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Price Linkage and Transmission in the Milk Market in Slovakia

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Abstract

Milk as a major commodity derived from animal production is the input of the processing industry, from which a number of products form a substantial part of the population's diet. Milk and dairy products are part of a food chain terminated by consumers for which the price is a criterion of availability. The paper studies the agri- food supply chain of milk production. Paper examine development of the farm-gate, retail and consumer prices of milk and dairy products in the time horizon 2006-2016. Paper examines through a regression and correlation analysis the dependence between the prices of all three stages of the supply chain and determines whether the price-dependence of the production, retailer and consumer prices are statistically significant. If dependence will be confirmed, paper quantifies these dependencies more accurately.

Key words: cow milk, prices, agri-food supply chain, milk market

JEL classification: E31, Q10

Agriculture is affected by many undesirable impacts and variables such as production dependent mainly on weather conditions, market and risks, mostly the risk of inputs or outputs price uncertainty, mean market risk.

The study by **Kinnucanon – Forker, 1987** has shown that the transfer of retail prices in the dairy and milk sector is characterized by high asymmetry. The relationship between the milk price at the primary production level and the retail prices of dairy products represented by butter, cheese, ice cream and liquid milk was analysed by an econometric model. As milk prices rise, the price of dairy products is also rising, and this response is faster than in the case of the dairy prices reaction to a decline in the milk price level. This is a visible sign of price asymmetry.

The study by **Stewart-Don, 2011** examining milk price transmission between producer and retailer showed that prices for full fat milk and Cheddar cheese are asymmetrically transported between the above-mentioned degrees of vertical and price shocks emerging from the farm are reflected in a time-lagged retail trade. Moreover, the transmission for full fat milk and Cheddar cheese has different character.

Serra-Goodwin, 2010 analysis, which also connected to the relation between milk price and the retail prices of dairy products, confirmed also in Spain a high degree of asymmetry.

As factors influencing milk prices **Dong - Du – Gould, 2011** listed the US dollar exchange rate changes, supply and demand conditions in the cheese market and seasonality factor.

Milk is produced in every Member State of the European Union without exception. Milk is even the most important product in the EU in terms of value, as it accounts for about 15% of agricultural production. The EU is an important member of the world market for milk and dairy products as a leading exporter of many dairy products, most of which are cheeses. The total current EU - 28 production is estimated at around 151 million tons per year. The main producers are Germany, France, Great Britain, Poland, Netherlands and Italy, which account for almost 70% of the total EU production (**Hörl-Hess, 2017**). The largest world producers are also the US, Australia and New Zealand.

After years of significant overproduction of milk and dairy products, in 1984 the Common Agricultural Policy introduced milk quotas in the EU. Earlier, European milk producers had guaranteed milk prices (significantly higher than on world markets) regardless of market demand. The system also had an impact on prices in the world market as the EU subsidized

exports to these markets. Since 1984 each European state has had two types of quota: the first defined the maximum quantity of milk delivered to the dairy and the other determined the limit for direct sales at farm level. If the manufacturer exceeds a given limit and achieves overproduction, appropriate sanctions have been imposed. (Eurostat, 2015)

Progressive reforms of the EU Common Agricultural Policy have focused more on the market providing more tools to help producers in sensitive areas such as mountain areas where production costs are higher. In 2003 the European Commission decided to partially reform the dairy sector and abolish the quota system in 2015. (European Commission, 2017)

Methodology

The regression and correlation analysis methodology is applied in order to determine changes in the sales prices, depending on the farm-gate level and consumer prices throughout the analysed period in milk supply chain. To describe the dependency, the exponential model is used. The general form of the model is:

$$y = b_0 * b_1^{x_1} \quad (1)$$

Modified form is:

$$RPM = b_0 * b_1^{FMP} \quad (2)$$

$$RPCH = b_0 * b_1^{FMP} \quad (3)$$

$$CPM = b_0 * b_1^{RPM} \quad (4)$$

$$CPCH = b_0 * b_1^{RPCH} \quad (5)$$

where:

b_0, b_1 - regression coefficients

FMP – farm-gate milk price

RPM – retail price of liquid semi-skimmed milk

$RPCH$ – retail price of cheese

CPM – consumer price of liquid full-fat milk

$CPCH$ – consumer price of cheese

The following form of the equation after the logarithmisation of the first equation can be written:

$$\ln RPM = \ln b_0 + FMP * \ln b_1 \quad (6)$$

$$\ln RPCH = \ln b_0 + FMP * \ln b_1 \quad (7)$$

$$\ln CPM = \ln b_0 + RPM * \ln b_1 \quad (8)$$

$$\ln CPCH = \ln b_0 + RPCH * \ln b_1 \quad (9)$$

Output from regression in MS Excel consists of correlation analysis, model verification and regression analysis. Data used in our analysis contain the average yearly cow's raw milk prices. The time-series cover the period from January 2006 to 2016 based on the Ministry of Agriculture and Rural Development of the Slovak Republic statistics.

