THE RELATIONSHIP BETWEEN FOOD PRODUCTION PRICES AND INFLATION IN BULGARIA

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Abstract: The study aims to find relationships between the total producer price index for food products and the harmonized consumer price index for food products in Bulgaria. The analysis of the relationships aims to reveal the impact of producer prices on the final consumer price of food products, as well as the period in which the strongest relationships are present. The sharp rise in food prices in Bulgaria, the macroeconomic forecasts for the continuation of this trend and their impact on the welfare of citizens make it necessary to analyse various interrelationships that serve the study and forecasting of certain processes in the country. The study concludes that there is a causal relationship between the total producer price index for food products and the harmonized consumer price index for food products in Bulgaria. In contrast to the general case where inflationary processes are transmitted from producer prices to consumer prices with a lag of 5 months, in the case of food products this happens within the same month.

Key words: producer price index for food products, consumer price index for food products, inflation, forecasting.

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1. Introduction

The economic crisis triggered by the Covid-19 pandemic led to significant inflationary trends in the late 2021. Record levels of inflation have been observed both in Bulgaria and in the Euro area, the US and the UK (Trading Economics, 2022). In December 2021, the annual inflation in Bulgaria is 7.8% and in the Euro area 5%. In the US and UK, the annual inflation for the same period is 7% and 5.4%, respectively. The US has not seen such inflation rates since 1982 and the UK since 1992. In most countries, the main upward pressure on consumer inflation is exerted by energy and electricity prices, while in Bulgaria the biggest influence is exerted by food, housing and utility prices, as electricity in the country is traded on a regulated market and the National Assembly has introduced a moratorium on household electricity prices (Borisov, 2021).

According to the BNB's December macroeconomic forecast, the services and food groups are expected to contribute the most to the growth of the harmonised CPI (BNB, 2021). Specifically, the Central Bank expects the harmonized consumer price index to reach 7.5% and food price growth to be 14.7% by the end of 2022. The BNB's revision to the previous forecast is for consumer price inflation in food to increase by 11.9 percentage points. All these inflationary trends call for more and more attention to the issue by both central banks and governments with a view of taking appropriate socio-economic measures. From the central banks' point of view, inflation is a sensitive issue because they are legally obliged to maintain price stability, i.e. inflation rates of around 2%. The unprecedented rise in prices at the end of 2021 in a number of leading economies puts central banks in an unprecedented situation. The European Central Bank, the Federal Reserve and the Bank of England are also facing rapid price increases (Borisova, 2021).

The inflationary challenges in the global context increasingly call for various dependencies to be explored in order to analyse the interrelations and dynamics of inflationary processes. Currently in Bulgaria, it appears that consumer inflation related to food prices is emerging as the most significant problem, which in turn leads to a sharp decline in the purchasing power of the lowest income groups of the population. This process calls for rapid management decisions to preserve the social status of the affected population groups. At the same time, statistical and economic means are needed to obtain the necessary information quickly.

The aim of the study is to analyse the relationships that exist between the Total Producer Price Index for Food (TPPIF) and the Harmonised Index of Consumer Prices for Food (HCPIF) in Bulgaria.

The thesis is that for the period from 2016 to date, there is a strong causal relationship between the Total Producer Price Index for Food and the Harmonised Consumer Price Index for Food. In contrast to the general case where inflationary processes are transmitted from producer prices to consumer prices with a lag of 5 months, in the case of food products this happens within the same month.

In the literature related to the study of the relationships between producer and consumer prices, there are a number of publications based on different methodologies. Generally, in the production chain theory, part of the inflation from producer price indices can be transferred to consumer price indices (Vilcu, 2015). Using the Granger causality test and the rolling window approach, for example, causality has been demonstrated in Slovakia from the producer price index to the consumer price index (SU et al., 2016). These correlations have been studied in the period 2016-2021 for Bulgaria (Borisov, 2021). The study shows that for this period there is a very strong correlation between the harmonised consumer price index and the total producer price index in Bulgaria, the indices compared being based on 2015. The highest Pearson coefficient values are reached when comparing the monthly indices with a lag of five months (T-5). The proven causal linear relationship between producer prices and consumer prices makes it possible to forecast the dynamics of the harmonised CPI in Bulgaria within five months. With respect to food prices, a comparison of price indices from 1995 to 2010 in Finland reveals that there is a statistically significant long-run equilibrium relationship between food prices and the prices of the main input variables used in the food chain, namely agricultural commodities, labor, and energy (Irz, Niemi, & Liu, 2013). The results of another study show that agricultural commodity prices and exchange rates play a key role in determining short- and long-term food price movements in the United States (Baek, & Koo, 2010). It is also found that energy price is a significant factor that influences US food prices in the long run, but has little influence in the short run. The results of other regression analyses suggest that commodity prices are the main determinant of producer and consumer price increases in the euro area, underpinning the strong increase in food prices during 2007-2008 (Ferrucci, Jiménez-Rodríguez, & Onorante, 2010).

