro area reaching 60% year-on-year in some months. Food prices have

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followed a similar trend, rising by more than 17% in some months. The consequences of the war on the territory of Ukraine are not only felt in Europe, but also globally. For example, according to the World Bank, in the immediate aftermath of the conflict, natural gas prices rose by 30% and coal prices by 60%. Wheat prices rose by around 40%. All these processes, combined with the collapse of European logistics systems, are also leading to a sharp rise in food prices. As a result of higher energy prices and other factors, such as the collapse of many European logistics systems, the prices of basic foodstuffs are rising rapidly. At the same time, some of the major euro area economies are beginning to experience difficulties, with slower economic growth and even quarters of contraction in real GDP. The second half of the year has also been characterised by a renewed rise in oil product prices, after an initial significant moderation. All this calls for an examination and analysis of the interrelationships between the prices of the most expensive commodity groups over the past five years. The correlation between energy prices and food prices is particularly relevant in the eurozone, where the most developed European economies are concentrated. In addition, energy prices can serve as a basis for predicting food price dynamics.

The aim of the study is to analyse the existence of correlation and causal links between energy and food prices.

The thesis is that over the past five years, there has been a strong month-to-month correlation between annual changes in energy and food prices. There are significant causal relationships between changes in energy and food prices with a lag of six months. Based on this information, and in the case of significant changes in energy prices, it is possible to forecast the dynamics of food prices and develop specific economic measures and policies.

2. Literature Review

There are several studies analysing the relationships and linkages between energy and food prices. The causal relationship between energy prices and food prices has been studied and was of great interest during and after the 2008 economic crisis. For example, Toda-Yamamoto causality, Fourier Toda-Yamamoto causality and BC spectral causality tests have been used (Kirikkaleli & Darbaz, 2021). The relationship between energy and food prices over the period 2000-2016 is analysed using panel VAR for eight Asian economies. The results confirm that energy prices have a significant impact on food prices. According to the results, there is an impulse response with food prices responding to each shock (Taghizadeh-Hesary et al., 2019). The COVID-19 pandemic has been analysed for temporal spillover effects between food and crude oil markets. The spillover effects between food and crude oil markets under the influence of COVID-19 are examined (Cao & Cheng, 2021). The impact of the COVID-19 pandemic on global energy commodity prices and their interaction with global food commodity prices is further studied. Using World Bank data on commodity prices, evidence is sought for changes in energy and food prices induced by the onset of the COVID-19 pandemic, which is assumed to be a negative supply and demand shock to the world economy. A time series analysis of world energy and food price indices following the onset of the COVID-19 pandemic shows that energy and food prices fall (Figiel et al., 2023). The links between food and energy prices following the Russia's invasion of Ukraine have also been examined. While tensions in food supply chains are caused by many factors, the link with the global energy crisis has not been ignored. In particular, the disruptions caused by the war on Ukrainian territory have drawn attention to the interconnectedness of global energy and food supply chains (Levi & Molnar, 2022). The effects of price volatility and the links between food and energy prices are felt globally. Additionally, a link has been established between the rapid rise in food prices, which is a catalyst for inflation worldwide. This is evident from recent trends in economic data (Barrett, 2022). The relationship between energy and food prices is examined using an empirical test. This approach shows that energy prices have a significant impact on food prices. According to the results of the impulse response functions, agricultural food prices react positively to any increase in the price of oil. Furthermore, variance decomposition shows that oil prices account for most of the volatility in agricultural food prices. Changes in oil prices account for a large part of the dispersion in food prices (Rasoulinezhad et al., 2023).

3. Methodology

Official, publicly available statistics published by Eurostat for the euro area are used to analyse the causal relationship between energy and food inflation. In particular, monthly Harmonised Index of Consumer Prices (HICP) data on an annual basis (annual rate of change) are used. In this article, energy price inflation refers to the group Electricity, gas, solid fuels and heating, which is part of the Classification of Individual Consumption According to Purpose (COICOP). From the same classification, the line for the annual rate of change for food is also used. The period considered is from January 2019 to April 2024. This period includes the pre-crisis state of the economy before the COVID-19 pandemic, as well as the entire period of restrictive measures imposed on businesses and individuals during the pandemic. It includes the period of recovery from the pandemic as well as the accelerated price growth before and after the war in Ukraine. The statistical information used is the Harmonised Index of Consumer Prices (HICP) as defined in Regulation (EU) 2016/792 of the European Parliament and of the Council of 11 May 2016.

