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THE CHARACTER OF PRICE TRANSMISSION WITHIN MILK COMMODITY CHAIN IN THE CZECH REPUBLIC

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Abstract

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The article is focused on price transmission within milk commodity chain in the Czech Republic. The article distinct on milk products with low value added – cow milk/paper box milk and products with higher value added – cow milk/butter. Price transmission is measured by the coefficient of elasticity of the price transmission (EPT); price transfer is examined in demand as well as supply direction. Next part of the analysis measures price differences (by coefficient determination – R^2) in supply direction. Last step in this analysis is the impact of time delay at the price transmission process (measured by R^2). The price transmission is asymmetric in the supply direction on both parts of commodity chain (EPT = 0.29 and 0.62), in the demand direction is more symmetric (EPT = 0.31 and 1.02). The assumption of better transfer of positive price changes was confirmed. At the commodity chain of milk/dairy products the time delay is not so much important. With both tested commodity chains there was found higher power of downstream markets, proving demand driven behaviour of these commodity chains, and there was detected oligopsony market structure as well. The data represent monthly prices on both chosen vertical levels in the period of 1/2000–8/2013.

Keywords: agribusiness, agriculture, milk, dairy product, price, transmission, commodity chain, elasticity, asymmetry

INTRODUCTION

Agri-food commodity chain analysis is one of the most useful tools especially about informing the influence of specific individual market entities on the development of the agribusiness industry.

This sector of economy has really long history across the past. Nowadays it is necessary to follow agriculture in wider consequences, this approach is called agribusiness. Since nowadays the agriculture is characterized as shifting of power from the first producers to the finalizing levels and distributing in agri-food commodity chains. Market power of these parts of commodity chains is still higher, and dependence of producers on finalizing level of chains is increasing, while the risk is transferred as well through commodity chain. First of these factors is change of dimension and of approach in the economic sector, that was very clear and closed in the past. Very important aspect for changing environment is also the process of globalization. At this time it is important to monitor also food security. Not only the size of basic food (from the farmers), but also the possible relationships between price creations at particular segment of commodity chain (Bečvářová, 2005).

One of the several determinants is a market structure. As Čechura and Šobrová (2008) wrote, market structure not is influent only by the agricultural market, but also by the other vertically related markets in the particular agri-food chain. The market structure in agri-food chain is usually represented by oligopoly and oligopsony. The question is, if market power is transferred in either supply, or demand direction in commodity chain. As well, the impact of the oligopoly and oligopsony power within commodity verticals points, Weldegebriel (2004) and Lloyd *et al.* (2009).

There are two reasons why industrial organizations put little attentions to the market power of demands. It is that they do not think that demander's market power is important and they do not believe in any current models of market power between sellers and buyers (Rogers, Sexton, 1994).

Price development of partial commodity chain market has a strong influence on the price development of an upstream or downstream market of commodity chain. Increase resp. decrease of price on a partial market influences the price of final product of agri-food chain. On the other side there is no rule saying that price changes of final product influence the price on the upstream market. This is described f.e. by Revoredo, Nadolnyak, Fletcher (2004).

Possible approach is characterization of market power within agro-food commodity chain by price transmission analysis.

With relations of this agri-food price transmission analysis, the economists explain this effect by two essential influences (Revoredo *et al*., 2004). First is *existence of market power* (in the agribusiness sector there is an imperfect competition). The scope of price transmission asymmetry does not depend only on the firm behaviour but on the strength of demand or supply elasticity, too (McCorriston *et al.,* 2001). The second influence is *profit maximizing inventory management*. The inventory management introduce additional price rigidity. Products which are possible to keep in stock for a longer time should be sold for the current price in the future. Thus, parts of sectors with perishable inventories are more price-flexible than other (better) storable inventories.

In this way, market power and inventory management grounds, but also asymmetric price transmission should be connected with the *cost rigidity*, such as *menu cost* (Azzam, 1999) or *sticky wages*.

Structural changes have been passed from 1989 in European agriculture and food industry as well (Bečvářová, Vinohradský, Zdráhal, 2009). Nevertheless *agribusiness* is considered as a highly dynamic business environment (Zdráhal, Bečvářová, 2013).That is the reason to do this type of analysis, especially on milk commodity chain. Milk and dairy products are very closely connected with globalization and it is necessary for the next analysis to show how this sector works in the Czech Republic, and afterwards it is possible to include Czech Republic in to the broader context.

