ANNALS OF THE POLISH ASSOCIATION OF AGRICULTURAL AND AGRIBUSINESS ECONOMISTS

received: 21.09.2020
acceptance: 08.11.2020
published: 22.12.2020
JEL codes: Q11, Q13, L66

Annals PAAAE • 2020 • Vol. XXII • No. (4)

DOI: 10.5604/01.3001.0014.4930

JOANNA DOMAGAŁA

Warsaw University of Life Sciences – SGGW, Poland

LINKS BETWEEN SMP PRICES IN POLAND AND SELECTED FOREIGN MARKETS

Key words: SMP market, prices, time series analysis, cointegration tests, causality analysis

ABSTRACT. The aim of the paper was to determine the links between SMP prices in Poland and SMP prices in selected countries. The article uses secondary data for the monthly price of butter at a level of countries collected by the Milk Market Observatory and the Italian Dairy Economic Consulting portal for 2000-2016. The analyzed period was divided into two periods: 2000-2004 and 2005-2016. The article uses Johansen cointegration tests, and Granger's causality analysis. The analyzes in the first stage concerned the links between SMP prices in Poland and SMP prices in Western Europe, the USA and Oceania. In the second stage, the links between SMP prices in Poland and selected EU countries were identified. The results of the study confirmed a stronger link between SMP prices in Poland and SMP prices in Western Europe and Oceania. It is worth noting that these links mainly occurred in the period following Poland's accession to the EU. Within EU countries, SMP prices in Belgium, the Czech Republic, Germany, Ireland and the Netherlands were related to prices in Poland.

INTRODUCTION

The mechanism of linking and transmitting prices between markets that are space-separated has long been a subject of many scientific studies [Rembeza, Chotkowski 2006, Rembeza, Seremak-Bulge 2007]. The market is a basic concept used in economics [Tirole 1994]. The main factor that affects the market is price. It contains vital information about, i.a., the value, usability and quality of a product. Moreover, price is an indicator of competitiveness within the whole economy and selected markets [Judzińska 2015]. It was Alfred Marshall [1920] who claimed that: "The more nearly perfect a market is, the stronger the tendency for the same price to be paid for the same thing at the same time in all parts of the market".

Globalisation processes and economic reforms that aim to liberalise the functioning of internal markets may result in an enhanced linkage of agricultural product prices between various countries [Dercon 1995, Baffes, Gardner 2003, Conforti 2004]. Such a strengthening may manifest itself in the price alignment and price reaction of one market to price changes in another market. Market integration processes are often considered better indicators of changes in price rather than in trade volume [Barrett, Li 2002, Rembeza 2009].

Price alignment between markets may be distorted or impaired by e.g. trade restrictions, transportation costs, consumer preferences and economic crises, etc. These factors widen the price range within which they differ in two different markets. Therefore, the analysis of price linkage is often used in testing market integration [Dercon 1995, Conforti 2004].

The analysis of casual relations in the milk market was addressed by, i.a.: Jerzy Rembeza, Jadwiga Seremak-Bulge and Krzysztof Hryszko [2005], who analysed the links between milk purchase prices in Poland and Germany as well as France and Holland; Zoltán Bakucs, Jan Fałkowski and Imre Fertő [2010] analysed integration between the milk market in Poland and Hungary; while Jadwiga Seremak-Bulge and Monika Roman [2016] analysed the influence of global prices on Polish butter, SMP and the cheese market. Costas Katrakilidis [2008] studied the causal relations between raw milk prices in Germany, France, Belgium, Denmark and the Netherlands, while Awadhesh Jha, Krishna Singh and Ram Singh [2012] focused on the integration of the wholesale milk market in India.

MATERIAL AND METHODS

In order to determine the links between the prices of skimmed milk powder (SMP) in Poland and selected countries of the world, secondary data – collected by Italian Dairy Economic Consulting and the European Milk Market Observatory – on the country's monthly SMP prices were used.

