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LIQUID FUEL PRICES AND THEIR IMPACT ON FOOD INFLATION IN BULGARIA

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Abstract. In recent years, food inflation has become one of the major economic challenges, affecting households and economic policy across Europe. Developments in energy markets are among the factors contributing to rising food prices and have attracted increasing attention. Liquid fuels are a vital part of transport, agriculture and distribution, so changes in their prices are a key factor in food costs. Geopolitical tensions in the Middle East and concerns about the security of oil shipments through the Strait of Hormuz, one of the world's most important energy transit routes, have added to this uncertainty. These events have increased volatility in the global oil market and influenced the price of liquid fuels in Bulgaria. This study examines the relationship between the consumer price indices for liquid fuels and food in Bulgaria. Using monthly data, the analysis employs dynamic, correlation, and regression methods to evaluate whether a causal relationship exists between the two indicators. The empirical results reveal a statistically significant linear relationship, providing evidence that changes in liquid fuel prices are followed by corresponding movements in food prices. The strongest relationship is observed at an eight-month lag. These results confirm the significance of fuel price developments in influencing food inflation, suggesting that fuel price indicators could be a valuable tool for anticipating future inflationary pressures in the food sector.

Keywords: liquid fuel prices, food prices, causal relationship.

JEL Classification: C13, E31, E37, Q41, Q43

1. Introduction

Food inflation is one of the most significant economic challenges facing Bulgarian households and policymakers. Food products account for a large proportion of household spending, so changes in food prices have a significant impact on living standards, purchasing power and social welfare. Over the past decade, Bulgaria has experienced several periods of heightened inflationary pressure associated with global and domestic economic developments. More recently, inflation has been driven by supply chain disruptions, the consequences of the COVID-19 pandemic, the war in Ukraine, and growing geopolitical uncertainty in the global energy market. Similar developments have been observed in Central and Eastern European countries, where post-pandemic recovery has been accompanied by accelerating inflation, expansionary monetary policies, and growing economic uncertainty. In addition to the consequences of the Covid-19 crisis, the outbreak of war in Ukraine has posed new challenges to economic stability and sustainable growth in the region (Mihaylova-Borisova, 2023). Among the factors influencing food prices, liquid fuel prices occupy a central position. Fuel is essential for agricultural production, as well as for transportation, storage and distribution activities. Consequently, significant changes in fuel prices can impact the final prices of food products via multiple channels. This relationship has become increasingly important during periods of elevated volatility in the energy market. Recent geopolitical tensions in the Middle East and concerns about the security of oil transportation through the Strait of Hormuz have further exacerbated the uncertainty in the global petroleum market. The Strait of Hormuz is one of the world's most important oil transit routes, so any disruption to shipments may lead to substantial increases in fuel prices and generate additional inflationary pressures. The importance of this issue is highlighted by recent events in Bulgaria. According to Eurostat data, fuel prices for personal transport in Bulgaria increased by 34.1% year on year in May 2026, while the country recorded one of the highest inflation rates in the European Union. In May 2026, annual HICP inflation reached 6.3%, with food prices and transport-

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related expenditure continuing to rise substantially. These developments underscore the necessity of examining the transmission mechanism between liquid fuel prices and food inflation (EUROSTAT, 2026). The period under review saw the highest annual inflation in food prices recorded in October 2022, when it reached 27.4%. The most significant escalation in inflation of liquid fuel prices, as indicated by the harmonised consumer price index, was documented in June 2022, at 59.7%.

The objective of this study is to analyse the existence of correlation and causal relationships between liquid fuel prices and food inflation in Bulgaria. The analysis is based on monthly data for the period from January 2015 to May 2026, and employs dynamic correlation and regression analysis. The present study examines the relationship between the consumer price index for liquid fuels and the consumer price index for food.

The main thesis is that there is a statistically significant causal relationship between the price of liquid fuels and food inflation in Bulgaria. Specifically, changes in liquid fuel prices precede changes in food prices by eight months. Identifying such a relationship would provide valuable opportunities for forecasting food inflation and developing timely economic policies to mitigate the effects of future energy price shocks.

