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Challenges for the Global Agricultural Trade Regime after Doha

VOLATILE WORLD MILK PRICES AND ITS AFFECT TO NATIONAL MARKET – CASE OF SERBIAN MILK MARKET[1]

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Abstract: International milk market is created by 7% of world production volume. Volatile world milk prices in recent 6 years caused different forms of its transmission to national levels. In the paper this phenomena is investigated on two levels. First, on macro level how world milk price affects national markets in case of New Zealand as leading world exporter, Germany with growing net export, and Serbia with self-sufficient production. Second, it is analysed vertical price transmission in Serbian milk supply chain, according its magnitude, speed, nature and direction in period January 2007 to May 2013. Results improved understanding how world milk price influence milk price in Serbia and how price shocks are transmitted through milk supply chain for several most important kinds of milk products.Applied vector error correction model in horizontal milk price transmission indicates asymmetry in price transmission from world to Serbian milk market. Milk prices in Serbia respond to price signals from German and world market, but with significant time lags and increasing magnitude over time. From first to fourth month delay, milk prices from German market positively influence Serbian market, and from fifth to tenth month further increasing influence of world milk prices are presented. Nature of

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spatial asymmetry is positive. Results of threshold vector error correction model applied on dairy supply chain, suggests similar conclusionsfor all four major dairy products on Serbian market. Retail prices react mostly on raw milk price changes, with constant response to processor's prices. Price shocks are originate at the processor level and are passed to farmers and to retailers. Blurred relationship between processing and retail sector permits more accurate analysis.

Keywords: milk, price, transmission, World, Serbia.

INTRODUCTION

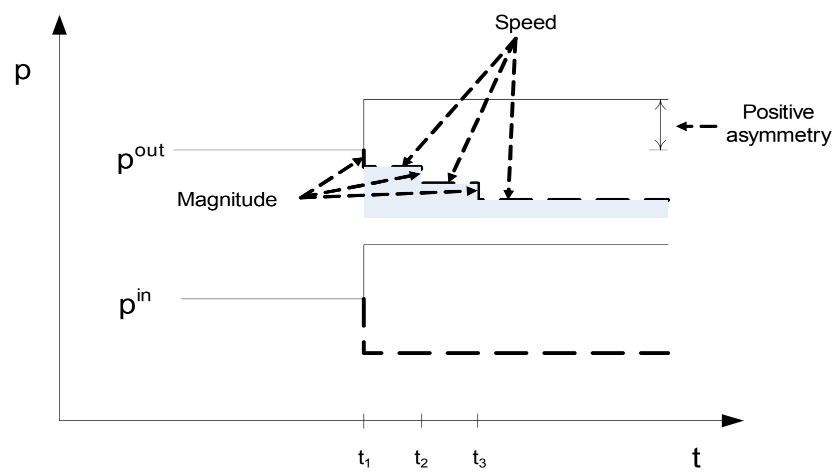
Rapid price rises and falls of almost all main types of food (cereals, oils dairy, meat, sugar) on world market since 2007/08 increased interest in price volatility. Food price volatility on world market has certain impact on all national markets that differ only in speed and size. Dairy market, until nowproves as one with strongest volatility. Objective in this paper is twofold, first to research horizontal milk price transmission from world to Serbian and several other national markets. Goal is to understand howSerbian milk market reacts on world milk price signal, and how it is different than on several other markets. And second, to analyze vertical price transmission on Serbian dairy market.

Vast number of studies in area of food price transmission was done in previous decades. Some were focused in horizontal (spatial) price transmission, from one market to another, but the most examined vertical price transmission throughout food supply chain at national market. Asymmetry were often reported and it is defined as degree for which transmission differs according to whether prices are increasing or decreasing (Meyer, Cramon-Taubadel, 2004).

