Investigation of the Determinants of Market Power on Czech Pork Meat Market

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Abstract

An increasing market concentration in food retailing has generated concerns about the market power of retailers towards consumers and input suppliers. This is especially true for the Czech Republic, which has a CR5 in food retailing greater than 50%. Based on different indicators of food chain and pork meat market with respect to four groups of meat products with low and high value added it was analysed whether the evidence of market power in the Czech pork market exists. Analysis based on a New Empirical Industrial Organization model investigated the degree of market power of meat processing industry. The evidence of market power in meat processing industry is rather weak, although has increasing trend in the last year accompanying by growing market concentration ratio. However, the empirical results suggest that market power of retailing exists towards consumers and towards input suppliers (in particular, in the case of meat products with higher value added).

Keywords

Food processing, pork market, retailing, market power, concentration ratio.

Introduction

The food supply chain plays an important role in the European economy, connecting sectors such as agriculture, food processing industry and the distribution. Though, the question of market power and competition policy in food supply chains has emerged as an important economic issue and a highly sensitive point on the policy agenda around the world.

In economic theory agricultural markets have been considered as an example of perfect competition markets. However, growing concentration at the food processing and retail level change the market structure and shift bargaining power (Sexton, 2013). Consequently, research in last years focused more and more on the food processing and retail sector as a possible source of oligopoly power with welfare loss implications for farmers and final consumers. Due to the great importance of the evaluation of the market structure, there have been numerous studies analysing the competitive conditions in several industries around the world.

For market power investigation, three different approaches have been applied in the literature: the structure-conduct-performance (SCP) approach

was first introduced by Mason (1939; 1949) and later extended by Bain (1951; 1968). Structural variables, such as concentration ratios, are used as explanatory variables of firm performance in this analysis. These variables are usually obtained from accounting data. SCP draws a relationship between market concentration and economic performance in terms of profits (Schmalensee, 1989). The positive relation is usually considered as the presence of market power. Demsetz (1973) criticises this approach, as higher profits in an industry might be either the outcome of collusive behaviour of firms or due to differential efficiency. Firms with a higher efficiency can increase market share and receive profits above the average, which causes the positive relation (Sexton and Lavoie, 2001). Consequently, no direction of causality between structure and performance can be derived (Salhofer et al., 2012; Bhuyan, 2014).

Another approach, price transmission analysis, aims to reveal imperfect price transmission and market power. The general idea is that imperfect price transmission might exist when price changes at one level of the supply chain are not immediately reflected at the other level. Imperfect

price transmission can exist either because price changes are not fully transmitted along the food chain, or because increases or decreases at one level of the chain are not transmitted instantaneously, but instead distributed over time. Another explanaton is that the price reaction is different for positive and negative shocks (making the transmission asymmetric) (London Economics, 2004). This may generate temporary profits. Asymmetric price transmission for food products seems to be the rule rather than the exception (London Economics 2004). However, market power is only one possible explanation for imperfect price transmission (Bunte, 2006). Adjustment costs such as labelling, or advertising costs might make price changes rather expensive and can be an explanatory factor for price levelling. Other explanations of imperfect price transmission are stock building or imperfections due to the perishability of products.

The third approach, the New Empirical Industrial Organization (NEIO), began to appear in 1980s (Bresnahan, 1989; Hyde and Perloff, 1995). NEIO focuses on detecting market power or, in general, market imperfections. Most of these studies are based on the Lerner index (Lerner, 1934). Another method for measuring market power within NEIO uses the conjectural variations (CV) to infer competitive behaviour, which assumes that each firm believes that its choice of price will affect the price selected by its competitor, and that the competitor's reaction can be captured by a single parameter (Iwata, 1974, Kutlu and Sickles, 2012, Muth and Wohlgenant, 1999). Kumbhakar et al. (2012) introduced an approach based on stochastic frontier analysis.

Although the NEIO approach has frequently been used to investigate market power in food processing, especially in the world (Schroeter, 1988; Schroeter and Azzam, 1990; Azzam and Pagoulatos, 1990; Azzam, 1997; Bhuyan and Lopez, 1997, O'Donnell et al., 2007, Lopez, 1984), applications to European food markets are rather rare. Exceptions are, for example, Steen and Salvanes (1999) for oligopoly power in the European market for salmon, or Bettendorf and Verboven (2000) for oligopolistic behaviour in the Dutch coffee market. Cechura at al. (2014) investigated market power of European slaughetering, fruit and vegetable dairy, milling industry based on mark-up and mark-down model, and stochastic frontier methodology. The estimated mark-down model revealed some degree of non-competitive behaviour in the input food processing market for all analysed sectors. The degree of market imperfections differs among the sectors.