To analyse the correlation between the annual rate of inflation by month for energy products and the inflation rate for food, the linear correlation coefficient is tested by shifting the months. This is done in order to find the highest value of the linear correlation coefficient at different lags. The tests of correlation at different monthly lags provide information on the ability of energy inflation to predict food inflation. The Pearson coefficient is used for this purpose. After finding the highest value of the correlation coefficient between the energy and food inflation series, a regression analysis is carried out. The aim of the regression analysis is to establish the existence of a causal relationship and also the existence of a functional relationship between the two indicators. The study also seeks to reject the so-called null hypothesis, i.e., that there is no causal relationship between energy inflation and food inflation. Furthermore, the statistical significance of the causal relationship between the two indicators is analysed for the period January 2019 – April 2024. Furthermore, after using dynamic analysis, correlation and regression analysis, the causal relationship is explored through Granger causality test. This approach confirms the results of the regression analysis and proves that energy inflation has predictive power with respect to food inflation, with the appropriate lag of months.

4. Results and Discussion

4.1. Correlation Relationships

To analyse the strength of the correlation between energy inflation and food inflation between January 2019 and April 2024, the Pearson coefficient is tested by starting the study of the month-to-month relationship and continuing by shifting the series by one month until the highest correlation coefficient is reached. Once the lag with the highest correlation is found, the same lag is then used in the regression analysis of the functional relationship between the two inflation indicators.

The results show that there is a very strong correlation between the monthly HICP (y/y) for energy products (electricity, gas, solid fuels and thermal energy) and the same index for food. The Pearson's coefficient increases with increasing monthly lags when comparing the series and reaches a maximum of 0.9439 at a lag of 6 months. Therefore, a lag of 6 months is used in the next part of the study.

The very high values for the linear Pearson correlation between energy inflation and food inflation are confirmed by the dynamic analysis of the two indicators with a lag of 6 months. The dynamic analysis shows that the two indicators follow the same dynamics, with energy inflation (electricity, gas, solid fuels and heating energy) leading food inflation by 6 months. Once the time lag is imposed on the time series, they follow a similar trend and maintain relatively constant values before the start of the COVID-19 pandemic. After the peak of the pandemic and the administrative

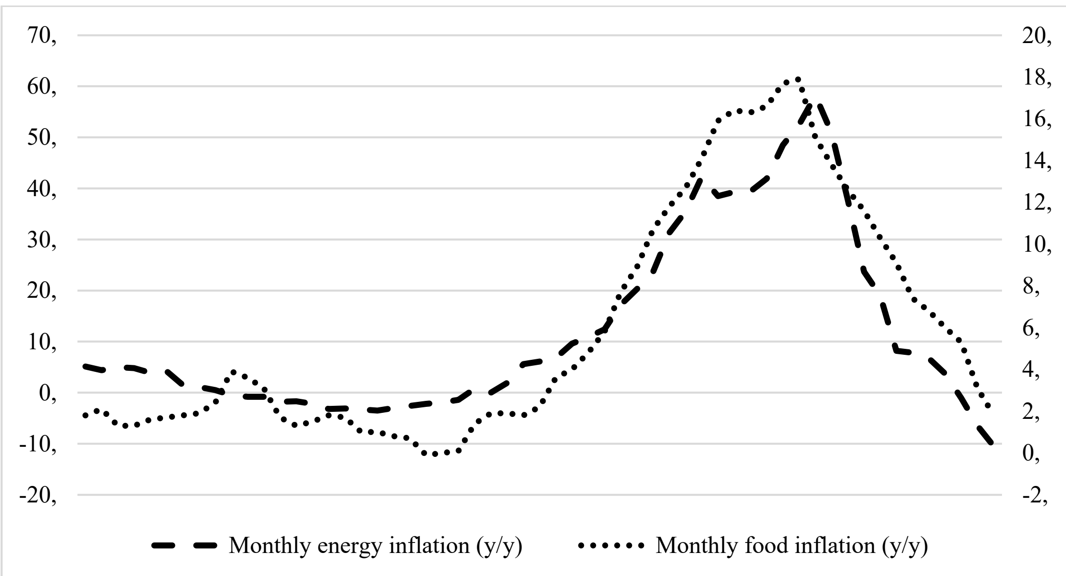

Figure 1. Monthly energy inflation (t-6) and monthly food inflation, (y/y)

