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ANALYSIS OF DEVELOPMENT OF RAW COW MILK PRICES IN THE CONDITIONS OF THE SLOVAK REPUBLIC

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ABSTRACT

The paper is focused on the evaluation of the price development of raw cow milk in the Slovak Republic. The aim of the paper is to analyse the development of average prices of the raw Q class cow´s milk in 2006 – 2018 and to forecast the trend of these prices by June 2019. Monthly data from the Market Report of Milk and Dairy Products issued by the Agricultural Information Department – ATIS, as part of the Agricultural Paying Agency, were the base of our information resource. These data were analyzed by using the statistical software called SAS. Box-Jenkins methodology was used to model the future trend of average purchase prices of the raw Q class cow´s milk, designed for modeling stationary and non-stationary time series and time series with seasonal components. During the period of 2006 – 2018 the Slovak dairy market showed significant changes in the prices of raw Q class cow´s milk. Three crisis periods of the dairy sector have been identified, during which the milk price has fallen below 0.30 € per kilogram. Long-term low prices of raw cow milk led to the liquidation of primary milk producers. In the next forecast period, by February 2019 a moderate increase in the average purchase price of raw Q class cow´s milk is expected, followed by a decrease by June 2019.

Keywords: analyse; crisis; milk; price; trend

INTRODUCTION

Eating food is one of the most important needs of every person **(Nagyová et al., 2019)**. Milk and milk products are the essentials of human nutrition. The Central Europe is a region with long tradition of production and consumption of milk and milk products. There is quite strong competition between production capacities in the Central Europe **(Špička, 2015)**. Cow´s breeding can be considered as strategic, especially in relation to other categories of cattle and its connectivity to arable land and permanent grassland. Cattle´s breeding represents a crucial condition to maintain a balance between the plant production and breeding processes of agricultural business activities **(Siničáková, 2012)**. Raw cow´s milk represents one of the most important commodities in the agricultural market. Raw cow´s milk is an essential source of the nutrition of calves and a raw material for the production of liquid milk and dairy products, which have a unique place in the human nutrition and dietetics **(Šimo, Mura and Buleca, 2016)**. The dairy industry is one of the most important industrial sectors for healthy development of Europe. There is not a single country being part of the European Union that does not produce milk **(Pilvere, Nipers and Krievina, 2016)**. European vertical of milk production and processing is influenced by the Common Agricultural Policy. Milk producers (farmers) are supported through direct and indirect operational subsidies. Farmers are not able to generate profits without current subsidies **(Doubek et al., 2012; Foltínová and Špička, 2014)**. A relatively wide range of policy forms and tools have been used within Common Agricultural Policy, both with direct and indirect effects on the volume of production and production-cost relations of this production. Nonetheless, within the proclaimed single framework of the Common Agricultural Policy, size and level of production, and consequently also involvement in various stages of commodity chain, production and processing of milk vary considerably between individual European Union member states. Among the largest producers of milk and dairy products are Germany, France, Great Britain, and from the group of new member states Poland **(Zdráhal and Bečvářová, 2018)**. Sectors of milk production and milk processing play an important role in the development of the agrarian sector and global agribusiness in general. Particularly within the European Union, this sector is in addition to basic production features highly valued for its role in the practical implementation of the philosophy of multifunctional agriculture, i.e. in terms of its contribution to environmental and social field **(Bečvářová, 2011; Bečvářová and Zdráhal, 2013)**. The milk quota system, one of the most important instruments of the Common Agricultural Policy, was introduced in 1984 to the European Union dairy market,

