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PRICE PARITIES FOR VEGETABLES IN SERBIA - ANALYSIS AND FORECASTING

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SUMMARY

The paper analyzes price parities of important vegetable crops in Serbia in relation to wheat, which has always been a point of reference in price formation of other agricultural products. The analysis was carried out by means of descriptive statistics for the period 1994-2017 for the following vegetable crops: potato, bean, tomato, pepper, onion and cabbage. The method used for forecasting of the price parities for the period 2018-2022 is time series analysis, i.e. ARIMA models. The research results showed that the price parities of bean, tomato and pepper will increase: from 9.1 to 12.3 for bean, from 1.9 to 3.5 for tomato and from 2.3 to 3 for pepper. The price parities for potato (1.4) and cabbage (1.4) will remain practically unchanged, while the price parity of onion will decrease to 1.5.

Key words: vegetables, price parity, Serbia, forecasting.

INTRODUCTION

The analysis of the relative prices, i.e. price parities of certain vegetable crops in relation to bread wheat was carried out for the entire period 1994-2017. The aim of the analysis was to formulate a relative movement of the economic position of certain vegetable crops in relation to the most important cereal cultivated in our conditions, i.e. wheat. Considering the length of the time series, forecasting of the price parities for the observed vegetable crops was carried out for a five-year period 2018-2022.

A certain number of papers have already dealt with forecasting vegetable prices and their parities. Most commonly used models in these studies are based on time series analysis (Bannikova et al. 2018, Ivanišević et al., 2015, Miljanović et al., 2014, Mutavdžić et al., 2016, Novković et al., 2016, Novković & Mutavdžić 2016, Mihajlović 2019). Novković et al. (2018) forecast the price parities of vegetables in relation to wheat based on extrapolation of the change rate in the analyzed long-term period. The subject of this study was the analysis and forecast of the price parities of vegetables in relation to the price of bread wheat in Serbia.

In this paper, the analysis and forecast of the price parities in relation to wheat were made for the following vegetable crops: potatoes, bean, tomato, pepper, onion and cabbage.

MATERIAL AND METHODS

The analysis of price parities of vegetable crops commonly cultivated in Vojvodina and Serbia in relation to wheat was carried out by means of descriptive statistics. The analysis was conducted for the period 1994-2017. It included the following vegetable crops: potato, bean, tomato, pepper, onion and cabbage.

The forecast of the price parities of the vegetables in relation to wheat was made for the period 2018-2022 using the ARIMA models, i.e. Autoregressive Moving Average (ARMA(p,q)). The assumption in this class of models is that the current value (member) of the series depends on the values of the previous members of the series, the current value of the random process and the previous values of the random process (white noise). This class of models is a combination of the autoregressive model (AR(p)) and the moving average model (MA(q)).

The statistical data used in the paper were obtained from the official sources of the Statistical Office of Serbia.

RESULTS AND DISCUSSION

Analysis and forecasting of the potato price parity

The relative price of potato in relation to wheat, i.e. the potato/wheat price parity, in the analyzed period from 1994 to 2017 was on average 1.42. This means that 1 kilogram of potato was worth on average 1.42 kilograms of wheat. The parity varied in the interval from 0.93 in 2005 to 2.7 in 2000. The relative variation in the potato price matched the variation in the absolute price, which is confirmed by almost the same coefficient of variation of 26.6%. In contrast to the absolute price of potato, the relative price of potato did not show a tendency of growth, but a gentle decline at an average annual rate of -0.89%. This means that despite the absolute increase in potato prices, its relative economic (price) position in relation to wheat slightly deteriorated in the observed period.

The forecasting model shows that the potato/wheat price parity was statistically significantly influenced by the value of this parity from previous two years (Table 1).

Table 1. Parameters of the model for forecasting the potato/wheat price parity

Input: PKR/PŠ Transformations: none Model: (2,0,0) MS Residual=.03002						
Paramet.	Param.	Asympt. Std. Err.	Asympt. t (19)	P	Lower 95% Conf	Upper 95% Conf
Constant	1.423365	0.047726	29.82347	0.000000	1.323473	1.523257
p(1)	0.763156	0.195209	3.90942	0.000942	0.354578	1.171734
p(1)	-0.570200	0.194568	-2.93059	0.008581	-0.977437	-0.162964

The forecast parity values of potato (Table 2) show that the oscillations of this parity will be common also in the following period. The parity will range from 1.41 to 1.45 kilograms of potatoes per kilogram of wheat. At the end of the forecast period (in 2022), it is expected that a kilogram of wheat will have the value of 1.41 kilograms of potato, which is slightly less than the average parity in the analyzed period.