Research consisted of two stages. In the first stage, the links between SMP prices in Poland and Western Europe, the US and Oceania were analysed. The choice of foreign markets was intentional, as Western and Central Europe, North America (excluding Mexico) and Oceania form the "Triad" of the world's dairy industry, which is characterised by high production and consumption of milk *per capita*. Production in these regions accounts for 35% of total output and is higher than consumption, as confirmed by high self-sufficiency rates. What is more, these regions have a large share in global trade. In 2016, their total share in the volume of dairy exports was approx. 85%, and import – approx. 60%. These are also known as places where numerous global dairy companies have originated, which through direct foreign investments have expanded their businesses to other regions.

In the second stage of the study, links between SMP prices in Poland and selected EU countries were determined. The time period of analysis is 2004-2016 (period subject to data availability). For the analysis of price linkage, six EU countries were selected. Their selection was determined by data availability for the whole analysed period.

All analyses were conducted for the whole 2000-2016 (global market) and 2004-2016 (EU markets) periods. Additionally, as part of the global price analyses, a research for two intentionally separated sub-periods was also carried out. While determining the sub-periods, Poland's accession to the EU and the related internationalisation of the dairy industry were taken into account; thus, for the purposes of global market analysis, the following sub-periods were distinguished: 2000-2004 and 2005-2016. Poland's accession to the EU has significantly altered the functioning of domestic agricultural markets, including price levels and changes. As a result, two phenomena can be expected: an

adjustment of the average price level to that of EU markets and an increase in the reactive force of Polish prices to price changes in the EU. The second period of analysis is related to reforms of the Common Agricultural Policy (CAP), which aim to liberalise the milk market and support its exposure to the global market.

Due to the fact that the analysed time series were more multiplicative than additive and that the least squares method was used, calculations were based on logarithmic data. The time series transformation caused the volatility amplitude to remain at approximately the same level [Hamulczuk 2007, Seremak-Bulge, Roman 2016]. Time series were also cleared of seasonal variations using the X-12 ARIMA method in the Gretl programme[1].

In order to determine the long-term linkage between prices in Poland and the world/EU, cointegration analysis was performed, based on Johansen's method. However, in the analysis of the short-term linkage between SMP prices in Poland and the world/EU – the Granger causality test was used.

Cointegration analysis focused on links between SMP prices in Poland and the world/EU. The analysis facilitated the identification of false-positive links and enabled to determine whether there is a certain balance between the price series, in which deviations tend to be zero. These deviations are short-term in nature and do not determine the long-term linkage between prices. Non-stationary variables demonstrating such links are called cointegrated variables.

Johansen's test was aimed to estimate the model of vector autoregression [Czapla 2010, p. 268] $\Delta x_t = \prod x_{t-1} + \sum_{i=1}^{k-1} \Gamma_i x_{t-1} + \Phi D_t + \varepsilon_t$, the estimation of maximum likelihood, the determination of Π matrix's eigenvalues and the verification of non-zero eigenvalues. In addition, Johansen's method involved testing with unrestricted intercepts and restricted trends. Trace statistics and maximum values were used to test cointegration.

However, in the analysis of the short-term linkage between SMP prices in Poland and the world/EU – the Granger causality test was used. According to this method: "Variable *X* is said to Granger-cause variable *Y*, if current *Y* values are better explained using lagged and current X values than without them" [Hamulczuk et al. 2012, p. 54]. Causality was examined based on the following test [Hamulczuk, Klimkowski 2011]:

$$y_t = A_0 D_t + \sum_{j=1}^{k} \alpha_j y_{t-1} + \sum_{j=1}^{k} \beta_j x_{t-1} + \varepsilon_t$$

where: A_0, α_j, β_j – model parameters, D_t – deterministic variables, y and x are the analysed model variables, k – lags.

[1] The deseasonisation procedure was implemented in the GRETL programme. Time series were deseasonised because the prices of dairy products are characterised by seasonality.