in order to control the structural surpluses of milk. These surpluses arose because of imbalances between supply and demand for milk **(Costa-Font and Revoredo-Giha, 2018)**. The cow milk production volumes were not regulated in the European Union before the milk quota system has been introduced. Intervention purchases and guaranteed prices for milk producers were provided by previous system regardless of the milk production volume **(Vőneki, Mándi-Nagy and Stark, 2015)**. According to **Dreve, Călin and Bazgă (2016)**, the reason for milk quota system was to limit public spending on the sector, to control milk production, and to stabilize milk prices and the agricultural income of milk producers. The milk quota system has been removed since the 1st of April 2015. The development of more competitive and market-oriented dairy sector is expected by the European Commission after the milk quotas were removed **(Salou et al., 2017)**. After abolition of milk quota system, the European milk producing countries started to be exposed to the milk prices of the world market **(Buleca, Kováč and Šubová, 2019)**. The market conditions have been liberalized therefore the milk price volatility is expected. The milk producers will be more dependent on the milk prices of the world market **(Schulte and Musshof, 2018; Schulte, Musshof and Meuwissen, 2018; Parzonko, 2018)**. The dairy sector is one of the most important sectors of agriculture in the Slovak Republic. The natural conditions for keeping dairy cows are particularly suitable in Slovakia, therefore the dairy sector belongs to the prospective sectors of the Slovak agriculture **(Lajdová, Kapusta and Bielik, 2017)**. For several years, the dairy sector in Slovakia has faced a number of problems concerning reducing size of dairy herd, lowering amount of milk production, insufficient purchase price of milk and shrinking number of milk producers and processors that have raised as a consequence of declining milk consumption **(National Agricultural and Food Centre, 2015; Trend.sk, 2015)**. The dairy production has a longstanding tradition in Slovakia. Despite the fact that situation has changed significantly in recent years and the share of milk production in the total agriculture production tends to decline, milk and milk products still represent a significant part of the food components of Slovak households **(Jamrich and Vargová, 2018)**. The national milk quota of Slovakia was around 1.1 milliard kilograms. Slovakia never exceeded its national milk quotas from the beginning of the 2004/2005 quota year. From 1993 to 2010, the number of dairy cows in Slovakia decreased from 386,000 to 161,300, while the average milk yield per 1 dairy cow increased from 3,042 to 5,692 kg. Despite this substantial milk yield growth, the total volume production of raw milk declined from 1,250 to 918 million kilograms **(Weldesenbet, 2013)**. The number of cattle in the Slovak Republic reached 471,600 heads only at the end of 2012, out of which the number of dairy cows reached 150,800 animals **(Šimo et al., 2016)**. According to **Gurčík et al. (2016)** in the Czech Republic and the Slovak Republic remains long-term economic imbalances (loss) for breeding dairy cows, this affects the continuing reduction of livestock number. Farmers are replacing the reduction in number of dairy cows by a higher efficiency of dairy cows, which ensures adequate milk production for each country. Density of livestock at the level of the European Union average is achieved only in Poland, which has become a major exporter of animal products. Hungary and the Czech Republic come to about half of the level of the EU-28 and at the end comes the Slovak Republic with a continuous decline in recent years **(Szabo et al., 2018)**. Most popular kind of milk is cow milk in Slovakia. Consumption of cow's milk and dairy products made from cow's milk represents approximately 98% of total milk and dairy products consumption in the Slovak Republic **(Ministry of Agriculture and Rural Development of the Slovak Republic, 2019)**. The Milk Market System, issued by the Ministry of Agriculture and Rural Development of the Slovak Republic **(Decree of the Ministry of Agriculture of the Slovak Republic, 2002)**, sets the quality criteria for classification of the raw cow milk into individual quality classes. According to the content of somatic cells and the total number of micro-organisms, two quality classes are defined, namely quality class Q and quality class I. Other quality is considered non-standard milk. According to **Swinnen et al. (2006)**, there are indications that the quality of milk produced by Slovak farms has improved in recent years. For instance, the share of milk in the highest quality classes (class Q and class I) has increased from an already satisfactory level in the late 1990s up to 95% of all milk delivered belonging to class Q and I. Milk of that quality is of acceptable quality according to the European Union standards. Milk as a raw material to milk industry has been produced in adequate volume, even though the share of milk production at its consumption was markedly decreased. As to competitiveness of Slovak milk industry products, at domestic market their share was significantly decreased, at European Union markets their competitiveness was deteriorated namely by products with the higher value added **(Matošková and Gálik, 2014)**. The main aim of the milk production efficiency should be based on the definition of the objective value of costs per one production unit **(Michaličková et al., 2014)**. Contrary to the costs, the milk price could be less influenced by the farms. It is formed in the markets (international and national) through the interaction of supply and demand. It should be more influenced by the negotiating power of farmers. Dairy farmers should promote higher market prices of milk for example by marketing associations. In the future, a detailed analysis should be focused on the interaction of biological and economic parameters in the dairy cattle sector. From the results of the model calculations it can be concluded that with increasing capacity and rising capacity utilization rate considerable cost economies can be achieved. On the other hand, it appears that cost economies as a function of the number of production days are minimal because of the low share of the per diem fixed costs in total costs **(Schmidt and Krell, 1996)**. At present, agriculture in the Slovak Republic mainly uses traditional methods for the calculation of production costs. Traditional calculation formulas work with overheads (as opposed to modern methods of calculations that convert non-specific, anonymous overheads into direct costs). Traditional calculations do not reflect the needs of the market environment **(Hudáková Stašová, 2018)**. According to results of dairy inquiry organic milk products create higher costs at processing and marketing than conventional milk products within the added value chain. On collection level, apart from extra charges for organic milk, the collection costs of raw material are higher per kilogram organic milk. Further costs occur in the

dairies, particularly due to a low utilization degree of processing capacities as well as to higher costs for auxiliaries and additives, for distribution, for packaging and quality assurance **(Burchardi and Thiele, 2003)**. The milk prices in dairy industry within the food vertical in the territory of Slovakia is developed also by **Kadlečíková et al. (2012)**, **Brodová (2013)**, **Matošková and Gálik (2014)** and **Božík et al. (2016)**.

Scientific hypothesis

The aim of the paper is to analyse the development of average purchase prices of raw Q class cow milk in a time period 2006 – 2018. The analysis was based on monthly data from the Reports on the market of milk and dairy products. At the time of submitting the data, data were available until July 2018. The paper is aimed at analysing the trend of average prices of raw Q class cow milk ex post and based on this ex post analysis to carry out an ex ante prognosis by June 2019. The result of this are the following two hypothesis:

Hypothesis 1: Based on an ex-post analysis, we expect that the forecast for the further development of average prices of raw Q class cow milk will fluctuate but will not be affected by the seasonal component.

Hypothesis 2: As the retained sample was already being worked on at the time the paper was finalized (July 2018 to February 2019), we assume that the predicted prices for raw Q class cow milk will not significantly differ from the actual prices.

MATERIAL AND METHODOLOGY

In the process of writing this paper, information from the Dairy Market Reports issued by the Agricultural Information Unit – ATIS, which is part of the Agricultural Paying Agency, was used. Monthly data from January 2006 to June 2018 on average monthly purchase prices of raw Q class cow milk were used. These data were presented in Slovak Crown until May 2008, and therefore were converted at the conversion rate of 1 EUR = 30.1260 SKK. The statistical software SAS was used for the analysis.

Statistic analysis

Modeling the future development is a methodically demanding activity that can be realized by several methods. In general, more advanced methods and approaches, such as exponential smoothing or Box-Jenkins methodology (ARIMA and SARIMA models) are used to analyse time series and forecast their future development.

