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Monopolistic markups in the Polish food sector

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Abstract

Research background: Agro-food sectors are commonly considered as highly regulated, traditional and of strategic importance, mainly due to the food security issues. Changes in the related market structures are subject of constant interest because of their importance for competition and economic welfare of food producers and consumers. In Poland, a rising concentration among various branches of the food industry can be observed. Unfortunately, there is a lack of studies regarding the level of actually exerted market power.

Purpose of the article: The main objective of the article was to depict the changes of the market power execution in the Polish food sector and its branches in the period 2002–2013.

Methods: As a measure of market power, markups of price above the marginal cost were applied and for their estimation two methods were used, namely the Roeger method involving primal and dual Solow residuals and the method based on the marginal cost of labour. Yearly data from F-01 financial statements regarding 32 food sector branches and various accounting categories were used in the calculations.

Findings & Value added: It was found that in the analyzed period the markup over marginal cost on average amounted to 9.75%, and it was increasing over time. The labour input category seemed to be not sufficient for the markup calculation. The evolution of the monopolistic power in the Polish food sector appears to be associated not only with the business cycle, but also with the sector developments accelerated by the accession to the EU. Moreover, the differences in results for the branches indicate a considerable heterogeneity in the Polish food industry companies pricing practices. The research constitutes the first trial

of the measurement of both the Roeger markups in the Polish food sector branches and the labour markups changes in the Polish food sector.

Introduction

The market structures in the food sector are subjected to constant changes. As early as in 1966, in the report prepared by the US National Commission on Food Marketing, it was admitted that the concentration in many branches of the U.S. food sector reached a too high, undesirable level, and the marketing and promotion expenses were excessive. It was also found that through mergers and acquisitions companies are getting bigger exceeding sizes needed to maintain their operational efficiency (Sexton, 2000, pp. 1087–1104). The intensification of the concentration processes in the agro-food sector has a worldwide character and has been noticed in many countries for a long time. Figiel & Kufel (2013) proved high and statistically significant correlation between the value of the world agro-food production and the value of mergers and acquisitions in the world in the period 2000–2010.

Also in the Polish food industry concentration processes occur. In 2010 companies hiring more than 250 workers, constituting only 1.7% of all nearly 16 thousands companies operating in the sector, made 36.9% of all employment and 54.1% of all production value. Three capital groups generated 85.7% of revenues in oil manufacturing, 78.5% in brewing manufacturing, 76.9% in the tobacco industry, 75.6% in potato manufacturing and 69.6% in sugar manufacturing. In the period 2003–2010, while the production value increased from 102.7 to 158.9 bn. PLN, the number of entities decreased from 19.52 to 15.97 thousand. The concentration ratio in sales in 2013 amounted to 0.79 in the food production, in the production of beverages — 0.66, and in the tobacco industry — 0.37. It is also envisaged that the process of concentration in the food sector will be continued and the role of large firms will grow (see Szczepaniak, 2012, pp. 78–87).

Potentially, a high concentration can contribute to non-competitive conduct of main players in the industry, leading to higher markups of price above the marginal cost¹. There are plenty of research results concerning relation between concentration and market performance, e.g. (Tirole, 1988; Carlton & Perloff, 2005, pp. 263–267) and it turns out that most of the time the relation between these variables is positive and statistically significant, but weak. Therefore, increasing concentration in the Polish food sector data may be a sign of increasing markups, which may influence competition and

¹ This paradigm is known as a Structure-Conduct-Performance (SCP) hypothesis.

economic welfare of food producers and consumers. However, this may not be true, as already in 70-ties it was proved that the positive correlation between concentration and market performance is consistent with the increasing effectiveness hypothesis, as a company may create innovations which decrease costs and improve quality. This makes it possible to increase markups and profits, as well as to gain dominant position in the market, which accelerates the concentration processes (compare Demsetz, 1973, pp. 1–9).

Consequently, the main aim of the article is to depict changes of monopolistic markups in the Polish food sector in the period of 2002–2013. Moreover, two additional research questions were formulated. Firstly, can the markup be considered as a symptom of market power? Secondly, were labour markups changes good indicators of market power execution changes in the Polish food sector in the period 2003–2012? In order to answer the first question, the concept of markup and its estimation methods will be presented. Afterwards, the key aspects of methodology for markup estimation will be discussed, in particular the Roeger (1995) and the Rotemberg & Woodford (1999) methods. Then, the results of applications of both methods will be showed and compared in order to assess the appropriateness of the second method for the Polish food sector.