Source: Eurostat, own calculation

restrictions on economic activity, energy and food prices fall. The recovery from the COVID-19 pandemic was accompanied by an increase in both indicators, again with a lag of 6 months. The beginning and the first months of the war on the territory of Ukraine led to a peak in energy prices, followed within 6 months by a peak in food prices. Although food and energy products belong to different product groups, the dynamics are very similar with a lag of 6 months and, in fact, the dynamics of energy product prices can be used as a forecast for the dynamics of food prices.

Table 1
Coefficient of linear correlation (Pearson)

Monthly food inflation (y/y)	Monthly energy inflation (y/y)	Linear correlation coefficient
month – t	month – t	0.5188
month – t	month – t-1	0.6230
month – t	month – t-2	0.7106
month – t	month – t-3	0.8013
month – t	month – t-4	0.8704
month – t	month – t-5	0.9189
month – t	month – t-6	0.9439
month – t	month – t-7	0.9438
month – t	month – t-8	0.9202
month – t	month – t-9	0.8791

Source: Eurostat, own calculation

The results of the correlation analysis between the two indicators show that there is a very strong correlation of 0.9439 with a lag of 6 months. The high value of the Pearson's correlation coefficient requires a detailed regression analysis to establish whether there is a causal relationship between energy prices and food prices. A detailed analysis will also answer the question of whether energy inflation can be used as an indicator of expected food price increases. To do this, it is also necessary to reject the hypothesis that there is no causal relationship between energy inflation and food inflation.

4.2. Regression Analysis

The Regression function was used to conduct the regression analysis, and the relevant indicators were interpreted accordingly. The results of the study between monthly energy inflation in annual terms as a factor (variable X) and food inflation as a dependent variable according to the methodology are presented in Table 2.

– According to the results of the regression analysis, the Pearson's correlation coefficient (Multiple R) is 0.9439, which indicates a strong relationship between energy inflation as a factor (variable X) and food inflation as a dependent variable.

– 89.1% of the variation in food inflation is explained by the variation in food inflation. This is because the model shows that R2 (R square) is 0.8909.

– Adjusted R2 (R Square) is 0.8889.

– The standard error of the model is 1.8603. This means that in the regression model, the observed values deviate from the regression line by 1.86 units over 57 observations on average.

– The significance of F is 3.92651E-28. This indicates that the functional relationship between energy and food inflation is statistically significant at the specified confidence level of 0.05. The value of this indicator is extremely low and it also indicates that the regression model is statistically significant.

– The coefficients in the regression equation show that the relationship between energy and food inflation using monthly data and annual changes can be represented by the following formula:

Yt = 2.3643+0.2940*Xt-6, in which:

Y is monthly Harmonised Index of Consumer Prices (HICP) on an annual basis (annual rate of change) for the food;

X monthly Harmonised Index of Consumer Prices (HICP) on an annual basis (annual rate of change) for the group electricity, gas, solid fuel and thermal energy;

– t is the month with published food inflation.

– According to the model, the intercept in the function is (2.3643), and the corresponding P-value is 1.00785E-10<0.05, which means that the intercept is statistically significant.

– The coefficient before the factor (X) is 0.2940. The coefficient is statistically significant at the 0.05 level of significance (P-value = 0.0028 < 3.92651E-28).

The pooled and aggregated results of the regression analysis show that there is a statistically significant causal relationship between energy inflation and food inflation with a lag of 6 months. The relationship can be expressed by a linear equation using the data for energy inflation, which is reflected in food inflation after 6 months. The overall model also shows that 89.1% of the variance in food inflation can be explained by the variance in energy inflation. Moreover, the coefficients obtained in the regression equation are also statistically significant.

4.3. Granger Causality Test

The results of the Granger causality test for energy and food inflation are shown in Table 3.

