VEGETABLE PRICES IN SERBIA – TENDENCIES AND FORECASTING

Šumadinka Mihajlović[1], Nataša Vukelić [2], Nebojša Novković[3], Beba Mutavdžić[4]

*Corresponding author E-mail: vukelicn@polj.uns.ac.rs

A B S T R A C T

The subject of this paper is analysis of the tendencies and forecast of the prices of most significant vegetable crops in Serbia: potato, bean, tomato, pepper, onion, cabbage and watermelon. The aim of the paper is to forecast the absolute prices of the studied vegetables. Time series analysis of vegetable prices expressed in euro per ton (2002-17) was performed by means of descriptive statistics, while adequate ARIMA models were used for price forecasting (2018-22). The analysis of the studied vegetable crops showed that bean had the highest average annual price, while watermelon had the lowest. The price of tomato showed the highest fluctuations over the years, while the lowest were for onion and cabbage. All vegetable crops showed a tendency of absolute increase in prices expressed in euro. Based on the foregoing, it can be concluded that the market position of vegetables is generally improving, but oscillations will continue to occur.

Introduction

Vegetable production is one of the most intensive branches of plant production, and along with grain production, it is one of the most intensive branches of arable land production. This is confirmed both by the yields produced per unit of area, i.e. the amount of organic matter produced annually per unit of area, and by achieved economic

1   Šumadinka Mihajlović, Mr.Sci., Ph.D. student, University of Novi Sad, Faculty of Agriculture, Serbia, Phone: +38163287971, E-mail:mihajlovic.sumadinka@gmail.com, https://orcid.org/0000-0003-0670-786X

2   Nataša Vukelić, Ph.D., Assistant Professor, University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, Phone: +381214853392, E-mail: vukelicn@polj.uns.ac.rs, Serbia ORCID ID (https://orcid.org/0000-0001-7516-9204)

3   Nebojša Novković, Ph.D., Full Professor, University of Novi Sad, Faculty of Agriculture, Trg D. Obradovica 8, Novi Sad, Serbia, Phone: +38162200132, E-mail: nesann@polj.uns.ac.rs, https://orcid.org/0000-0003-2419-5765

4   Beba Mutavdžić, Ph.D., Associate Professor, University of Novi Sad, Faculty of Agriculture, Trg D. Obradovica 8, Novi Sad, Serbia, Phone: +38162200133, E-mail: bebam@polj.uns.ac.rs, https://orcid.org/0000-0002-7631-0465

effects. Bearing in mind the importance that this branch of agriculture has in both the production and economic sense for producers as well as for agriculture as a whole, it is justified to expect its further development. The subject of the research in this paper is analysis of the tendencies and forecast of the prices of most significant vegetable crops in Serbia: potato, bean, tomato, pepper, onion, cabbage and watermelon. The aim of the paper is to use time series analysis of vegetable prices from the past period as a basis for forecasting the absolute prices of these vegetables expressed in euro for the future period and forecasting economic (market) conditions for production of these crops.

There are numerous examples of applying quantitative and qualitative methods in analysing, modelling, forecasting and planning of production and economic characteristics of agricultural products and inputs in agriculture. Bannikova et al. (2018) analyzed the alternatives of development of the Russian vegetables market concerning the changes of the level and structure of production and consumption of vegetables. The main objectives of the research were to collect and analyze data of the Russian market of vegetable production, modeling and scenario forecasting vegetables market, a substantiation of directions of development of the market. Mutavdžić et al. (2007) analysed the tendencies and forecast the movements in price parities of fattening pigs and commercial maize. Novković et al. (2008) analysed the possibilities for future development of vegetable production in Serbia and Vojvodina using the SWOT analysis. Vukelić, Novković (2009) analysed the economic results of milk production on large family farms. Husemann, Novkovic, (2014) defined a quantitative model for managing a multifunctional farm. Mutavdžić et al. (2010) focused on forecasting of price parities of the main field crops based on time series analysis and the application of the ARIMA model. Mutavdžić et al., (2017) analysed quarterly movements of wheat and maize retail prices in Serbia and the Republic of Srpska in the period 2010-15. By applying the method of ratio to the overall quarterly average, the results showed that the prices of grains in the Republic of Srpska are higher. Ivanišević et al. (2015) analysed the movements of tomato prices in Serbia using the method of descriptive statistics, followed by forecasting its value in the future period based on time series analysis. Jasinthan et al. (2015) by using a Markov chain model analyzed and predicted vegetable price movement in Jaffna. Novković, Mutavdžić (2016) performed the analysis of bean prices in Serbia by means of descriptive statistics. On the basis of these results, an adequate ARIMA model was applied to forecast the movements of bean prices for the following period. Mutavdžić et al.(2011) analysed the tendencies in development of vegetable production in Serbia, concluding that in the period 2001-10 the total vegetable production in Serbia significantly increased, primarily as a result of intensification of production, i.e. yield increase. The study showed the following average annual increase in production: pea 56%, pepper 26%, carrot 20%, potato 18%, cucumber 17%, cabbage and kale 13%, watermelon 12%, tomato and onion 5% and garlic 2%. Increasing trends in production were found for the following vegetables: tomato, pea, onion, pepper, bean, carrot and cucumber. Decreased trends in production were determined for potato, watermelon and garlic, while cabbage and kale showed the