It needs to be added that there have been not enough extensive attempts to measure market power in the Polish food sector, and the main point was rather to discover the price transmission mechanism or the power distribution among the food marketing chain actors (compare Seremak-Bulge, 2012, pp. 5–24; Urban, 2001, pp. 1–120). The only studies carried out were the ones by Gradzewicz & Hegemajer (2007a,b). The average markup in the Polish food sector in the period 1996–2004 estimated with the Roeger method amounted to 0.224, which was the third highest result among all manufacturing industry branches.

The concept of markups and methods of their estimation

The markup is a gap between the price (P) that a firm charges and its marginal cost (MC): $\mu = P/MC$ (see Samuelson & Marks, 2009, pp. 118–120; Pindyck and Rubinfeld, 2013, pp. 372–373). The total revenue (TR) of the company can be written as follows: $TR = Y \cdot P$, where Y is an output, and the change in total revenue caused by production of an additional unit is: $MR = \frac{dTR}{dY} = P + Y \cdot \frac{dP}{dY}$. On the other hand, the price elasticity of demand

can be expressed as follows: $\varepsilon = -\frac{dY}{dP} \frac{P}{Y}$. Hence we have: $\frac{P}{\varepsilon} = Y \cdot \frac{dP}{dY}$ and $MR = P + \frac{P}{\varepsilon} = P(1 + \frac{1}{\varepsilon})$. The optimal markup is a markup received under the profit maximizing condition: $MR = MC$. From the formula for markup we get: $MC = \frac{P}{\mu}$. Consequently, we have: $P(1 + \frac{1}{\varepsilon}) = \frac{P}{\mu}$, and the optimal markup can be expressed as follows: $\mu = \frac{1}{1 + \frac{1}{\varepsilon}}$. The two main conclusions are that the increase of price elasticity of demand (absolute value) causes the markup to fall and vice versa, and that the optimal markup calculation allows an enterprise to set the profit maximizing price: $P = \frac{MC}{1 + \frac{1}{\varepsilon}}$.

Olive (2002) enumerated five economic meanings of markups. Firstly, they indicate a market power. Also, according to Church (2000), a market power is a firm's ability to profitably rise the price above the marginal cost². Although the markup is rather a realization of this ability, not this ability itself, since the markup grows along with the perturbation between a price and a marginal cost, it is commonly used as a measure of market power and these two concepts are used interchangeably. As a firm has a market power, when it concerns rising price above marginal cost as profitable, the market power depends on the market structure. The situations of a perfect competition and a monopoly are presented in Figure 1. We can see that while in the first situation the market power of the monopoly amounts to μ , in the perfect competition a firm has no ability to exercise market power and because price equals marginal cost, the markup amounts to zero.

The reason for the dependence of the markup on the market structure is its relationship with price elasticity of demand, so on the character of the demand curve. In the case of homogenous goods, the higher number of competitors, and in the case of diversified products — the higher cross-price elasticities of demand, the higher is the price elasticity of demand and the lower is the market power exercised by the company on the imperfectly competitive market (see: Church & Ware, 2000, pp. 31–34). Tremblay & Tremblay (2012, p. 328) concluded that the market power measured by markups is growing when: there are entry barriers, which implies higher concentration on the market; there are no potential entries; products are diversified; firms compete more by quantity than by price; firms create an

² This is the most common definition of market power. However, also other can be met, e.g. in the opinion of Pindyck and Rubinfeld (2013) a market power is either a seller's or a buyer's ability to influence a price of a product.

effective cartel; firms make strategic investments in order to decrease costs or to rise prices in the future. Because these factors intensities are different depending on the market, also markups illustrating market power are different depending on the market. What should be added, however, is that while calculating market power a proper attention should be paid to the time and market boundaries. Moreover, the business cycle and technological change can matter (Church & Ware, 2000, p. 147).