Table 2. Forecast potato/wheat price parities (2018-22)

Forecasts: Model: (2,0,0) Input: PKR/PŠ Start of origin: 2 End of origin: 23				
Case No.	Forecast	Lower 95.0000%	Upper 95.0000%	Std. Err
24	1.406378	1.043709	1.769046	0.173275
25	1.450892	0.994677	1.907107	0.217969
26	1.454059	0.997822	1.910295	0.217979
27	1.431093	0.949427	1.912759	0.230129
28	1.411761	0.916479	1.907044	0.236635

The graphic representation of the changes in potato/wheat price parities (**Figure 1**) confirms the findings based on the forecasting model.

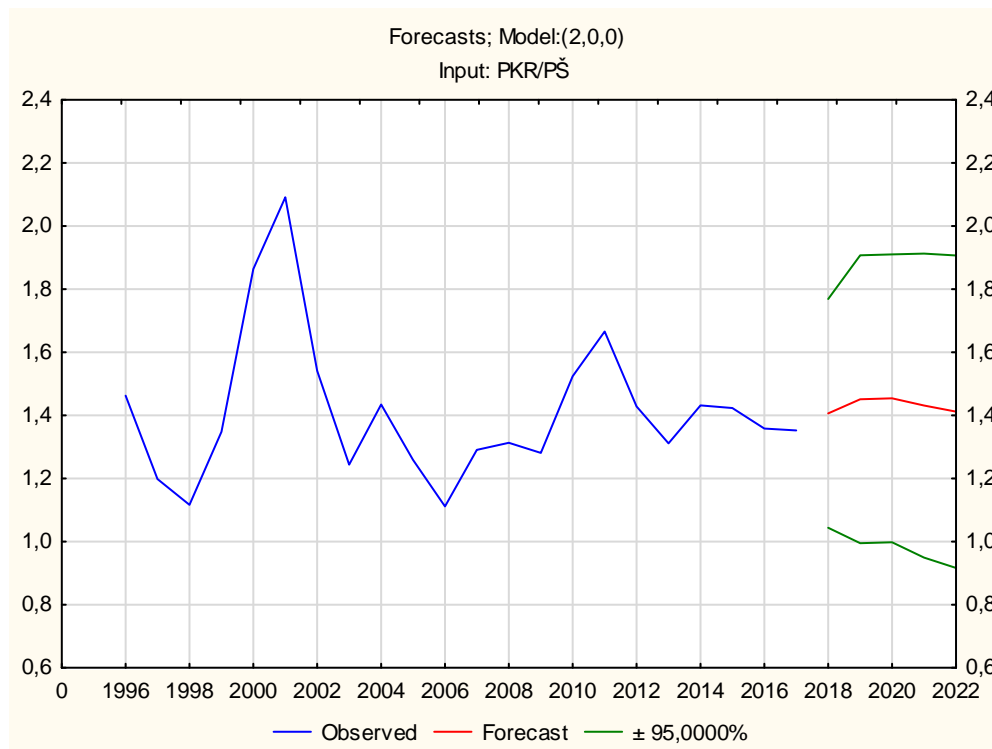


Figure 1. Changes in the potato/wheat price parities

Analysis and forecasting of the bean price parity

The average annual price parity of bean in relation to wheat in the analyzed twenty-four-year period was 9.14. This means that 1 kilogram of bean was worth more than 9 kilograms of wheat. The price parity varied in the interval from 4.43 in 1996 to 14.54 in 2014. As in potato, the relative variation matched the absolute variation in the bean price (the coefficient of variation was 27.65%). In contrast to potato, however, not only the absolute price but also the relative price of bean showed a tendency of growth – at an average annual rate of 2.19%. In other words, the absolute price of bean increased, but its relative economic (price) position in relation to wheat improved, as well.

These differences between the trends in the absolute and relative prices of potato and bean can be accounted for by the fact that the absolute values and the price parities were analyzed in different periods. The relative price of bean experienced even a slightly higher growth rate than the absolute price expressed in euro.