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general tendency of stagnation in production. Novković et al. (2013) focused on the analysis and tendencies of development of vegetable production in Vojvodina. In the period 2001-10 the harvested areas of the studied vegetables were reduced for almost all vegetable crops, except for pea, pepper and garlic, for which the harvested area was slightly larger compared to the previous decade. The yields of all studied vegetable crops increased (except for tomatoes) and the total vegetable production significantly increased as a result of intensification of production.

Materials and methods

The research methods applied in this paper were selected based on the described subject and aim of the research. The statistical methods included descriptive statistics and time series analysis. Descriptive statistics was used for analysis of the vegetable prices in the studied period. Forecasting of the vegetable prices was carried out using the ARIMA models, based on time series analysis. Time series analysis was conducted using the prices of seven major vegetable crops in Serbia (potato, bean, tomato, pepper, onion, cabbage and watermelon). The average annual vegetable prices in the analysis were converted into euro per tonne to enable comparison with foreign countries and to reduce the factor of domestic inflation. The absolute vegetable prices were analysed for the period 2002-17, starting thus from the year when euro entered into circulation. Conversion of the prices into euro was carried out according to the average annual exchange rate of euro based on the data of the National Bank of Serbia. Since there were shorter time series, the forecast of the vegetable prices was made for a period of five years: 2018-2022. The series of studied phenomena in this paper were either taken entirely or formed on the basis of statistical publications of the Statistical Office of the Republic of Serbia. Statistical software used for the analysis of the collected data included Statistica 10, Eviews 3.1 and SPSS.

Results

Analysis and forecast of potato prices

The average potato price in the period 2002-17 was 183.3 EUR/t. The price ranged from 84.5 EUR/t in 2005 to 249 EUR/t in 2013. The coefficient of variation was relatively high: 27%. The average annual price of potato had a rather pronounced tendency of growth, at an average annual rate of 3.83%. Such relatively high growth rate of potato price is an indicator of the improvement of its absolute position on the market. The analysis and forecasting model shows that potato price in a certain year is significantly influenced by random processes from the preceding two periods (Table 1).

On the basis of the estimated model, potato prices for the period 2018-22 were forecast (Table 2), indicating that in the following five year-period potato price will fluctuate over the years (which was also the case in the analysed period). These findings are illustrated by a graphical representation of potato price movements (Figure 1).

Table 1. Model parameters for forecasting potato prices

Paramet.	Input: Krompiret: Transformations: D(1) Model:(1,1,2) MS Residual= 2943,9					
	Param.	Asympt. Std.Err.	Asympt. t(12)	p	Lower 95% Conf	Upper 95% Conf
p(1)	-0,694871	0,379337	-1,83180	0,091904	-1,52138	0,131634
q(1)	-0,266954	0,333751	-0,79986	0,439339	-0,99414	0,460227
q(2)	0,552352	0,226873	2,43463	0,031465	0,05804	1,046666

Table 2. Forecast of potato prices (2018-22)

CaseNo.	Forecasts; Model:(1,1,2) Input: Krompiret: Start of origin: 1 End of origin: 16			
	Forecast	Lower 95,0000%	Upper 95,0000%	Std.Err.
17	200,3884	82,17182	318,6050	54,25735
18	188,5011	52,30655	324,6956	62,50860
19	196,7612	55,50266	338,0198	64,83283
20	191,0215	38,15485	343,8881	70,16053
21	195,0099	35,97128	354,0485	72,99324

Figure 1. Changes in potato prices

http://ea.bg.ac.rs
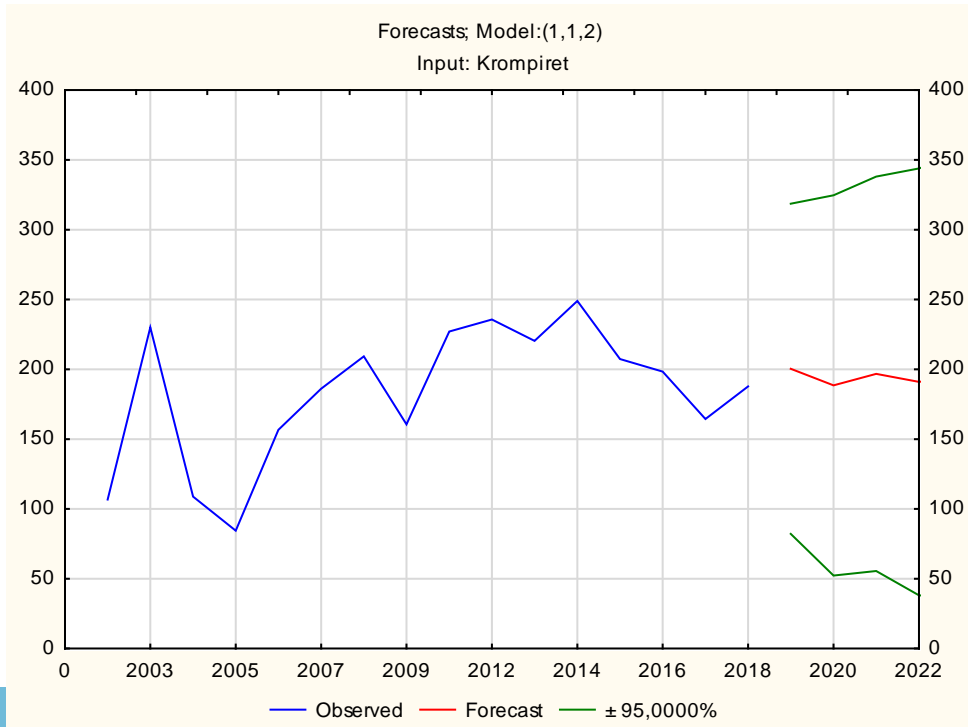
Analysis and forecast of bean prices