The second meaning of markups is that they represent the welfare loss for the society (see Olive, 2002, p. 3). The common welfare measure is the total surplus, being the sum of consumer and producer surpluses. It's the value which producers and consumers are willing to pay for the equilibrium quantity at the equilibrium price. This welfare measure is maximized in the competitive equilibrium and each departure decreases its value. The competitive equilibrium is characterised by the desired efficiency and welfare levels, and according to the Pareto rule, no actor can improve its position without worsening the situation of the other one (see Carlton & Prestoff, 2005, pp. 69–71). In order to measure this effect of markup pricing, the so called deadweight loss (DWL) is calculated. It's the cost of inefficient market performance incurred by the society, measured by the loss in total surplus comparing to the situation of competitive equilibrium. Church & Ware (2000) highlighted that this allocative inefficiency leading to lowering the volume of production is the main outcome of market power execution. DWL in the situation of a monopoly is presented on the Figure 2. We can observe that the output in the monopoly is lower than the optimal one ($Q^m < Q^c$). The loss of welfare in the uncompetitive market structures may be an effect of: monopolistic pricing practices, achieving excessive profits, reduced production, unused production capacity, weak tendency to cost reduction and to innovate because of the lack of competitive pressure.

Thirdly, according to Olive (2002) markups are incentives for investment and technological change. Yet Schumpeter (1965) noticed that market power encourages research and development. Without the prospect of monopolistic profits companies would not have enough incentives to conduct research and development. What is interesting, DWL will have positive meaning when it enables innovation regarding products and technologies leading to an economic growth as well as improving life quality standards.

Fourthly, markups at the aggregated level change along the business cycle, and are used as an argument in the macroeconomists discussions on the character of cyclicity of real wages (see Olive, 2002, p. 3). Finally, markups are used as key exogenous variables in the macroeconomics models of inflation and general equilibrium models (see Olive, 2002, p. 3), especially in the New Keynesian dynamic stochastic general equilibrium

(DSGE) models, utilized nowadays in the majority of central banks for the needs of monetary policy, in which the markups level is an exogenous variable and the assumptions about their cyclicalities are used for the construction of the supply side.

The point is that high markups and their variability influence the price dynamics in the business cycle, which affects the monetary policy effectiveness. Monopolistic structures in the economy, reflected by high markups, change economy response to both demand and supply disturbances. Countercyclical markups and their positive influence on inflation implies an asymmetric reaction of monetary policy and an economic activity variation. During economic downturns the fact that inflation does not fall as much as when markups were stable, limits the abilities of central banks to sustain the aggregated activity level through the decrease of interest rates. On the contrary, the markups decrease in the expansion phase limits the inflation pressure and enables central banks to delay introduction of a restrictive monetary policy.

What is interesting, the Keynesian models depend on countercyclical markups only since early 80-ties. Before, the leading one was the assumption of sticky wages (compare Taylor, 1980, pp. 1–23), but because the earlier models appeared to contradict the cyclical properties of real wages, researchers changed the assumption of sticky wages to the one of sticky prices (see Gordon, 1981, 493–530; Rotemberg, 1982, pp. 517–531). As stated Nekarda & Ramey (2013), from the Woodford model (2003), in all New Keynesian models markups fall in response to positive demand shifts. Sticky prices together with pro-cyclical marginal cost cause that an expansionary monetary or government spending shock decreases the average markup. This is also true in the newest models built in the New Keynesian spirit joining sticky prices and sticky wages, e.g. (Erceg *et al.*, 2000, pp. 281–313; Smets & Wouters, 2003, pp. 1123–1175; Christiano *et al.*, 2005, pp. 1–45). In the inspiring model of Jaimovich and Floetotto (2008) procyclical entry of firms leads to countercyclical markups, and then to procyclical TFP. Regarding inflation, Ball *et al.* (2003) or Steinsson (2003) in their New Keynesian models assume positive correlation between markups and inflation, and a markup change is that of a cost nature. It's also worth highlighting that understanding the mutual relation between markups and prices is especially important in countries, which set inflation targets, e.g. in Poland.

The above discussion shows that markups are and can be regarded as symptoms of market power. Moreover, it can even be stated that they are the only right indicator of the market power execution, and it is hardly impossible to think about the better one. In practice, in order to assess the

market power execution, the so called Lerner index is utilized: $\mathcal{L} = \frac{P-MC}{P}$. Its values for different structures in the static setting are presented in table 1. For diversified products and dynamic markets characterized by today production and sales influencing future profits, e.g. those including learning-by-doing, the Lerner indexes formulations are far more complicated, see (Tremblay & Tremblay, 2012, pp. 336–337).