The availability of various studies that analyze the interrelations between producer and consumer prices, as well as the drastic rice of food price in Bulgaria at the end of 2021, which outpaces the rate of inflation, highlight the relevance of the issue and the need to analyze the interrelations between the total producer price index for food products and the harmonized consumer price index for food products in Bulgaria. These interlinkages also need to be explored in view of the need to undertake compensatory mechanisms in respect

of the low-income groups affected and also to reveal the reason for the current faster growth in food prices.

The article contains three parts. The first part presents the relevance, the aim and the thesis defended. The second part of the paper presents the methodology and the data used, and analyses the relationships between and TPPIF and HCPIF. The conclusions are stated in the last part.

2. Analysis of the relationship between the total producer price index for food products and the harmonized consumer price index for food products

2.1. Methodology and used data

In analysing the relationships between the total producer price index for food products and the harmonised consumer price index for food products, we have used the available public statistical information from the NSI. The period covered by the study is 2016-2021. For this period, the statistical information is available and publicly disclosed for all months. The data used are sub-components of the total industry producer price index and the harmonised index of consumer prices at 2015 base. Specifically, for the producer price index for food products, we have used data for products with code C10 according to the Classification of Economic Activities (NACE - 2008). For the Harmonised Index of Consumer Prices for food products, we have used data with code 01.1 of the European Classification of Individual Consumption according to Purpose (ECOICOP). Data for both indices are based on the NSI methodology (NSI, 2021a; NSI, 2021b). The period analysed includes sub-periods with different price dynamics, with both deflation and sharp increases in the index values. The total producer price index for food is the resultant of the domestic and international price indices, weighted by the turnover structure of the two markets. The index information is accumulated by the NSI on a sample basis. The overall index is at 2015 base.

The Harmonised Index of Consumer Prices for Food is also used for the 2015 base year. It is calculated according to the harmonised methodology of Eurosat and measures the relative price change of food products consumed by households. Given that the data for the two monitored indices are reported on a monthly basis under the 2015 base year, the survey uses all monthly data from January 2016 to the end of 2021. Lags are used in the correlation analysis in order to find the highest Pearson correlation coefficient value. The study is complemented with the Granger causality test to determine whether one of the time series is useful in predicting the other. After selecting the lag characterized

by the highest values of the correlation coefficient between the overall producer price index for food and the harmonized consumer price index for food, regression analysis was performed. It demonstrates the causal relationship between the indices and presents the functional relationship between them. The analysis is implemented on the basis of data from the Regression function of the statistical package for data analysis (in Microsoft Excel), and the necessary indicators are interpreted.

2.2.Results of the analysis

2.2.1 Correlation relationships

The dynamic analysis of the 2016-2021 TPPIF and HCPIF shows similar fluctuations between the two indices, which are more pronounced in the consumer price curve. It is evident from the dynamic graphical analysis that smaller deviations in producer prices lead to sharper movements in the HCPIF curve. In addition, both indices show accelerated increases after mid-2021 (Figure 1).
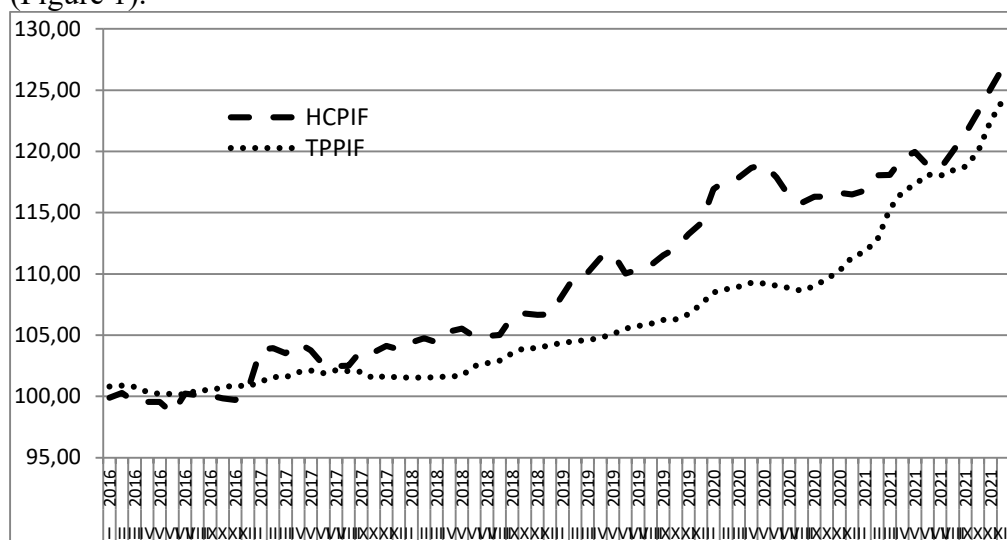
Figure 1. ***Total producer price index for food and harmonised consumer price index for food***
(**Source:** NSI)

