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Milk price changes in Poland in the context of the Common Agricultural Policy

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Abstract: Changes in the retail prices of pasteurised milk, purchase prices, and the price relationship between retail prices for pasteurised milk and other food products are analysed for Poland during the period from 2004–2018. In addition, the paper presents factors affecting changes in milk prices in Poland and characterises the Common Agricultural Policy (CAP) on the milk market. The adoption of a long period of analysis allows for the study of periods of both high and low variability. The data analysis uses various methods including the Augmented Dickey-Fuller (ADF) test and the Autoregressive-Moving-Average Model (ARMA). The milk market showed significant response because it was one of the few that was strongly administered by the European Union. These policies led to a significant increase in milk prices in the analysed period. The average price of pasteurised food milk increased by 63% in 2003–2015, and the purchase farm price of milk increased by 91.74%. The situation changed when the production limits were eliminated after 2015. In the initial period after quotas ended, the price of milk decreased and then increased. Similar changes were observed in other EU countries. Even short-term fluctuations associated with economic crises did not significantly affect the milk market.

Keywords: Common Agricultural Policy; milk market; price volatility; purchase prices

Price volatility for agricultural products is a critical issue for countries with large agricultural sectors. Price changes destabilise the economic market and impact the management decisions of producers, intermediaries, and consumers. Price volatility is the result of factors including weather, inflation, supply and demand changes, consumer income, and government policy. Prices are also shaped by consumer tastes and prefer-

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ences. Prices also play an important role in creating income for market participants and in assessing the efficiency of pursuing various types of economic activity. Price research provides producers, consumers, and administrators with detailed and up-to-date information. On this basis, market entities can make decisions, and scientific institutions can assess the efficiency of the market mechanism and regulatory instruments (Rembeza and Seremak-Bulge 2010).

In the economic literature, there are many views regarding the market efficiency in determining prices and the inefficiency of the market mechanism. This is often cited as a justification for a protectionist market policy, the result of which is an extensive system of regulations (Hamulczuk 2013). Agricultural commodity prices increased in the European Union as the result of greater demand after accession new member states in 2004 (Borawski et al. 2018, Borawski et al. 2019). The proper approach is to analyse the price trends at all levels of the agribusiness chain.

The issue of price volatility has been investigated worldwide and many articles have appeared in agricultural and economic journals. Wang et al. (2018) analysed the price transmission effects of corn on hogs. They found that "the influence of corn prices on hog price fluctuations is attributed to many factors such as: cost-push inflation, risk stabilisation effect, and the coexistence of cost-push and risk-stabilisation effects from the perspective of adaptive expectations". Santeramo et al. (2018) analysed the grain price volatility drivers. They found that exogenous factors, such as spatial and temporal arbitrage and supply and demand drivers affect grain price volatility. Wang et al. (2018) analysed the effect of monetary policy on agricultural growth and food prices. They found that "tight monetary policy significantly reduced food inflation and agricultural production." However, little attention is paid to changing prices in the milk market, which is considered as the most important in food policy.

Milk is one of the most volatile agricultural commodities in the international market. Global milk prices have an impact on domestic prices and this information is particularly important to design of appropriate policy to reduce the level of milk price volatility (Acosta et al. 2014). Such a situation is not good for the EU farmers because they are more dependant on the conditions being set by their clients downstream the supply chain (Dolezalova et al. 2014). Price changes especially impact milk and its products. The average price of milk purchased from farmers in 2018 was 0.3% higher than in 2017. Milk prices typically fall in June–July when supply increases and rise during winter months when supply decreases. In June 2018, sales prices in the dairy industry increased by 4.1% in comparison to the previous year, with retail prices increasing 3.6% and the price of butter increasing 25.6% (Milk Market 2018). These data show that the price of dairy products is particularly sensitive to price changes in the milk market. With internal consumption on dairy farms and direct sales to consumers decreasing, Polish milk production is now mainly distributed via market channels. The supply of raw material to the dairy industry increased by 3.9% to 11.8 billion litres and accounted for 85% of milk production. Milk production is directly affected by cow numbers which showed an annual increase of 2.3% to 2 429 000 cows from 2017 to 2018. In addition, milk yield has grown to 6 350 litres/cow (Milk Market 2018). Relations between producers, wholesalers, and retailers affect the level of prices and the shape of competition in the milk market (Weldesenbet 2013). This issue is particularly interesting because the quota system has been eliminated in the European Union (EU) and changes in the milk market depend more on supply and demand. It should be noticed that in Poland in the years of study there was a constant and still ongoing process of consolidation as well as in the case of milk production and processing. In the dairy industry, an accelerated process of capital concentration is recorded. As a consequence, the number of dairies decreases year by year. In Poland, the number of milk processing companies decreased from 272 in 2004 to 168 entities in 2017 (Milk Market 2018).