Price development

The price transmission analysis requires assigning the corresponding price to each level of chain. The first stage is characterized by milk production prices, second stage retailing prices for food processors and third consumer food prices. The following table shows the development of these prices in analysed period.

Table 1: Production, retail and consumer prices of milk in euro per kg or litre in 2006-2016

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
I. level	Farm-gate cow milk prices	0.25	0.29	0.32	0.21	0.27	0.32	0.31	0.32	0.34	0.28	0.25
II. level	Retail price of semi-skimmed milk	0.40	0.40	0.49	0.36	0.41	0.42	0.41	0.45	0.43	0.35	0.33
	Retail price of cheeses	2.90	3.50	3.92	3.38	3.91	4.16	4.19	4.76	4.88	4.55	4.75
III. level	Consumer prices of full-fat milk	0.50	0.60	0.73	0.60	0.77	0.84	0.88	0.90	0.96	0.92	0.78
	Consumer prices of cheeses	4.40	5.20	6.30	4.94	5.36	6.11	6.21	6.28	6.48	6.00	5.71

Source: own processing based on the Ministry of Agriculture and Rural Development of the Slovak Republic (2018)

The price transmission generally assumes that the commodity price development on the first level of the vertical will be followed by the following steps. It is assumed that milk farm-gate prices affect retailer and consumer prices. The graphical analysis of price developments allows to partially evaluate this reaction. It is possible to see in the graphs how the retailer price of the cheese does not reflect with the farm-gate milk price development in the monitored period.

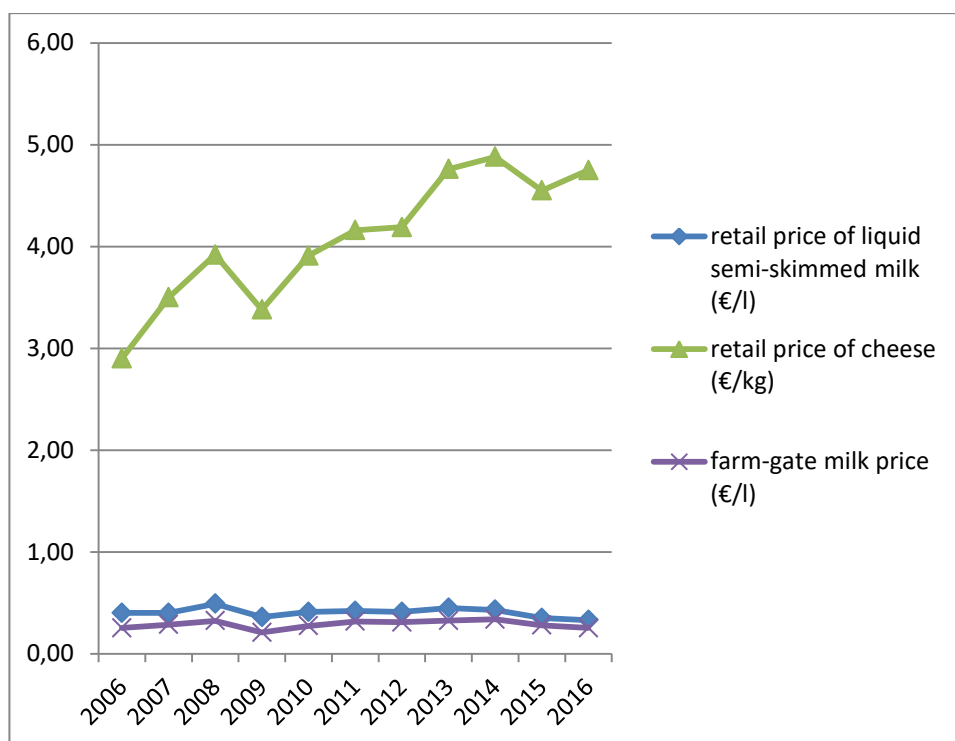


Figure 2 Production and retail prices of milk and retail prices of cheese for the period 2006-2016