MATERIALS AND METHODS

The goal of the article is to analyse character of the price transmission within milk commodity chain in the Czech Republic, and also to evaluate the impact of market structure within chosen agri-food commodity chain. The commodity chain of milk was divided into two separately lines, there is a distinct product with lower value added (cow milk) and a product with higher value added (butter).

Price time series of farmers, processors and consumers of individual markets are represented by monthly prices (from January 2000 to August 2013), shown in Tab. I.

Analysis of price transmission is implemented in three following parts (McCorriston, 2002; Lechanová, 2005; Blažková, Syrovátka, 2009; Meyer, Cramon-Taubadel, 2004; Fernández-Amador *et al*., 2010).

First part of the analysis assesses all possible levels of the observed commodity chain. For the assessment of character and quantification of the price transmission intensity, the coefficient of the elasticity of price transmission (EPT) is used as the basic indicator. EPT presents a change of price on downstream market, if the price on upstream market was changed. As long as there are two markets within commodity chain, and these markets are described as *i* and *j*, it is possible to determine coefficient of price transmission (EPT_{ij}) formulated by this relationship (McCorriston *et al*., 2001):

$$EPT_{ij} = \frac{\frac{\delta p_j}{p_j}}{\frac{\delta p_i}{p_i}} = \frac{\delta p_j}{\delta p_i} \times \frac{p_i}{p_j}.$$

In this formula the progression of parameters *i* and *j* are determinative for the direction of evaluated market and explanation of price transmission. By this way defined coefficient of EPT_{ij} tells, how many percent the price was changed at j^{th} market, if the price at i^{th} market was changed by 1%. For all levels of commodity chain average of coefficients EPT_{ij} was counted and these coefficients were arranged into the matrix (see in the Tab. II).

Second part of this analysis is focused on downstream partial markets within chosen commodity chain, where the analysis of price differences is brought in order to assess the difference in result in case positive resp. negative price changes. Peltzman (2000) wrote that price

I: *The structure of the data base for the price transmission in milk commodity chain*

Price transmission analysis within milk commodity chain	
Monthly prices/differences (1/2000–8/2013)	Monthly prices / differences (1/2000–8/2013)
Farm prices (FP) – cow milk (Kč.l^{-1})	Farm prices (FP) – cow milk (Kč.l^{-1})
Processor price (PP) – cow milk 1.5% fat (Kč.l^{-1})	Processor price (PP) – butter (Kč.kg^{-1})
Consumer price (CP) – cow milk 1.5% fat (Kč.l^{-1})	Consumer price (CP) – butter (Kč.kg^{-1})

Source: Own

II: *EPT matrix (from left: milk, butter)*

EPT cow milk	FP cow milk Δp_1	PP cow milk 1.5% fat Δp_2	CP cow milk 1.5% fat Δp_3	EPT butter	FP cow milk Δp_1	PP butter Δp_2	CP butter Δp_3
FP cow milk Δp_1	x	EPT_{12}	EPT_{13}	**FP cow milk Δp_1**	x	EPT_{12}	EPT_{13}
PP cow milk 1.5% fat Δp_2	EPT_{21}	x	EPT_{23}	**PP butter Δp_2**	EPT_{21}	x	EPT_{23}
CP cow milk 1.5% fat Δp_3	EPT_{31}	EPT_{32}	x	**CP butter Δp_3**	EPT_{31}	EPT_{32}	x

Source: Own

increase is reflected in the input price promptly which is not the case of price decrease. This analysis proves if the positive or negative price changes are transferred better. For analysis of positive and negative changes the regression models were used (simple regression). The strength of the regression of time series is represented by monthly price differences where distinct positive and negative price differences were detected (Revoredo, Nadolnyak, Fletcher, 2004). Regression models are verified by the determination coefficient (Hušek, 2007).

$$\Delta P_{jt} = A^{+} + \sum_{l=1}^{k} B_l^{+} \times \Delta P_{it}^{+}, \text{ resp. } \Delta P_{jt} = A^{-} + \sum_{l=1}^{k} B_l^{-} \times \Delta P_{it}^{-}.$$

Third part of this analysis is focused on impact of time delay on the price transmission between downstream partial markets. The intensity of time delay is measured by determination coefficient. In commodity chains (milk and butter) there was evaluated the length from no delay to two months price transmission delay. This length was chosen because of nature of milk and dairy products, durability of milk and milk products is not so long.