2. Literature Review

The relationship between energy prices and inflation is a topic of significant interest in economic literature, particularly during periods of volatility in the commodities market. Fuel price shocks have been found to generate long-lasting inflationary effects, particularly in developing economies. However, studies based on crude oil prices tend to underestimate the pass-through of inflation compared to analyses using retail fuel prices (Kpodar & Liu, 2022). These findings emphasise the importance of examining the impact of final fuel prices on consumer prices. The interconnections between the energy and food markets have also been widely studied. Notably, significant spillover effects have been identified between oil and food commodity markets, particularly during periods of heightened economic uncertainty, such as during the COIVD-19 pandemic (Cao & Cheng, 2021). The results suggest that developments in the oil market can influence the food commodity market via various channels, with these effects being most pronounced in the short term. Several studies have examined the direct impact of fuel prices on food prices. One study found that positive gasoline price shocks led to statistically significant increases in aggregate food prices, as well as in the prices of individual food categories (Diab & Karaki, 2023). The same study shows that higher fuel prices lead to increased costs of fertiliser and animal feed, which subsequently raises food production costs. Historical analysis confirms that increases in fuel prices have contributed to food price growth during major periods of economic disruption, including the conflict between Russia and Ukraine. Research conducted in developing countries further confirms the importance of fuel and fertiliser costs for food systems. The results demonstrate that agrifood systems are particularly susceptible to price hikes in these areas and that such price hikes have substantial ramifications for poverty and food security (Arndt et al., 2023). A similar conclusion was reached in a study of fertiliser markets in Kenya, which observed substantial fertiliser price increases during the 2020–2022 fuel-fertiliser-food crisis (Willwerth et al., 2025). The authors found evidence of asymmetric price transmission, whereby fertiliser prices responded more quickly to increases than to decreases in import prices. These findings suggest that fuel-related shocks impact agricultural production costs and generate additional inflationary pressures within food supply chains. Another important transmission channel is associated with logistics and transportation costs. Food supply chains depend heavily on transportation, warehousing, and distribution activities, all of which are directly impacted by fuel prices. Cost function modelling shows that logistics-related costs are among the most important factors influencing overall food industry costs and the competitiveness of food producers and distributors (Popa et al., 2025). Consequently, increases in liquid fuel prices may be passed on to consumers in the form of higher food prices due to increased transportation and distribution costs. The broader economic implications of shocks to food and fuel prices have also been examined. While both types of price shock generate stagflationary effects and reduce household purchasing power, food price increases tend to have a stronger impact on lower-income households (Bhattarai et al., 2025). These findings highlight the economic and social importance of understanding the factors that determine food inflation. Several studies have focused specifically on the causal relationship between energy and food prices. Research based on volatility analysis shows that increases in oil prices lead to higher agricultural food prices, and that oil prices account for a significant proportion of food price volatility (Rasoulinezhad et al., 2023). Further evidence is provided by causality analyses, which reveal bidirectional causal relationships between energy prices and different food price categories, including grains, oils and other food products (Kirikkaleli & Darbaz, 2021). The findings indicate a robust correlation between energy and food markets, underscoring the significance of fluctuations in energy prices in elucidating food price trends.

The transmission of energy price shocks to food inflation has also been investigated directly. Empirical evidence for the euro area indicates that both food and energy price shocks have a statistically significant and persistent impact on food inflation (Borrallo et al., 2026). The estimated effects gradually intensify over time and reach their maximum approximately twelve months after the initial shock. The study also found evidence of asymmetric transmission, with price increases having a stronger effect on food inflation than price decreases.

There is relatively little evidence for Bulgaria. One study examining the relationship between producer and consumer food prices in Bulgaria found a statistically significant causal relationship between the two (Borisov, 2022). The results demonstrate that changes in producer food prices are rapidly reflected in consumer food prices, emphasising the importance of identifying the factors that influence production costs and food inflation.

The reviewed literature provides substantial evidence of a relationship between energy and food prices. Existing studies demonstrate that fuel price shocks affect food markets through various channels, such as fertiliser costs, transportation expenses and agricultural production costs, as well as broader inflationary processes. However, most empirical research focuses on global commodity prices, aggregate energy indices, or large cross-country samples. There is limited evidence regarding the relationship between liquid fuel prices and food inflation at the national level, particularly in Bulgaria. Furthermore, few studies examine the time lag through which changes in fuel prices are transmitted to consumer food prices.