The results of the mark-up model suggest that market imperfections on the output market are not so significant for the slaughtering sector. However, the degree of market imperfections is higher for the output market in the dairy and milling sectors. Cechura et al. (2015) compared market power of dairy industry of 24 EU member states using mark-up model. The results proved the existence of market failures on the EU output milk-processing market. Grau and Hockmann (2016) analysed German dairy supply chain and found lower levels of market imperfections on the raw milk and dairy output market. Bakucs et al. (2009) proved the existence of market power on German and Hungarian pork market, although on a relatively low level.

Market power of retailers in Europe was estimated in a number of papers with, however, very rare used of NEIO approach. Gohin and Guyomard (2000) studied market power in French food retailing considering milk, meat, and other food products. They strongly rejected the hypothesis of perfect competition. Anders (2008) investigated competition in German retailing with respect to meat products. The author's results strongly suggest evidence of retail oligopoly and even stronger oligopsony power. Sckokai et al. (2009) estimated market power in the cheese market in Italy and concluded that evidence for oligopoly power is stronger than for oligopsony power. Salhofer et al. (2012) estimated the market power of food retailers towards consumers and input suppliers with respect to three groups of dairy products. Results of the study suggest that market power of retailing exists towards consumers and towards input suppliers. In the European Union, Mérel (2009) examined behaviour in the French cheese market. The results of the paper do not confirm the evidence of market power. Spicka (2016) analysed the market of grocery retailers in the European Union and concluded that market structure of the Central European grocery retailers has mostly a character of asymmetric oligopoly.

This paper contributes to the analysis of market power in the Czech Republic. The price transmission analysis, provided by the internal project of IAEI (Rudinskaya et al., 2017) found that price transmission on the pork market in the Czech Republic is asymmetric from the point of view of different reaction to positive and negative price change on the different levels of pork chain. The objective of present paper is to extend the analysis of market imperfections on pork market and identify the reasons that may have affected the contemporary development of spreads between

farm gate prices and retail prices in recent years. The study focuses on developments since 2006 till 2016 in the Czech Republic and covers several pork products.

The paper addresses the following research questions. The first question is aimed to the analysis of development of market concentration ratio of retailers in the European Union and in the Czech Republic. The second question relates to the analysis of spread between farm-gate, processor and retailer prices in recent years for pork products with low and high value added. The third question concerns market imperfections in the meat processing market. The aim is to identify the degree of oligopoly market power.

The paper is organised as follows: in the next section (Materials and methods), the theoretical model and its empirical implementation is presented. Section describes the data and estimation techniques. Section Results and discission presents the estimation results and discussion on them. Conclusions are drawn in the last section.

Materials and methods

There are several different sources of market power in literature. Market power, that can threat agricultural sector, can flow from the companies, which provide inputs for agriculture (feed processing companies, seed suppliers, machinery companies etc.) The second source is food processing companies, which in the case of high concentration ratio have bargaining power and lower the farm-gate prices of agricultural products. The third source is represented by the power of retailers, that can cut the processing prices. This paper is aimed to investigation of the second and third source.

In this chapter, we provide the comparison of market concentration ratio of European and Czech retail sector. Next, we undertake an analysis of development in the level of farmer-processor and processor-retailer price spreads of the several pork products, and then we present the results of correlation analysis between, on one hand, the level of processor-retailer price spreads and, on the other hand, the level of concentration in the food retailing industry. Finally, the estimation of the degree of market power of meat processing companies based on NEIO approach is provided.

The present study is based on data, collected from different sources: Passport database by Euromonitor International, Albertina database,

Eurostat database, and Ministry of Agriculture of the Czech Republic. The data covers period 2005-2016. However, taking into account data availability of prices, time period 2006-2016, 2006-2017 was analysed.

The measures of the industry's structure are related to the degree of competitiveness in the industry. Common measures include the concentration ratio (CR), Herfindahl-Hirschman Index (HHI)), the degreeof product differentiation and the economies of scale.

This study uses market concentration ratio CR3 (for European Union) and CR5 (for the analysis of the Czech market structure). These ratios were chosen as the best fitting indicators for Czech food chain based on available data. The concentration ratio (CR_m) is calculated as the percentage of market shares held by *m* largest firms in a sector. Market share of the five biggest companies (CR5) is calculated as:

$$CR_5 = \sum_{i=1}^{5} S_i \qquad (1)$$

where S_i denotes the individual market share, i.e. the percentage of the i-th firm calculated as the production of the company divided by the sum of production of all firms in the market.