Table 3
Granger causality test

	F-Statistic	Prob.
The HICP (y/y) for the electricity, gas, solid fuel and thermal energy group (month – t-6) does not cause the Granger HICP (y/y) for the food group (month – t)	5,79291	0,0002

Source: Eurostat, own calculation

Table 2
Regression function results from the data analysis package

SUMMARY	OUTPUT								
Regression	Statistics								
Multiple R	0.9439								
R square	0.8909								
Adjusted R square	0.8889								
Standard error	1.8603								
Observations	57								
ANOVA									
	df	SS	MS	F	Significance F				
Regression	1	1554.338	1554.338	449.130	3.92651E-28				
Residual	55	190.343	3.461						
Total	56	1744.680							
	Coefficients	Standard error	tStat	P-value	Lower 95%	Upper 95%		Lower 95%	Upper 95%
Intercept	2.3643	0.2969	7.961	1.00785E-10	1.769	2.959		1.769	2.959
X Variable 1	0.2940	0.0138	21.193	3.92651E-28	0.266	0.321		0.266	0.322

Source: Eurostat, own calculation

The Granger causality test carried out is based on the null hypothesis that energy inflation does not affect food inflation. The test rejects the null hypothesis with the greatest strength at a lag of 6 months. This means that the monthly HICP on an annual basis for energy products can be used to predict the dynamics of the same index for food with a lag of 6 months. In this context, the results of the dynamic and regression analysis presented, as well as the established causal relationship between energy and food inflation, are confirmed by the Granger test. In particular, the Granger test proves that energy price inflation is useful for predicting food inflation 6 months ahead.

5. Conclusions

The study provides an overview of the pre-pandemic period, the pandemic period and the recovery of the euro area economy. It also analyses the period of rising inflation after the pandemic, as well as the peaks in price growth induced by the war on the territory of Ukraine and the subsequent calming of inflationary processes. The period analysed is from the beginning of 2019 to April 2024. The period is characterised by different types of crises affecting the euro area economy and, in particular, by significant deviations in energy and food prices. The existence of this type of crisis also leads to the identification of indicators that can serve as an early warning of food price dynamics and can also be used to take the necessary economic policy measures. Over the period under review, there is a very strong correlation between energy inflation and food inflation, with this correlation peaking with a lag of 6 months. Correlation and dynamics analyses show that there is a relationship between the two indicators. Moreover, energy inflation has similar dynamics to food inflation with a 6-month lag. The detailed regression analysis shows that there is a statistically significant linear relationship between the monthly harmonised HICP for energy products on an annual basis and the similar index for food products with a lag of 6 months. The regression analysis also shows that 89.1% of the variance in food inflation can be explained by the variance in energy inflation 6 months earlier. Based on the statistically significant regression model, a functional relationship between energy inflation and food inflation is also inferred. The results of the Granger causality test confirm the results of the regression analysis with a lag of 6 months between the two indicators. In addition, the Granger test also shows that food inflation is able to predict 6-month food inflation in the euro area. All this suggests that, in times of crises that have had a strong impact on economies and price dynamics, energy inflation can be used as an early warning of impending food inflation and thus as a basis for action by euro area governments.

References:

Barrett, P. (2022). How food and energy are driving the global inflation surge. IMF. Sept, 12.

Borisova, G. M. (2021). Comparative Study of Major Central Bank's Monetary Policy in Response to the Pandemic Crisis. *Finance, Accounting and Business Analysis (FABA)*, Vol. 3(2), p. 96–106.

Cao, Y., & Cheng, S. (2021). Impact of COVID-19 outbreak on multi-scale asymmetric spillovers between food and oil prices. *Resources Policy*, 74, 102364.

Figiel, S., Floriańczyk, Z., & Wigier, M. (2023). Impact of the COVID-19 Pandemic on the World Energy and Food Commodity Prices: Implications for Global Economic Growth. *Energies*, 16(7), 3152.

Kirikkaleli, D., & Darbaz, I. (2021). The causal linkage between energy price and food price. *Energies*, 14(14), 4182.

Levi, P., & Molnar, G. (2022). How the energy crisis is exacerbating the food crisis. Available at: www.policycommons.net

Rasoulinezhad, E., Taghizadeh-Hesary, F., & Yoshino, N. (2023). Volatility linkages between energy and food prices. In The Handbook of Energy Policy (pp. 715–738). Singapore: Springer Nature Singapore.

Taghizadeh-Hesary, F., Rasoulinezhad, E., & Yoshino, N. (2019). Energy and food security: Linkages through price volatility. *Energy policy*, Vol. 128, p. 796–806.

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