3. Methodology

The analysis of the relationship between liquid fuel prices and food inflation is based on official statistical data published by Eurostat for Bulgaria. More specifically, the study uses monthly Harmonised Index of Consumer Prices (HICP) data, measured as annual rates of change. Food price dynamics are represented by the annual rate of change of the HICP for 'Food', while fuel price dynamics are represented by the annual rate of change of the HICP for 'Liquid fuels and fuels and lubricants for personal transport equipment'. Both indicators form part of the Classification of Individual Consumption by Purpose (COICOP) and are published within the framework of the Harmonised Index of Consumer Prices, as set out in Regulation (EU) 2016/792 of the European Parliament and of the Council of 11 May 2016. The period under consideration extends from January 2015 to May 2026. This timeframe encompasses several significant economic and geopolitical events that have impacted fuel and food prices. These include the period before the pandemic, the pandemic itself and its impact on global supply chains, the subsequent economic recovery, the subsequent inflationary shock following the war in Ukraine and the recent increase in uncertainty in the global energy market due to geopolitical tensions in the Middle East and concerns about transporting oil through the Strait of Hormuz. The long observation period enables the analysis to capture the various phases of the economic cycle and episodes of commodity price volatility. To identify the strongest relationship between liquid fuel and food inflation, the monthly time series are shifted sequentially by different time lags. This procedure aims to establish the time period after which changes in liquid fuel prices are most strongly reflected in food price dynamics. Pearson's linear correlation coefficient is then used to evaluate the strength of this relationship at each lag. The lag associated with the highest statistically significant correlation coefficient is considered the most appropriate period for analysing the transmission mechanism between the two indicators. Following the correlation analysis, a dynamic analysis of the two time series is performed to examine their co-movement over time, identifying periods of accelerated growth and decline. Particular attention is paid to significant inflationary periods and their impact on the two price indices. Having identified the optimal lag structure, a regression analysis is conducted to examine the causal relationship between liquid fuel inflation and food inflation. This estimates the extent to which changes in liquid fuel prices can explain subsequent changes in food prices. The analysis also evaluates the statistical significance of the estimated coefficients and the model's explanatory power. The existence of a statistically significant functional relationship would suggest that changes in fuel prices could be used to predict future food inflation. In addition to correlation and regression analyses, the study employs the Granger causality test. This test determines whether past changes in liquid fuel prices provide additional information for predicting food inflation. The test provides further insight into the direction of causality, complementing the results obtained from dynamic, correlation and regression analyses. The study's main hypothesis is that there is a statistically significant causal relationship between liquid fuel inflation and food inflation in Bulgaria. More specifically, the study examines whether changes in the annual inflation rate of liquid fuels and lubricants for personal transport equipment predict changes in food inflation. The null hypothesis states that there is no statistically significant causal relationship between the two indicators.

4. Results and Discussion

4.1 Correlation Relationships

To identify the strongest relationship between liquid fuel and food inflation in Bulgaria, the Pearson linear correlation coefficient was calculated by progressively shifting the time series of the two indicators. The analysis uses monthly data covering the period from January 2015 to May 2026. The annual rate of change of the Harmonised Index of Consumer Prices (HICP) for food is compared with the annual rate of change of the HICP for liquid fuels and fuels and lubricants for personal transport equipment. The fuel inflation series is successively shifted by one-month intervals to determine the period after which changes in fuel prices are most strongly reflected in food price dynamics. Once the lag associated with the highest correlation coefficient has been identified, this lag is subsequently used in the dynamic, regression and causality analyses.

The results suggest a strong positive correlation between food and liquid fuel inflation in Bulgaria. The value of Pearson's correlation coefficient increases as the fuel inflation series is shifted forward, suggesting that changes in fuel prices are gradually transmitted to food prices. The highest correlation coefficient value is observed at a lag of eight months, when the coefficient reaches 0.82. After this point, the correlation gradually declines. The findings suggest that food prices react to changes in liquid fuel prices with a considerable delay. This reflects the time required for increases in fuel costs to be transmitted through the production, transportation and distribution channels of the food supply chain. Based on the correlation analysis results, an eight-month lag was selected for subsequent dynamic, regression and Granger causality analyses.