Source: own processing

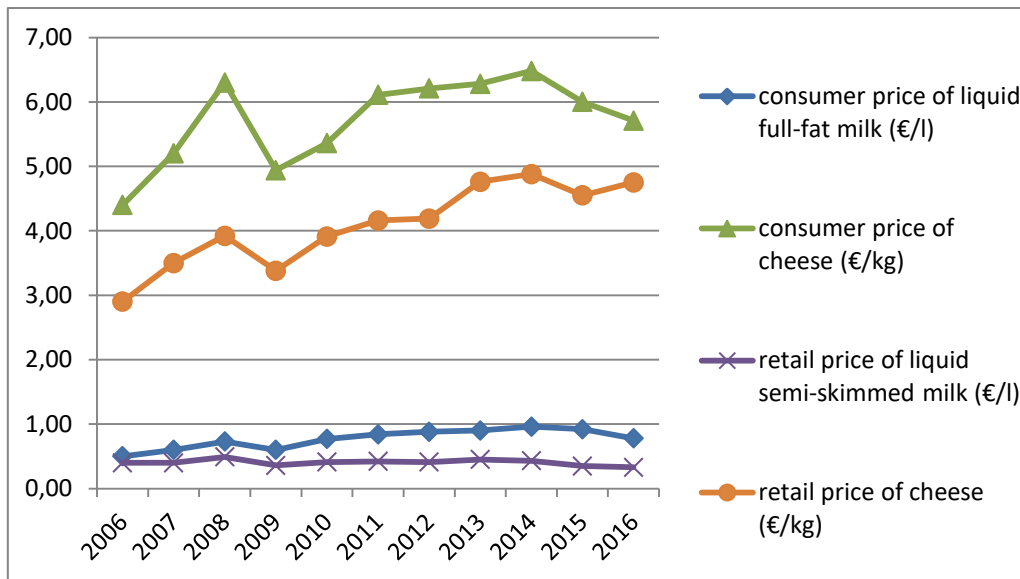


Figure 3 Retail and consumer prices of dairy products 2006-2016

Source: own processing

Changes in the retailer prices of dairy products, depending on changes in the milk price, were analysed by an exponential model. This model was able to explain changes with statistical significance between the first and second degree of the vertical only for the retail and production milk price.

The model explained 54% of the variability in the retail price of semi-skimmed liquid milk through changes in the farm-gate milk price. The exponential model appears as appropriate for defining this dependency. The dependence of the retail and production price of milk is characterized by a correlation coefficient of 0.73, indicating a strong dependence. The formula for the relationship between milk prices is as follows:

$$RPM = 0,22 * 8,43^{FMP} \quad (10)$$

The coefficient b1 of the equation can be interpreted as a percentage change in the milk retail price for a unit change in the milk price. Thus, if the production price increases by € 1, the price of milk processing will increase by 8.43%.

The dependence valuation of the second and third level of supply chain represented by retailer and consumer prices through regression and correlation analysis showed that the dependence between the retail prices of semi-skimmed milk and the consumer prices of full-fat milk is not interpretable using an exponential, linear neither power model from the annual data with statistical significance.

The dependence between the cheese retail prices and consumer prices during analysed period is strong with a correlation coefficient of 0.85 and the model has been able to describe for up to 72% of consumer price changes based on retail prices. The equation of regression coefficients has the form:

$$CPCH = 2,93 * 1,18^{RPCH} \quad (11)$$

Based on equation above we can state that, if the retail price of cheese is increasing by 1 unit (€), the consumer cheeses price may increase by 1.18%.

Conclusion

Milk is an important commodity and food component of people, so it is necessary to monitor its prices and their development. The food vertical of milk indicates the path of this commodity from the first realisation by the producers, through the processing into dairy products by its processors to the consumption of the last level of the vertical - the final consumer. In analysed period milk production prices did not rise above 0.40€ and in the last year prices returned to the same value as in the first year. Retail prices of semi-skimmed milk have fallen and retail prices of cheese have increased significantly. Consumer prices of milk and cheeses during period 2006-2016 grew.

The annual price data showed a statistically significant dependence of the milk retail prices on the production price, and regression analysis showed that when the milk price of the producer increased by € 1, the price of milk for processing industry may increased by 8.43%. The consumer price of cheese is also highly dependent on the sale price of this product and with a rise in the sales price by € 1, the price of cheeses for the consumer increases by 1.18%. The dependence of the retail price of cheese on the producers' milk prices was not determined by regression and correlation analysis as suitable for interpretation due to low statistical significance. Likewise, the price dependence of liquid milk was not interpretable between second (processors) and third level of supply chain (consumers) as being not interpretable with respect to non-identical price developments in the analysed horizon.

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