The estimated model for the analysis and forecasting of the bean/wheat price parities indicates that the parity in the current year is significantly influenced by the parity in the previous two years. In the following period, the ratio of prices of bean and wheat will oscillate over the years, i.e. it will have a tendency to rise until the middle year of the forecast period, which will be followed by a fall in the parity value by the end of the forecast period (**Table 3**). The parity oscillations range from 10.80 to 13.63. In the last year of the forecast, the parity will be 12.31, which is well above the average parity in the analyzed period.

The indicated characteristics are illustrated by the graphic representation of this parity (**Figure 2**).

Table 3. Forecast bean/wheat price parities (2018-22)

Forecasts: Model: (2,1,0) Input: PPA/PŠ Start of origin: 2 End of origin: 23				
Case No.	Forecast	Lower 95.0000%	Upper 95.0000%	Std. Err
24	10.79389	8.790778	12.79700	0.953444
25	12.58609	8.816613	16.35557	1.794202
26	13.62554	9.193967	18.05712	2.109349
27	13.13035	8.611322	17.64938	2.150974
28	12.31340	7.740116	16.88667	2.176796

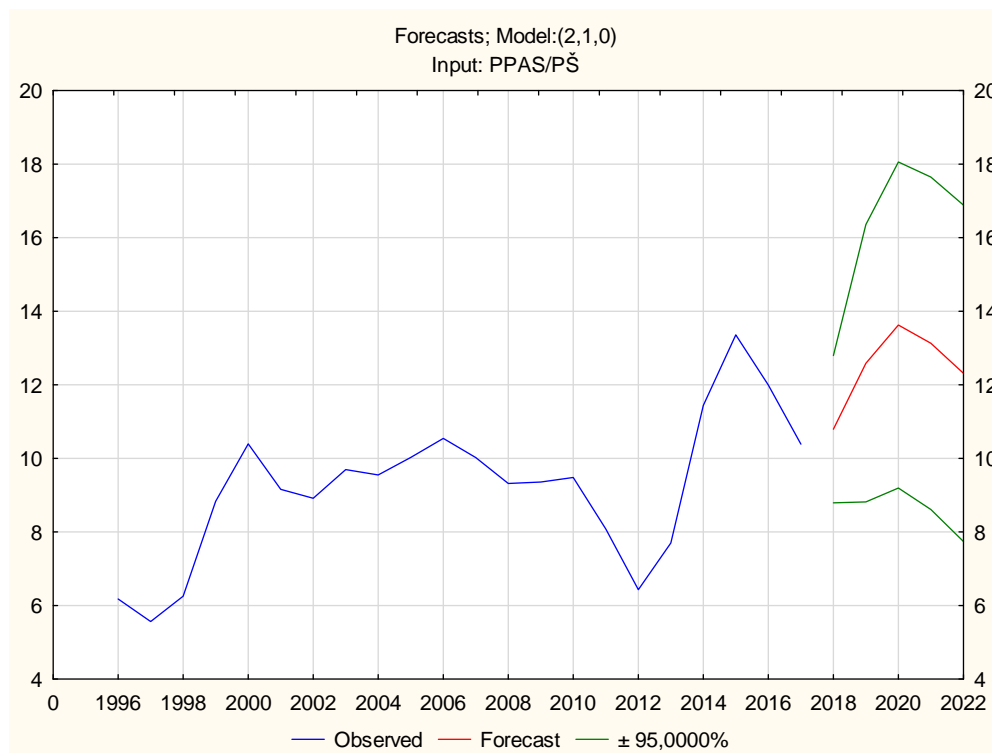


Figure 2. Changes in the bean/wheat price parities

Analysis and forecasting of the tomato price parity

The average annual price parity of tomato in relation to wheat in the analyzed period in Vojvodina was 1.89. The parity varied in the interval from 0.63 in 1996 to 3.71 in 2014. The relative variation of tomato prices matched the absolute variation (the coefficient of variation was extremely high: 47.8%). The relative price of tomato also showed the tendency of growth at an average annual rate of 3.17%, which is almost three times lower than the absolute price growth rate. This means that apart from the increase in the absolute price of tomato, its relative economic (price) position relative to wheat also improved, but to a much lesser extent.

The estimated model for the analysis and forecasting indicated that the tomato/wheat parity value was statistically significantly influenced by the values from the previous two years. The tomato/wheat parity values in the forecast period will increase over the years, ranging from 3.13 to 3.47 (Table 4). At the end of the forecast period (2022), one kilogram of tomato will have a value of 3.47 kilograms of wheat.