If $\beta_1 = \beta_2 = ... = \beta_k = 0$, thus the *X* variable is not the Granger-cause of the *Y* variable. By contrast, if the *X* variable is the cause of the *Y* variable and the *Y* variable is the cause of the *X* variable, then mutual causation exists. To verify this hypothesis, the Fisher-Sendecor test was used [Charemza, Deadman 1997].

RESULTS

Poland is a significant EU producer of both skimmed milk powder and whey. These products are mostly exported to international markets, including China. As a result, the domestic price of SMP is strongly dependent on the global economic situation.

The study identified long-term links between SMP prices in Poland and those in Western Europe and Oceania. Nonetheless, it is worth noting that these links mainly occurred in the period following Poland's accession to the EU (Table 1). Moreover, in the years 2005-2016, there were long-term links between Polish SMP prices and US SMP prices.

Table 1. Results of co-integration analysis between SMP prices in Poland and those in Western Europe, the USA and Oceania

Region	H_0	H_1	2000-2016		2000-2004		2005-2016	
			trace test	maximum eigenvalue test	trace test	maximum eigenvalue test	trace test	maximum eigenvalue test
			test statistic [p-value]					
Western Europe	$r = 0$	$r = 1$	36.021 [0.001]	29.811 [0.001]	20.063 [0.227]	17.425 [0.094]	29.469 [0.015]	23.232 [0.011]
	$r \leq 1$	$r = 2$	6.210 [0.445]	6.210 [0.446]	2.637 [0.903]	2.637 [0.904]	6.238 [0.441]	6.238 [0.442]
USA	$r = 0$	$r = 1$	18.572 [0.313]	11.200 [0.505]	16.226 [0.483]	13.246 [0.320]	33.499 [0.004]	25.122 [0.005]
	$r \leq 1$	$r = 2$	7.372 [0.317]	7.372 [0.317]	2.980 [0.868]	2.980 [0.869]	8.377 [0.229]	8.377 [0.229]
Oceania	$r = 0$	$r = 1$	29.311 [0.016]	23.626 [0.009]	19.164 [0.277]	16.389 [0.131]	32.087 [0.006]	24.425 [0.007]
	$r \leq 1$	$r = 2$	5.684 [0.511]	5.684 [0.513]	2.775 [0.889]	2.775 [0.891]	7.662 [0.289]	7.662 [0.289]

Note – blue cells indicate cointegration at the significance level $\alpha = 0.05$
Source: own study based on CLAL.IT data

Table 2. Granger-Causality Tests

Hypothesis tested	2000-2016		2000-2004		2005-2016	
	Fisher-Sendecor	price dependency direction	Fisher-Sendecor	price dependency direction	Fisher-Sendecor	price dependency direction
	test [p-value]					
Poland – Western Europe	1.341 [0.248]	E → PL	0.052 [0.821]	E → PL	2.9583 [0.055]	E → PL
Western Europe – Polska	76.720 [0.000]		18.251 [0.000]		25.774 [0.000]	
Poland – USA	2.186 [0.141]	USA → PL	0.268 [0.607]	USA x PL	3.598 [0.030]	USA ↔ PL
USA – Poland	20.703 [0.000]		0.502 [0.481]		10.492 [0.000]	
Poland – Oceania	2.165 [0.117]	O → PL	0.501 [0.482]	O → PL	3.690 [0.027]	O ↔ PL
Oceania – Poland	19.440 [0.000]		7.212 [0.009]		16.926 [0.000]	

Note – blue cells indicate Granger causality at the significance level $\alpha = 0.05$,
x – no causality, ↔ unidirectional, → bidirectional
Source: own study based on CLAL.IT data

In the case of SMP, prices in Europe, the US and Oceania influenced prices in Poland (Table 2). Throughout the entire period under examination, as well as in all the sub-periods, prices in Western Europe influenced SMP prices in Poland. On the other hand, the direction of transmission of SMP prices from the US and Oceania to Poland varied. For the US, no causality was identified between SMP prices in the US and Poland in 2000-2004, whereas in 2005-2016 a two-way causality occurred. For Oceania, SMP prices in Oceania influenced prices in Poland in 2000-2004, and after 2004 – a mutual causality was observed.

