

FORECASTING THE PRICE INDICATORS OF SIGNIFICANT INDUSTRIAL PLANTS IN THE REPUBLIC OF SRPSKA

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Abstract

Using the ARIMA model, the paper forecasts five-year price and price parity movements of the most represented industrial plants in the Republic of Srpska (soybeans, rapeseed and tobacco). The main goal of the paper was to analyse changes in price and their parities, as well as the future tendency of price indicators of observed crops. The results show that a constant increase in soybean prices over the upcoming five-year period can be expected, where the ratio of soybean prices to wheat will be very favourable. For rapeseed, price fluctuations in the prediction period can be expected, while its parity will be very favourable, as is the case with soybeans. As with soybeans, tobacco can also be expected to have a constant price increase over the five-year forecast period, while tobacco/wheat parity will continue to decline in the coming period.

Key words: forecasting, ARIMA models, industrial plants, price, price parity.

Introduction

Industrial plants are of great economic importance in our country, and favourable agro-ecological conditions enable successful production. Despite this, Gadžo et al. (2011) state that crops that can be sown under our conditions do not occupy a proper place in the structure of sowing. Specifically, according to data from Institute of Statistics of the Republic of Srpska (ISRS, 2019), the share of industrial plants in cultivated arable land was only 2.41% in 2017, while within the structure of crop production, industrial plants were at last place behind dominant cereals, forage herbs and vegetables. According to the same source, in the observed year, soybeans (4,132 ha), rapeseed (1,978 ha) and tobacco (1,063 ha) were the most cultivated crops, which are also the subject of research. Given the economic importance of the observed industrial crops, the main goal of research was analysis of change in prices and their parities, as well as the future tendencies of these price parameters. The Box-Jenkins methodology or ARIMA models were used for this purpose.

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Many domestic as well as foreign authors have used the ARIMA model in their research, thus predicting production and economic indicators in agriculture, and therefore in crop production (Ivanisević, 2015; Bussay et al., 2015; Hossain, Abdulla, 2015; Novković et al., 2016; Ilić et al., 2016; Iqbal et al., 2016; Jadhav et al., 2017; Santosha et al., 2017; Sharma et al., 2018; Nedeljković, Krstić, 2019). For example, in their paper, Nedeljković and Maksimović (2019a) make a prediction of soybean production in the Republic of Srpska (RS) by selecting the appropriate ARIMA model. Obtained results show that in the coming years, it is expected that the area of this oilseed plant will decrease continuously, and that the production and yield of soybeans will show oscillatory movement in the five-year prediction period.

When it comes to forecasting the prices of certain vegetable crops, Ivanišević et al. (2015) analyse the changes and future tendencies of the price parameters of tomatoes in Serbia using descriptive statistics to analyse the time series of data within the scope of seventeen years (1994-2010), while for the forecasting in the following five years (2011-2015) the authors have used appropriate ARIMA models.

Mutavdžić et al. (2016), using the ARIMA model, predicted the movement of wheat and corn prices and their parities up to the year 2020 in Serbia.

Method and data sources

In the process of collecting, collating and presenting data for analysis in this research, we use the *descriptive analysis method*. It will also be used as a method of determining specific indicators that are relevant to the description of observed features. The descriptive statistics method is used for research purposes to analyse observed features in the period 2005-2017. This include: average value, variation interval/extreme values, coefficient of variation and change rate.

For the purpose of explaining and evaluating variability, as well as statistical inference and predicting the behaviour of observed phenomena in the future, the analytical statistical method will be used.

The prediction of observed phenomena refers to a five-year period, (2018-2022), and ARIMA (*Autoregressive Integrated Moving Average*) models based on time series analysis were used for prediction.

The economic indicators taken for analysis and forecasting of the selected industrial crops are price, as an absolute indicator, and price parity as a relative price indicator. Price analysis covers the period 2005-2017.

The analysis and forecasting of the price parity of the analysed industrial plants were done according to the prices of wheat, which in this case was selected as a competitive crop species in relation to which the economic position of each industrial plant that was the subject of this research was intended to be predicted.

All prices analysed are average annual prices of observed crops in Republic of Srpska published by Republic of Srpska Institute of Statistics, which have been converted from Bosnian marks (BAM) to Euros (EUR) for the purposes of the research in this paper.