Asymmetry of price transmission can happen in three aspects. First, is when price shocks, positive or negative are not fully transmitted to next level in food supply chain. In Graph 1 it is presented a magnitude of response of dependant p^{out} to negative price change at p^{in}. It is obvious that p^{out}, although is adjusted infew time periods it is not fully transmitted, or not with same magnitude. Second aspect of imperfection of price passing throughout supply chain is with respect of speed. Price p^{out} is three times (t_1, t_2 and t_3) adjusted to p^{in}new level, and there is significant lag. Third aspect is in reaction between positive and negative price shocks. If p^{out}reacts faster and fully on increase in p^{in}, than to decrease, the asymmetry is called positive. Oppositely, if reactions of dependant price are fullyand faster on decreasein p^{in}, than to increase, asymmetry is called negative.

Among research in previous literature few questions dominated: is there asymmetry in price transmission and what cause it. Studies in food supply chains reviled that price transmission asymmetry exist very often (Peltzman, 2000, Bunte, 2006, Conforti 2004, Vavra, Goodwin, 2005, Lass, 2005, Popovic, Radovanov, 2010, etc.). In some cases even, when price transmission exist, like in case with highly perishable dairy products in Spain (Serra, Godwin, 2003) market power of retail sector was not excluded. As main drivers for vertical asymmetric price transmission in food sector were identified:market power, costs of adjustment, menu cost, presence of inflation, government price support (floor prices, premiums), economics of size in information gathering of some agents, etc. In horizontal price transmission, main causes for asymmetry are: asymmetric adjustment costs, asymmetric information, market power and asymmetric price reporting (Meyer, Cramon-Taubadel, 2004).

Graph 1. Asymmetric price transmission



Source: Adjusted according Meyer and von Cramon-Taubadel (2004)

Methodology applied in research asymmetric price transmission changed significantly through recent history. Earlier applied models with discovered impediments were replaced with newer once. But, there is still no ideal model.Earlier studies of the spatial price transmission had used simple correlation coefficient, as well as regression analysis in which the regression coefficient represented the measure of the prices co-movement. The high value of the correlation coefficient indicated that prices move in the same direction and was often interpreted as a sign of the market efficiency (Minot, 2010).The problem that had been observed in the studies that have used some of the previously mentioned methods is non stationary series of price data. As the prices series are generally non-stationary, and the conventional methods are invalid when using this kind of data, it was necessary to use modern econometric techniques to overcome this problem (FAO, 2006). The inclusion of non-stationary time series as explanatory variables results in a model that does not meet the assumptions of classical linear regression analysis. This means that the classical linear model is not an adequate framework for the analysis of the interdependence of non-stationary data. Another problem that arises from the analysis of the interdependence of non-stationary time series is the appearance of the spurious regression. A spurious regression may indicate a high value of the regression coefficient and the existence of a significant relationship between variables. However, the high value of the regression coefficient does not necessarily mean that estimated regression is statistically significant, and in fact results are without any economic meaning (Mladenović, Petrović, 2010).

Now days, most of the studies utilize time series methods which can be very useful when it comes to the analysis of market integration and price transmission. The development of these methods, that consider co-integration and error correction model become standard tool for spatial price transmission analysis, replacing former methods such as correlation coefficient and regression (FAO, 2003). Likewise, recent empirical research of the vertical price transmission has also given more attention to the time-series properties of price data. Non-stationary data and possible co-integration relationships between prices at various levels of the market have been made an important part of price transmission model (Goodwin, 2006). Because of that, the most widely used method for the vertical price transmission analysis is likewise error correction term model (ECM). Lately, some empirical research provided evidence of non-linearities in vertical price transmission process. Therefore method used should be flexible and permit non-linear price behaviour. In the field of price transmission analysis, models that become popular and are employed in large portion of the published articles and studies are: the asymmetric vector error correction model (AVECM), threshold vector error correction model (TVECM) and smooth transition vector error correction model (STVECM) (Hassounch, Von Cramon-Taubadel, Serra, Gil, 2012).