In the analysed period, the average annual price of bean was 1,333.6 EUR/t, ranging from 948.4 EUR/t in 2004 to 2,213.2 EUR/t in 2014. The coefficient of variation was, similarly to potato, moderately high amounting to 28.5%. The absolute average annual price of bean also showed a tendency of increase, but it was slightly lower compared to potato. The average annual growth rate of bean was 1.33%, which means that bean showed the tendencies of slight improvement of its absolute price (economic) position on the market. Bean production is characterised by oscillations, which is reflected also in the prices of this crop. Bean price in a certain year is influenced by the price from the preceding year, and it is statistically significantly influenced by a random process from the preceding two years (Table 3).

**Table 3.** Model parameters for forecasting bean prices

Paramet.	Param.	Asympt. Std.Err.	Asympt. t(11)	p	Lower 95% Conf	Upper 95% Conf
	Input: PASULJET: Transformations: D(1) Model:(1,1,2) MS Residual= 79536,					
Constant	17,18598	18,88401	9,100810E-01	0,382289	-24,3774	58,74939
p(1)	0,27152	0,32447	8,368215E-01	0,420501	-0,4426	0,98567
q(1)	0,32940	0,00000	2,011084E+16	0,000000	0,3294	0,32940
q(2)	0,67050	0,00000	5,039653E+32	0,000000	0,6705	0,67050

The estimated model provided the forecast values of bean prices for the five-year period (Table 4), showing that bean price will alternatively decline and grow over the years. The graphical representation of changes in bean prices is given in Figure 2.

Table 4. Forecast of bean prices (2018-22)

| CaseNo.	Forecast	Lower 95,0000%	Upper 95,0000%	Std.Err.
	Forecasts; Model:(1,1,2) Input: PASULJET: Start of origin: 1 End of origin: 16			
17	1596,261	975,5357	2216,986	282,0215
18	1487,382	634,5705	2340,194	387,4682
19	1470,339	602,8603	2337,818	394,1321
20	1478,231	609,6779	2346,785	394,6203
21	1492,894	624,2604	2361,527	394,6566

Figure 2. Changes in bean prices
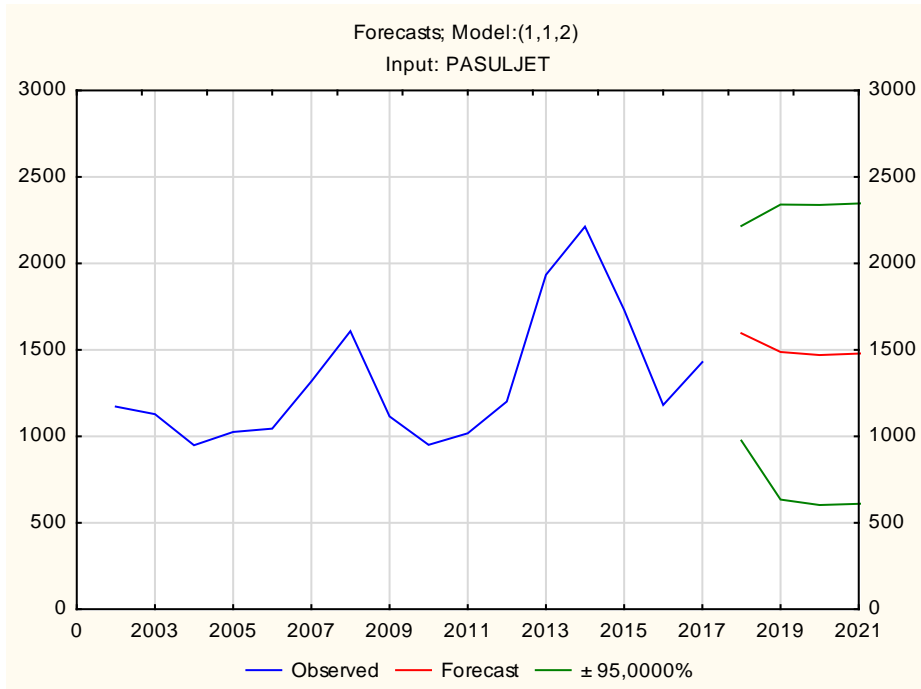
Analysis and forecast of tomato prices