Table 4. Forecast tomato/wheat price parities (2018-22)

Forecasts: Model: (2,1,0) Input: PPAR/PŠ Start of origin: 2 End of origin: 23				
Case No.	Forecast	Lower 95.0000%	Upper 95.0000%	Std. Err
24	3.126469	2.643757	3.609181	0.229762
25	3.264194	2.411388	4.117001	0.405920
26	3.335292	2.357229	4.313354	0.465540
27	3.383868	2.379503	4.388233	0.478059
28	3.466987	2.428304	4.505670	0.494394

The described characteristics are confirmed by the graphical representation of the changes in this parity (Figure 3).

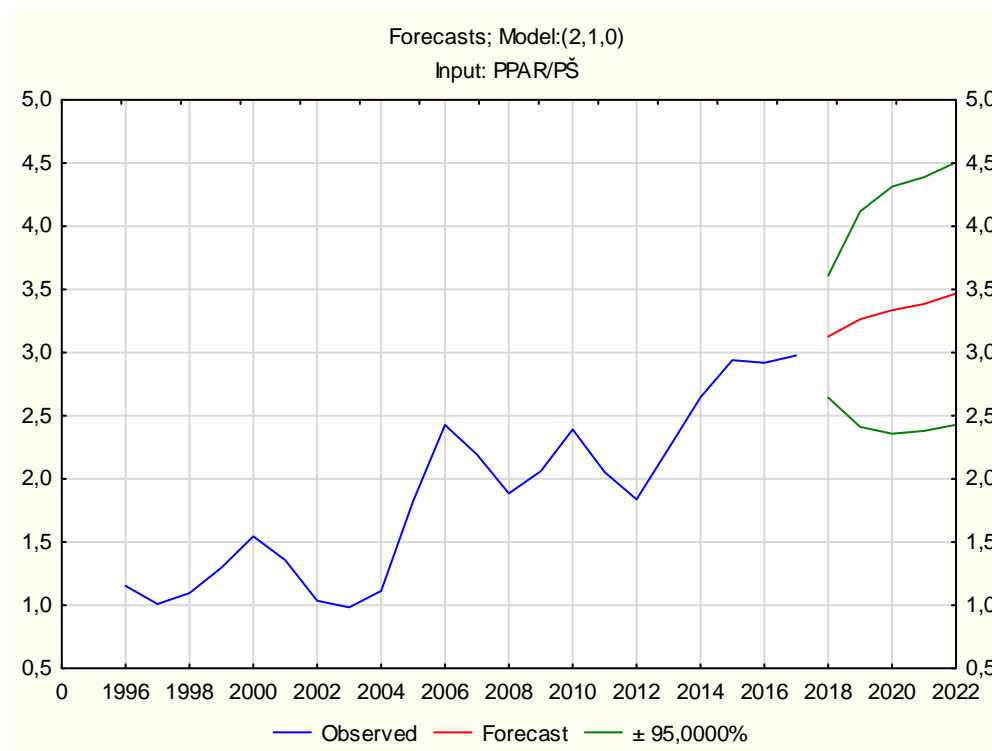


Figure 3. Changes in the tomato/wheat price parity

Analysis and forecasting of the pepper price parity

The average annual price parity of pepper in relation to wheat was 2.29. This parity varied in the interval from 1.31 in 1997 to 3.29 in 2000. The relative variation in the pepper price was slightly more moderate than the absolute variation. The coefficient of variation was moderately high: 26.7%. The relative price of pepper in relation to wheat also showed a tendency of growth at an average annual rate of 1.13%, which is almost two times lower than the absolute price growth rate. This means that besides the increase in the absolute price of pepper, its relative economic (price) position also improved, but to a much lesser extent.

The pepper/wheat price ratio in the current period is significantly influenced by the values of this parity and random processes from the previous two years. The results of the forecast are not in agreement with the observed tendencies in the analyzed period. The pepper/wheat price parity will have a tendency of decrease in the following period, and at the end of the forecast period a kilogram of peppers will be worth 3.04 kilograms of wheat, which is 25% higher compared to the average parity in the analyzed period (Table 5). This finding indicates that the economic conditions for pepper production will improve.