The comparison of Polish SMP prices to prices in selected EU countries revealed long-term links between SMP prices in Poland and SMP prices in Belgium, the Czech Republic, Germany, Ireland and the Netherlands (Table 3). SMP prices in Poland were not cointegrated with prices in Latvia.

Table 3. Results of co-integration analysis between SMP prices in Poland and those in selected EU countries in 2004-2016

Country	H_0	H_1	Trace test	Maximum eigenvalue test
			test statistic [p-value]	
Belgium	$r = 0$	$r = 1$	37.428 [0.001]	31.228 [0.000]
	$r \leq 1$	$r = 2$	6.201 [0.446]	6.201 [0.447]
Czech Republic	$r = 0$	$r = 1$	56.895 [0.000]	50.428 [0.000]
	$r \leq 1$	$r = 2$	6.467 [0.414]	6.467 [0.4149]
Germany	$r = 0$	$r = 1$	34.888 [0.002]	29.368 [0.001]
	$r \leq 1$	$r = 2$	5.521 [0.533]	5.521 [0.534]
Ireland	$r = 0$	$r = 1$	46.134 [0.000]	46.134 [0.000]
	$r \leq 1$	$r = 2$	7.596 [0.295]	7.596 [0.296]
Latvia	$r = 0$	$r = 1$	24.835 [0.065]	17.861 [0.081]
	$r \leq 1$	$r = 2$	6.974 [0.357]	6.974 [0.358]
Netherlands	$r = 0$	$r = 1$	46.165 [0.000]	40.863 [0.000]
	$r \leq 1$	$r = 2$	5.302 [0.562]	5.302 [0.530]

Note – blue cells indicate cointegration at the significance level $\alpha = 0.05$
Source: own study based on EU Milk Market Observatory data

Table 4. Granger-Causality Tests

Hypothesis tested	Fisher-Sendecor test [p-value]	Price dependency direction
Poland –Belgium	3.223 [0.075]	Belgium → Poland
Belgium – Poland	61.467 [0.000]	
Poland – Czech Republic	66.740 [0.000]	Poland → Czech Republic
Czech Republic – Polska	0.009 [0.921]	
Poland – Germany	5.583 [0.019]	Poland ↔ Germany
Germany – Poland	95.772 [0.000]	
Poland – Ireland	19.123 [0.000]	Poland ↔ Ireland
Ireland – Poland	5.696 [0.004]	
Poland – Latvia	10.850 [0.001]	Poland → Latvia
Latvia – Poland	3.251 [0.073]	
Poland – Netherlands	4.310 [0.040]	Poland ↔ Netherlands
Netherlands – Poland	86.428 [0.000]	

Note – blue cells indicate Granger causality at the significance level $\alpha = 0.05$,
↔ unidirectional, → bidirectional
Source: own study based on EU Milk Market Observatory data

Taking the direction of causality into account, as determined by the Granger method, it was Polish SMP prices that influenced prices in the Czech Republic and Latvia. In the case of Germany, the Netherlands and Ireland, a two-way causality with respect to prices in Poland was observed (Table 4). Moreover, the changes of SMP prices in Belgium had a strong impact on Polish prices (F = 61.5).

CONCLUSIONS

The milk market in Poland has undergone significant changes over the last several years. There is a surplus supply on the Polish milk market and foreign trade constitutes a key element of market equilibrium. As a result, the domestic market is highly dependent on prices in foreign countries.

Research proved that in the period 2005-2015, as compared to the period 2000-2004, the interdependence of SMP prices in Poland with prices on the markets of Western Europe and Oceania has significantly increased. Substantial links were identified between SMP prices in Poland and EU countries such as Belgium, the Czech Republic, Germany, Ireland and the Netherlands. Therefore, the results suggest that the SMP market has a transnational spatial dimension. Such a conclusion has been reached by other researchers as well [Seremak-Bulge, Roman 2016, Roman 2017, Baran 2019].