Box-Jenkins methodology

By analysing the average purchase price of raw Q class cow milk, the best model suitable for constructing future development forecasts is looked for. The Box-Jenkins methodology is designed for modeling of stationary and non-stationary time series and time series with seasonal component. It consists of three steps: identification, parameter estimation and model validation. Methodology has its advantages and disadvantages. Its advantage is flexibility and quick adaptation to changes in the character of the time series. The entire modeling process can be full automated using software applications, reducing the subjective human factor intervention. The intuition of the solver plays a decisive role in the forecasting process. The disadvantages include, for example, a need to have a sufficiently long time series (at least 50 observations) available for the modeling, the practical application is time consuming and the possibility of simple interpretation of the resulting models' parameters is lost.

ARIMA models (AutoRegressive Integrated Moving Average models) are constructed from time series values, which are a linear combination of intrinsic historical values and historical values of residual deviations (so-called random shocks). A presumption of stationarity is the condition of using Arima models, i.e. the time series statistical properties do not change over time. It is a random variable that has a constant mean value over time, the variance is constant over time, and the linear relationship between the two time shifted random variables is zero **(Obtulovič, Sojková, 1999)**.

The paper also uses combined models consisting of several models because, in some cases, they offer the best quality smoothing of the time series of the average purchase price of raw Q class cow milk.

Forecast accuracy rates

The result of the time series extrapolation is forecasts based on an estimate of the parameters of a mathematical model whose quality has been confirmed by various statistical tests. For this reason, it can be expected that the forecasts obtained will not differ significantly from reality. Over a longer period of forecasting, forecasting accuracy (ex-ante) is assessed using different average characteristics. Forecasting accuracy measures represent timing alignment accuracy and this accuracy (model quality) can be measured absolute or relative. The paper uses the evaluation of trend quality by mean absolute percentage error (MAPE).

$$MAPE = \frac{1}{n} \sum_{t=1}^{n} \frac{|y_t - y'_t|}{y_t}$$

In percentage terms, it represents the average magnitude of forecast errors compared to actual values over the entire forecast period t = 1, 2, ... , n. It is the most widely used indicator of the accuracy of forecasting. The accuracy of the ex-ante forecasts obtained by the Box-Jenkins methodology is sufficiently reliable for short horizons.

RESULTS AND DISCUSSION

The Slovak dairy market has been in an unfavourable situation in recent years. Several majors changes have been made to the dairy market through this situation. Figure 1 presents the evolution of the raw Q class cow milk average prices from early 2006 to July 2018. It is evident from the development that milk prices have changed significantly in the period under review, they were fluctuating. The prices of agricultural commodities have been volatile in recent years and the dairy sector has not been an exception **(Vargová and Rajčániová, 2017)**. During the evaluation period 2006 – 2018, three dairy crisis periods can be identified, during which the prices has fallen below 30 eurocents per kilogram of milk. Such low prices do not cover the costs of primary milk producers despite the aid granted. According to the Slovak Chamber of Agriculture and Food, production costs are between 40 and 42 eurocents per kilogram.

The 2008 – 2009 period is referred to as the „Great Dairy Crisis“, as this was the most significant drop in milk prices over the whole period under review. In the year before, in 2007, a rapid and significant price increase occurred due to a significant decrease in the quantity of milk delivered from Oceania. After the resumption of world milk supply, prices have returned to their normal levels, but the subsequent economic crisis has had a negative impact on European Union milk producers, which has contributed to price volatility. Despite the production of milk in the European Union remained stable, a decline in global demand and European demand for milk and dairy products have resulted in price collapse in European Union. As a result, the price of raw cow milk in Slovakia also dropped significantly. In the first months of 2008, the average price of raw Q class cow milk was 39 eurocents per kilogram of milk, the highest price for the whole period under review. In the following period, milk prices were falling until they fell below 30 eurocents per kilogram of milk in November 2008. The decline in milk prices continued in 2009 until April, when the price of milk fell below 18 eurocents per kilogram (EUR 17.9/100 kg). This price is at the same time the lowest price of raw Q class cow´s milk in the period from 2006 to 2018. In the following period the price gradually increased and in December 2010 exceeded the limit of 30 eurocent per kilogram of milk (30.63 EUR/100 kg).

As a result of the partial recession of the economic crisis, the price of raw Q class cow milk was stable in 2011, at around 32 eurocents per kilogram. Another crisis period, when the price of raw Q class cow milk fell below the critical level of 30 eurocent per kilogram, can be identified in 2012.

This decrease was only temporarily recorded during May to October and was the result of a previous significant increase demand. This fact also affected the price level of milk in Slovakia. The lowest price during this crisis period reached 27.24 EUR/100 kg in July 2012. In the following period, the price of milk continued to rise until February 2014, when the price of milk exceeded 36 eurocents per kilogram (36.04 EUR/100 kg). However, since that period, the price of milk has been falling steadily.

The unfavourable price development resulted in another milk crisis in 2015 – 2016. The price of milk fell below 30 eurocents per kilogram in February 2015 and remained below this level for more than two years until April 2017. The lowest price recorded during this crisis period was in June 2016, when 100 kg of raw Q class cow milk was purchased for 23.34 EUR. The unfavourable price development in the dairy sector during this dairy crisis was influenced by several factors. High prices of dairy products at the turn of 2013 and 2014 caused a global decline in demand for milk and dairy products.

Another reason for the decline in demand was the ban on agricultural products import from the European Union into the Russian Federation, which was introduced on 7th August 2014. The Russian Federation was the largest export market for dairy products from the European Union.