The average annual price of tomato in the analysed period was 298.2 EUR/t. The price varied within the range of 106.6 EUR/t in the first year of the analysed period (2002) to 564.9 EUR/t in 2014. The coefficient of variation of the average annual tomato price was extremely high amounting to 44.6%. The average annual rate of price change was the highest for tomato compared to other analysed vegetable crops, amounting to 9.1%. This means that tomato had the most pronounced tendency of price growth of all analysed vegetable crops, i.e. it had the tendency of the greatest improvement of economic (price) conditions for its production. Unlike the potato prices, the forecast price of tomato in the following five years showed a tendency of increase. The forecast values were obtained on the basis of the estimated model (Table 5), which shows that tomato price in a current year is significantly influenced by its price in the preceding year. The tendency of increasing prices in the following period is illustrated graphically (Figure 3).

Table 5. Forecast of tomato prices (2018-22)

CaseNo.	Forecasts; Model:(1,1,0) Input: Paradajzet Start of origin: 1 End of origin: 16			
	Forecast	Lower 95,0000%	Upper 95,0000%	Std.Err.
17	444,9676	223,4167	666,5184	102,5523
18	441,5752	213,7784	669,3720	105,4435
19	479,8995	188,7984	771,0006	134,7460
20	486,4824	183,6015	789,3633	140,1987
21	517,2167	175,6456	858,7877	158,1078

Figure 3. Changes in tomato prices

Forecasts; Model:(1,1,0)
Input: Paradajzet

— Observed — Forecast — ± 95,0000%
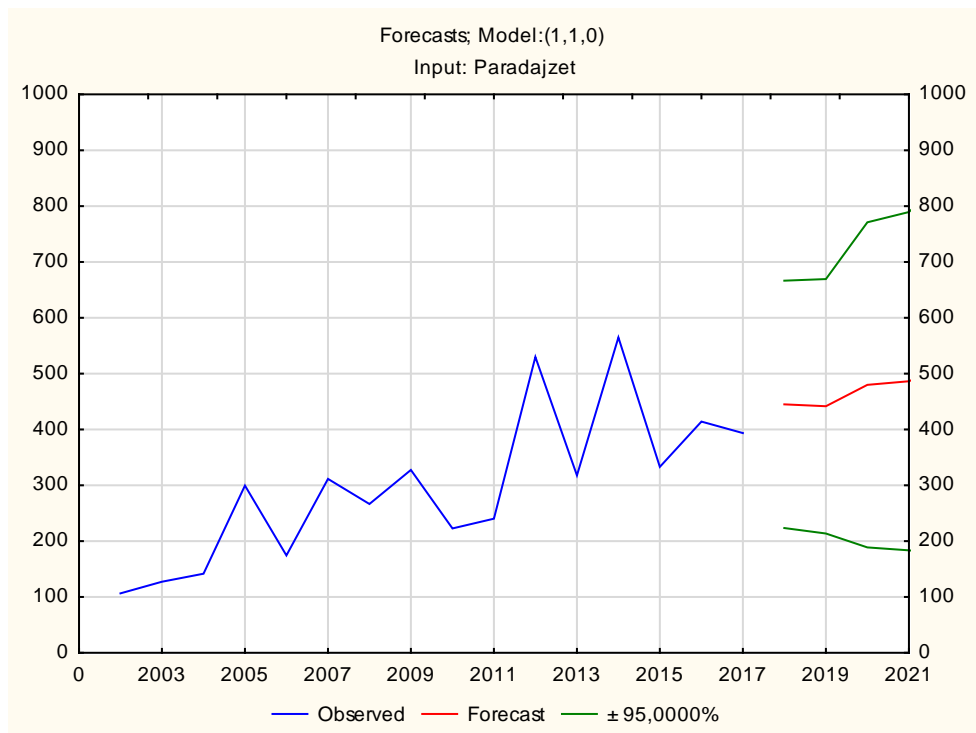
## Analysis and forecasting of pepper prices

In the analysed period, the average annual price of pepper was 310.5 EUR/t. The price varied within the range from 188.3 EUR/t in 2006 to 447.8 EUR/t in the last year of the analysed period (2017). The coefficient of variation of the average annual price of pepper was high, amounting to 31.3%. The average annual rate of change in pepper prices was very high and amounted to 5.87%. This means that pepper also had a significant tendency of absolute improvement of its economic position. Pepper price in a certain period was, as was the case with most other analysed vegetable crops, influenced by its

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prices in the preceding two years. The estimated model forecast pepper prices for the following five years (Table 6), showing that pepper price is expected to continuously increase over the years to the end of the forecast period (by 2022). The movements of pepper prices are given in Figure 4.