To assess whether the market concentration ratio and price spreads show any systematic upward or downward trend through the analysed period, a simple equation relating the concentration ratio, farmers-processor or processor-retailer price spread of a specific commodity to a time trend variable was estimated in the following equation:

$$Y_j = \alpha + \beta t \qquad (2)$$

where Y_j is concentration ratio of *j*-country or price spread of *j*-commodity, *t* is a trend variable. Of key interest is the sign of the coefficient *β* and whether it is statistically significant.

To evaluate the relationship between the price spread and market concentration ratio of retailing sector, Pearson correlation coefficient was used (Pearson, 1895).

The research analysis of market power will be provided by estimating a mark-up model and employing stochastic frontier methodology. The mark-up model is derived from the standard profit maximization rule. The solution of the optimization problem results in product price corresponding to marginal costs for a competitive market, and price exceeding marginal costs for a non-competitive (oligopolistic) market:

$$P > MC \equiv \frac{\partial C}{\partial Y} \qquad (3)$$

where Y is an output, and C stands for total costs.

If we multiply relation (3) by the share of revenue in total costs, we can write:

$$P\frac{Y}{C} > MC\frac{Y}{C} = \frac{\partial C}{\partial Y}\frac{Y}{C} = \frac{\partial lnC}{\partial lnY} \qquad (4)$$

The inequality can be transformed to an equality by adding a non-negative, one-sided error term (u), i.e. u represents a measure of market failures (mark-up) (5).

$$\frac{PY}{C} = \frac{\partial lnC}{\partial \ln Y} + u, u \geq 0 \qquad (5)$$

The relation (5) can be estimated using stochastic frontier methodology. The stochastic frontier approach for detecting the degree of monopoly power was first introduced by Kumbhakar et al. (2012).

In relation (5) estimation of the first derivative of the cost function must be done. In the case of input and output prices absence, the duality theorem can be applied, and the first derivative of the input distance function can be estimated instead (Kumbhakar et al., 2012):

$$\frac{PY}{C} = \frac{\partial lnC}{\partial lnY} + u = \frac{\partial lnD^I}{\partial lnY} + u, u \geq 0 \qquad (6)$$

Input distance function in a translog form can be written as following:

$$\begin{aligned} lnD^I = \ &\beta_o + \beta_T T + 0.5\beta_{TT}T^2 \\ &+ \beta_Y lnY + \beta_{YT}lnYT + 0.5\beta_{YY}(lnY)^2 \\ &+ \sum_{j=1}^{J-1}\beta_j ln\tilde{X}_j + 0.5\sum_{j=1}^{J-1}\sum_{k=2}^{J}\beta_{jk}ln\tilde{X}_j ln\tilde{X}_k \\ &+ \sum_{j=1}^{J-1}\beta_{JY}ln\tilde{X}_j lnY + \sum_{j=1}^{J-1}\beta_{jT}ln\tilde{X}_j T \qquad (7) \end{aligned}$$

The function (7) can be estimated as:

$$\frac{PY}{C} = \beta_Y + \beta_{YY}lnY + \sum_{j=1}^{J-1}\beta_{jY}ln\tilde{x}_j + \beta_{YT}T + u + v \qquad (8)$$

where v is a variable capturing the statistical noise.

For the purpose of the analysis input distance function was estimated on the form of True Random Effects model (Greene, 2005).

Defining the relative mark-up (θ) as $\theta = \frac{P-MC}{MC}$, we get the estimation of relative mark-up:

$$\hat{\theta} = \frac{\hat{u}}{\hat{\beta}_Y + \hat{\beta}_{YT}T + \hat{\beta}_{YY}lnY + \sum_{j=1}^{J-1}\hat{\beta}_{jY}lnX} \qquad (9)$$

The data for the analysis was collected from the Albertina database. The database contains accounting information of companies in the

Czech Republic. The panel data set that was used in the analysis contains companies whose main activity is meat processing, according to the NACE classification. It is an unbalanced panel data set, which represents the period from 2005 to 2016 and contains 1,616 observations of meat processing companies.

