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RELATIONSHIP BETWEEN PRICES ON INDIVIDUAL LEVELS OF MILK FOOD VERTICAL

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Abstract

The aim of the paper is to find out the relationship between milk prices on individual levels of its food vertical in Slovak republic, i.e. as milk price on one level of milk food vertical influences the price on the other level of the same vertical. Logarithmic regression analyses with corrected heteroscedasticity and autocorrelation is used to observe the relationship between prices of milk on its individual vertical levels. All estimated logistic regression models were statistically highly significant and all possible variations of primary milk production prices, milk processor prices and retail prices were provided. In case one of the variables was not statistically significant, new observation without not significant independent variable was conducted. Except of one observation with unit elasticity, all other observations revealed inelasticity in elasticity of price transmission between individual milk food vertical prices. This fact indicates that prices at individual levels of the milk food vertical are not distributed proportionally and the price change on one vertical level is not fully reflected on to other lever of milk food vertical.

Key words: *milk, milk price, food vertical, regression analyses, elasticity of price transmission*

JEL classification: *A1, A10 l, C01*

1 Introduction

Even though continuous decrease in dairy cow's number is Slovak republic still self-sufficient in milk production. This self-sufficiency was provided by continuous increase in milk yield.

The consumption of milk varies during the period 2010-2016 between 44.4 and 52.3 liters on inhabitant. Because of milk crises in 2017 accompanied by milk price decrease, the milk and milk products consumption increased by almost 10 kilograms in comparison to 2016. The world demand for milk has increased dramatically during the last decade. Consumption has particularly increased in eastern, middle eastern Asia and in Africa. Thiele et. al. (2013) forecasted the increasing milk world consumption with an average growth of 12 million tons per annum until 2022, implying that demand will grow from today's 630 million tons to about 750 million tons. At present, liquid milk reached maturity. The UHT technology has been, due to the logistic limitations overcome, the great contribution to the expansion of the milk market (Mambriani, D. & Gonano, S. 1996). Consumption of milk and dairy products has been increasing on a global level as a reason of both a growing population and increases in per capita consumption. It is generally recognized that economic factors such as higher consumer income and declining retail prices for milk and dairy products over the recent decades, relative to other foods, have caused most of this increase in per capita consumption. While global food demand increases with income, the total share of household's budget spent on food generally falls as income rise. Although the proportion of a household's budget spent on food decreses with income, wealthier countries tend to be less responsive to changes in food prices (Agra CEAS Consulting 2004).

In connection with the analysis of the agrifood chains and their partial markets, the economists dealing with this field of study often focus on the research of the intermarket price transmission (Revoredo et. al. 2004). It is possible, at least to some extent, according to the magnitude of the price transmission elasticity to assess the market structure performed within the given commodity chain, respectively its partial markets (Mc Corriston, S. 2002).

The assessment of price change along the supply chain, consequently how fast and to what extent price changes are transmitted between different levels of food vertical, is often used as an indicator of the efficiency and effectiveness of the chain as well as the assessment of the level of competition in the production and distribution (Vavra, P. A. & Goodwin, B. K. 2005).

1.1 Vertical food chain and the share of agricultural producers on retail price

The food vertical characterizes the production, processing and marketing processes, their interactions on individual markets that operate within the scope of this definition respectively global network. Vertical in this sense are generally discharged from the initial production of agricultural products (commodity or aggregation of the same commodities) as raw materials. Verticals are observing the flows from producer to consumer. In traditional model, which is characterized by supply side preferences, the flow of the product from production to final processing, the decisive position within the chain was concentrated in the production phase of agricultural products, i.e. at the level of primary agricultural production. Other related articles are understood primarily as processing agents for all agricultural production into final food without decisive influence on the size and parameters of the supplied raw material (Bečvářová, V. 2011).

Agricultural economists are often dealing with the questions of price creation, starting with manufacturers and ending with end-seller. The policy makers are interested in the consequences of the specific policy or economic changes. The ratio of agricultural producers on retail price is in generally a simple share of the farmers price and retail price. Obviously, the higher the number of this share is, the higher share of the retail price gets the farmer. With increasing number of elements in the food chain vertical (processing, storage, transportation, advertising, etc.), this share decreases. The final value (price) of the product is distributed between other elements on the market (Hudson, D. 2007)

2 Data and methodology

We used the Eurostat data of milk price on individual levels of milk food vertical from primary milk producers true milk processors to consumer or retail price. Original data in Euro for one kilogram of milk were converted on Euro for one liter of milk. Coefficient 1.03kg equals to 1 liter of milk was used (Ministry of Agriculture and Rural Development of the Slovak republic, 2002).