Because the Lerner index calculation is usually problematic, mostly because of the lack of data on marginal costs (available data typically include only average cost), other market power measures have been developed. Majority of them is focused on profitability, e.g. q Tobin, rate of return, profit to sales ratio, relative profit diversification (see Tremblay & Tremblay, 2012, pp. 311–318), and they are not free of drawbacks. Firstly, price can exceed marginal cost even when profits are zero, e.g. in the monopolistic competition. Secondly, for the majority of companies it is hard to identify shares of revenue, costs and assets connected with certain products or markets. Thirdly, they employ accounting profits being only a weak approximation of economic ones (compare Carlton & Perloff, 2005, pp. 249–252).

Consequently several methods of indirect markups estimation were developed, e.g. the total cost function estimation, the price response to a change in costs, New Empirical Industrial Organization (NEIO), stochastic frontier method, game theory, overall efficiency loss estimation, single input margin (see: Tremblay & Tremblay, 2012, pp. 318–326; Einac & Levin, 2010, pp. 145–162; Rotemberg & Woodford, 1999, pp. 1051–1135). The main disadvantage of them is that it is hard to state which part of the difference between revenues from sales and marginal costs is the result of market power (a relationship between price and marginal costs), and which is a result of economies of scale (a relationship between average and marginal costs) (compare Gradzewicz & Hagemeyer, 2007a, pp. 515–540). Hence, it is assumed that there are no economies of scale.

Research methodology

In order to assess market power execution in the Polish food sector two methods were chosen, because they are the most well-known and the most frequently applied regarding problems on both micro and macro levels (compare Gradzewicz & Hagemeyer, 2007b, pp. 13–27; Nekarda & Ramey, 2013, pp. 1–47). The first one was developed by Roeger (1995), and the second one by Rotemberg and Woodford (1999).

The Roeger method is one of the methods studying the price response to a change in costs. The main idea of this group of methods is that on the perfectly competitive market each increase in costs will be completely transmitted on consumers, whereas on the imperfect one the pass-through is different from zero. Therefore, the range, in which a price responds to change in costs, can be used for markup estimation. In the majority of studies taking advantage of this broad category of methods, directly or indirectly Hall (1988) developments are used. He calculated markups from the following equation: $\Delta \ln \frac{Y}{K} = \mu \Delta \ln \frac{X}{K} \cdot \theta + \xi$, where Y is an output, K is a capital input, X is a labour input, and θ is a share of labour costs in production value. The main problem with this method was that disturbances in unobserved productivity are a part of random error of the model and therefore could be correlated with the production factors, what induces markups estimates bias. This problem was solved by introducing instrumental variables influencing unobserved residual in the Solow model, which influence changes in employment and demand, and not in productivity, e.g. world oil price, government military expenditures, dummy variable connected with a ruling party. Additionally, because data must be in real terms, there was a problem concerning the influence of products quality changes on prices. Finally, markups estimates were too high comparing with a lack of profits in certain branches.

The great deal of these problems was solved by Roeger (1995). Whereas Hall took advantages of the primal Solow residual (*SR*) based on the production function, Roeger added the dual Solow residual (*DSR*) based on the cost function. By *SR* we understand a share of a technology change in the production, and by *DSR* the share of a technology change in the change of total costs of production. Using primal and dual Solow residuals enables elimination of an unobserved productivity variable from the regression equation (no bias under constant returns to scale), which gives more precise and closer to reality markup estimates (see Gradzewicz & Hagemeyer, 2007b, pp. 13–27). Consequently, the estimation could be performed with a normal least square method. There is no need to look for instrumental variables.

Moreover, because of the assumption that markups are constant in a particular branch in a particular year, data may be in nominal terms (see Gradzewicz & Hagemeyer, 2007b, pp. 13–27). Additionally, because of the assumption of constant returns to scale, estimators are equally burdened in time (compare Gradzewicz & Hagemeyer, 2007b, pp. 13–27), which does not influence the markups dynamics. Consequently, this method is relevant to study the markups dynamics, as well as the impact of exogenous variables on markups. Roeger estimates represent a lower bound of markups in

branches with growing returns to scale, large sunk costs and a strong rigidity of adjustments over the business cycle (compare Martins *et al.*, 1996, pp. 1–47). The assumption of constant returns to scale was however broadly criticized.