Table 5. Forecast pepper/wheat price parities (2018-22)

Forecasts; Model: (2,0,2) Input: PPAP/PŠ Start of origin: 2 End of origin: 23				
Case No.	Forecast	Lower 95.0000%	Upper 95.0000%	Std. Err
24	3.456842	3.067156	3.846527	0.184701
25	3.371140	2.364916	4.377363	0.476925
26	3.234203	1.706990	4.761416	0.723861
27	3.118137	1.335377	4.900898	0.844984
28	3.036418	1.145277	4.927559	0.896354

The indicated characteristics of the changes in the price parity in the observed period and the tendencies in the forecast period are shown in Figure 4.

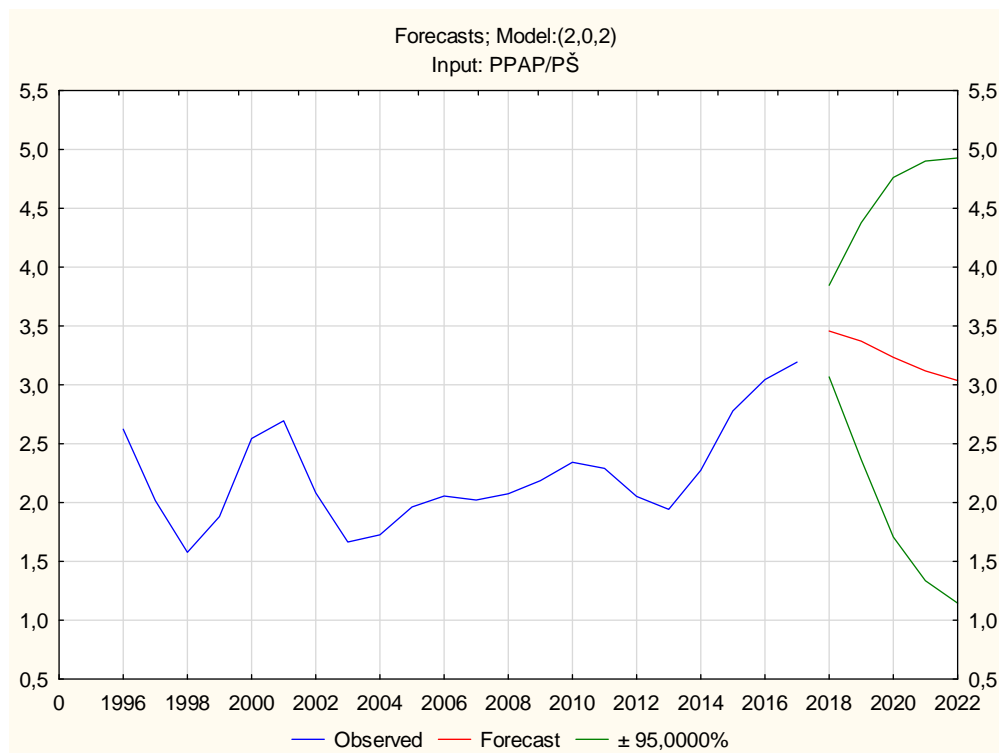


Figure 4. Changes in the pepper/wheat price parity

Analysis and forecasting of the onion price parity

The average annual price of onion in relation to wheat in the observed period amounted to 1.52. The parity ranged in the interval from 1.1 in 2013 to 2.07 in the initial year of the analyzed period (in 1994). The price parity of onion did not show the same tendency as its absolute price. The parity (relative price) had a tendency of decline at an average annual rate of -5.45%, which is the most pronounced decreasing tendency compared to all observed vegetable crops. In other words, despite the slight absolute improvement of the onion price, its relative economic (price) position relative to wheat considerably deteriorated. This phenomenon is accounted for by the fact that the absolute and relative prices were analyzed in different time periods, and by the fact that the highest relative onion price was achieved in the first year of the analyzed period (1994).

The estimated model for forecasting shows that the value of the onion/wheat price parity in the current year is significantly influenced by its value as well as by the random processes from the previous two years. In the forecast period, there will be oscillations in the onion price in relation to wheat (Table 6). In the first three years of the forecast period, there will be a decline in the value of this parity, while the parity value is expected to increase in the last two years.