Under regression we understand study of the relationship between two or more variables using statistical model, which is characterizing the dependency between the selected variables. Using regression model expresses the regression analyses the quantitative influence of separate explanatory (independent) variables on the explained (dependent) variable. The linear regression model explains the relationship between dependent variable Y and k number of independent variables X_j (j = 1, 2, …, k). It has a general form:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_k x_{ik} + e_i,$$

The absolute member – coefficient β_0 is called *intercept*. It is interpreted as a conditional mean value variable *Y* assuming that all explanatory variables take the value zero.

Coefficients X_j (j = 1, 2, …, k*)* are called *regression coefficients*. Regression coefficient β_J shows how the mean value of the dependent variable Y changes, if the independent variable X_j changes by one unit and the other variables stays unchanged (Šoltéz, E. 2008).

All regression analyses were conducted using regression model. All the data were logarithm. Multicollinearity wasn`t proved in any model. Heteroscedasticity and autocorrelation problem was removed using heteroskedasticity autocorrelated consistent (HAC). Due to the use of logarithmical data in regression models, all the regression coefficients present elasticity of price transmission. The time shift in price transmission wasn't an object of the observations.

3 Results and discussion

The regression equation in the first model was compiled using three variables. The dependent variable *y* represents milk prices at primary producers. For the time series data, the prices of Q quality milk in Euro per one liter for individual levels of milk food vertical were selected. Selected dependent variables are x_1 – milk processor's prices and x_2 – retail prices.

Model 1: OLS, using observations 2010:01-2016:12 (T = 84)
Dependent variable: l_Production
HAC standard errors, bandwidth 3 (Bartlett kernel)

	Coefficient	Std. Error	t-ratio	p-value	
const	−0,853489	0,0687910	−12,41	<0,0001	***
l_Processing	0,334706	0,109169	3,066	0,0029	***
l_Retail	0,628753	0,117533	5,350	<0,0001	***

Mean dependent var	−1,179823		S.D. dependent var	0,081650
Sum squared resid	0,129060		S.E. of regression	0,039917
R-squared	0,766758		Adjusted R-squared	0,760999
F(2, 81)	28,67288		P-value(F)	3,84e-10
Log-likelihood	152,8974		Akaike criterion	−299,7948

Schwarz criterion	−292,5024		Hannan-Quinn	−296,8633
rho	0,868560		Durbin-Watson	0,266890

The estimated regression function has the form:

$$y = -0{,}8535 + 0{,}3347x_1 + 0{,}6288x_2$$

This model was statistically significant and explained 76,68% of changes in the milk producer's prices. The elasticity of the price transmission for the independent variable x_1 – milk processor's prices can be interpreted as follows: an increase in prices of milk processing units by 1% may cause a non-elastic increase of primary milk producer's prices by 0,33% on average. The regression coefficient is statistically significant. The second regression coefficient denotes that an 1% increase in retail prices of milk could cause an increase in primary producer's prices by 0,63% on average. This regression coefficient was also statistically significant.

The regression equation of Model 2 is compiled as follows. Prices at processing level as the dependent variable *y*. The independent variable x_1 are prices of milk producers and x_2 retail prices.

Model 2: OLS, using observations 2010:01-2016:12 (T = 84)
Dependent variable: l_Processing
HAC standard errors, bandwidth 3 (Bartlett kernel)

	Coefficient	Std. Error	t-ratio	p-value	
Const	0,453516	0,238147	1,904	0,0604	*
l_Production	1,00370	0,229714	4,369	<0,0001	***
l_Retail	−0,230407	0,318429	−0,7236	0,4714	

Mean dependent var	−0,696511		S.D. dependent var	0,096455
Sum squared resid	0,387019		S.E. of regression	0,069123
R-squared	0,498805		Adjusted R-squared	0,486430
F(2, 81)	16,67351		P-value(F)	8,62e-07
Log-likelihood	106,7733		Akaike criterion	−207,5467
Schwarz criterion	−200,2542		Hannan-Quinn	−204,6152
rho	0,846733		Durbin-Watson	0,311870

We estimated the regression equation in following form:

$$y = 0{,}4535 + 1{,}0037x_1 - 0{,}2304x_2$$

The estimated model explains 49.88% of the dependent variable changes and it is statistically highly significant. Almost unit-elasticity was estimated between dependent variable y (processing prices) and the independent variable x_1 (production prices). An increase of the producer's prices could cause nearly the same increase in processor's prices in average. High statistical significance was revealed by this regression coefficient. Retail prices regression coefficient wasn't statistically significant and was removed from following model.

Model 3 was estimated using one independent variable. It explains 48.62% of the dependent variable (processor's prices) changes and is statistically highly significant. As already mentioned the relationship observation for retail prices was removed. The only one independent variable x_1 are primary producer's prices.