The main goal of this paper is therefore to study the changes in the retail prices of pasteurised milk, purchase prices, and the price relationship between retail prices for pasteurised milk and other food products in Poland during the period 2004–2018. The adoption of a long period of analysis allows for the study of periods of both high and low variability.

Common Agricultural Policy in the milk market. Milk production is an important part of the European Union (EU) and the world economy. Total EU 28 milk production is estimated at around 170 million tons per year. In 2018 there were around 23 million cows, with an average production of 7 000 kg of milk per cow. The EU's main producers are Germany, France, the United Kingdom, Poland, the Netherlands, and Italy, which together account for almost 70% of the EU milk production (Milk Market 2018). The surplus of supply and dairy exports

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in the Polish milk market is of great importance to the market balance. As a result, the domestic market is impacted greatly by the price situation in foreign markets.

With the accession to the EU, Poland was required to abide by production limits and in return received subsidies for processing and storing dairy products. The EU milk market has common customs tariffs in relation to non-member countries. Until 2015, milk producers were bound by contracts, which meant that they had purchasers for their raw milk and the processors were guaranteed a sale. Since 2015, however, production limits have been abolished. It was caused by the growing demand for milk and dairy products on the global market. In addition, production limits, while guaranteeing attractive prices, hampered the development of efficient milk production. Previously, farmers in the EU countries with overproduction had to pay fines. New regulations since 2015 allow for the signing of production contracts between farmers and raw milk collectors (Borawski et al. 2018).

Therefore, many agricultural economists are assessing the impact of changes in the milk market in Poland and other EU countries after the elimination of production limits. The EU milk quota regime has been in place since 1984. The removal of milk quotas is expected to have significant implications for the dairy sector across Europe. First of all, it will contribute to an increase in milk production. The increase in milk production is likely to come about in those countries that have previously produced in accordance with their allocated quotas or exceeded the limits. When quotas are abolished, these countries will be ready to expand their production, using already existing resources, such as dairy herds and land (Binfield 2009, Voneki et al. 2015). In particular, milk production is likely to increase in Austria, Ireland, Denmark, Germany, the Netherlands and Luxembourg (Lips and Rieder 2005; Commission 2009). When milk production increases, this will exert downward pressure on producer prices. According to many scientists, this will reduce the prices of dairy products (Requillart 2008; Kempen et al. 2011). In the long run, the lower dairy prices will exert economic pressure on countries in less competitive regions that have previously benefitted from the quota system. In particular, milk production is likely to decrease in Sweden, Finland, Greece and Portugal (Lips and Rieder 2005; Commission 2009). In these countries, farmers will start to leave the industry and consumers will switch from domestically produced dairy products to cheaper imported ones. A number of *ex-ante* studies of the implications for Ireland have been published (Binfield et al. 2007; Donnellan et al. 2009; Hennessy et al. 2009). According to Lapple and Hennessy (2012), Irish production will be greater than the EU average however the aggregate EU milk production will increase and milk prices will decline.

The problem will also appear among dairies competing with one another on the EU market. Small dairy companies must adapt products to the expectations of the local or regional markets. Although they operate well domestically, the milk processing sector in Poland will likely see considerable consolidation. Polish processing plants are too dispersed and have low levels of productivity compared to processors from Germany, Great Britain, France, Belgium, or the Netherlands and this severely limits their ability to compete in the EU and global markets.