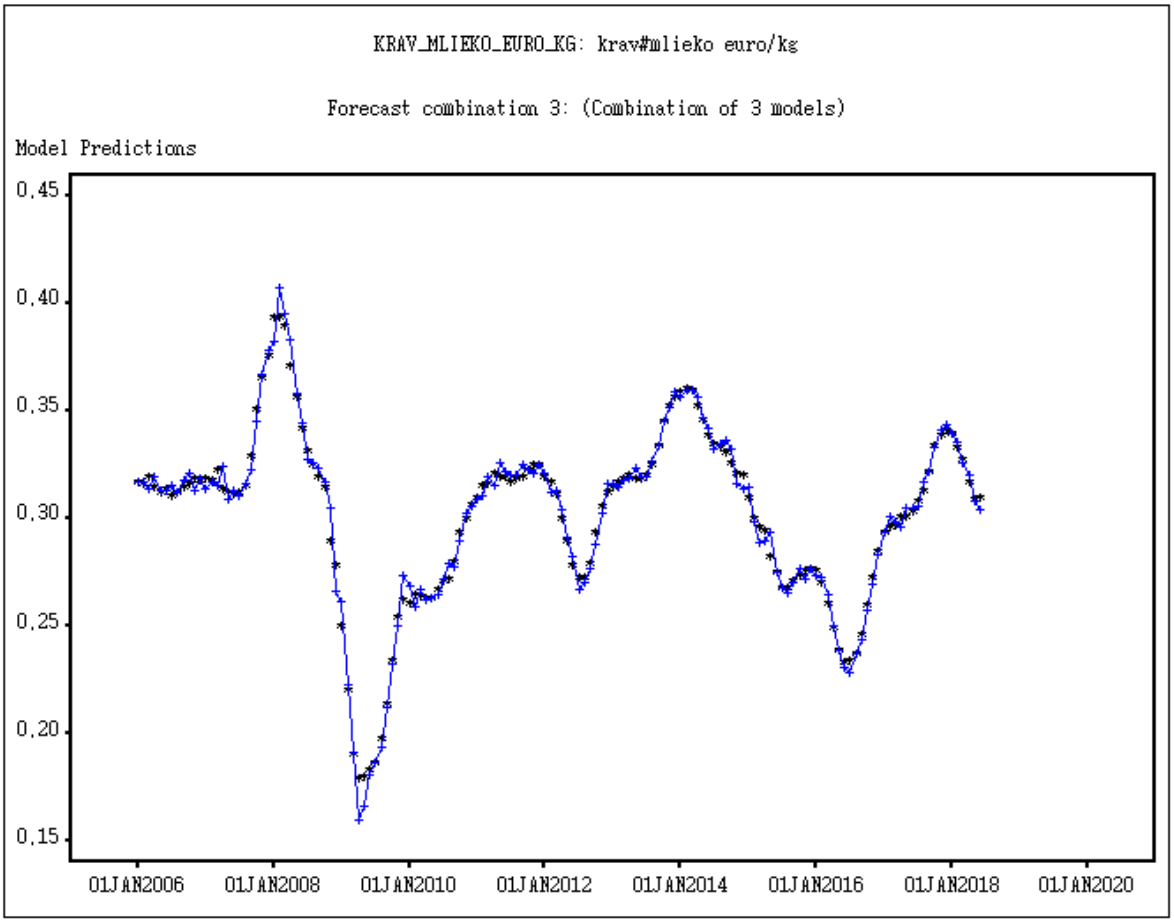

Figure 1 Development of the raw Q class cow milk´s average price. Note: Monthly reports on purchase of milk and cream and production of milk products (MARD SR), own calculations using SAS sofware.

Currently, the validity of the Russian embargo is extended until 31st December 2019. A declining demand from China for dried cow milk from European producers had also had a negative impact on the dairy sector crisis. The unfavourable situation during this period was also affected by the abolition of the milk quota system in the European Union on 1st April 2015. The abolition of milk quotas led to higher milk production, resulting in high milk surpluses on the European Union market and consequently a decline in milk prices. The new era of milk output without quota constraints will result in both opportunities and challenges for the European Union dairy industry. The opportunities will arise from the expanding global diary market. The challenges will involve the ability of the European Union dairy industry to achieve international competitiveness in servicing the increased global demand for dairy products **(Donnellan and Keane, 2015)**.

The long-term unfavourable situation in the dairy sector in Slovakia began to stabilize in the second half of 2017, since the purchase price of raw Q class cow milk has fluctuated between approx. 31 – 34 eurocents per kilogram.

The White Noise Test indicates a violation of zero mean conditions, constant scattering and residue independence. It is usually assumed that the residual component is the white noise. It consists of random movements (fluctuations) over the time series of the average purchase price of Q class cow milk, which are not of a systematic (recognizable) character. Figure 2 provides a preview of the white noise process from which it can be concluded that the conditions are met.

SAS offers 582 models. The MAPE value, also a graphical representation of the white noise process, are critical elements for model selection. It should be pointed out that there is no reliable and objective criterion that exhaustively and accurately determines the final shape of the model. The sensitive approach of the investigator plays a decisive role. Accordingly, all offered models are recalculated in the calculations and five top quality models are selected. Subsequently, the model that achieves the best quality results is chosen.

The Combined Model Variance, which is the same weight combination of Log Winters Method - Additive, Winters Method – Additive and Winters Method – Multiplicative, was used to analyse the ex post development and forecast the expected Q class cow milk purchase prices.

The degree of forecast accuracy in the model is determined, among other characteristics, by the MAPE value (1.22 %), which can be considered a very good result (R-Square = 0.986). The model was chosen not only based on the MAPE value, but also on the white noise and the presence of the unit root.