Model 3: OLS, using observations 2010:01-2016:12 (T = 84)
Dependent variable: l_Processing
HAC standard errors, bandwidth 3 (Bartlett kernel)

	Coefficient	Std. Error	t-ratio	p-value	
Const	0,275370	0,199228	1,382	0,1707	
l_Production	0,823752	0,174504	4,721	<0,0001	***

Mean dependent var	−0,696511		S.D. dependent var	0,096455
Sum squared resid	0,396719		S.E. of regression	0,069556
R-squared	0,486244		Adjusted R-squared	0,479978
F(1, 82)	22,28359		P-value(F)	9,57e-06
Log-likelihood	105,7336		Akaike criterion	−207,4673
Schwarz criterion	−202,6056		Hannan-Quinn	−205,5129
Rho	0,854420		Durbin-Watson	0,295622

The simple regression equation has a form:

$$y = 0{,}2754 + 0{,}8238x_1$$

A possible increase by 1% in milk producer's prices may cause an increase in the processing prices by 0.82% on average. The price transmission in the model is inelastic. The regression coefficient is statistically significant.

The retail prices are the dependent variable y in model 4. For the independent variables were selected - x_1 milk producer's prices and x_2 – processor's prices of milk. The model is statistically significant and explains 65.74% changes of the milk retail prices.

Model 4: OLS, using observations 2010:01-2016:12 (T = 84)
Dependent variable: l_Retail
HAC standard errors, bandwidth 3 (Bartlett kernel)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0,802398	0,0707737	11,34	<0,0001	***
l_Production	0,868396	0,111697	7,775	<0,0001	***
l_Processing	−0,106120	0,169923	−0,6245	0,5340	

Mean dependent var	−0,148242		S.D. dependent var	0,079168
Sum squared resid	0,178250		S.E. of regression	0,046911
R-squared	0,657350		Adjusted R-squared	0,648890
F(2, 81)	93,76337		P-value(F)	8,31e-22
Log-likelihood	139,3352		Akaike criterion	−272,6705
Schwarz criterion	−265,3780		Hannan-Quinn	−269,7390
Rho	0,900037		Durbin-Watson	0,199125

The estimated regression model:

$$y = 0{,}8024 + 0{,}8684x_1 - 0{,}1061x_2$$

The price transmission inelasticity between variables y and x_1 was estimated at 0.87%. An increase of the retail prices by 1%, can lead to an increase of the primary producer's prices by 0.87% on average. Regression coefficient for the explanatory variable x_2 was statistically not significant and therefore removed from the following regression model.

In the model 5 the regression function without statistically not significant explanatory in model 4 was estimated. The explained variable y are the milk retail prices. The explanatory variable is primary producer's prices. Constructed model is statistically highly significant and explains 64,88% of the milk retail prices variations.

Model 5: OLS, using observations 2010:01-2016:12 (T = 84)
Dependent variable: l_Retail
HAC standard errors, bandwidth 3 (Bartlett kernel)

	Coefficient	**Std. Error**	**t-ratio**	**p-value**	
const	0,773176	0,0874734	8,839	<0,0001	***
l_Production	0,780979	0,0755161	10,34	<0,0001	***

Mean dependent var	−0,148242		S.D. dependent var	0,079168
Sum squared resid	0,182718		S.E. of regression	0,047205
R-squared	0,648762		Adjusted R-squared	0,644479
F(1, 82)	106,9549		P-value(F)	1,58e-16
Log-likelihood	138,2955		Akaike criterion	−272,5911
Schwarz criterion	−267,7294		Hannan-Quinn	−270,6367
rho	0,907609		Durbin-Watson	0,182877

Regression model has the form:

$$y = 0{,}7732 + 0{,}7810x_1$$

Both, intercept and regression coefficient in constructed model are statistically highly significant. Price transmission was inelastic, and it denounce that an increase of the primary producer's prices by 1%, could cause an increase in retail prices of milk by 0.78% on average.

4 Conclusion

All the statistically significant regression coefficients in our models were positively corelated. Except of one model all the price transmission elasticities were smaller than one. In model 2 the price transmission elasticity 1.0037% for dependent variable processor's prices and independent variable producer's prices was revealed. The lowest price transmission elasticity was found between producer's prices and processor's prices, where an increase in processor's prices by 1% can lead to an increase of producer's prices by 0.34% in average. This model explains 76,68% of changes in explained variable. In reverse, the price transmission elasticity 0.82% was revealed. In model 4 we found the highest price transmission elasticity. An increase of producer's prices by 1% can lead to an increase of retail price by 0.87% in average. At the end we observed the relationship between retail price and producer's prices. An increase of producer's prices by 1% can lead to an instant increase of retail prices by 0.78% in average.

From the results we can conclude, that price changes between individual levels of vertical milk food chain were not fully transmitted or were transmitted with delay. The lowest level of price transmission was found between level of production and processing level (0.34%). In contrary, an increase of producer's prices by 1% can cause an increase of processor's prices by 0.82% or even 1.0037% in average. The highest transmission lever (0.87%) was revealed between producer's prices

and retail price. The significant regression coefficient between processor's prices and retail price wasn't revealed.

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