The strong correlation between food and liquid fuel inflation, as identified through Pearson's coefficient, is further confirmed by dynamic analysis with an eight-month lag. Figure 1 illustrates the relationship between the annual rate of change of the HICP for 'Food' and the annual rate of change of the HICP for 'Liquid fuels and fuels and lubricants for personal transport equipment', shifted by eight months. This

Table 1
Coefficient of linear correlation (Pearson)

Monthly HICP 'Food' (y/y)	Monthly HICP 'Liquid fuels and fuels and lubricants for personal transport equipment' (y/y)	Linear correlation coefficient
month – t	month – t	0.4162
month – t	month – t-1	0.4929
month – t	month – t-2	0.5629
month – t	month – t-3	0.6313
month – t	month – t-4	0.6991
month – t	month – t-5	0.7569
month – t	month – t-6	0.7990
month – t	month – t-7	0.8189
month – t	month – t-8	0.8200
month – t	month – t-9	0.8026
month – t	month – t-10	0.7707

Source: Eurostat, own calculations

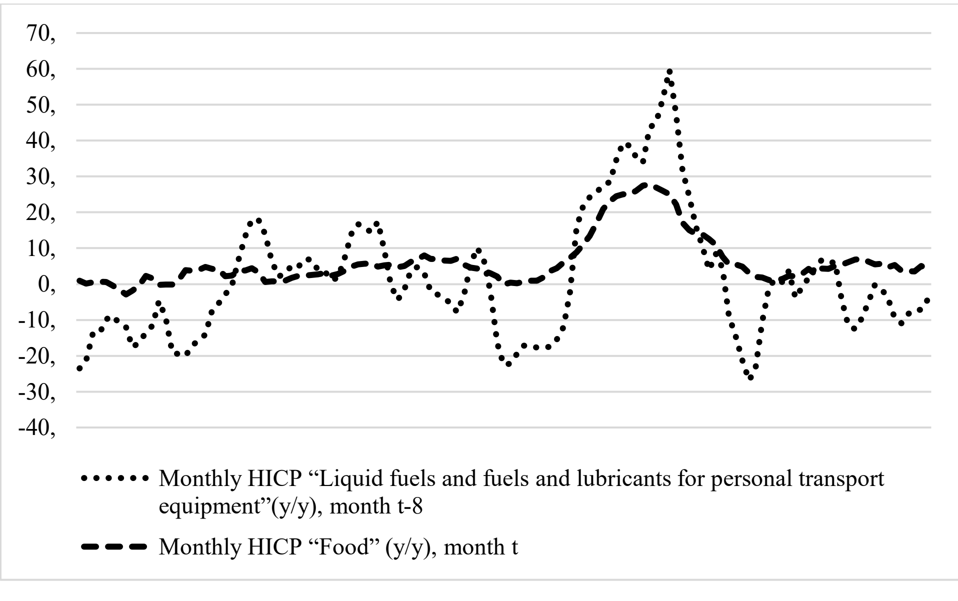

Figure 1. Monthly HICP for Liquid Fuels and Fuels and Lubricants for Personal Transport Equipment (y/y), lagged by 8 months, and Monthly HICP for Food (y/y), Bulgaria

Source: Eurostat, own calculations

analysis shows that the two indicators follow a similar pattern over time, particularly during periods of significant economic and geopolitical shocks. Prior to the onset of the COVD-19 pandemic, both price indices exhibited relatively modest fluctuations. However, the pandemic and subsequent supply chain disruptions led to increased volatility in fuel and food prices. Following the reopening of economies and the recovery of economic activity, liquid fuel prices rose significantly in response to growing demand for energy products and disruptions in international energy markets. Around eight months later, food inflation followed a similar upward trend. The strongest increases in both indicators occurred after the outbreak of the war in Ukraine. During this period, liquid fuel inflation reached exceptionally high levels, reflecting uncertainty in the global energy market and concerns about energy supply security. Food inflation subsequently increased several months later, indicating the gradual transmission of higher fuel costs through the production, transportation and distribution channels of the food supply chain. A similar pattern was observed during periods of declining fuel prices, when food inflation moderated with a noticeable delay. The dynamic relationship between the two indicators has become especially significant in recent times, amid heightened geopolitical tensions in the Middle East and mounting concerns about the security of oil transportation through the Strait of Hormuz. These developments have increased uncertainty in the global fuel market and emphasise the need to understand the link between fuel prices and food inflation. Dynamic analysis confirms the results of correlation analysis, supporting the existence of a strong relationship between the two indicators. Given the relatively high value of the eight-month lagged Pearson's correlation coefficient of 0.82, it is necessary to investigate whether this relationship is causal in nature. To address this question, a regression analysis was conducted. The regression analysis aims to determine whether changes in liquid fuel inflation can statistically predict subsequent changes in food inflation, and whether liquid fuel prices can predict future food price dynamics. Additionally, the analysis seeks to reject the null hypothesis that there is no statistically significant relationship between the annual rate of change of the HICP for 'Liquid fuels and fuels and lubricants for personal transport equipment' and 'Food' in Bulgaria.