Table 6. Forecast of pepper prices (2018-22)

CaseNo.	Forecasts; Model:(2,1,0) Input: Paprikaet: Start of origin: 1 End of origin: 16			
	Forecast	Lower 95,0000%	Upper 95,0000%	Std.Err.
17	479,5019	359,3420	599,6619	55,14926
18	470,8765	339,5894	602,1637	60,25628
19	494,4590	361,6839	627,2341	60,93921
20	523,7226	369,7675	677,6776	70,66005
21	530,8480	363,7849	697,9110	76,67618

Figure 4. Changes in pepper prices
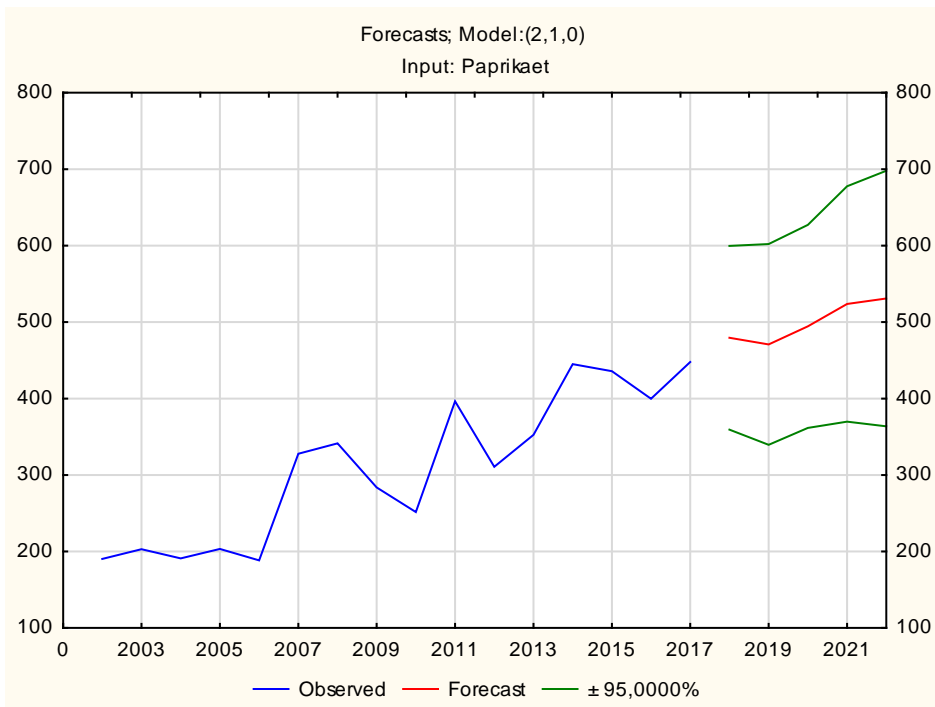
Analysis and forecast of onion prices

The average annual price of onion in the observed period amounted to 178.2 EUR/t, ranging from 119 EUR/t in 2004 to 270.7 EUR/t in 2011. The variation coefficient of the average annual price of onion was moderately high (but the lowest compared to

other analysed vegetables) and it amounted to 22%. The average annual rate of change in onion price was positive and amounted to 1.63%. This means that onion had a slight tendency of price increase in the analysed period, i.e. there was a tendency of slight improvement in the economic (price) conditions for its production.

Based on the prices in the period 2002-17, the estimated model showed that onion prices in an observed year were significantly influenced by the prices from the preceding two years. On the basis of the model, forecasting of onion prices was made for the period 2018-22 (Table 7), indicating that onion prices will continuously increase over the years during the forecast period. This is illustrated by graphical representation of price movements in the analysed and forecast period (Figure 5).

Table 7. Forecast of onion prices (2018-22)

CaseNo.	Forecasts; Model:(2,1,0) Input: Crniluket: Start of origin: 2 End of origin: 15			
	Forecast	Lower 95,0000%	Upper 95,0000%	Std.Err.
16	189,2947	154,1689	224,4205	15,76465
17	193,8105	135,6749	251,9461	26,09157
18	195,5434	131,2175	259,8693	28,86979
19	196,0136	130,0927	261,9345	29,58564
20	197,8529	128,2964	267,4094	31,21731