Based on the chosen model, a forecast of future development of the Q class cow milk´s average purchase price in the Slovak Republic was realized. The monthly trend by June 2019 is shown in Figure 3, which shows a graph of actual and estimated values.

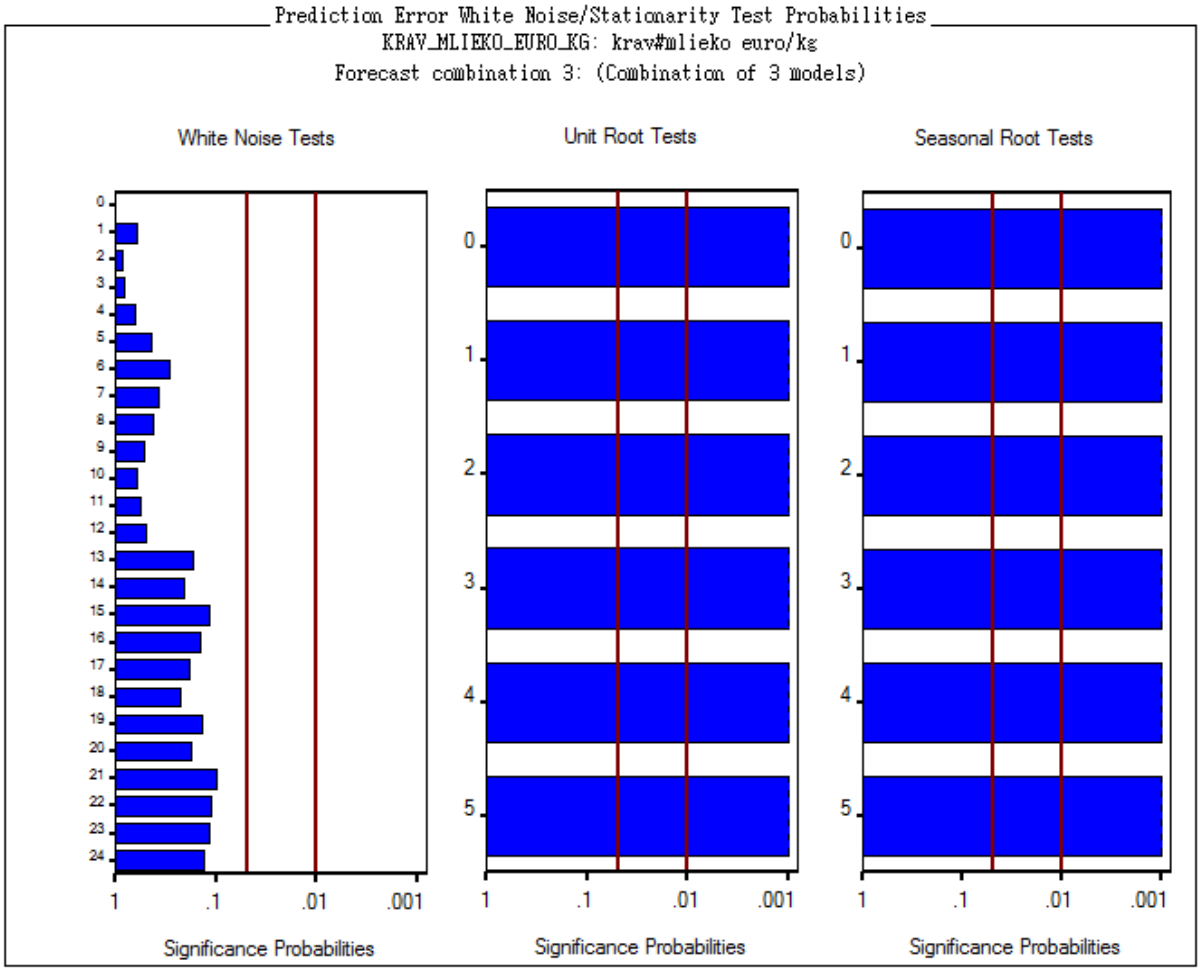

Figure 2 White noise and unit root test. Note: Monthly reports on purchase of milk and cream and production of milk products (MARD SR), own calculations using SAS software.