The sources of data used in the paper were the data from the Statistical Yearbooks of the Republic of Srpska (Institute of Statistics) for the period 2005-2017, followed by statistical bulletins containing the necessary data for observed municipalities, as well as other available relevant data sources from the websites of the Republic Institute and the line Ministries. The data collected were processed with adequate statistical software (*Statistica 13.1, Eviews 10, SPSS*).

Research results with discussion

Within the analysed period average price of soybeans was 330.63 EUR/t with increasing tendency and annual change rate of 3.25%. The coefficient of variation of 21.14% shows a relatively unstable movement in the observed period with a minimum of 228.9 EUR/t reached at the beginning of analysed period up to a maximum of 495.39 EUR/t recorded in 2012 (Table 1.).

Table 1. Indicators of soybean prices in Republic of Srpska (2005-2017)

Average value (EUR/t)	Min. (EUR/t)	Max. (EUR/t)	Coeff. of variation (%)	The rate of change (%)
330,63	228,9	495,39	21,14	3,25

Source: Authors calculation based on data ISRS, 2019.

The estimated model for analysis and forecasting of soybean prices shows that the price level of the current year is affected by soybean prices from the previous two years, as like random fluctuations from the previous year, with only random fluctuations showing statistical significance (Table 2.).

Table 2. A model for predicting soybean prices

Paramet.	Input: soybean price Transformations: D(1), D(1) Model: (2,1,1)(0,1,0) MS Residual=8055,6					
	Param.	Asympt. Std. Err.	Asympt. t(7)	P	Lower 95% Conf	Upper 95% Conf
Constant	0,786589	3,336623	2,357441E-01	0,820380	-7,10327	8,676448
p(1)	-0,020627	0,436067	-4,730251E-02	0,963593	-1,05176	1,010506
p(2)	-0,497817	0,431109	-1,154734E+00	0,286092	-1,51723	0,521595
q(1)	0,999898	0,000000	7,293952E+16	0,000000	0,99990	0,999898

Source: Results of the research.

Forecasting soybean prices with the estimated model is showing that a constant price growth can be expected in coming period. In last year the soybean prices will be for 22% higher than the average price in 2005-2017 (Table 3.).

Table 3. Soybean price forecasting (2018-22)

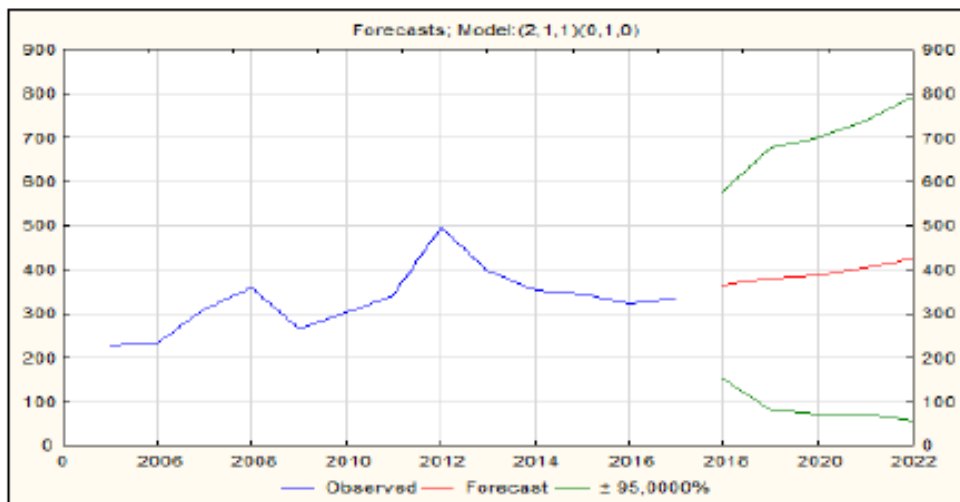
Years	Forecasts; Model: (2,1,1)(0,1,0) Input: Soybean price Start of origin: 1 End of origin: 13			
	Forecast	Lower 95,0000%	Upper 95,0000%	Std. Err.
2018	365,8894	153,6574	578,1214	89,7529
2019	379,6056	82,5284	676,6828	125,6340
2020	386,7366	72,5275	700,9456	132,8790
2021	403,2030	71,3707	735,0353	140,3319
2022	423,9496	55,9156	791,9836	155,6416

Source: Forecast results

The following chart (Chart 1.) confirms the continued rise in the price of soybeans over the forecast period.