Analysis and forecast of cabbage prices

In the analysed period, the average annual price of cabbage was 158.8 EUR/t. The price ranged from 80.5 EUR/t in 2004 to 212.5 EUR/t in 2007. The coefficient of variation of the average annual price of cabbage was moderately high and amounted to 22.3%. The average annual rate of change in cabbage price was slightly positive and amounted to 1.48%. This means that cabbage had a slight tendency of absolute improvement of its economic (price) position. Cabbage price in a certain year was statistically significantly influenced by prices from the preceding period. Based on the estimated model, price movements were forecast for the following five years (Table 8), showing that the price of cabbage will fluctuate over the years, i.e. it will alternatively decrease and increase. These tendencies are confirmed by the graphical representation of price movements in the analysed and forecast period (Figure 6).
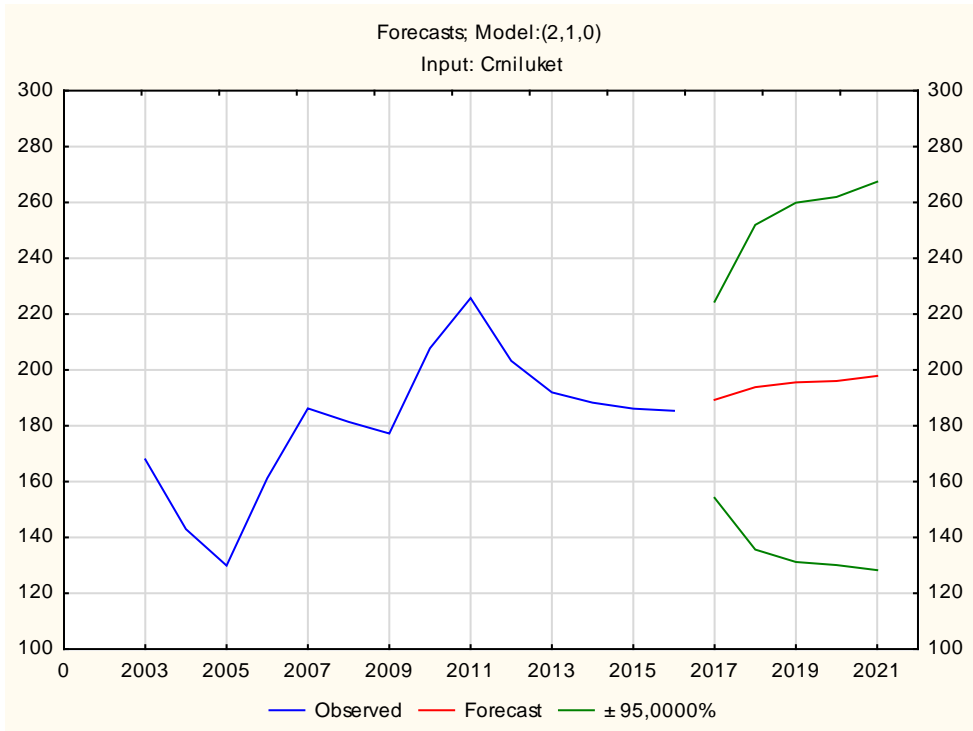
Figure 5. Changes in onion prices

Table 8. Forecast of cabbage prices (2018-22)

CaseNo.	Forecasts; Model:(1,1,0) Input: KIKET Start of origin: 1 End of origin: 16			
	Forecast	Lower 95,0000%	Upper 95,0000%	Std.Err.
17	156,3881	62,31970	250,4565	43,54276
18	169,6683	67,96312	271,3735	47,07769
19	164,9611	40,75553	289,1666	57,49276
20	170,8477	36,16592	305,5294	62,34202
21	170,4950	21,63835	319,3516	68,90334

**Figure 6.** Changes in cabbage prices
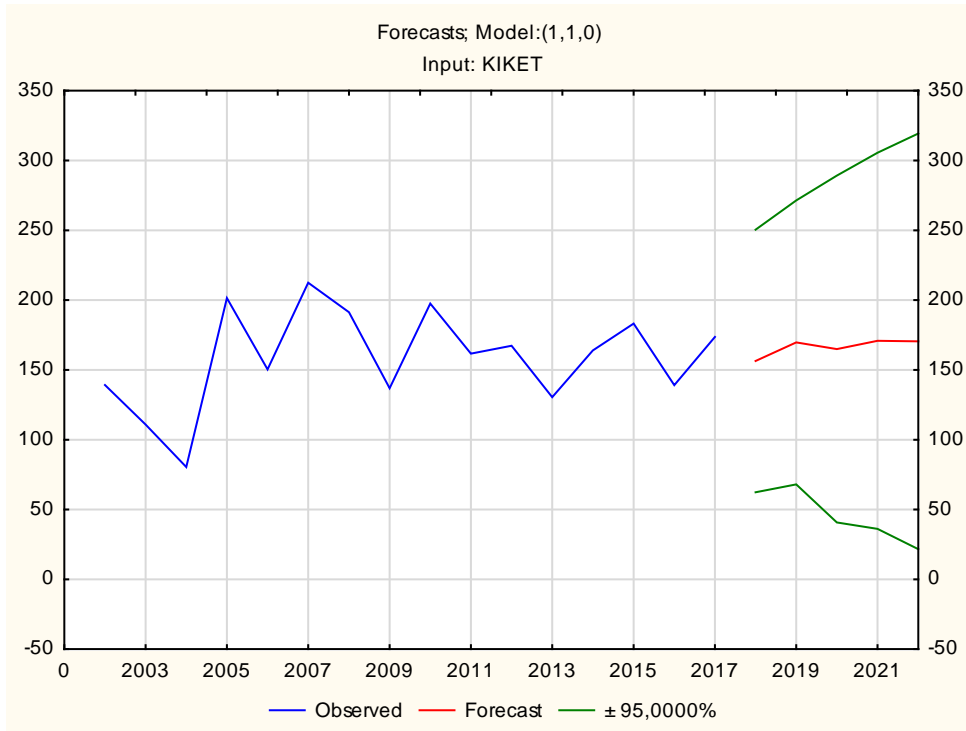
Analysis and forecast of watermelon prices