A second, more optimistic scenario assumed quick adaptation to new market conditions by EU milk producers and processors and an increase in milk production and sales, especially to third world country markets. This requires consolidating the sector and adapting the different links in the supply chain to achieve higher economic efficiency. This can lead to the dairy herd size increase in many EU countries (Krpalkova et al. 2016).

Certain changes will likely be seen in the first few years after the abolition of production limits. According to the USDA (2018), milk production in the US, the EU, New Zealand, Australia, and Argentina will increase by 1.3% in 2019. This increase will mainly be observed in the US (+1.5% in 2019 compared to 2018). Production may decline (–1.6%) in Australia, caused by drought in regions with a high concentration of dairy cows. Production in New Zealand may slow down slightly (–0.13% in 2019 in comparison to 2018) due to a decrease in the number of dairy cows. In the EU countries, a slower production growth should also be expected. However, this will not be due to the abolition of production limits, but to the effects of drought in 2018. In addition, the decline in milk production in the EU may be due to a decrease in the number of dairy cows in some EU countries because of feed shortages resulting from drought. According to USDA (2018), milk deliveries in 2019 will continue to grow at the same pace as in 2018. Short feed supplies during the first half of 2019 will moderate production growth. However, if 2019's grain, feed and forage production return to more typical levels, milk production will recover during the second half of the year.

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AIM AND METHODS

Monthly milk price data from 2004–2018 for EU countries from the Milk Market Observatory (Milk Market 2018) is the basis for the analysis. Various methods were used to evaluate changes in milk prices including descriptive statistics, Augmented Dickey-Fuller (ADF) tests, and Auto-Regressive (ARMA) models. Among descriptive statistics, there were kurtosis and skewness asymmetry measures provided. The kurtosis measures the height of frequency distribution and describes the thickness of the tails. Skewness measures the shape of the distribution and whether the tail is on the left or right side of the distribution. Skewness is negative if the tail on the left side of the distribution is longer or fatter than the tail on the right side.

In the analysis, the ADF test was used. This test was proposed in 1979 and is also called the unit-element test (Dickey and Fuller 1979). In practice, the existence of a unit root, i.e. the hypothesis, $r = 1$, is checked. The null hypothesis in the ADF test claims the presence of the unit root, which means that the process is not stationary. If we reject H_0, we accept the alternative hypothesis H_1, that the unit root does not exist and the process is stationary (Borawski et al. 2019).

$$y_t = \rho y_{t-1} + u_t \quad (1)$$

where: y_t – explanatory variable; t – time index; ρ – coefficient; u_t – estimation error (white noise).

ARMA models are used to analyse trends and prepare the forecast (Figiel and Hamulczuk 2010). Their form is expressed as:

$$Y_t = B_1 Y_{t-1} + B_2 Y_{t-2} + \ldots + B_p Y_{t-p} + E_t + \theta_1 E_{t-1} + \theta_2 E_{t-2} + \ldots + \theta_q E_{t-q} \quad (2)$$

where: B – delay operator; Y – analysed variable; E – random component; θ – autoregression parameters.

RESULTS AND DISCUSSION

European raw milk markets have been generally characterised as competitive. To evaluate raw milk price changes in the EU descriptive statistics including the coefficient of variation, skewness, and kurtosis are calculated. This analysis uncovers some very interesting information concerning raw milk changes in the EU countries.

The highest mean raw milk price was in Cyprus (EUR 50.441 per 100 kg) and Malta (EUR 48.30 per 100 kg). This is the result of a lack of self-sufficiency in milk production and low milk production. The lowest average raw milk prices were found in Latvia (EUR 14.720 per 100 kg), Lithuania (EUR 14.980 per 100 kg), and Poland (EUR 16.000 per 100 kg). These countries belong to eastern EU countries where the production of milk is high, but prices are not. The low prices can be the effect of lower production costs on one side and high production on the other.

The coefficient of variation provides a measure of the relative dispersion of raw milk prices in the years 2004–2018 and allows for comparison between countries. The highest coefficients of variation were in Lithuania (21.8%), Latvia (19.1%), and Estonia (16.4%). This means that these countries noted the biggest changes and these changes were increasing. The lowest changes of raw milk prices were in the years 2004–2018 in Malta (6.6%), Croatia (7.4%) and Italy (8.1%).