Soybean is characterized by very favourable price parity for wheat. Namely, the average of this parity is 1.9 and ranges from 1.45 to 2.31. In the analysed period, this parity shows quite stability with a calculated coefficient of variation of 11.26%, as well as a tendency of faster price growth in relation to wheat at a change rate of 1.16% (Table 4.).

Chart 1. Soybean price movement



Source: Forecast results

Table 4. Indicators of soybean price parity in Republic of Srpska (2005-2017)

Average	Min.	Max.	Coeffi. of variation (%)	The rate of change (%)
1,9	1,45	2,31	11,26	1,16

Source: Authors calculation based on data ISRS, 2019.

The estimated ARIMA model shows that the current year parity is significantly affected by random fluctuations from the previous two years (Table 5.).

Table 5. A model for forecasting soybean / wheat price parity

Paramet.	Input: Soybean/wheat Transformations: D(1) Model: (0,1,2) MS Residual=,05878					
	Param.	Asympt. Std. Err.	Asympt. t(8)	p	Lower 95% Conf	Upper 95% Conf
Constant	0,021374	0,013330	1,603453E+00	0,143298	-0,008781	0,051529
q(1)	0,635934	0,000000	3,890981E+11	0,000000	0,635964	0,635964
q(2)	0,363994	0,000000	3,890981E+11	0,000000	0,363994	0,363994

Source: Research results

Soybean/wheat parity values obtained from the estimated ARIMA model (0,1,2) show that this parity tends to increase in the future year by year. By the end of the prediction period (2022), tons of soybeans will be worth just under 2.2 tons of wheat (Table 6.).

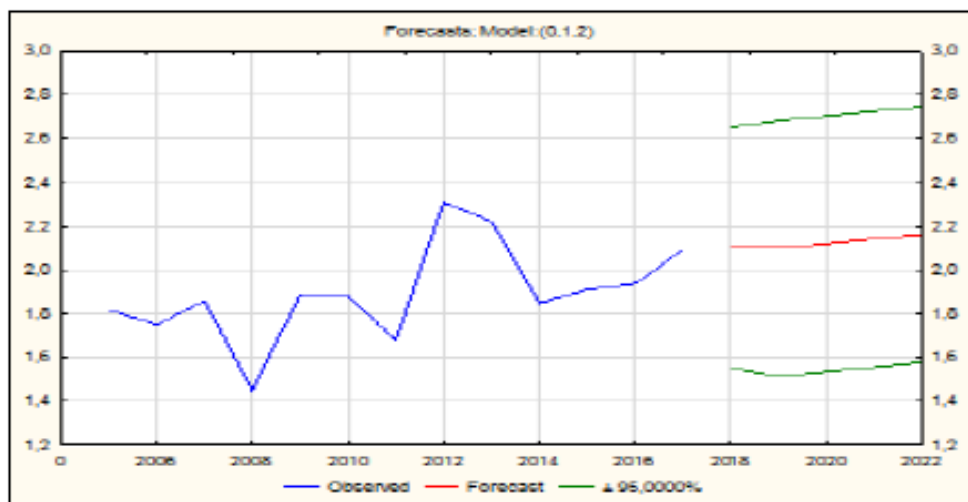
Table 6. Predicting soybean/wheat price parity (2018-22)

Years	Forecasts; Model: (0,1,2) Input: soybean/wheat Start of origin: 1 End of origin: 13			
	Forecast	Lower 95,0000%	Upper 95,0000%	Std. Err.
2018	2,099710	1,551280	2,648139	0,242437
2019	2,097846	1,514201	2,681491	0,258004
2020	2,119220	1,535576	2,702865	0,258004
2021	2,140595	1,556950	2,724239	0,258004
2022	2,161969	1,578325	2,745614	0,258004

Source: Forecast results

Below is a graphical representation of the movement of this parity which shows that significant fluctuations were present in the analysed period, but that in the forecasting period the soybean-wheat price ratio will stabilize (Chart 2).

Chart 2. Soybean/Wheat Price Parity Movement



Source: Forecast results

What characterized the price of rapeseed in the observed period was a growth tendency that was 3.62%. The average price was at the level of 339.06 EUR/t and ranged from 202.51 EUR/t (2006) to 444.31 EUR/t (2012). The coefficient of variation that measured the stability in price movement of this industrial plant was 22.72% (Table 7.).