In the analysis Output, Labour, Capital, Material, and Revenue share variables were used. Output variable is represented by the operating revenue (Turnover) of the company. Labour variable is represented by the cost of employees, Material variable is the total costs of materials and energy consumption, and Capital costs is calculated as the value of net worth with added cost of services and extracted amortization. Revenue share was calculated by the following way: Revenue share = Revenue/Costs. Costs are the sum of Labour, Material and Capital costs. Material and Capital variable were normalised by Labour variable. To eliminate the inflation, Output variable was deflated by the sectoral index of processing price index (in meat processing industry). Material and Capital variables were deflated by the index of processor prices (total index).
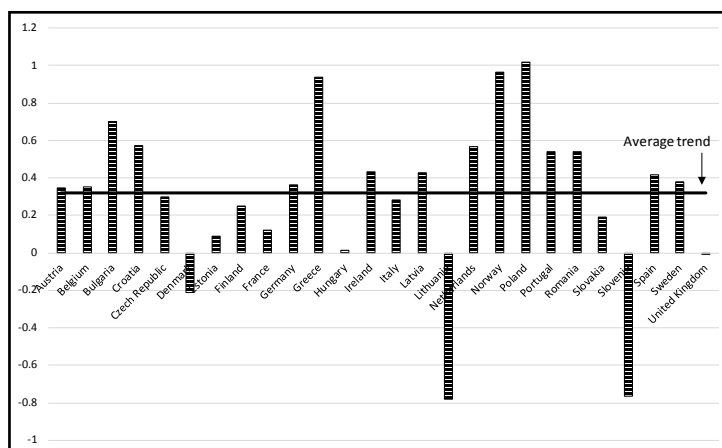
Results and discussion

In this chapter, we undertake a descriptive analysis of a) market concentration ratio of European Union member states; b) the development of price spread on farmer-processor and processor-retailer level; c) correlation of processor-retailer price spread and retailers market concentration ratio (CR5); and d) estimation of market power coefficient and the relationship of the degree of market power and concentration ratio of meat processors.

1. Retail concentration in the European Union

Development of market concentration of retailing of Top 3 companies is presented in the Figure 1. Market concentration ratio represents the share of revenue of the three biggest companies in total revenue including grocery and non-grocery retailing. Development of market concentration was estimated according to (2) and represented by the parameter coefficient of linear trend, which displays whether market concentration ratio has decreasing or increasing trend over the estimated period.

Concentration in European food retailing has increased throughout the European Union. Only in three Member States (Denmark, Lithuania and Slovenia) concentration ratio decreased over the analysed period. The highest growth

Note: Exc. Cyprus, Malta, Luxemburg.
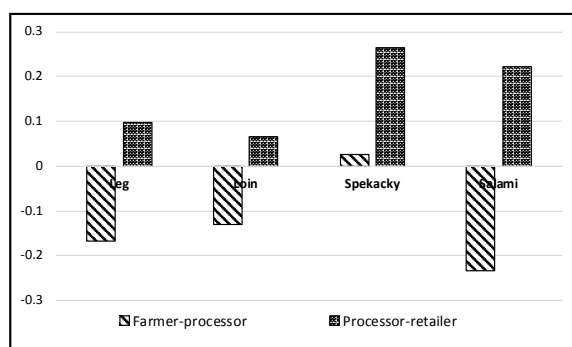Source: own processing based on Passport data

Figure 1: Linear regression of CR 3 in the European Union (2008-2017).

of CR3 experienced Poland, Norway and Greece. Increase of CR3 in the Czech Republic, expressed by the parameter of linear regression, is slightly below average level of European Union Member States.

2. Changes in farmer-processor and processor-retailer price spreads in the Czech Republic

Estimated trend coefficients of pork and pork products price spread in the Czech Republic are represented in the Fugure 2. Spread represents the difference between two prices on the different levels of pork chain, i.e. 1) between farm-gate price and processor's price (farmer-processor); 2) between processor's and retailer's price (processor-retailer). Development of prices spreads is represented by the coefficient of linear trend according to (2).