1. MATERIAL AND METHODOLOGY

Empirical analysis of milk prices at Serbian dairy sector observes prices from January 2007 to May 2013. Monthly time-series data are used from three sources: International farm comparison network (IFCN) – Dairy research centre Kiel, Statistic office Republic of Serbia and personal prices collection from processors and biggest retailers. World milk price indicator reported from IFCN is based on weighted average of 3 IFCN world milk price indicators: 1. SMP and butter (35%), 2. cheese and whey (45%), 3. WMP (20%), based on shares of the related commodities traded on the world market (Hemme, et al. 2012). National milk prices are reported from Official statistics and adjusted to Energy corrected milk (ECM) with 4% fat, and 3.3% protein to enable comparability. Processors and retail milk prices for 4 the most important dairy products in Serbia are collected from processor and retail chains with biggest market share. Temporary retail discount prices in periods shorter than two weeks are not taken in account.

Some authors propose use of weekly prices as more appropriate for price transmission analysis. Here, monthly used data has les impediments. It is because retail prices on weekly basis with dynamic marketing activity of processors and with confidential rebates to the retailers do not allow reasonable analysis.

Vector error correction model (VECM) is applied in spatial price transmission analysis in next steps:

$$\Delta pd_t = \alpha + \sum_{j=1}^{k} \beta_{1j} \cdot \Delta pw_{t-j+1} + \sum_{j=1}^{k} \beta_{2j} \cdot \Delta pg_{t-j+1} + \sum_{j=1}^{k} \beta_{3j} \cdot \Delta pu_{t-j+1} + \sum_{j=1}^{k} \beta_{4j} \cdot \Delta pn_{t-j+1} + \omega \cdot e_{t-1} + \varepsilon_t$$

$$\Delta pw_t = \alpha + \sum_{j=1}^{k} \beta_{1j} \cdot \Delta pd_{t-j+1} + \sum_{j=1}^{k} \beta_{2j} \cdot \Delta pg_{t-j+1} + \sum_{j=1}^{k} \beta_{3j} \cdot \Delta pu_{t-j+1} + \sum_{j=1}^{k} \beta_{4j} \cdot \Delta pn_{t-j+1} + \omega \cdot e_{t-1} + \varepsilon_t$$

where is:

Δpd_t - return rates on domestic milk price

Δpw_t - return rates on world milk price(j indicates number of lags from 1 to k)

Δpg_t - return rates on German milk price

Δpu_t - return rates on USA milk price

Δpn_t - return rates on New Zealand milk price

e_{t-1} - estimated residuals from vector autoregressive model (VAR) for raw data

ω - indicates ECM correction for long-run equilibrium

ε - is residual of ECM

Vertical price transmission error correction model has following form:

$$\Delta p_t^3 = \alpha + \sum_{j=1}^{k} \beta_j^2 \cdot \Delta p_{t-j+1}^2 + \sum_{j=1}^{k} \beta_j^1 \cdot \Delta p_{t-j+1}^1 + \omega \cdot e_{t-1} + \varepsilon_t$$

where is:

Δp_t^3 - return rates on milk product price in retail (third level)

Δp_t^2 - return rates on milk product price in milk processing (second level)

Δp_t^1 - return rates on raw milk price (first level)

Threshold vector error correction model takes next form:

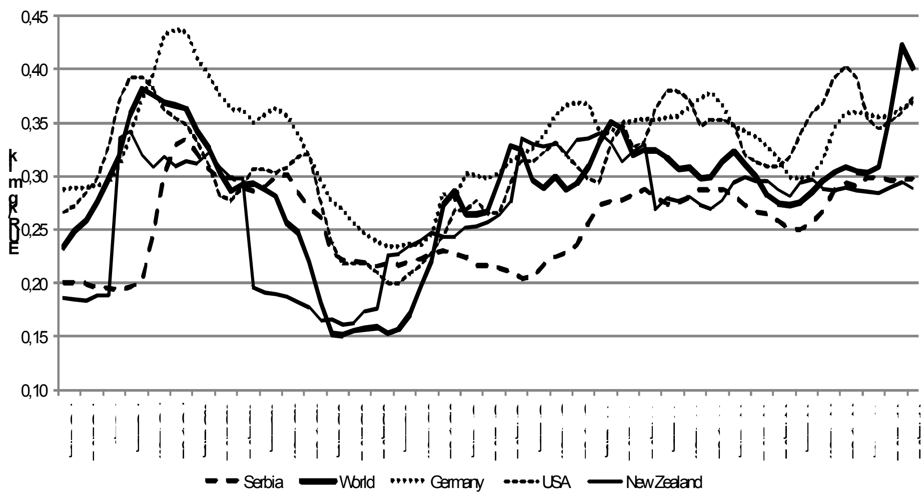
$$\Delta p_t^3 = \alpha + \sum_{j=1}^{k} \beta_j^2 \cdot \Delta p_{t-j+1}^2 + \sum_{j=1}^{k} \beta_j^1 \cdot \Delta p_{t-j+1}^1 + \gamma^+ \cdot \nu_{t-1}^+ + \gamma^- \cdot \nu_{t-1}^- + \varepsilon_t$$

Where v_{t-1}^{+} and v_{t-1}^{-} are dummy variables for positive and negative changes in retail milk price respectively or denotes positive or negative deviation from long-run equilibrium prices. Data analysis was done by E-Views program which was used to observe results of ECM models.

2. RESULTS

Milk price development or more precisely its volatility for world, Serbia, New Zealand, Germany and USA marketis presented in Graph 2. Data for Serbia revealed two periods with biggest lags when world milk prices rose. First is from 2007 when first big lag is observed, and second is from 2010. In both cases huge lags finished inSeptember. In periods when world milk prices lowered there weren't big lags. Milk prices in New Zealand, Germany and USA were more sensitive to dynamics of world price.

Graph 2. Dynamics of raw milk prices at world and national market levels in: Serbia, New Zealand, Germany and USA



Source: IFCN-Dairy Research Center (2013) and Statistic office of the RS

Correlation between Serbia (RS) and world (WR) milk prices data is positive but moderate, and at same time other three countries USA, Germany (DE) and New Zealand (NZ) have strong correlation with world milk prices (Table 1). Those countries are main world dairy exporters, so it is reasonable that price signals from world market cause reaction on national markets on very fast way. Correlation of Serbian and German milk prices is strong and positive, and it can be explained by geographic market proximity.

Table 1. Correlation matrix for milk prices at world and national marketlevels for: RS, NZ, DE and USA

	RS	*DE*	*USA*	*NZ*	*WR*
RS	1	0.722301	0.466528	0.270364	0.450874
DE	0.722301	1	0.743167	0.581987	0.800345
USA	0.466528	0.743167	1	0.571766	0.809736
NZ	0.270364	0.581987	0.571766	1	0.727498
WR	0.450874	0.800345	0.809736	0.727498	1

Calculated critical values for intercept and trend and intercept at 1% significance level are -3.52 and -4.0853 respectively. According to the data from Table 2,estimated values from Augmented Dickey-Fuller Test (ADF) do not exceed critical values (at 1% level significance). Therefore, we accept Null hypothesis of unit root existence in time series. It allows further use of co-integration test.

Table 2. Results of ADF test.