RESULTS

The results of first part of price transmission analysis for cow milk commodity chain and butter commodity chain are written in Tab. III. There are shown coefficients of EPT_{ij} between all downstream and upstream markets in these commodity chains. Coefficients above the diagonal in the matrixes represent price transmission in supply direction, contrary coefficients below diagonal represent price transmission in demand direction. The factors influencing demand and supply direction are different, that is also the reason why the coefficients in different directions are diverse.

The results of *first part of price transmission* have shown that at the first level (relationship between farmer and processor) of commodity chain of milk *in supply direction* price transmission is inelastic. (EPT_{ij} = 0.29). Price transmission at *the first level* of commodity chain of butter is unambiguously inelastic (EPT_{ij} = 0.05), too. On the other side in *demand direction* at the *first level* of commodity chain the price transfer is inelastic, especially in commodity chain of milk, but in branch where the product with higher added value was tested – butter was coefficient almost 1 – and that points out on elastic price transfer (EPT_{ij} = 0.31 resp. 0.99).

Result of EPT_{ij} at the *second level* (relationship between processor and retail/final consumer) of commodity chain in *supply direction* is also in both branch of commodity chain of milk inelastic EPT_{ij} = 0.62 resp. 0.69). Contrary in the *demand direction* there was found the price transmission as elastic within both tested commodity chains of milk; values of EPT_{ij} = 1.02 resp. EPT_{ij} = 1.05.

Second part of the price transmission analysis was focused on analysis of price positive resp. negative differences expressed by coefficient of determination (Tab. IV). The assumption in this case is, there is a better transfer of price increase than price decrease into the downstream market. And this analysis presented following results. At the *first level of commodity chain* of cow milk and commodity chain of butter was assumption confirmed. Coefficient of determination is significant in case of price increase. At the *second level of commodity chain* of cow milk and commodity chain of butter assumption was confirmed, too. But at the *second levels* of commodity chain, especially in the commodity chain of butter,

III: *EPT matrix (from left: milk, butter)*

EPT cow milk	FP cow milk Δp_1	PP cow milk 1.5% fat Δp_2	CP cow milk 1.5% fat Δp_3	EPT butter	FP cow milk Δp_1	PP butter Δp_2	CP butter Δp_3
FP cow milk Δp_1	x	0.29	0.26	**FP cow milk Δp_1**	x	0.05	0.02
PP cow milk 1.5% fat Δp_2	0.31	x	0.62	**PP butter Δp_2**	0.99	x	0.69
CP cow milk 1.5% fat Δp_3	0.65	1.02	x	**CP butter Δp_3**	0.98	1.05	x

Source: Own, MA CR

IV: *The interdependence of positive and negative differences*

		First level of commodity chain FP-PP	Second level of commodity chain PP-CP
Cow milk	Price increase	46.43%	44.75%
	Price decrease	16.72%	1.64%
Butter	Price increase	42.75%	66.62%
	Price decrease	38.85%	43.66%

Source: Own, MA CR

V: Values of determination coefficient for various lengths of time delay

Lengths of time delay	no time delay	1 month	2 months
First level of commodity chain of milk FP-PP	43.83%	34.79%	23.19%
Second level of commodity chain of milk PP-CP	41.67%	19.51%	20.57%
First level of commodity chain of butter FP-PP	50.71%	23.36%	0.06%
Second level of commodity chain of butter PP-CP	67.67%	57.24%	32.3%

Source: Own, MA CR

the coefficient of determination is significant in case of price decrease, too.

At the *third part of price transmission* the time delay was tested. In case of milk we tested only the length of two month because of nature of milk, and their low time of durability to stay fresh. The reason is that milk and also butter are fast-perishing products. The price transfer is expressed by determination coefficient (see in Tab. V).

The analysis at the *first level* of both commodity chains brought following results. On the first level the time delay is not important. Coefficient of determination is significant primarily without of the time delay. The others determination coefficients have had still lower level of significance. At the *second level* of commodity chains it is necessary to describe separately these two commodity verticals. In the *commodity chain of cow milk* there is still significant determination coefficient without time delay. Contrary in the *commodity chain of butter* there are significant determination coefficients of length time delay for one month and two months. That emphasizes the importance of storage at this level of commodity chain. Time of expiration of butter could be up to three months, but if we talk about "fresh butter", there is expiration up to 20 days in maximum.