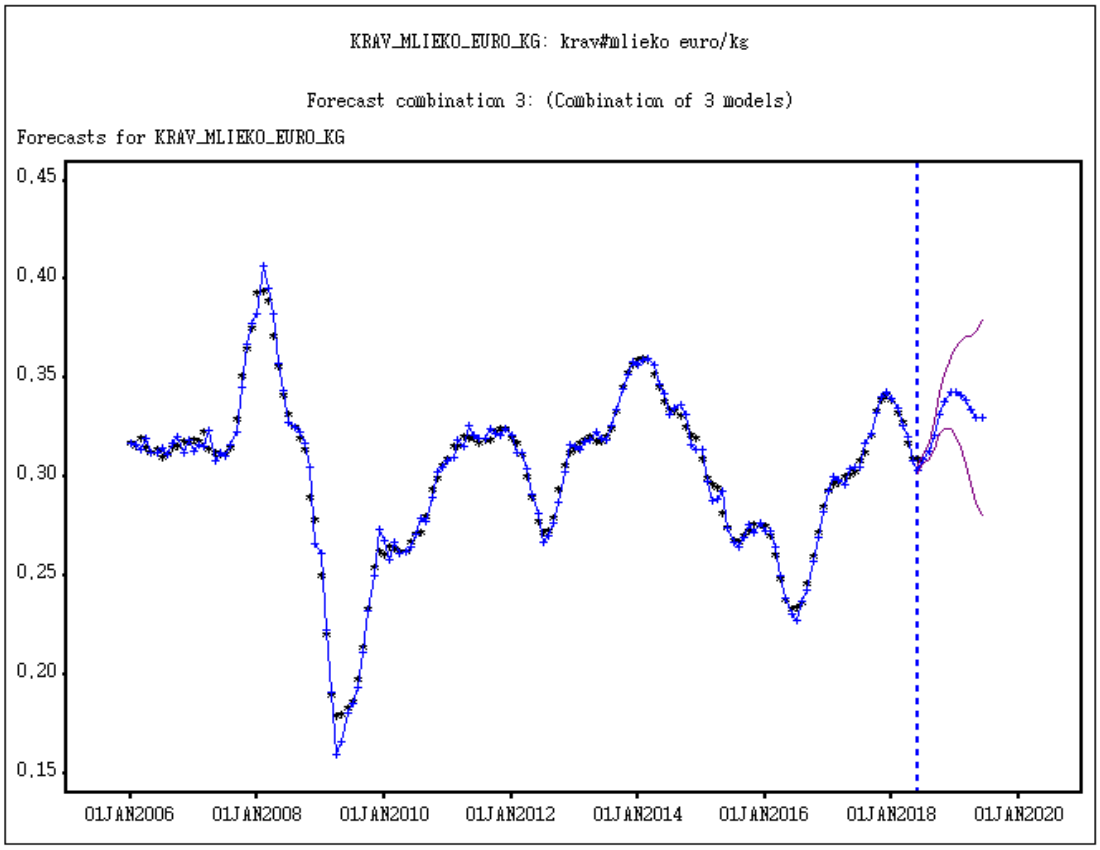

Figure 3 Development and forecast of the raw Q class cow milk´s average price. Note: Monthly reports on purchase of milk and cream and production of milk products (MARD SR), own calculations using SAS software.

Table 1 Actual and forecasted average prices for raw Q class milk. Note: Monthly reports on purchase of milk and cream and production of milk products (MARD SR), own calculations using SAS software.

Raw Q class cow milk prices	Period							
	7/2018	8/2018	9/2018	10/2018	11/2018	12/2018	1/2019	2/2019
Actual prices	0.312	0.315	0.322	0.328	0.333	0.334	0.336	0.334
Forecasted prices	0.309	0.313	0.321	0.332	0.338	0.343	0.343	0.342

The continuous line joins equalized values that represent a time series equalization using the selected combined model from January 2006 to June 2019. From the dashed vertical line, the forecast by June 2019 is shown in both a monthly point and a 90 % confidence interval estimate.

The results show that in the next forecasted period, that is for 2018 – 2019, the average purchase price of raw Q class cow milk is expected to increase slightly until February 2019, followed by its decline.

The retained sample prices of the raw Q class cow milk covered the period from July 2018 to February 2019. Table 1 shows the actual average prices of raw Q class cow milk together with the forecasted milk prices using the above-mentioned combined model. A comparison of the retained sample and the forecasted milk prices shows that the model used has provided a good forecast, as the differences are negligible.

As in the previous period and in the next forecast period, fluctuations in the average prices of raw Q class cow milk, as presented in Figure 3, can be expected. This confirmed the established research hypothesis.

CONCLUSION

The paper focused on the analysis of the trend of average purchase prices of raw Q class cow milk in Slovakia in the period from 2006 to July 2018. Based on the ex post analysis carried out, a forecast of milk price development by June 2019 has also been done. It can be stated that the average prices of raw Q class cow milk in both, the reference period and the forecast period, showed a fluctuation course, so hypothesis 1 was confirmed. At the time the paper was finalized, we worked with the retained sample (from July 2018 to February 2019), allowing forecast prices to be compared with actual milk prices. As the largest difference between the forecasted and the actual price is the difference of 0.9 eurocents, we confirm hypothesis 2, on the basis of which we assumed insignificant differences between the forecasted and the actual prices of raw Q class cow milk.

Based on the analysis of the development of average prices of raw Q class cow milk, three periods were identified as critical for the dairy sector during the reviewed period. During these periods, the price of milk has fallen below 30 eurocents per kilogram. Even at such low prices, despite the support provided to primary milk prouducers, there is a loss as production costs are high. According to the Slovak

Chamber of Agriculture and Food, the cost of raw cow milk production is between 40 and 42 eurocents per kilogram.

The lowest price of milk during the reviewed period was found in April 2009, when it fell below 18 eurocent per kilogram. This period 2008 – 2009 is also referred to as the period of the Great Dairy Crisis, when milk prices have been long below 30 eurocent per kilogram. Many businesses closed their milk production during the Great Dairy Crisis. Another milk crisis in 2015 – 2016 again led to the liquidation of this area of animal husbandry. At the beginning of the reviewed period before the Great Dairy Crisis, 777 primary producers of raw cow milk were registered in Slovakia, currently there are only 415 (as from 31 December 2018), which represents a decrease of 47 %.

The performed analysis of raw cow milk prices under the conditions of the Slovak Republic is a starting point for further scientific work in which the price disparities of raw cow milk according to quality classes, years and regions of the Slovak Republic will be identified.

REFERENCES

Bečvářová, V. 2011. The European Model of Agricultural Policy in the Global Context. In Pachura, P. (Ed.). *New Knowledge in a New Era of Globalization*. 1st ed. Rijeka, Croatia: InTech Open, p. 285-310. ISBN 978-953-307-501-3. https://doi.org/10.5772/18492

Bečvářová, V., Zdráhal, I. 2013. *Agriculture and Rural Development in the European Model of Agricultural Policy - Shaping Strategy in the Context of Environmental Changes*. 1st ed. Brno : Mendel University in Brno, 138 p. ISBN 978-80-7375-858-5.