Variable	*Specification*	*ADF test*
RS	intercept	-2.584608
	trend and intercept	-2.621609
DE	intercept	-3.032991
	trend and intercept	-3.015544
USA	intercept	-1.75006
	trend and intercept	-1.98214
NZ	intercept	-2.440216
	trend and intercept	-2.384263
WR	intercept	-1.766606
	trend and intercept	-1.827956

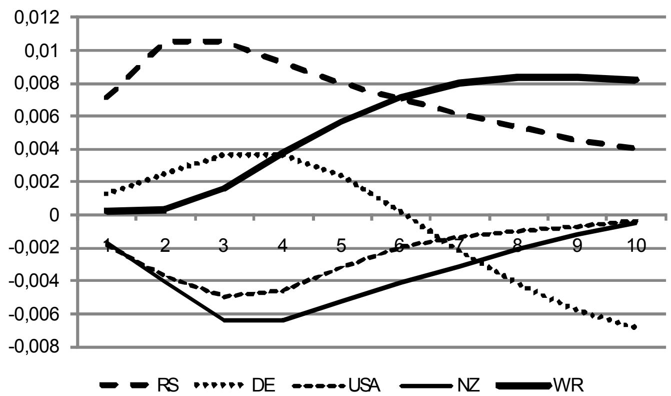
In Table 3, the characteristic roots or eigenvalues are put in ascending order. Using those eigenvalues, the Johansen test statistics calculate likelihood ratio test statistics and show rejection for the null hypothesis of no co-integrating vectors (co-integration equation) under both, 1% and 5% critical values. Moving on to test the null of at most one co-integrating vectors, the test statistics exceeds only 5% critical value which is 47.21, so the null is just rejected at 5%, but not rejected at 1%. Finally, examining the null that there are at most two co-integrating equations, the test is now bellow 5% critical value, suggesting that the null should not be rejected. Hence, there are two co-integrating equations.

Table 3. Results of maximum likelihood ratio test

Eigenvalue	*Likelihood ratio*	*5 % Critical value*	*1 % Critical value*	*Hypothesized No. of CE(s)*
0.376622	88.5232	68.52	76.07	None **
0.321252	53.55058	47.21	54.46	At most 1 *
0.164335	24.87522	29.68	35.65	At most 2
0.093394	11.59019	15.41	20.04	At most 3
0.056894	4.334683	3.76	6.65	At most 4 *

**(**) denotes rejection of the hypothesis at 5%(1%) significance level*
L.R. test indicates 3 cointegrating equation(s) at 5% significance level

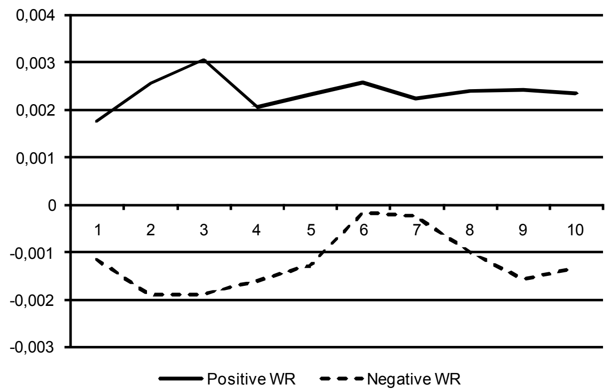
Graph 3. Impulse responses function of milk prices in Serbia, on exogenous price signals



The Graph 3 shows the responses of raw milk prices in Serbia to the impulses of the world milk price changes. The impulse responses represent percentage changes in prices to one standard deviation shock of the error correction term (Vavra, Goodwin, 2005). When the impulse is world milk prices, every response of milk price in Serbia is all positive at each responsive period, but with the significant increase in magnitude after the second lag. The maximum positive response is achieved after 7 months. The impulses, made by milk prices in USA and New Zealand, are all negative and near zero showing no considerable fluctuations in Serbian milk price responses.

The magnitude of positive responses (Graph 4) of milk prices in Serbia to positive impulses of world milk prices is more pronounced in each period of time then negative changes. On the other hand, presented impulse response lines follow the similar pattern indicating a symmetric distribution of data.

Graph 4. Nature of asymmetry of Serbian milk prices on world price signals



Milk prices development for four most important dairy products on Serbian market is depicted in Graph 5, separately for each level in supply chain. Dairy products can be grouped as perishable: pasteurised milk and yogurt, and product with longer shelf life: UHT milk and cheese. Otherwise, it is possible to group them as low value added: pasteurised milk, UHT milk and yogurt and high value added as it is cheese.