DISCUSSION

The paper was focused on price transmission within commodity chain of milk. The results imply that both commodity chains are represented by demand driven behaviour. This consequence is possible to deduce from three parts of price transmission.

The model of first part of price transmission shown asymmetric price transfer in supply direction at the first and second level of commodity chain of cow milk and butter, too. Coefficient of elasticity is here statistically significant. The price asymmetry in supply direction means that price changes on upstream market (from FP to PP; from PP to CP) are not fully transferred into the downstream market. That could be due to two reasons; it is a reason of market power – specifically imperfect competition and inventory management. Because from the third part of price transmission analysis we might take out reason of inventory management, especially in commodity chain of cow milk and at the first level of butter commodity chain, there was proven (by determination coefficient) the price transfer without of time delay. So this implies the reason of imperfect competition, probably some type of oligopoly structure.

In the other way – demand direction coefficient of price transmission elasticity has shown at the first level also inelastic price transfer. But at the second level, and it is interesting, there is coefficient of elasticity higher than 1, and that implies symmetric price transfer in both commodity chains. It could be due to existence of market power of finalizing partial market of commodity chains (retail and consumers). But also we can argue that price movement arises here at the end of finalizing market. From the previous affirmations we might tell that probably general reason of price asymmetry on commodity chains of milk is due of imperfect competition. Since the commodity chain has shown symmetric price transmission in demand direction, probable structure of competition could be oligopsony. Oligopsony structure is pronounced especially in commodity chain of butter. There is coefficient of elasticity almost 1 ($EPT_{ij} = 0.99$) at the first level of commodity chain of butter. That means products with higher added value are related to significant demand driven behaviour and higher bargaining power of downstream markets to upstream markets. This situation of market power confirmed also second part of price transmission, where we proved better price transfer of price increases than price decreases, into the downstream partial market of commodity chain.

This also points on continuing environment changes, for example Novák (2007) wrote that

inelastic price transmission was only in the commodity chain of cow milk, while within dairy product with higher added value there was elastic price transfer shown, and this implies market power only between first levels of commodity chain (farmers and processors). This article has shown new situation and constant development in this field. It also implies in case of oligopsony market structure less efficient of agrarian policy. Also this model has shown that development of milk and dairy products prices are not so strongly connected with prices on downstream market, especially because of existence of united European market and globalization. For determination of price maker in the Czech Republic within commodity chain of milk it is necessary in this time to prepare broader analysis.

CONCLUSION

This paper was focused on process of price transmission analysis within commodity chain of milk in the Czech Republic. The price transmission was distinct to two branches of products; one was product with lower added value (cow milk and cow milk in paper box 1.5% fat). The second is product with higher added value (cow milk and butter). The aim was fullfield by three parts of price transmission analysis, first was focused on price transmission between all possible levels of the observed commodity chains. The results of this part have shown more asymmetric price transmission in supply direction. In demand direction was found more symmetric price transfer. Second part of price transmission, focused on analysis of price differences of positive and negative price changes, has shown better price transfer of price increases into the downstream markets of commodity chains than price transfer of price decreases into the downstream markets of commodity chains. Third part of price transmission has shown influence of time delay in price transmission. Time delay is important only in the second level of commodity chain of butter, where it is possible to storage this product, otherwise these products are perishable.

The results of price transmission analysis, divided into three parts, implie asymmetry price transfer in commodity chain of milk. Also from this analysis can be conducted demand behaviour of these commodity chains, especially of commodity chain of cow milk/butter, where it was proven in the demand direction on the first level and on the second level of commodity chain elastic price transfer. Moreover, the asymmetric price transmission demonstrates less effects of agrarian policy of the Czech Republic. Created price transmission suggest oligopsony market structure, its impact on the commodity chain is significant. Due to oligopsony market power, there exists demand driven behaviour of the commodity chains, too, which was proven by the analysis. It means power of downstream markets in the commodity chains and their strong position in negotiation about purchase prices with upstream markets and also their role in creating contracts. The price transmission analysis is necessary for understanding of the price transmission within specific commodity chain in the country, because sector of agribusiness is still dynamic and the conditions of the market are changing continuously. Nowadays trends have shown that the price of processor does not depend on price on retails. This aspect arises because of reason of globalizations and coherence of countries on the same level of production. These consequences assumed continuing analysis of regression of markets on the same level of production and price transfer into the Czech Republic.

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