4.2 Regression Analyses

The regression function was used to estimate the relationship between liquid fuel inflation and food inflation in Bulgaria. In accordance with the methodology, the annual rate of change of the HICP for 'Liquid fuels and fuels and lubricants for personal transport equipment' was used as the independent variable (X), while the annual rate of change of the HICP for 'Food' was used as the dependent variable (Y). The fuel inflation series was lagged by eight months to reflect the results obtained from the correlation and dynamic analyses. The main results of the regression analysis are presented in Table 2.

The findings of the regression model suggest the presence of a robust linear correlation between the inflation of liquid fuel and food prices in Bulgaria. The Pearson correlation coefficient (Multiple R) achieves a value of 0.82, thereby confirming the existence of a strong positive relationship between the two indicators when an eight-month lag is applied. The explanatory power of the model is relatively high. The coefficient of determination (R Square) is 0.6724,

Table 2
Regression function results from the data analysis package

SUMMARY	OUTPUT							
Regression	Statistics							
Multiple R	0.8200							
R Square	0.6724							
Adjusted R Square	0.6698							
Standard Error	4.0368							
Observations	129							
ANOVA								
	df	SS	MS	F	Significance F			
Regression	1	4247,091	4247,091	260,63	1,45E-32			
Residual	127	2069,532	16,296					
Total	128	6316.623						
	Coefficients	Standard Error	tStat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	5,6238	0,3568	15,761	1,11E-31	4,918	6,330	4,918	6,330
X Variable 1	0,3305	0,0205	16,144	1,45E-32	0,290	0,371	0,290	0,371

Source: Eurostat, own calculations

indicating that approximately 67.2% of the variation in food inflation can be explained by changes in liquid fuel inflation. With an Adjusted R Square value of 0.6698, the estimated relationship is stable after adjusting for the number of explanatory variables included in the model. The overall regression model is statistically significant. The F-statistic is 260.63, while the corresponding significance F is 1.45E-32, which is substantially below the conventional significance level of 0.05. These results allow for the rejection of the null hypothesis that there is no statistically significant relationship between the two variables. Based on the estimated coefficients, the relationship between liquid fuel inflation and food inflation can be represented by the following equation:

$$Yt = 5{,}6238 + 0{,}3305 * Xt-8$$

where:

- Y represents the annual rate of change of the HICP for 'Food';
- Xt–8 represents the annual rate of change of the HICP for 'Liquid fuels and fuels and lubricants for personal transport equipment' lagged by eight months;
- t denotes the current month.

The estimated coefficients are statistically significant. The intercept coefficient is 5.6238 and is significant at the 5% level. The coefficient associated with liquid fuel inflation is 0.3305, with a p-value of 1.45E-32, indicating a very high level of statistical significance. The positive sign of this coefficient suggests that increases in liquid fuel inflation are followed by increases in food inflation approximately eight months later. The results of the regression analysis provide strong evidence of a statistically significant relationship between liquid fuel and food inflation in Bulgaria. The model demonstrates a satisfactory degree of explanatory power, and the statistical significance of all estimated coefficients indicates that developments in liquid fuel prices can serve as an important predictor of future food price dynamics. The identified eight-month transmission lag is consistent with the gradual pass-through of fuel costs through transportation, logistics, agricultural production and food distribution channels. However, it should be noted that approximately one-third of the variability in food inflation remains unexplained by the model. This finding suggests the presence of other factors, such as agricultural commodity prices, labour costs, weather conditions and external supply shocks, that may also influence food price developments. In order to furnish further evidence regarding the direction of causality, the analysis is expanded through the implementation of the Granger causality test.

4.3 Granger Causality Test

The results of the Granger causality test to detect causality between liquid fuels and fuels and lubricants for personal transport equipment inflation and food inflation are presented in Table 3.