The development of spread has one interesting characteristic: while the spread of processor-retailer prices is increasing for all products over the analysed period, the farmer-processor price spread is decreasing (except "spekacky", that has a growing trend).
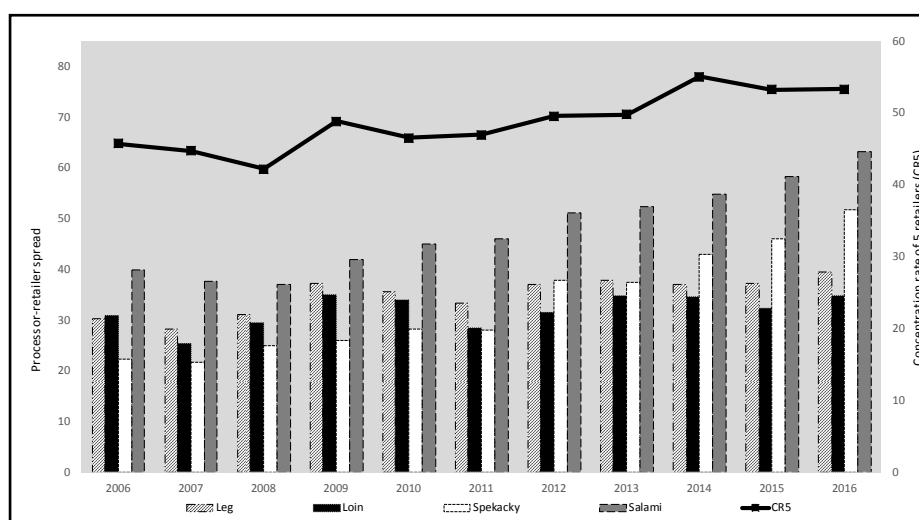

Source: own processing

Figure 2: Development of price spread in the Czech Republic in the years 2006-2017.

The proportion of agricultural products in the final product, used by the food processing industry, has changed in recent years and may have had some impact on price spread development as well as on the bargaining relationships along the supply chain. The negative development of farmer-processor price spread might have been either the result of lower content of agricultural material in final product, or the result of growing market power of retailing sector. Further factor that can have had an impact on farmer-processor price spread is modernization of food processing industry, that can result to higher productivity and lower costs of final products of processing industry. Productivity of meat processing companies, measured by Gross value added per employee, increased from 2008 to 2016 by 31.4 % (Ministry of Agriculture of the Czech Republic, 2017). After the elimination of price changes in meat processing industry (inflation) the indicator amounts to 31.2 %

One of the factors that may affect the size of the spread between farm-gate, processor and retail prices is food retailing concentration ratio. For this part of the analysis concentration ratio (CR5) of Czech retailing was calculated based on Albertina and Eurostat data sources. Turnover of five companies with largest turnover was divided by the total turnover of Czech grocery sector.

Correlation analysis of the processor-retailer price spreads and concentration ratio (CR5) of the food retailing industry in the CR shows that the link between these two variables is very strong (Figure 3). The correlation analysis shows a positive relationship with the highest correlation coefficient of 0.903. The correlation coefficient is higher in the case of products with higher value added (salami and spekacky). The results

Source: own processing

Figure 3: Correlation between processor-retailer spread and CR5 in the Czech Republic
in the years 2006-2016.

of the correlation analysis suggest that the impact of food retail concentration on the farm gate-retail spread is rather strong, especially for products with higher value added, that are more heterogenous comparing to unprocessed products (pork leg and loin).

3. Mark-up of Czech meat processing sector

Table 1 provides a parameter estimate of the mark-up model for the meat processing sector in the Czech Republic.

Variable	Coefficient	Standard Error	P>z
Constant	0.874	0.009	0.000
Time	-0.003	0.001	0.000
Output	0.072	0.003	0.000
Labour	0.032	0.006	0.000
Material	0.045	0.005	0.000
Sigma_u	0.096	0.004	0.000
Sigma_v	0.030	0.003	0.000
Lambda	3.244	0.006	0.000

Source: own processing

Table 1: Estimated parameters of mark-up model.

All estimated parameters are significant. The estimates show the positive impact of the output, labour and material inputs on revenue share of the meat processing sector. Higher labour and material inputs relate to a production characterized by higher value added. Finally, the firms with higher output have a higher revenue share. This could be also related to higher degree of market power.
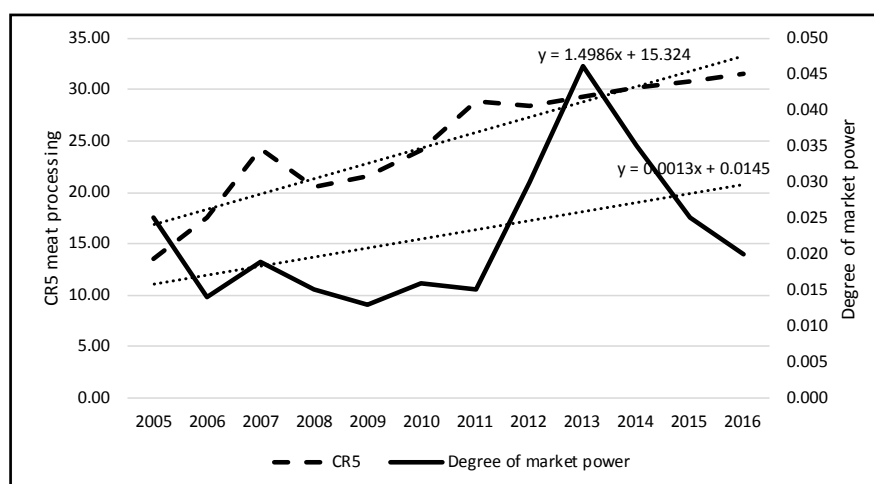
The impact of time on revenue share is negative,