Table 7. Indicators of rapeseed in Republic of Srpska (2005-2017)

Average (EUR/t)	Min. (EUR/t)	Max. (EUR/t)	Coeff. of variation (%)	The rate of change (%)
339,06	202,51	444,31	22,72	3,62

Source: Authors calculation based on data ISRS, 2019.

The values of the estimated model for the prediction of rapeseed show that the prices from the previous three periods have a statistically significant effect on the price of rapeseed (Table 8.).

Table 8. A model for forecasting the price of rapeseed

Paramet.	Input: the price of rapeseed Transformations: none Model: (3,0,0) MS Residual=4964,9					
	Param.	Asympt. Std. Err.	Asympt. t(9)	P	Lower 95% Conf	Upper 95% Conf
Constant	226,8652	137,4673	2	0,133274	-84,1074	537,8378
p(1)	0,7358	0,0000	38341571	0,000000	0,7358	0,7358
p(2)	-0,0654	0,5942	-0	0,914785	-1,4096	1,2788
p(3)	0,3295	0,0000	383415371	0,000000	0,3295	0,3295

Source: Research results

The projected price values show that the price of rapeseed will alternate between from year to year. At the end of the forecast period, the price is expected to be about six percent higher than the average realized price in the observed period (Table 9.).

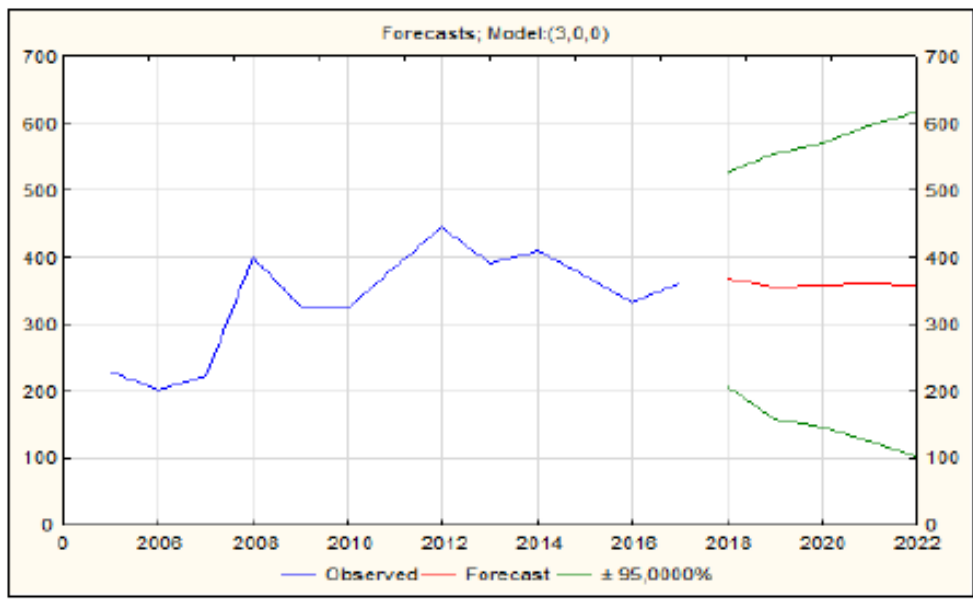
Table 9. Forecasting the price of rapeseed (2018-22)

Years	Forecasts; Model: (3,0,0) Input: the price of rapeseed Start of origin: 1 End of origin: 13			
	Forecast	Lower 95,0000%	Upper 95,0000%	Std. Err.
2018	367,6965	208,2996	527,0933	70,4623
2019	356,6006	158,6999	554,5013	87,4832
2020	357,6949	145,7437	569,6461	93,6943
2021	361,0624	126,4061	595,7186	103,7312
2022	359,8122	101,5835	618,0409	114,1515

Source: Research results

A graphical representation of the price trend for rapeseed shows that prices fluctuated significantly in the analysed period and will decrease during the forecast period (Chart 3.).

Chart 3. The movement of the rapeseed price



Source: Forecast results

The average price parity of rapeseed/wheat of 1.94 shows that, during the analysed period, rapeseed worth almost twice as compared to wheat. The calculated coefficient of variation of 14.53% shows that it is a relatively stable movement of this parity over the observed period. That the price of rapeseed had a higher tendency to increase, compared to wheat, also shows the annual change rate of 1.83%. Rape/wheat parity differs from 1.33 (minimum) to 2.30 (maximum), (Table 10.).