The average annual price of watermelon was 118.1 EUR/t. The price of watermelon varied from 68.4 EUR/t in 2004 to 213 EUR/t in 2010. The variation coefficient of the average annual price of watermelon was moderately high, amounting to 31.1%. The average annual rate of change in watermelon price was moderately high, amounting to 2.84%. This means that watermelon had a pronounced tendency of absolute improvement of its economic (price) position. The estimated model for analysing and forecasting watermelon prices showed that the price in a certain year was influenced by prices from the preceding two years, while the influence of the price from the previous year was statistically significant. On the basis of the estimated model, price movements of watermelon were forecast for the following five-year period (Table 9), showing that in the initial years the price will have a decreasing tendency, i.e. it will decrease in the first three years of the forecast period, while in the last two years of this period it is expected that watermelon price will increase. The indicated characteristics of watermelon price movements, especially the forecast values, are confirmed by the graphical representation of these movements (Figure 7).

Table 9. Forecast of watermelon prices (2018-22)

| CaseNo. | Forecasts; Model:(2,1,0) Input: DILET : Start of origin: 1 End of origin: 16 | | | |
	Forecast	Lower 95,0000%	Upper 95,0000%	Std.Err.
17	138,1975	48,98740	227,4075	40,94434
18	137,7790	43,75934	231,7986	43,15177
19	132,1873	33,50217	230,8725	45,29308
20	143,3726	29,86298	256,8823	52,09703
21	145,6496	25,77610	265,5231	55,01780

Figure 7. Changes in watermelon prices
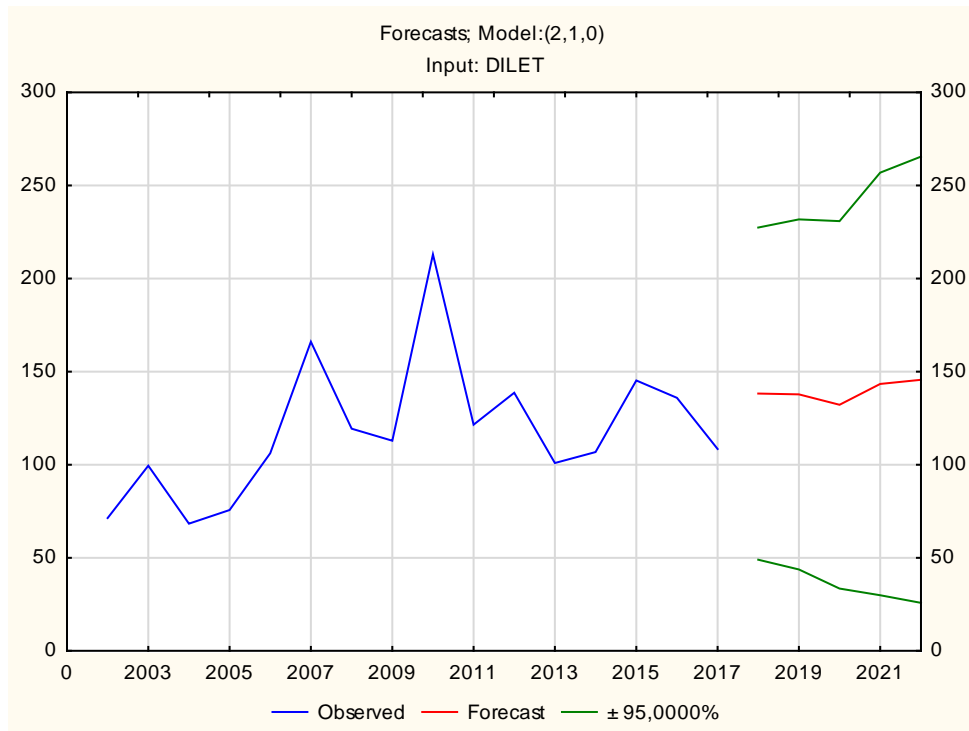
Discussion and Conclusion

The analysis which included seven vegetable crops indicated that in the period 2002-17 in Serbia bean had the highest average annual price, while watermelon had the lowest average annual price. The highest price fluctuations on the annual basis were found for tomatoes, while onion and cabbage had the lowest fluctuations (twice as low). All vegetable crops showed the tendency of absolute increase in prices expressed in euro. By far the highest average annual growth rate was found for tomato, whereas it was

the lowest for beans. Considering the prices of individual vegetable crops in the period 2018-22, the results of the forecast are as follows:

The price of potato will fluctuate over the years (which was also the case during the observed period). The price of this crop will range from 200 EUR/t in 2018 to 191 EUR/t in 2021.