Kurtosis was negative in most countries of the EU (Table 1). Positive kurtosis was found only in Spain, Luxemburg, Poland and Portugal. Only eight countries had negative skewness (Bulgaria, Italy, Cyprus, Latvia, Hungary, Poland, Romania, Slovakia).

Bergmann et al. (2015) decomposed German, Irish, and an average EU farmgate milk price time series into trend, seasonal, and cyclical components using structural time series models. Their analysis showed that in the recent decade most of the price variation was attributed to the cycle component along with the seasonal to a lesser degree. The authors concluded that price volatility for this period seemed to be endemic to the dairy industry and to be predictable to some degree and best addressed using countercyclical measures. The price of milk on the EU market depends on various factors, among which the most important are demand and supply of the liquid milk and dairy commodities and international trade, mainly within the EU Common Market (Simo et al. 2016).

Germany is the most important milk market for Poland. The milk industry in that country is highly concentrated and cooperative. Firms implemented the cost-minimizing strategy and aim to fully utilise their production (Richards et al. 2001; Grau and Hockmann 2018). In this country, milk prices for cheese processing at the producer level are less strongly linked to foreign prices than milk prices for industrial dairy production. The level of border protection determines the degree and speed of price transmission (Hillen and Cramon-Taubadel 2019).

To check the stationarity of the monthly time series of weighted average EU milk prices in the years

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Table 1. Descriptive statistics of raw milk prices in the EU 2004–2018 (EUR/100 kg)

	Average	Median	Minimal	Maximal	(+–) number	Coefficient of variation	Skewness	Kurtosis
EU 28 countries	31.906	31.805	24.390	40.210	3.738	11.716	0.207	–0.663
Austria	33.823	34.085	25.270	42.700	4.206	12.436	0.251	–0.716
Belgium	30.844	30.130	20.780	43.200	4.810	15.596	0.346	–0.164
Bulgaria	29.794	30.350	20.780	37.020	3.528	11.841	–0.404	–0.334
Cyprus	50.441	51.890	37.380	58.860	6.579	13.043	–0.670	–1.031
Croatia	32.714	32.285	27.890	37.760	2.416	7.386	0.149	–0.577
Czech Republic	29.049	28.295	21.120	38.300	3.906	13.446	0.041	–0.819
Denmark	33.179	32.790	25.380	43.500	4.385	13.218	0.371	–0.694
Estonia	27.924	27.395	19.050	40.330	4.588	16.429	0.286	–0.528
Finland	39.614	38.560	30.730	49.500	4.369	11.030	0.315	–0.682
France	32.122	32.275	23.580	39.480	3.292	10.247	–0.026	–0.483
Germany	31.708	31.650	22.00	42.460	4.756	14.998	0.150	–0.569
Greece	39.850	39.560	28.320	47.390	3.685	9.247	0.055	–0.796
Hungary	27.931	28.360	19.800	36.870	3.970	14.214	–0.024	–0.864
Ireland	32.164	31.710	21.830	45.400	5.233	16.269	0.393	–0.346
Italy	35.362	35.245	29.020	41.790	2.849	8.057	–0.057	–0.611
Latvia	25.273	24.915	14.720	35.150	4.838	19.144	–0.111	–0.777
Lithuania	24.486	23.525	14.980	37.000	5.335	21.786	0.255	–0.719
Luxemburg	32.557	32.015	23.690	46.420	4.312	13.245	0.641	0.638
Malta	48.030	47.430	41.520	56.070	3.161	6.581	0.497	–0.433
Netherlands	33.030	33.125	21.560	45.090	5.338	16.162	0.054	–0.829
Poland	27.956	28.265	16.000	37.170	4.299	15.376	–0.452	0.319
Portugal	30.889	30.545	26.200	39.500	3.126	10.119	0.797	0.147
Romania	27.160	27.705	18.460	33.780	3.594	13.234	–0.619	–0.346
Slovakia	28.423	28.560	17.670	36.875	4.179	14.705	–0.294	–0.527
Slovenia	29.094	28.670	23.160	37.290	3.075	10.569	0.426	–0.324
Spain	31.712	30.680	26.850	45.100	3.312	10.444	1.907	4.088
Sweden	33.603	33.073	23.480	45.520	4.467	13.294	0.800	–0.909
United Kingdom	30.415	30.100	22.610	10.010	4.190	13.778	0.379	–0.739