Table 6. Forecast onion/wheat price parities (2018-22)

Forecasts: Model: (2,1,2) Input: PCL/PŠ Start of origin: 2 End of origin: 23				
Case No.	Forecast	Lower 95.0000%	Upper 95.0000%	Std. Err
24	1.230183	0.796811	1.663554	0.204430
25	1.092831	0.572139	1.613523	0.245620
26	1.099374	0.566333	1.632414	0.251445
27	1.180163	0.640057	1.720269	0.254778
28	1.209763	0.634254	1.785273	0.271497

Figure 5 presents the described characteristics of the changes in the onion/wheat price parities and the tendencies in the forecast period.

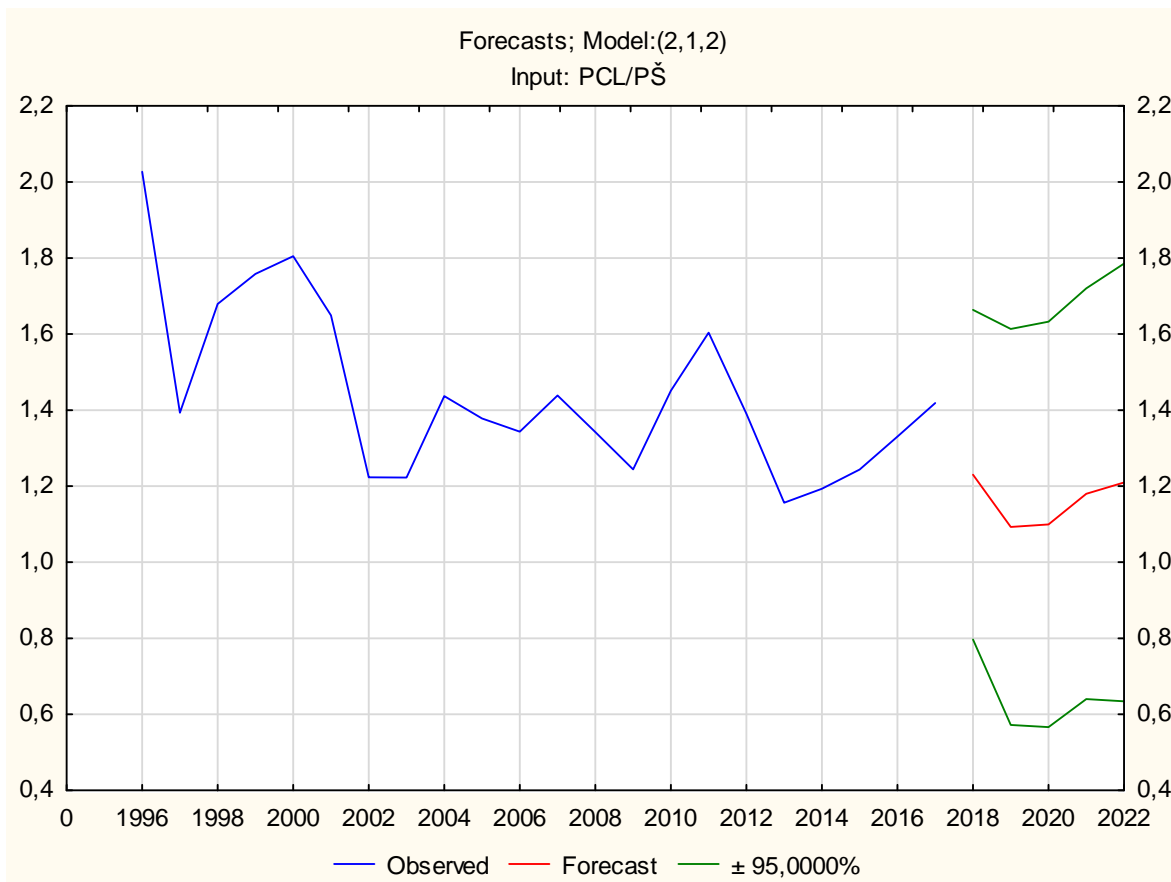


Figure 5. Changes in the onion/wheat price parity

Analysis and forecasting of the cabbage price parity

The average annual price parity of cabbage compared to wheat was 1.39. The parity varied in the interval from 0.84 in 2013 to 2.89 in 1994 (the first year of the analyzed period). The relative variation in the cabbage price was far more pronounced than the absolute variation. The coefficient of variation was extremely high: 39.9%. The relative price of cabbage in relation to wheat showed a tendency of decline at an average annual rate of -3.54%.