Table 10. Indicators of price parity for rapeseed in Republic of Srpska (2005-2017)

Average (EUR/t)	Min. (EUR/t)	Max. (EUR/t)	Coeff. of variation (%)	The rate of change (%)
1,94	1,33	2,30	14,53	1,83

Source: Authors calculation based on data ISRS, 2019.

The model for the forecasting of rapeseed/wheat price parity shows that the parity value in the current year is influenced by the parity values from the previous two years, with a statistically significant parity from the previous year (Table 11.). Based on the estimated model, the expected parity values for the next five-year period are also predicted (Table 12.). The projected values show that it can be expected that the rapeseed/wheat price parity will drop constantly until the end of the forecast period.

Table 11. A model for forecasting price parity of rapeseed/wheat

Paramet.	Input: rapeseed/wheat Transformations: none Model: (2,0,0) MS Residual=,06378					
	Param.	Asympt. Std. Err.	Asympt. t(10)	P	Lower 95% Conf	Upper 95% Conf
Constant	1,965216	0,123502	15,91236	0,000000	1,69004	2,240397
p(1)	0,780141	0,33005	2,34273	0,041147	0,03816	1,522121
p(2)	-0,359295	0,331116	-1,08510	0,303342	-1,09707	0,378478

Source: Research results

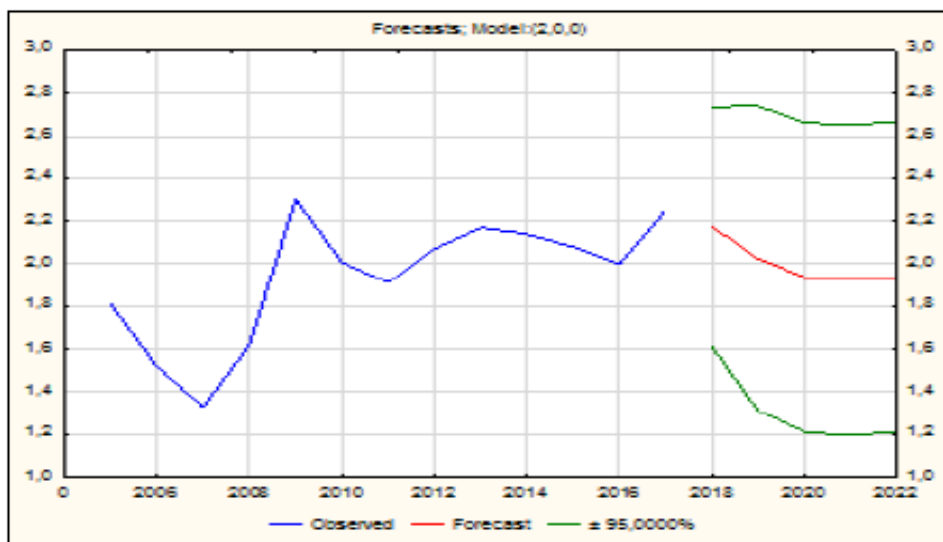
Table 12. Forecasting the price parity of rapeseed/wheat (2018-2022)

Years	Forecasts; Model: (2,0,0) Input: rapeseed/wheat Start of origin: 1 End of origin: 13			
	Forecast	Lower 95,0000%	Upper 95,0000%	Std.Err.
2018	2,174890	1,612168	2,737612	0,252552
2019	2,026470	1,312762	2,740177	0,320316
2020	1,937668	1,210301	2,665035	0,326446
2021	1,921716	1,192749	2,650684	0,327164
2022	1,941178	1,212100	2,670257	0,327214

Source: Forecast results

Chart 4 shows that there is a decline in the price of rapeseed compared to the price of wheat.

Chart 4. Price parity movements of rapeseed/wheat



Source: Forecast result

The price of tobacco is by far the highest among all crop species observed so far and its average for the period 2005-2017 was 1562.22 EUR/t. The price growth rate of this industrial plant in the analysed period was slightly below one percent and recorded moderate variability. The lowest tobacco price of 1,210.26 EUR/t was recorded in 2007, and the highest price of 1877.45 EUR/t was recorded in 2013 (Table 13.).

Table 13. Basic tobacco price indicators in Republic of Srpska (2005-2017)

Average (EUR/t)	Min. (EUR/t)	Max. (EUR/t)	Coeff. of variation (%)	The rate of change (%)
1562,22	1210,26	1877,45	12,71	0,96

Source: Authors calculation based on data ISRS, 2019.