Source: Own calculations on the basis of monthly milk price data from 2004–2018 for EU countries (Milk Market 2018)

2007–2017, the Augmented Dickey-Fuller (ADF) test was used. The significance of the delay from the order of 13 was tested for the AIC criterion (Akaike information criterion) and showed that the time series of weighted average EU milk prices were stationary (*P*-values were under 0.05). Therefore, an ARMA model was estimated to test if weighted average milk prices in the EU depend on the previous values in the period under examination (Table 2). The next step was to check how many lags should be taken into account when constructing the ARMA model. For this purpose, the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) were processed. The function ACF computes (and by default plots) estimates of the autocovariance or autocorrelation function. Function PACF is the function used for the partial autocorrelations.

The European market for milk is a market that faces many regulations. From 1984 to 2015 the EU used a milk quota system to stabilise milk prices. The key advantages of the system included upholding milk prices, increasing farm income, and protecting farms in less-favoured areas. The fundamental flaw of quotas was a slowdown of production concentration processes and structural transformations on the milk market. Abolishing the quotas in 2015 triggered con-

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Table 2. ARMA estimation for weight monthly average EU milk prices in the years 2007–2017 (N = 180; Hessian standard errors)

	Coefficient	Standard error	*z*	*P-value*
Constant	31.9303	0.8738	36.5400	<0.0001***
Phi_1	1.6314	0.0757	21.5500	<0.0001***
Phi_2	–0.6895	0.0742	–9.2910	<0.0001***
Theta_1	0.0045	0.0959	0.0470	0.9623
Theta_2	0.2091	0.0866	2.4140	0.0158**
Arithmetic average of the dependent variable		31.9059		
Average random disorders		–0.0034		
Logarithm of credibility		–158.2081		
Bayes. Schwarz criterion		347.5739		
Standard deviation of the dependent variable		3.7382		
Standard deviation of random disorders		0.5754		
Akaike information criterion		328.4161		
Hannan-Quinn criterion		336.1838		
	Real	Delusional	Module	Intermittency
Autoregressive model				
Root 1	1.1831	–0.2253	1.2043	–0.0299
Root 2	1.1831	0.2253	1.2043	0.0299
Moving average				
Root 1	–0.0108	–2.1867	2.1867	–0.2508
Root 2	–0.0108	2.1867	2.1867	0.2508

** statistical significance at α = 0.05, *** statistical significance at α = 0.01; ARMA – Autoregressive-Moving-Average Model
Source: Own calculations on the basis of monthly milk price data from 2004–2018 for EU countries (Milk Market 2018)

siderable positive changes in the market conditions. Limitation of supply, which in fact was a very strong intervention in the market fundamentals, had a negative impact on the efficiency and competitiveness of the dairy sector. The abolishment of milk quotas allowed for an acceleration of structural changes and an improvement in economic capacity. Moreover, it has reduced the strength of certain competitive forces within the dairy industry.

CONCLUSION

Changes in milk prices depend on conditions in European and world markets. The second important factor is consumer preferences. Milk prices are also determined by the level of costs incurred. Milk production is a labour-intensive and capital-intensive activity. The profitability of milk production in Poland depends on the improvement of the effectiveness of incurred costs. One of the aims of the CAP is to provide consumers with high-quality food. Ensuring food safety is more difficult for milk than in other types of food production. This requires milk producers to meet increasingly difficult requirements. They also must have the financial reserves needed to carry out the necessary investment and repairs.