The Granger causality test is employed to ascertain whether historical fluctuations in liquid fuel inflation offer statistically significant insights that can enhance the prediction of food inflation. The test is also used to examine the existence and direction of causality between the two indicators. The null hypothesis stipulates that alterations in the annual rate of change of the HICP for 'Liquid fuels and fuels and lubricants for personal transport equipment' do not Granger-cause changes in the annual rate of change of the HICP for 'Food'. The findings of the study suggest that the null hypothesis can be refuted. The probability value of 0.0002 is substantially below the conventional significance level of 0.05, thereby providing evidence of a statistically significant causal relationship from liquid fuel inflation to food inflation. This finding suggests that past developments in liquid fuel prices contain useful information for predicting future food price dynamics. In order to further examine the direction of causality, the reverse hypothesis is also tested. The findings indicate that the null hypothesis, proposing that food inflation does not Granger-cause liquid fuel inflation, cannot be rejected, as the corresponding probability value of 0.2230 exceeds the 0.05 significance threshold. Consequently, no statistically significant evidence has been found that past changes in food inflation improve the prediction of future liquid fuel inflation. The findings indicate a unidirectional causal relationship that links liquid fuel inflation to food inflation. The Granger causality test provides evidence that fluctuations in liquid fuel prices precede and help predict subsequent movements in food inflation. The findings are consistent with the correlation and regression analyses, which identify the strongest statistical relationship between the two indicators at a lag of eight months.

Table 3
Granger causality test

	F-Statistic	Prob.
HICP (y/y) for 'Liquid fuels and fuels and lubricants for personal transport equipment' (month – t-8) does not Granger Cause HICP (y/y) for 'Food' (month – t)	4,1596	0,0002
HICP (y/y) for 'Food' (month – t-8) does not Granger Cause HICP (y/y) for 'Liquid fuels and fuels and lubricants for personal transport equipment' (month – t)	1.3575	0.2230

Source: Eurostat, own calculations

5. Conclusions

Food inflation has been one of the most significant economic challenges facing Bulgaria over the past decade. Between 2015 and 2026, the country experienced a series of major economic and geopolitical shocks, including the COVID-19 pandemic, supply chain disruptions, the war in Ukraine and growing uncertainty in the international energy market. These developments have contributed to substantial fluctuations in both fuel prices and food prices, highlighting the need to examine the relationship between the two indicators. The present study investigates the relationship between the annual rate of change of the Harmonised Index of Consumer Prices for Liquid fuels and fuels and lubricants for personal transport equipment and the annual rate of change of the Harmonised Index of Consumer Prices for Food in Bulgaria. The analysis is based on monthly data from January 2015 to May 2026, and uses correlation, dynamic regression and Granger causality analyses. The empirical results reveal a strong positive relationship between liquid fuel and food inflation. Correlation analysis shows that the strongest relationship between the two indicators occurs at an eight-month lag, with a Pearson's correlation coefficient of 0.82. Dynamic analysis confirms that the two indicators exhibit similar patterns during significant inflationary periods, such as the post-pandemic recovery phase and the inflationary impact of the war in Ukraine. Regression analysis provides further evidence of a statistically significant linear relationship between the two variables. The estimated model indicates that around 67.2% of the variation in food inflation is explained by changes in liquid fuel inflation eight months prior. The estimated coefficients are statistically significant, demonstrating that increases in liquid fuel prices are followed by corresponding increases in food prices approximately eight months later. The results of the Granger causality test reinforce these findings. The test confirmed the existence of a statistically significant causal relationship between liquid fuel inflation and food inflation, with no evidence found for causality in the opposite direction. This suggests that changes in liquid fuel prices provide valuable information for forecasting future food price movements and can therefore act as an early indicator of food inflation in Bulgaria. The findings have important practical implications. Given the significant impact of fuel prices on transportation, logistics, agricultural production and food distribution, monitoring developments in fuel markets could offer an early indication of potential future inflationary pressures in the food sector. This is particularly relevant during periods of heightened uncertainty in global energy markets. Recent geopolitical tensions in the Middle East and the potential for oil shipments to be disrupted through the Strait of Hormuz illustrate how external energy shocks can rapidly influence fuel prices, which can then affect food inflation. The results suggest that policymakers, businesses, and market participants should closely monitor the dynamics of liquid fuel prices when assessing future inflation risks. The eight-month transmission lag identified provides a valuable forecasting horizon that could support the timely implementation of economic policies and anti-inflationary measures. Further research could extend the analysis by incorporating additional explanatory variables, such as producer food prices, agricultural commodity prices, wages, and international oil prices, to develop more comprehensive food inflation forecasting models for Bulgaria.

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