For the analysis of the relationships between the TPPIF and the HCPIF (2016 – 2021), correlation coefficients were tested starting from the months coinciding with the release of the data for both indices. Subsequently, a stepwise lagged time series for the HICPP from one to five months was made as shown

in Table 1. Thus, the aim is to find the highest correlation coefficient, and hence the lag for regression test of functional relationship between the two indices.

Table 1

Coefficient of linear correlation (Pearson)

HCPIF **(month - T)**	**Linear correlation coefficient**
TPPIF **(month – T)**	0.931349
TPPIF **(month – T-1)**	0.924026
TPPIF **(month – T-2)**	0.914959
TPPIF **(month – T-3)**	0.906121
TPPIF **(month – T-4)**	0.899052
TPPIF **(month – T-5)**	0.89532

(**Source:** NSI, own calculation)

In contrast to the correlation study using Pearson's coefficient, where it is shown that the highest correlation between the total producer price index (TPPI) and the harmonized consumer price index (HCPI) is observed when the time series of producer prices is pulled out by four and five months (Borisov, 2021), Table 1 gives different results when comparing the TPPIF and the HCPIF. The highest value of the Pearson coefficient is reported when the two time series are compared without any shift. In this case, the correlation coefficient is 0.931, indicating that there is a very strong correlation. This implies that the correlation between producer and consumer prices for food is the strongest in the same month when analysing the time series, rather than the general case with a lag of five months evident in Figure 2.

When examining the causal relationship between TPPIF and HCPIF, it could be implied that producer prices in food products have the strongest role on consumer prices in the same month, rather than in advance. Given this, for the purpose of the regression analysis, the time series without lag shifts are used as shown in Fig. 1. and where the highest value of the Pearson coefficient is evident in Fig. 2.

The same conclusion is reached when testing time series using the Granger causality test. When tested with more than one lag, it appears that there is no underlying causal relationship so that one indicator can serve to predict the other. When testing with one lag, it turns out that the TPPIF explains and can predict the HCPIF, with a 3.3% probability that this is not true. This is also the case where the correlation between the two indices is 0.924. An experimental application of the Granger test without lag shifts of the two time series proves causality, with the TPPIF explaining the HCPIF with a probability of rejecting this hypothesis of 2.38%.

All this makes it necessary to truncate the regression analysis using the time series without lag shifts, as shown in Fig. 1.
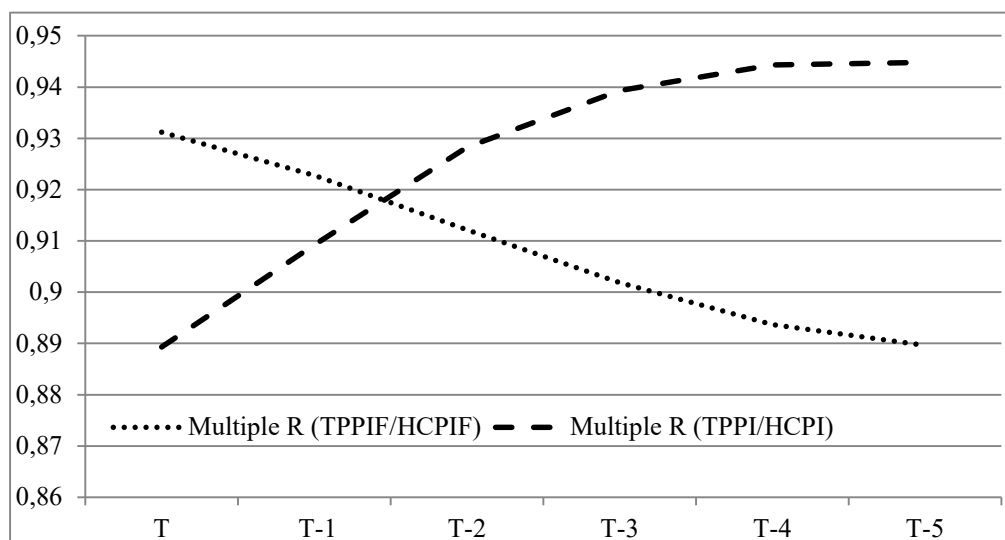

*Figure 2. **Coefficient of linear correlation between TPPIF and HCPIF and between TPPI and HCPI***
(**Source:** NSI, own calculation)

2.2.2 Regression analysis

For the purpose of regression analysis, the Regression function of the Statistical Data Analysis package in Microsoft Excel was used, and the relevant indicators were interpreted accordingly.