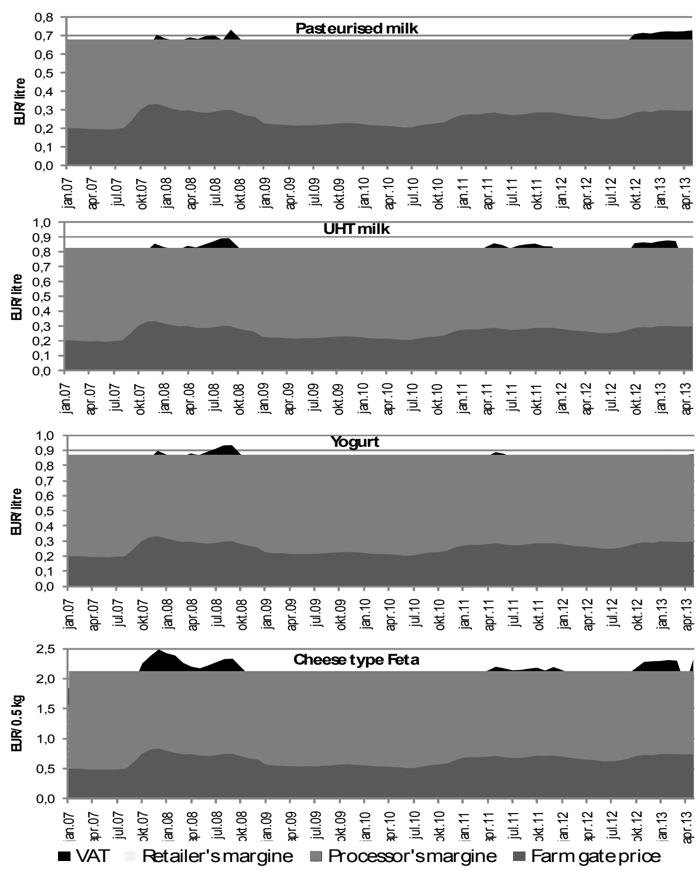
Data for period January 2007 to April 2009 reviled that there was not margins for retailers for first three products, and in case of cheese even it was negative. Of course, it was not real situation, since processors operated with biggest retailers on special confidential contract basis, which lowered official processors prices. Yet, in later period business relation between milk processors and retailers in Serbia is a kind of blurred. Tiny retail margins are not all what bigger retailers got, since there were many factors that decrease processors margins. Dairy processors had to give to retile chains: confidential rebates (up to 15%), longer period before payment, pay for use of shelf in store, accept returns on no sales, etc. Situation happen earlier in many developed countries become reality in Serbia in second half of first decade XX century, when retail market sector concentrates very intensively. Concentration rate for two biggest retail chains CR2 increased in period 2009 to 2012 from 37.6 to 53.6%, taking in account recent Agrokor's overtake of Mercator. In wider scope CR5 of retail sector changed in same period from 57.1 to 70.5%, indicating in both aspects high concentration in retail sector in Serbia. Concentration of dairy processing sector was faster in that period and reached in 2008 CR4=61% (Popovic, Radovanov, 2010).

Retail prices of two dairy products with longer shelf life: UHT milk and cheese had atypical dynamics in period February to May 2013. It is period known as Afla-toxin crisis in Serbian dairy sector. Feed produced in 2012, mainly in case of corn and corn silage was poisoned by Afla-toxin. Farmers (especially on bigger farms) start to use such feed by end of 2012, causing afla-toxin in milk.

Consumers, after publishing information of dangerous concentration of toxin in milk products were scared for its health. Consumption decreased, and processors piled up stocks with long life products. When situation came more under control, only solution from processors point of view was to give additional stronger rebates to retailers and decrease stocks for this two products.