It can be observed that the cabbage prices had the same trends as onion: despite the slight improvement of the absolute price, its relative economic (price) position relative to wheat considerably deteriorated. This phenomenon can be also explained by the fact that the study considered different time period for analyses of the absolute and relative prices, and that the highest relative price of cabbage was achieved in the first year of the analyzed period (1994).

The cabbage/wheat price parity in the current period is statistically significantly influenced by its value from the previous year. In the following period, the value of the cabbage/wheat parity will tend to increase in the first three years, while in the fourth and fifth year there will be a gentle decline in the parity value, so at the end of the forecast period the value of this parity will be 1.4, which is practically at the average level for the analyzed period (Table 7). This means that relative price will stabilize in cabbage production.

Table 7. Forecast cabbage/wheat price parities (2018-22)

Forecasts: Model: (2,0,0)				
Input: PKIK/PŠ Start of origin: 2 End of origin: 23				
Case No.	Forecast	Lower 95.0000%	Upper 95.0000%	Std. Err
24	1.332176	0.744285	1.920066	0.280881
25	1.394804	0.692175	2.097434	0.335701
26	1.411758	0.697429	2.126086	0.341290
27	1.409738	0.695400	2.124076	0.341295
28	1.404866	0.690106	2.119625	0.341496

The determined characteristics of the changes in the price parity of cabbage in relation to wheat and the tendencies in the forecast period are presented in **Figure 6**.

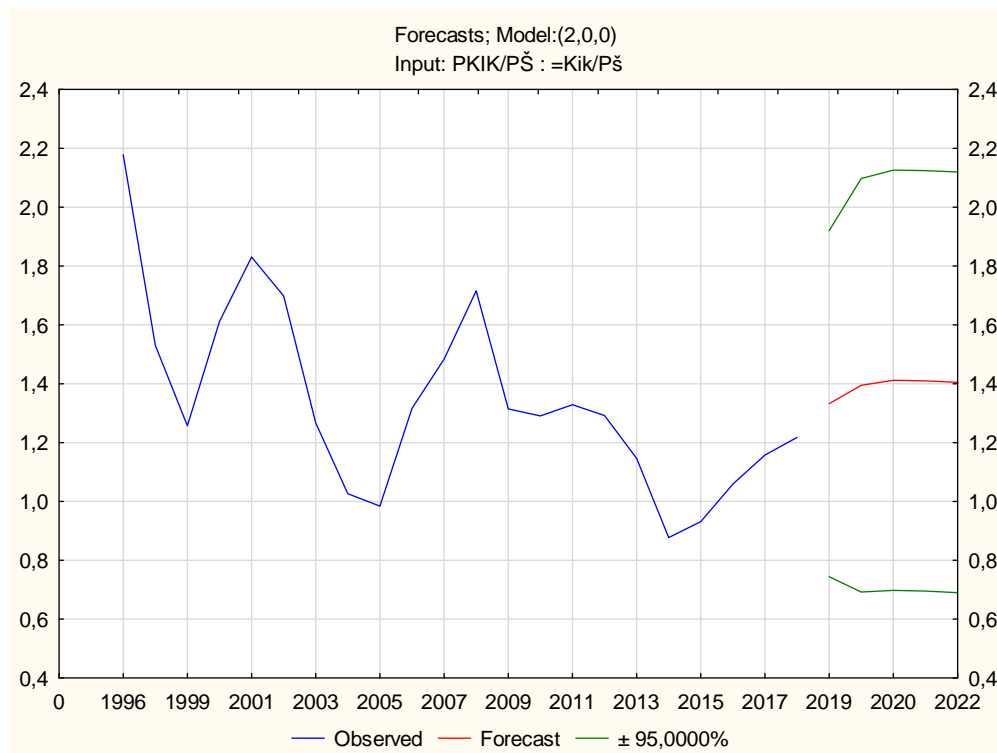


Figure 6. Changes in the cabbage/wheat price parity

CONCLUSION

The average price parity of individual vegetable crops in relation to wheat in the period 1994-2017 will not have the same tendencies in the forecast period as the absolute prices. The price parities of bean, tomato and pepper will improve: from 9.1 to 12.3 for bean, from 1.9 to 3.5 for tomato and from 2.3 to 3 for pepper. The parities of potatoes (1.4) and cabbage (1.4) will remain practically unchanged, while the parity of onion will decline to 1.5.

The general conclusion is that in the medium-term future the relative price position of vegetable crops in relation to cereals will significantly improve.

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