Božík, M., Uhrinčaťová, E., Chrastinová, Z., Krížová, S. 2016. Analýza agropotravinovej vertikály z hľadiska transmisie cien poľnohospodárskych komodít do cien potravinárskych výrobkov a spotrebiteľských cien (Analysis of agri-food vertical in terms of transmission of agricultural commodity prices to food product prices and consumer prices). *Economics of Agriculture*, vol. 16, no. 1, p. 27-44. (In Slovak)

Brodová, M. 2013. Cenový vývoj vo vertikále výroby a spotreby živočíšnych komodít v rokoch 2008-2012 (Price development in the vertical of production and consumption of animal commodities in 2008 – 2012). *Economics of Agriculture*, vol. 13, no. 3, p. 23-35. (In Slovak)

Buleca, J., Kováč, V., Šubová, N. 2019. Milk production related to price of raw cow´s milk in selected european countries. *Potravinarstvo Slovak Journal of Food Sciences*, vol. 12, no. 1, p. 798-805. https://doi.org/10.5219/1002

Burchardi, H., Thiele, H. D. 2003. Analysis of extra costs for organic milk during processing and marketing. *Kieler milchwirtschaftliche forschungsberichte*, vol. 55, no. 3, p. 213-223.

Costa-Font, M., Revoredo-Giha, C. 2018. An empirical analysis of UK milk contract prices 2004-2016. *Agribusiness*, vol. 34, no. 1 , p. 112-141. https://doi.org/10.1002/agr.21531

Donnellan, T., Keane, M. 2015. *The European dairy sector in a new era. In Proceedings of the 24th International Scientific Conference on Agrarian Perspectives – Global Agribusiness and the Rural Economy*. Prague, Czech Republic : Czech University of Life Sciences Prague, p. 5-19. ISBN 978-802-13258-1-4.

Doubek, V., Švasta, J., Ackermann Blažková, L. 2012. Agricultural trade on the example of milk from the perspective of the multi-criteria analysis. *Agricultural Economics*, vol. 58, no. 7, p. 315-323. https://doi.org/10.17221/168/2011-AGRICECON

Dreve, V., Călin, I., Bazgă, B. 2016. Economical prospect on medium term in the context of milk quota abolition. *Scientific papers: Series D, Animal Science – The International Session of Scientific Communications of the Faculty of Animal Science*, vol. 59, p. 282-287.

Foltínová, A., Špička, J. 2014. The use of controlling in agricultural enterprises and their competitiveness. *Agricultural Economics*, vol. 60, no. 7, p. 314-322. https://doi.org/10.17221/19/2014-AGRICECON

Gurčík, Ľ., Dobošová, Ľ., Richter, M., Kubicová, Ľ., Dobák, D. 2016. Controlling as a management system of milk production and consumption in Slovakia and the Czech Republic. *The agri-food value chain: challenges for natural resources management and society: International Scientific Days 2016*. Nitra, Slovak Republic, May 19-20, 2016, conference proceedings, p. 329-338. Nitra : Slovak University of Agriculture. http://doi.org/10.15414/isd2016.s5.03

Hudáková Stašová, L. 2018. Software support for cost calculation – application to the agricultural sector. *Potravinarstvo Slovak Journal of Food Sciences*, vol. 12, no. 1, p. 472-486. https://doi.org/10.5219/865

Jamrich, M., Vargová, L. 2018. Demand for dairy products in Slovak households: A Double-Hurdle approach. *Acta Oeconomica Universitatis Selye*, vol. 7, no. 2, p. 59-70.

Kadlečíková, M., Kapsdorferová, Z., Filo, M., Malejčíková, A. 2012. Trendy vo vývoji cien, v produkcii a v spotrebe potravín vo vybraných krajinách a v Slovenskej republike (Trends in price development, production and consumption of food in selected countries and in the Slovak Republic). *Economics of Agriculture*, vol. 12, no. 2, p. 41-51 (In Slovak)

Lajdová, Z., Kapusta, J., Bielik, P. 2017. Price analysis and competitiveness of the dairy supply chain. *In Proceedings of the 7th International Scientific Conference on Managerial Trends in the Development of Enterprises in Globalization Era (ICoM)*. Nitra, Slovak Republic : Slovak University of Agriculture in Nitra, p. 618-629. ISBN 978-80-552-1739-0.

Matošková, D., Gálik, J. 2014. Dodávateľsko-odberateľský reťazec v sektore mlieka (Supply chain in the dairy sector). *Economics of Agriculture*, vol. 14, no. 2, p. 23-35. (In Slovak)

Michaličková, M., Krupová, Z., Polák, P., Hetényi, L., Krupa, E. 2014. Development of competitiveness and its determinants in Slovak dairy farms. *Agricultural economics*, vol. 60, no. 2, p. 82-88. https://doi.org/10.17221/76/2013-AGRICECON

Ministry of Agriculture and Rural Development of the Slovak Republic, 2019. Mlieko: Situačná a výhľadová správa k 30. 6. 2019 (Milk: Situation and outlook report as of 30. 06. 2019). *Research Institute of Agricultural and Food Economics*, vol. XXVI, no. 2, 41 p. (In Slovak)

Nagyová, Ľ., Andocsová, A., Géci, A., Zajac, P., Palkovič, J., Košičiarová, I., Golian, J. 2019. Consumers´awareness of food safety. *Potravinarstvo Slovak Journal of Food Sciences*, vol. 13, no. 1, p. 8-17. https://doi.org/10.5219/1003

National Agricultural and Food Centre. 2015. *Situačné a výhľadové správy* (*Situation and outlook reports*). Available at: http://www.vuepp.sk/04_komodity.html. (In Slovak)