Dairy market situation in Serbia can be described as successive oligopsony. More than 200,000 dairy farms use processing industry as a main market channel. About 190 dairy processors companies collect and transport milk from farmers to processing facilities. Until now farmers do not organise any dairy cooperative although the vast number of them own small herds from 1 to 5 cows (Goss et. al, 2010). In such situation some bigger processors (Mlekara Subotica, Imlek, Somboled, Mlekoprodukt) took initiative and though various activities support changes of farm sector structure.Using vertical downstream coordination they provide financial and advisory services and inputs for farmers, when they needed, to secure in long-run input market.

Graph 5. Dynamics of three vertical level prices for: pasteurised milk, UHT milk, yogurt and cheese fetatype.



Estimated values, of prices for four dairy products, from ADF test do not exceed critical values (at 1% level significance), so Null hypothesis of unit root existence in time seriesis accepted.Results of examined the co-integration test at vertical transmission with three levels of one milk product are presented in the Table 4.

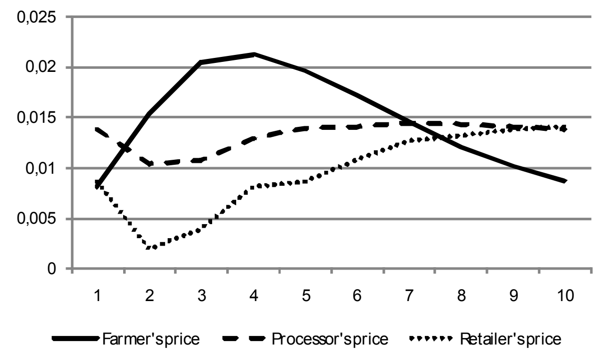
Table 4. Results of maximum likelihood ratio test for pasteurised milk.

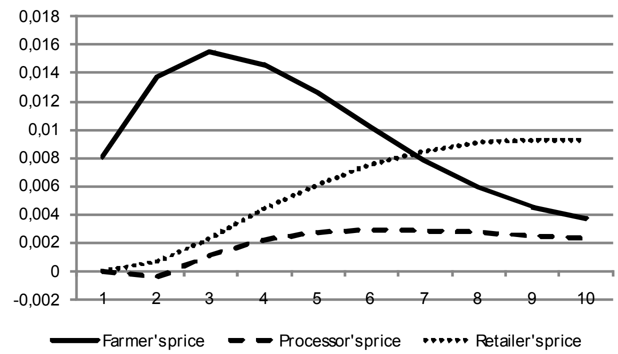
Eigenvalue	*Likelihood Ratio*	*5 % Critical Value*	*1 % Critical Value*	*Hypothesized No. of CE(s)*
0.522605	88.26971	29.68	35.65	None **
0.331451	37.98982	15.41	20.04	At most 1 **
0.144465	10.60991	3.76	6.65	At most 2 **

**(**) denotes rejection of the hypothesis at 5%(1%) significance level*
L.R. test indicates 3 cointegrating equation(s) at 5% significance level

According to established hypothesis there are rejections at any 1% or 5% significance level. Therefore, three co-integrating equation are identified. Repeated co-integration tests in case of other three dairy products leads to same conclusion.

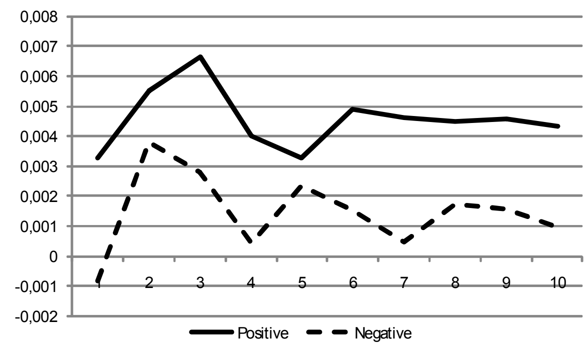
Graph 6. Impulse responses functions of pasteurised milk retailpriceson raw milk price signals, and opposite influence direction.