although very low. This is in line with slightly decreasing processors' prices and farmer-processor spread of pork meat and pork products.

Figure 4 represents the development of concentration ratio of meat processing industry (CR5) and the estimated degree of market power. CR5 was calculated based on the Albertina database and data of Ministry of Agriculture of the Czech Republic. Turnover of five companies with largest turnover was divided by the total turnover of Czech meat processing sector.

The analysis of development of concentration ratio in meat processing industry (CR5) and the degree of market power shows the similar growing trend. Correlation between CR5 of meat processing sector and degree of market power is 0.419 that is positive and relatively high.

The results of previous studies have different conclusions concerning market power of the food processing and retailing. There are studies of market power of food processing and retailing in European Union that found strong evidence of market power. But there are also studies that found only weak or even no evidence of market power. The food sector in the European Union can be characterised by significant concentration within the food processing industry and the retail sector (Dobson et al., 2001). Number of papers addressed the analysis of market power of milk processing industry. Bakucs et al. (2018) by analysing the market power of Hungarian milk processing found that the effects of market power are statistically significant, and the econometric results are

Source: own processing

Figure 4: Development of CR5 of meat processing and the degree of market power
in the Czech Republic in the years 2005-2016.

consistent with a relatively highly concentration in the Hungarian milk processing industry. Cechura et al. (2015) did not find the evidence of significant market power in milk food processing industry in the Czech Republic. However, the degree of market power increased during the analysed period. Cechura et al. (2014) investigated the mark-down and mark-up model for the member countries of EU and found that the slaughtering sector of the Czech Republic is characterised by lower market imperfections as compared to the EU average. Grau and Hockmann (2016) investigated German dairy supply chain and found low levels of market imperfections on the raw milk and dairy output market. Bakucs et.al. (2009) analysed the impact of market power on resource allocation in the German and Hungarian pork markets. The regression analyses suggest that market power exists, although on a relatively low level. In addition, the market power of processors in the German hog sector is decreasing, while in the Hungarian sector it is increasing. Salhofer et al. (2012) proved the existence of market power in retailing based on milk products data. Retailers apply market power towards consumers and towards input suppliers.

These results of the empirical analysis are consistent with the structural developments in pork production and pork processing. The results of this paper are in line with the results of previous studies. Degree of market power of meat processing industry is rather insignificant but increasing in time. The growth of market power corresponds to the concentration ratio of meat processing industry.

Retailer sector evidently has higher degree

of market power, based on the results of present paper and the results of internal project of IAEI (Rudinskaya et al., 2017).

Conclusions

The paper investigates the existence of market power in the food processing and retailing sector of pork meat and pork products. In this regard, one can note that perishable food products with little alternative sale channels are more likely to be subject of market power than products that can be easily stored.

Based on market concentration ratio (CR5), spread of farmer-processor and processor-retailer prices, correlation between spread and market concentration ratio and NEIO approach, it was proved that the degree of market power of meat processing industry is rather low. However, the degree of market power is increasing in time, as well as the concentration ratio (CR5). The development of farmers-processor price spread during the analysed period (2006-2016) has decreasing trend. The development of processor -retailer spread is, in opposite, increasing over time. The concentration ratio of Czech retailing is slightly below the European Union average. Moreover, correlation of CR5 and price spread is very high, that can imply the existence of market power in retailing.

These findings apply the important points towards some policy issues, particularly the fact that governments should be aware of the effect of market power. It is desirable to provide measures for effective strengthening of farmers bargaining

power. Joint selling through producer organisations can be an effective tool for rebalancing power in the agri-food system.

The challenge for future research is to proceed in investigation of the determinants of market power through the estimation of the degree of market power of retailers based on NEIO approach.

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