The average price of bean will alternatively decline and grow over the years, within the range from 1.596 EUR/t in 2018 to 1.470 EUR/t in 2020.

Unlike the prices of potatoes and beans, the forecast price of tomato shows a tendency of increase from 441 EUR/t in 2019 to 517 EUR/t in 2022.

Continuous price growth was forecast for pepper throughout the whole forecast period: from 470 EUR/t to 530 EUR/t in 2022.

Continuous price growth was also forecast for onion: from 189 EUR/t in 2018 to 198 EUR/t in 2022.

The forecast values of cabbage price show that there will be minor oscillations over the years, i.e. the price will alternatively increase and decrease, but with a positive tendency. The price of cabbage will range from 156 EUR/t in 2018 to 170 EUR/t in 2022.

The price of watermelon will have a tendency of decrease in the initial years (the first three years of the forecast period), while in the last two years the price is expected to increase. The price of this crop will vary from 132 EUR/t in 2020 to 145 EUR/t in 2022.

Based on presented analysis, it can be concluded that the market position of vegetables is generally improving, but there will still be fluctuations and variability of their prices over the years.

Conflict of interests

The authors declare no conflict of interest.

References

1. Bannikova V. N, Onezhkina N. O., Agalarova G. E., Tenishchev V. A. (2018): Forecasting the tendencies of the Russian vegetables market development, *Journal of Business and Retail Management Research (JBRMR)*, 13 (1), 148 – 155.

2. Husemann, Ch., Novkovic, N. (2014): Farm management information systems: A case study of on a German multifunctional farm, *Economics of Agriculture 61 (2)*, (269-552), 441-453.

3. Ivanišević, A., Mutavdžić, B., Novković, N., Vukelić, N. (2015): Analysis and prediction of tomato price in Serbia, *Economics of Agriculture 62 (4)* (899-1178), 951-961.

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4. Jasinthan, P., Laheetharan, A., Satkunanathan, N. (2015): A Markov Chain Model for Vegetable Price Movement in Jaffna , *Sri Lankan Journal of Applied Statistics,* Vol (16-2), 93-105.

5. Mutavdžić B., Drinić Lj., Novaković , T., Vaško Ž., Novković, N. (2017): The Comparative Analysis of Grain Prices in Serbia and Republic of Srpska, Book of Abstracts, 6th International Symposium on Agricultural Sciences, University of Banja Luka, February 27 – March 2, 2017 Banja Luka, Bosnia and Herzegovina, ISBN 978-99938-93-41-7, 54.

6. Mutavdžić B., Novković, N., Nikolić-Đorić E., Radojević, V. (2007): Analysis and prediction of pig price parity – maize, *Conteporary Agriculture 1-2*, 177-181. [*in Serbian*: Мутавџић Б., Новковић, Н., Николић-Ђорић Е., Радојевић, В. (2007): Анализа и предвиђање паритета цена свиње - кукуруз].

7. Mutavdžić Beba, Novković N., Ivanišević D. (2011): Tendencies of vegetable development in Serbia, *Agroznanje 12 (1)*, University of Banja Luka, Faculty of Agriculture, 23-31. [*in Serbian*: Мутавџић Беба, Новковић Н., Иванишевић Д. (2011): Тенденције развоја повртарства у Србији].

8. Mutavdžić, B., Novković, N., Ivanišević, D. (2010): Prediction of parity of prices of basic agricultural products, AroSym, Faculty of Agriculture East Sarajevo, Jahorina, 176-182. [*in Serbian*: Мутавџић, Б., Новковић, Н., Иванишевић, Д. (2010): Предвиђање паритета цена основних ратарских производа].

9. Novković N., Ilin Ž, Janošević M., Mutavdžić B. (2008): Importance of vegetable production for the multifunctional rural development, Multifunctional agriculture and rural development, IEP, Book I, Belgrade, 141-148. [*in Serbian*: Новковић Н., лин Ж, Јаношевић М., Мутавџић Б. (2008), Значај производње поврћа за мултифункционални рурални развој, зборник радова међународног научног скупа, Мултифункционална пољопривреда и рурални развој III"].

10. Novković, N., Mutavdžić B. (2016): Analysis and forecasting of bean prices in Serbia, Proceedings of papers: Policy and Economics for Sustainable Agricultural and Rural Development, AAEM 10th International Conference, 12-14 May, Ohrid, Association of Agricultural Economists of the Republic of Macedonia, 195-203.

11. Novković, N., Mutavdžić B., Ilin, Ž., Ivanišević, D. (2013): Potato Production Forecasting, *Agroznanje 14 (3)*; Banja Luka, 345-355.

12. Vukelić N., Novković, N. (2009): Economic results of milk production on large households, *Economics of Agriculture, 56,* 99-110 [*in Serbian*: Вукелић Н., Новковић, Н. (2009), Економски резултати производње млека на крупним сељачким газдинствима].