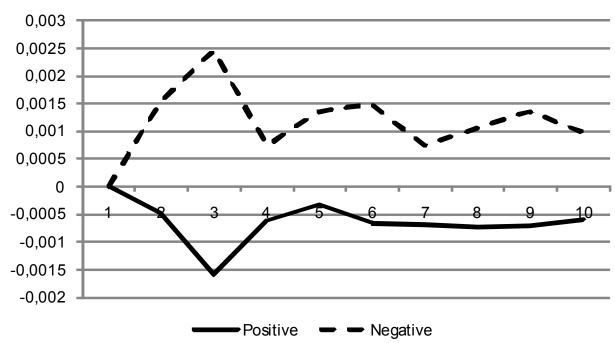




The responses of retail pasteurized milk price to the impulses of raw milk and processor's prices changes, are presented in left part of Graph6. All responses are positive with increasing influence of raw milk prices in first four period of time, while the responses to processors prices are relatively stable. In case for other three dairy products impulse responses are similar. Right part of Graph 6 shows the opposite direction, how a row milk price reacts on pasteurized milk price impulses from upward levels. All responses of row milk prices to the impulses of pasteurized milk on processor's and retailer's levels are positive and increased, except in second period for processor's price.

Graph 7. Nature of asymmetry of processors pasteurised milk price response on raw milk price signals and raw milk price response on processors pasteurised milk price signals





The left part of Graph 7is presented the influence of positive and negative impulses of raw milk price to positive and negative responses ofprocessor's pasteurized milk price. The magnitude of positive responses of processor's milk price to positive impulses of raw milk price is more pronounced in each period of time. Processors prices of UHT milk and cheese react stronger and fully on positive prices of raw milk. Only in case of yogurt negative price asymmetry is presented. Meanwhile, the influence of processors milk price positive and negative impulses to retail milk price positive and negative responses are almost the same in each period of time, inferred to similarities between processors and retail price data. Analysis of nature of asymmetry in opposite direction presented in right part of Graph 7 gives interesting conclusion. Here is case of negative asymmetry since decrease of processors pasteurized milk price is fully and faster transmitted to farmer's milk price than price increases. It explains the practice that raw milk prices are regulated from processor's side.

CONCLUSION

The results of this study suggest that raw milk prices in Serbia have moderate correlation(0.45) with world milk prices. At same time some main milk exporting countries: New Zealand, Germany and USAhave strong correlation with world milk market prices. Serbian milk prices have strong correlation 0.72 only with Germany, and it can be explained with market closeness. Applied vector error correction modelin horizontal milk price transmission indicatesasymmetry in price transmission from world to Serbian milk market. Milk prices in Serbia respond to price signals from German and world market,but with significant time lags. Magnitude of response is increasing over time. From first to fourth month delay, milk prices from German market positively influence Serbian market, and from fifth to tenth month further increasing influence of world milk prices are presented. The maximum positive response is achieving after 7 month period. Nature of spatial asymmetry is positive, since speed and magnitude of response to increased prices signals are slightly stronger, than in case of decreased prices. Market structure in Serbian dairy sector is successive oligopsony where market power is shared among highly concentrated processors and retailers. In such situation where information asymmetry exist world milk price signals are not passing fast to Serbian raw milk market.

Results of threshold vector error correction model applied on dairy supply chain, suggests similar conclusionsfor all four major dairy products on Serbian market. Retail prices react mostly on raw milk price changes, with constant response to processor's prices. Oppositely raw milk prices almost do not, or even negativelyrespond on upstream levels price changes in first two periods of delay. Positive responds increasing after third period, and strongly on retail milk prices. Price shocksare originate at the processor level and are passed to farmers and to retailers. Additional caution should be taken since there is no certain evidence is real share of retail margin increased in consumer price over time.Blurred relationship between processors and biggest retailers permits deeper analysis.

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