Taking the above research results into account, it would be worthwhile extending analysis and including price linkage of other dairy products, for example raw milk. It should also be noted that economic crises (together with the COVID-19 pandemic) in various foreign markets may affect the dairy sector's situation in Poland and the world, and thus change price correlations, which may also constitute an interesting topic for research.

BIBLIOGRAPHY

Baffes John, Bruce Gardner. 2003. The transmission of world commodity prices to domestic markets under policy reforms in developing countries. *Policy Reform* 6: 159-180.

Bakucs Zoltán, Jan Fałkowski, Imre Fertő. 2010. *Milk Market Integration between Hungary and Poland*. [In] 84th Annual Conference, March 29-31, 2010, Edinburgh, Scotland, Agricultural Economics Society, http://ageconsearch.umn.edu/bitstream/91809/2/74Bakucs_falkowski_ferto.pdf, access: 30.03.2016.

Baran Joanna. 2019. *Intensywność i zasięg geograficzny internacjonalizacji sektora przetwórstwa mleka* (Intensity and geographical scope of internationalization of the dairy processing sector). Warszawa: Wydawnictwo SGGW.

Barrett Christopher, Jau Rong Li. 2002. Distinguishing between equilibrium and integration in spatial price analysis. *American Journal of Agricultural Economics* 84: 292-307.

Charemza Wojciech, Derek Deadman. 1997. *Nowa ekonometria* (New Econometrics). Warszawa: PWE.

Conforti Piero. 2004. Price transmission in selected agricultural markets. *FAO Commodity and Trade Policy Research Working Papers* 7: 1-86.

Czapla Ewa. 2010. Powiązania długookresowe między stopami procentowymi Polski, Stanów Zjednoczonych i strefy euro (Are there any long-run linkages among Polish, US and Eurocurrency interest rates?). *Zeszyty Naukowe Instytutu Ekonomii i Zarządzania* 14: 265-275.

Dercon Stefan. 1995. On market integration and liberalization: method and application to Ethiopia. *Journal of Development Studies* 32: 112-143.

Hamulczuk Mariusz. 2007. Powiązania cen wieprzowiny pomiędzy rynkiem polskim, duńskim i niemieckim (The pork price linkages between Polish, Danish and German markets). *Problemy Rolnictwa Światowego* 2 (17): 195-206.

Hamulczuk Mariusz, Stanisław Gędek, Cezary Klimkowski, Stanisław Stańko. 2012. *Prognozowanie cen surowców rolnych na podstawie zależności przyczynowych* (Forecasting agricultural commodity prices on the basis of causal relationships. Warszawa: IERiGŻ-PIB..

Hamulczuk Mariusz, Klimkowski Cezary. 2011 Powiązania między cenami ropy a cenami pszenicy w Polsce (The Connection between Crude Oil Prices and Polish Wheat Prices), *Roczniki Nauk Rolniczych – Seria G, Ekonomika Rolnictwa* 98 (3): 176-190.

Jha Awadhesh, Krishna Singh, Ram Singh. 2012. Market integration in wholesale milk markets in India. *Social Science Research Network* May: 1-12. DOI: 10.2139/ssrn.2062821.

Judzińska Agnieszka. 2015. Konkurencyjność cenowa polskiego sektora mleczarskiego w Unii Europejskiej (Price competitiveness of Polish dairy market in the European Union). *Roczniki Naukowe SERiA* XVIII (5): 60-65.

Katrakilidis Costas. 2008. Testing for market integration and the law of one price: an application to selected European milk markets. *International Journal of Economic Research* 5 (1): 93-104.

Marshall Alfred. 1920. *Principles of Economics*. London: Macmillan and Co. The Online Library of Liberty, access: 4.09.2015.

Rembeza Jerzy. 2009. Powiązania pomiędzy cenami produktów rolnych w Polsce i krajach UE (Linkages of agricultural commodities prices between the Polish and the EU markets). *Zeszyty Naukowe Szkoły Głównej Gospodarstwa Wiejskiego w Warszawie. Problemy Rolnictwa Światowego* 7 (22): 111-119.