An analysis of prices for the domestic milk market showed that prices were characterised by high volatility (variability), particularly for raw milk prices. These developments make it more difficult to plan and budget, reduce investment and R&D spending and make less volatile substitutes more attractive. On the other hand, it is necessary that agricultural producers earn an adequate income. The increased volatility at the EU level can in part be attributed to reform of the CAP, which has resulted in movement from product to producer support with reduced market intervention. This has reduced the impact of world price fluctuations on farm income. In order to manage the increased risk which has resulted from this policy reform, the EU has expanded its risk management toolbox and implemented the milk package of 2012. This involved instituting the so-called market safety net, a series of measures aimed at boosting the position of dairy producers

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in the overall dairy supply chain. These are intervention instruments, which are activated when prices fall below a particular target level. However, there is a sense that these measures may be inadequate in times of market stress and are of limited use to others in the supply chain.

The Common Agriculture Policy (CAP) helped to stabilise agricultural markets in the European Union. CAP does not, however, solve the endemic problems of agriculture, broadly defined as the food economy and rural areas, in a comprehensive manner. Recent trends in agricultural commodity prices have been a subject of concern to policymakers at both EU and national levels. The price volatility of milk in Poland is of particular concern because the market is now under the control of the CAP. Before the end of the EU production quotas, Polish dairy farmers had good conditions for development because the quotas kept milk prices high. The quota system was introduced by regulating supply to make price fluctuations independent of fluctuations in milk prices on world markets. The cancellation of milk quotas has made the European market comply with the rules of the global market. This results in additional opportunities and threats. It was shown, however, that the fluctuations of milk prices in the European Union are lower than those on world markets now.

The current CAP for the period 2014 to 2020 represents one of the most market-oriented forms of European agricultural policy since its establishment. This has involved a shift away from price supports to direct income support and rural development. However, an analysis of price changes in the main agricultural sectors covering dairy, beef, pork, cereals, sugar, and fruit and vegetables shows a significant downward trend.

The rules of a competitive economy need to be more effectively implemented in food production. Among the challenges forcing further reforms in the CAP and rural development policy after 2020 are reduction of risks in agricultural activity and market instability, improvement of efficiency, counteracting the population exodus from peripheral areas, maintaining the agricultural activity in areas difficult for farming because of natural conditions, shortening the distribution chains, supporting small agricultural holdings, protection of the environment and cultural landscape, adaptation to climate change, development of renewable energy sources, food safety, food quality, and wellbeing of animals. This will result in the consolidation of dairy production in larger farms. The smallest farms will not be able to make a profit from milk production. Horizontal integration improves the position of milk producers in relation to suppliers. This change will also improve the competitiveness of the dairy industry.

As a result of the analysis, it can be concluded that:

– Milk production is an important part of the food economy. Poland is one of the six largest milk producers in the European Union. Milk prices can change significantly in a short period of time. The rise of the milk prices in Poland is faster than the EU-average.
– The dairy market is particularly sensitive to changes in raw milk prices and their impact on the retail prices of products.
– The supply of milk to the dairy industry is increasing. This is a result of growth in the number of cows and above all, an increase in the average milk productivity. Efficiency depends on the quality of feed and equipment used. The importance of international trade will increase, especially as milk prices in the EU differ widely.
– The elimination of milk quotas has changed the farming conditions across the EU. Farms with more cows are in the best position.
– The number of dairy enterprises in Poland has decreased, but it is still high and they are increasingly concentrated in the regions with the highest milk production. Further consolidation of the dairy processing factories will continue.

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REFERENCES

Acosta A., Ihle R., Robles M. (2014): Spatial price transmission of soaring milk prices from global to domestic markets. Agribusiness, 30: 64–67.

Bergmann D., O'Connor D., Thummel A. (2015): Seasonal and cyclical behaviour of farm gate milk prices. British Food Journal, 117: 2899–2913.

Binfield J., Donnellan T., Hanrahan K., Westhoff P. (2007): CAP Health Check Analysis: Impact on EU Milk Quota Expansion. Teagasc.

Binfield J. (2009): EU milk production quotas. Advances in Dairy Technology, 21: 71–84.

Borawski P., Beldycka-Borawska A., Dunn J.W. (2018): Price volatility of Polish agricultural commodities in the view of the Common Agricultural Policy. Agricultural Economics – Czech, 64: 216–226.