Following could be inferred from the value of the estimated ARIMA model (0,1,2), (Table 14.).

Table 14. A model for forecasting tobacco prices

Paramet.	Input: tobacco price Transformations: D(1) Model: (0,1,2) MS Residual=30438,					
	Param.	Asympt. Std. Err.	Asympt. t(9)	p	Lower 95% Conf	Upper 95% Conf
Constant	29,80546	8,592571	3	0,007063	10,36772	49,24321
q(1)	0,79160	0,000000	619076837	0,000000	0,79160	0,79160
q(2)	0,20838	0,000000	619076837	0,000000	0,20838	0,20838

Source: Research results

Based on the estimated model, expected tobacco prices are forecasted for the period 2018-2022. The forecasted values show that a constant increase of tobacco prices can be expected in the future period, so that at the end of the forecasting period it will be at the level higher than 18% of the average realized price, i.e. 1% more than the maximum price (Table 15.).

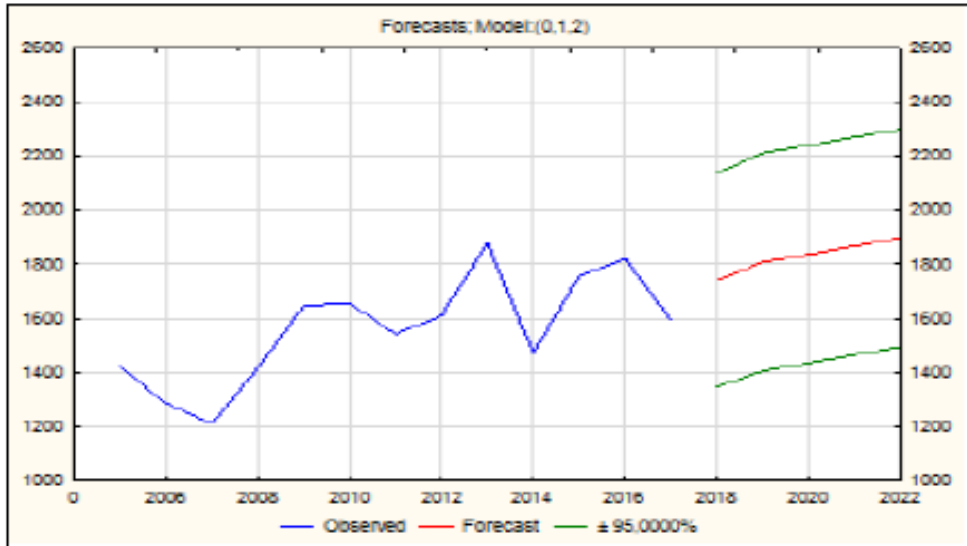
Table 15. Tobacco price forecasting (2018-2022)

Years	Forecasts; Model: (0,1,2) Input: tobacco price Start of origin: 1 End of origin: 13			
	Forecast	Lower 95,0000%	Upper 95,0000%	Std. Err.
2018	1742,247	1347,581	2136,914	174,4648
2019	1807,981	1404,835	2211,127	178,2132
2020	1837,787	1434,640	2240,933	178,2132
2021	1867,592	1464,446	2270,738	178,2132
2022	1897,398	1494,251	2300,544	178,2132

Source: Forecast results

The graphical presentation of tobacco prices in the analysed and forecast period confirms that a constant increase in prices of this crop can be expected (Chart 5.).

Chart 5. Tobacco price movement



Source: Forecast results

Of all the industrial plants analysed so far, tobacco had the most favourable price parity against wheat, which is understandable, since it is a highly commercial type of industrial plant. The average of this parity is 9.22 and ranged from 5.74 to 11.63. The coefficient of variation was 19.25% and a negative annual rate of -1.06 indicated that the tendency for a decrease in the price of tobacco for the analysed period was greater than a decrease in the price of wheat (Table 16.).

Table 16. Basic indicators of tobacco price parity in Republic of Srpska (2005-2017)

Average value	Minimum	Maximum	Coefficient of variation (%)	The rate of change (%)
9,22	5,74	11,63	19,25	1,06

Source: Authors calculation based on data ISRS, 2019.

The model for forecasting tobacco/wheat price parity shows that random fluctuations from the previous two years have a statistically significant effect on the value of parity in the current year (Table 17.).