Obtulovič, P., Sojková, Z. 1999. Adaptívne prístupy k modelovaniu vývoja vybraných ukazovateľov (Adaptive approaches to modeling the development of selected indicators). In *Agrarian Perspectives VIII*. Praha : Česká zemědělská univerzita, 1999, s. 673--676. ISBN 80-213-0563-0. (In Slovak)

Parzonko, A. 2018. Milk production costs in Polish and other EU countries dairy farms – assessment in 2009-2015. *In Proceedings of the 2018 International Scientific Conference "Economic Science for Rural Development"*. Jelgava, Latvia :

Latvia University of Life Sciences and Tecnologies, p. 154-161. ISBN 978-9984-48-294-1. https://doi.org/10.22616/ESRD.2018.131

Pilvere, I., Nipers, A., Krievina, A. 2016. Analysis of the factors affecting cost efficiency in the dairy industry in Latvia *In Proceedings of the 2016 International Scientific Conference "Economic Science for Rural Development"*. Jelgava, Latvia : Latvia University of Life Sciences and Tecnologies, p. 252-259. ISBN 978-9984-48-223-1.

Salou, T., van der Werf, H. M. G., Levert, F., Forslund, A., Hercule, J., Le Mouël, Ch. 2017. Could EU dairy quota removal favour some dairy production systems over others? The case of French dairy production systems. *Agricultural Systems*, vol. 153, p. 1-10. https://doi.org/10.1016/j.agsy.2017.01.004

Schmidt, E., Krell, E. 1996. Costs of the model department "pasteurized market milk". *Kieler milchwirtschaftliche forschungsberichte*, vol. 48, no. 4, p. 293-319.

Schulte, H. D., Musshoff, O. 2018. Insurance prospects after European dairy quota abolition. *Agricultural Finance Review*, vol. 78, no. 2, p. 223-232. https://doi.org/10.1108/AFR-06-2017-0047

Schulte, H. D., Musshoff, O., Meuwissen, M. P. M. 2018. Considering milk price volatility for investment decisions on the farm level after European milk quota abolition. *Journal of Dairy Science*, vol. 101, no. 8, p. 7531-7539. https://doi.org/10.3168/jds.2017-14305

Šimo, D., Mura, L., Buleca, J. 2016. Assessment of milk production competitiveness of the Slovak Republic within the EU-27 countries. *Agricultural Economics*, vol. 62, no. 10, p. 482-492. http://doi.org/10.17221/270/2015-AGRICECON

Siničáková M. 2012. Environmental protection expenditures in the European Union: The case of the Visegrad countries. *In Proceeding 12th International Multidisciplinary Scientific Geoconference SGEM 2012*. Albena, Bulgaria, vol. 4, p. 957-964. ISBN 978-1-62993-274-3. https://doi.org/10.5593/sgem2012/s22.v4017

Špička, J. 2015. The Efficiency Improvement of Central European Corporate Milk Processors in 2008 - 2013. *Agris on-line Papers in Economics and Informatics*, vol. 7, no. 4, p. 175-188.

Swinnen, J., Berkum Van, S., Bozik, M. 2006. *Market linkages in the Slovak agri-food sector (English). ECSSD Environmentally and Socially Sustainable Development working paper ; no. 43*. Washington, DC : World Bank, 47 p. Available at: http://documents.worldbank.org/curated/en/166881468294113109/Market-linkages-in-the-Slovak-agri-food-sector.

Szabo, Ľ., Grznár, M., Zelina, M. 2018. Agricultural performance in the V4 countries and its position in the European Union. *Agricultural Economics*, vol. 64, no. 8, p. 337-346. https://doi.org/10.17221/397/2016-AGRICECON

Trend.sk. 2015. *Slovenské mlieko v ohrození. Farmárov vraj ničí Európska únia aj zahraničná konkurencia* (*Slovak milk in danger. The European Union and foreign competition are said to be destroying farmers*). Available at: http://www.etrend.sk/podnikanie/produkcia-mlieka-na-slovensku-pomaly-vymiera-farmarov-nici-europska-unia-aj-zahranicna-konkurencia.html. (In Slovak)

Vargová, L., Rajčániová, M. 2017. Horizontal price transmission of the milk market in the Central European Union countries. *In Proceedings of Global Scientific Conference on Management and Economics in Manufacturing Location*. Zvolen, Slovak Republic : Technical University, p. 367-374. ISBN 978-80-228-2993-9.

Vőneki, É., Mándi-Nagy, D., Stark, A. 2015. Prospects for the European Union and Hungarian dairy sectors after the abolition of the milk quotasystem. *Studies in Agricultural* Economics, vol. 117, no. 1, p. 1-9. https://doi.org/10.7896/j.1424

Decree of the Ministry of Agriculture of the Slovak Republic, 2002. Decree of the Ministry of Agriculture of the Slovak Republic of 25 November 2002 no. 2953/2002-100 establishing the market order for milk (*Výnos Ministerstva pôdohospodárstva Slovenskej republiky z 25. novembra 2002 č. 2953/2002-100, ktorým sa vydáva trhový poriadok pre mlieko*). (In Slovak)

Weldesenbet, T. 2013. Asymmetric Price Transmission in the Slovak Liquid Milk Market. *Agricultural Economics*, vol. 59, no. 11, p. 512-524. https://doi.org/10.17221/150/2012-AGRICECON

Zdráhal, I., Bečvářová, V. 2018. Entry into the common market of the European Union in terms of Czech Republic´s foreign trade with dairy products. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, vol. 66, no. 2, p. 605-616. https://doi.org/10.11118/actaun201866020605

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