Borawski P., Beldycka-Borawska A., Szymanska E.J., Jankowski K.J., Dunn J.W. (2019): Price volatility of agricultural land in Poland in the context of the European Union. Land Use Policy, 82: 486–496.

https://doi.org/10.17221/178/2019-AGRICECON

Commission (2009): Economic Impact of the Abolition of the Milk Quota Regime – Regional Analysis of the Milk Production in the EU. Institute for Prospective Technological Studies: 1–127. Available at https://ec.europa.eu/agriculture/ (Accessed June 15, 2019).

Dickey D.A., Fuller W.A. (1979): Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association, 74: 427–431.

Dolezalova H., Picha K., Navratil J., Bezemkova A. (2014): Factors that influence the selling of milk through milk vending machines. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 62: 641–650.

Donnellan T., Hennessy T., Thorne F. (2009): Perspectives on the competitiveness of EU dairy farming. Eurochoices, 8: 23–29.

Milk Market (2018): Milk Market Observatory. European Commission. Available at https://ec.europa.eu/agriculture/market-observatory/milk_pl (accessed May 25, 2019).

Figiel S., Hamulczuk M. (2010): Measuring price risk in commodity markets. Olsztyn Economic Journal, 5: 380–394.

Grau A., Hockmann H. (2018): Market power in the German dairy value chain. Agribusiness, 34: 93–111.

Hamulczuk M. (2013): Asymmetric price transmission in the food chain. Example of prices of poultry in Poland. Research Papers of Wroclaw University of Economics, 307: 212–223.

Hennessy T., Shrestha S., Shalloo L., Wallace M. (2009): The inefficiencies of regionalised trade of milk quota. Journal of Agricultural Economics, 60: 334–347.

Hillen J., Cramon-Taubadel S. (2019): Protecting the Swiss milk market from foreign price shocks: Public border protection vs. quality differentiation. Agribusiness, 35: 516–536.

Kempen M., Witzkem P., Perez Dominguez I., Jansson T., Sckokai P. (2011): Economic and environmental impacts of the milk quota reform in Europe. Journal of Policy Modeling, 33: 29–52.

Krpalkova L., Cabrera V.E., Kvapilik J., Burdych J. (2016): Dairy farm profit according to the herd size, milk yield, and number of cows per worker. Agricultural Economics – Czech, 62: 225–234.

Lapple D., Hennessy T. (2012): The capacity to expand milk production in Ireland following the removal of milk quotas. Irish Journal of Agricultural and Food Research, 51: 1–11.

Lips M., Rieder P. (2005): Abolition of raw milk quota in the European Union: A CGE Analysis at the member country level. Journal of Agricultural Economics, 56: 1–17.

Rembeza J., Seremak-Bulge J. (2010): Changes in prices and price relationships in basic food markets. Issues of Agricultural Economics, 1: 112–125.

Requillart V. (2008): Economic analysis of the effects of the expiry of the EU milk quota system. IDEI Report, 5: 1–99.

Richards T.J., Patterson P.M., Acharya R.N. (2001): Price behavior in a dynamic oligopsony. Washington processing potatoes. American Journal of Agricultural Economics, 83: 259–271.

Santeramo F.G., Lamonaca E., Conto F., Nardone G., Stasi A. (2018): Drivers of grain price volatility: a cursory critical review. Agricultural Economics – Czech, 64: 347–356.

Simo D., Mura L., Buleca J. (2016): Assesment of milk production competitiveness of the Slovak Republic within the EU-27 countries. Agricultural Economics – Czech, 62: 482–492.

USDA (2018): EU-28 Dairy and Products Annual Dairy Production Affected by Drought in Northern and Eastern Europe. USDA. Available at https://gain.fas.usda.gov/Recent_GAIN Publications (accessed May 21, 2019).

Voneki E., Mandi-Nagy D., Stark A. (2015): Prospects for the European Union and Hungarian dairy sectors after the abolition of the milk quota system. Studies in Agricultural Economics, 117: 1–9.

Wang G.Y., Si R.X., Li C.X., Zhang G.T., Zhu N.Y. (2018): Asymmetric price transmission effect of corn on hog: evidence from China. Agricultural Economics – Czech, 64: 186–196.

Weldesenbet T. (2013): Asymetric price transmission in the Slovak liquid milk market. Agricultural Economics – Czech, 59: 512–524.

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