The result of the study between the total producer price index for food as a factor (X Variable) and the harmonized consumer price index for food as the dependent variable according to the methodology is presented in Table 2.

• According to the results of the regression analysis, the Pearson correlation coefficient (Multiple R) is 0.931, indicating a very strong correlation between the total producer price index for food as a factor (X Variable) and the harmonized consumer price index for food as the dependent variable.

• 86.7% of the variance of HCPIF can be explained by the variance of TPPIF. The result is provoked by the fact that R^2 (R Square) is 0.867.

• The adjusted R^2 (R Square) is 0.866.

• The Standard Error is 2.78. This means that for the variable-factor relationship in the model, the observed values deviate on average by 2.78 units from the regression line for the 72 observations made.

- The Significance F = 1.97495E-33 < 0.05, indicating that the functional relationship is statistically significant for the chosen significance level of 0.05. The value of the indicator is extremely low and this means that the regression model is statistically significant.
- The coefficients of the regression equation indicate that the relationship between HCPIF and TPPIF has the following form:
  - $Y_t = -12.898 + 1.1526*X_t$, in which:
  - Y is the Harmonised Index of Consumer Prices for Food at 2015 base;
  - X is the Total Producer Price Index for Food at 2015 base;
  - t is the month of issuing the data for the Harmonised Index of Consumer Prices for Food.
- According to the regression model, the Intercept in the function is (-12.898) and the corresponding value of the Student's t-criterion is (t= - 2.249) and since the P-value=0.0276<0.05, it follows that the Intercept is statistically significant.
- The coefficient in front of the factor (X) has a value of 1.1526. It is statistically significant at 0.05 level of significance (t= 21.39; P-value = 1.975E-32 <0.05).

Table 2

Regression function results from the data analysis package

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.9313491							
R Square	0.86741114							
Adjusted R Square	0.86551701							
Standard Error	2.78572777							
Observations	72							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	3553.802944	3553.802944	457.947821	1.97495E-32			
Residual	70	543.2195435	7.760279193					
Total	71	4097.022488						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-12.8979873	5.733823901	-2.249456472	0.02763073	-24.33373846	-1.4622361	-24.3337385	-1.4622361
X Variable 1	1.15259763	0.053860419	21.39971543	1.975E-32	1.045176417	1.26001885	1.04517642	1.26001885

(**Source:** NSI, own calculation)

Conclusions

The study provides an overview of the issues related to the accelerating inflationary processes in leading countries and Bulgaria as of the end of 2021. It highlights the challenges for the Bulgarian economy in 2022, related to the accelerating inflation as well as to the projected very high growth of food prices. The need to analyse and investigate the causal links between the total producer price index for food products and the harmonised consumer price index for food products in Bulgaria is presented, with a view of explaining the high price growth and to gather information for the implementation of specific socio-economic measures.

For the 2016-2021 period under consideration, for which monthly statistics for both indices are available on a 2015 basis, there is a very strong correlation between the indices. It appears that the correlation between producer and consumer prices for food is the strongest in the same month in the time series analysis as opposed to the general case between the producer price index and the harmonized consumer price index. The investigation of the causal relationship between the two indices for food using the Granger causality test shows that there is a causal relationship from the total producer price index for food to the harmonised consumer price index for food with no lagged time series shift or a lag of one month. Based on the regression analysis, it appears that there is a static significance of the functional relationship of the regression equation between the harmonized consumer price index for food as the dependent variable and the total producer price index for food as the factor.

The results of the study go some way to explain the reasons for the faster rise in food prices at the end of 2021 relative to the average rate of inflation. This is due to the fact that the dynamics of producer prices of food products are transmitted much faster to consumer prices, compared to the general case where this happens in 4-5 months. In this context, the total producer price index for food could not be used to predict consumer prices for food, or if it could, it could happen with a lag of 1 month. In view of this, it is also necessary to examine the causal relationships between the different components of producer prices and consumer prices of food products, as well as their inter-linkages with energy prices.

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