This parity in the analysed period was characterized by a declining tendency. Predicted parity values for 2018-2022 show that this tendency will continue in the future. From year to year the value of tobacco/wheat parity will be reduced to the level of 7.9 tons of wheat for 1 ton of tobacco (Table 18.).

Table 17. A model for forecasting tobacco/wheat price parity

Paramet.	Input: tobacco/wheat Transformations: D(1) Model: (0,1,2) MS Residual=5,6666					
	Param.	Asympt. Std. Err.	Asympt. t(9)	P	Lower 95% Conf	Upper 95% Conf
Constant	-0,210764	0,138355	-1,523362E+00	0,162002	-0,523744	0,102216
q(1)	0,550479	0,000000	3,460472E+10	0,000000	0,550479	0,550479
q(2)	0,449519	0,000000	3,460472E+10	0,000000	0,449519	0,449519

Source: Research results

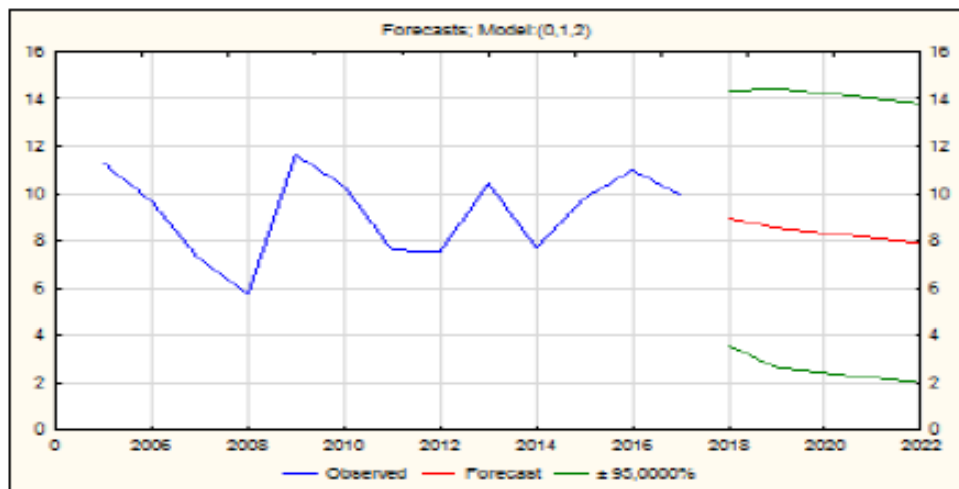
Table 18. Tobacco/wheat price parity forecasting (2018-2022)

Years	Forecasts; Model: (0,1,2) Input: tobacco/wheat Start of origin: 1 End of origin: 13			
	Forecast	Lower 95,0000%	Upper 95,0000%	Std. Err.
2018	8,959541	3,574564	14,34452	2,380461
2019	8,540044	2,636014	14,44407	2,609912
2020	8,329280	2,425250	14,23331	2,609912
2021	8,118516	2,214486	14,02255	2,609912
2022	7,907752	2,003722	13,81178	2,609912

Source: Forecast results

The graph of tobacco/wheat price parity movements confirms the above-mentioned parity movement characteristics (Chart 6.).

Chart 6. Tobacco/Wheat Price Parity Movement



Source: Forecast results

Conclusion

On the basis of the above, we can draw the following conclusions:

- The conducted research shows that a constant increase in soybean prices can be expected over the next five-year period, where the price will eventually reach the level of 423.94 EUR/t. The average parity of the price of soybeans to wheat is very favourable and has a fairly stable movement. There was also a positive tendency of growth of this parity.
- The price of rapeseed was characterized by an upward trend. During the current period, prices from the previous three periods have significantly influenced it, and based on the results of the research, oscillatory movement can be expected in the next five-year period, where the price will invariably rise and fall, and eventually reach a value of 359.81 EUR/t. The average price parity of rapeseed/wheat was very favourable for rapeseed, where rapeseed was worth almost twice as much as wheat and which also tended to grow. This parity is significantly influenced by the ratio of rapeseed and wheat from the previous year, and a constant decline in the value of this parity is expected throughout the forecast period until the last year of forecasting (2022).
- Tobacco prices are affected by random fluctuations from the previous two periods and the projected values show that a constant price increase can be expected, which in the last year will reach the value of 1897.40 EUR/t,

and will exceed the maximum realized price from 2013. In relation to the price of tobacco, its relation with wheat shows a negative tendency. In the prediction period, the tendency of a constant decline of this parity can be expected to continue.

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