Rembeza Jerzy, Jacek Chotkowski. 2006. Powiązanie cen produktów rolnych pomiędzy rynkiem polskim a rynkami UE (Butter market integration between Poland and selected European Union countries). *Zeszyty Naukowe Szkoły Głównej Gospodarstwa Wiejskiego w Warszawie. Problemy Rolnictwa Światowego* 15: 198-204.

Rembeza Jerzy, Jadwiga Seremak-Bulge, Krzysztof Hryszko. 2005. Ceny, ich relacje oraz transmisja na rynku mleka. [W] *Rozwój rynku mleczarskiego i zmiany jego funkcjonowania w latach 1990-2005* (Prices, their relations and transmission on the milk market. [In] Development of the dairy market and changes in its functioning in 1990-2005), ed. J. Seremak-Bulge, 177-212. Warszawa: IERiGŻ-PIB.

Rembeza Jerzy, Jadwiga Seremak-Bulge. 2007. Interakcja cen zbóż na rynku polskim z rynkami zagranicznymi (The interaction of grain prices on the Polish market with foreign markets). *Zagadnienia Ekonomiki Rolnej* (4): 111-121.

Roman Monika. 2017. Powiązanie cen masła między rynkiem polskim a wybranymi rynkami krajów Unii Europejskiej (Butter market integration between Poland and selected European Union countries). *Roczniki Naukowe SERiA* XIX (4): 169-174. DOI: 10.5604/01.3001.0010.5182.

Seremak-Bulge Jadwiga, Monika Roman. 2016. Sytuacja na światowym rynku mleka i jej wpływ na polski rynek i jego możliwości rozwojowe. [W] *Sytuacja na światowych rynkach mięsa i produktów mleczarskich oraz jej wpływ na rynek krajowy i możliwości jego rozwoju* (The situation on the world milk market and its impact on the Polish market and its development opportunities. [In] Situation on the world markets of meat and dairy products and its influence on the domestic market and its development opportunities), ed. S. Stańko, 105-154. Warszawa: IERiGŻ-PIB.

Tirole Jean. 1994. *The Theory of Industrial Organization*. Cambridge, London: The MIT Press.

***

POWIĄZANIE CEN OMP MIĘDZY RYNKIEM POLSKIM A WYBRANYMI RYNKAMI ŚWIATA

Słowa kluczowe: rynek OMP, ceny, analiza szeregów czasowych, testy kointegracji, analiza przyczynowości

ABSTRAKT

Celem artykułu jest określenie powiązań między cenami odtłuszczonego mleka w proszku (OMP) w Polsce a cenami OMP w wybranych krajach świata. Wykorzystano dane wtórne dotyczące miesięcznych cen OMP na poziomie państw, gromadzone przez EU Milk Market Observatory oraz portal Italian Dairy Economic Consulting za lata 2000-2016. Analizowany okres podzielono na dwa podokresy: 2000-2004 i 2005-2016. Do analizy powiązań zastosowano testy kointegracji Johansena oraz analizę przyczynowości Grangera. Analizy w pierwszym etapie dotyczyły powiązań cen OMP w Polsce z cenami OMP w Europie Zachodniej, USA i Oceanii. W drugim etapie zidentyfikowano powiązania między cenami OMP w Polsce i wybranych krajach UE. Badania potwierdziły długookresowe powiązania między cenami w Polsce a cenami OMP w Europie Zachodniej i Oceanii, które wystąpiły głównie w okresie po akcesji Polski do UE. W ramach krajów UE ceny OMP w Belgii, Czechach, Niemczech, Irlandii i Holandii były powiązane z cenami w Polsce.

AUTHOR

JOANNA DOMAGAŁA, PHD, DSC
ORCID: 0000-0001-9801-4344
Warsaw University of Life Sciences – SGGW
Institute of Economics and Finances
166 Nowoursynowska St., 02-787 Warsaw, Poland