If we assume that the production function is: $Y(X_1, \dots, X_N, K, E) = F(X_1, \dots, X_N, K)E$, where Y is an output, K is a capital input, X_i are inputs of production factors from 1 to N , and E is a neutral Hicks technology change, after logarithmic differentiation we get: $\frac{dY}{Y} = \sum_i \frac{\partial Y}{\partial X_i} \frac{dX_i}{Y} + \frac{\partial Y}{\partial K} \frac{dK}{Y} + \frac{dE}{E}$ (see Gradzewicz & Hagemeyer, 2007b, pp. 13–27). Assuming perfectly competitive production factor markets, we have: $w_i = \frac{\partial Y}{\partial X_i} \frac{P}{\mu}$, and $w_k = \frac{\partial Y}{\partial K} \frac{P}{\mu}$, where w_k and w_i are prices of capital and other production factors accordingly, P is a price of a final product, μ is a markup. Shares of production factors costs in total costs can be expressed as: $\alpha_k = \frac{w_k K}{Y \cdot MC}$ and $\alpha_i = \frac{w_i X_i}{Y \cdot MC}$. We get then: $\frac{dY}{Y} = \sum_i \frac{w_i X_i}{Y \cdot MC} \frac{dX_i}{X_i} + \frac{w_k K}{Y \cdot MC} \frac{dK}{K} + \frac{dE}{E}$. Because the shares of production factor costs in total revenue are as follows: $\theta_i = \frac{w_i X_i}{PY}$, we obtain: $\alpha_i = \frac{w_i X_i}{Y \cdot MC} = \theta_i \mu$, and $\alpha_k = \theta_k \mu$, accordingly. Assuming constant returns to scale, from the Euler theorem, we have: $\sum_i \alpha_i + \alpha_k = 1$. Then: $\frac{dY}{Y} = \sum_i \theta_i \mu \frac{dX_i}{X_i} + \theta_k \mu \frac{dK}{K} + \frac{dE}{E}$. After transformations we can get the primal Solow residual: $SR = \frac{dY}{Y} - \sum_i \theta_i \frac{dX_i}{X_i} - (1 - \sum_i \theta_i) \frac{dK}{K} = \left(1 - \frac{1}{\mu}\right) \left(\frac{dY}{Y} - \frac{dK}{K}\right) + \frac{1}{\mu} \frac{dE}{E}$.

From the cost function we can obtain marginal cost: $MC = \frac{G(w_1, \dots, w_N, w_K)}{E}$. After logarithmic differentiation we get: $\frac{dMC}{MC} = \sum_i \frac{\partial G}{\partial w_i} \frac{dw_i}{G} + \frac{\partial G}{\partial w_k} \frac{dw_k}{G} - \frac{dE}{E}$. In accordance with the Shepard lemma we notice that: $X_i = \frac{\partial C}{\partial w_i} = \frac{\partial G}{\partial w_i} \frac{Y}{E}$. Hence, we have: $\frac{dMC}{MC} = \sum_i \frac{X_i dw_i}{Y \cdot MC} + \frac{K dw_k}{Y \cdot MC} - \frac{dE}{E}$. Assuming constant markups in a certain year in a certain branch $\frac{dMC}{MC} = \frac{dP}{P}$, we have: $\frac{dP}{P} = \sum_i \frac{\theta_i \mu dw_i}{w_i} + \frac{(1 - \sum_i \theta_i \mu) dw_k}{w_k} - \frac{dE}{E}$. After transformations we can get the dual Solow residual: $DSR = \sum_i \theta_i \frac{dw_i}{w_i} + (1 - \sum_i \theta_i) \frac{dw_k}{w_k} - \frac{dP}{P} = \left(1 - \frac{1}{\mu}\right) \left(\frac{dw_k}{w_k} - \frac{dP}{P}\right) + \frac{1}{\mu} \frac{dE}{E}$. Then, subtracting DSR from SR , would give us the Nominal Solow Residual (NSR), with the technological change can-

celled out: $NSR = \frac{dY}{Y} + \frac{dP}{P} - \sum_i \theta_i \left(\frac{dX_i}{X_i} + \frac{dw_i}{w_i} \right) - (1 - \sum_i \theta_i) \left(\frac{dK}{K} + \frac{dw_K}{w_K} \right) = \left(1 - \frac{1}{\mu} \right) \left[\frac{dY}{Y} + \frac{dP}{P} - \left(\frac{dK}{K} + \frac{dw_K}{w_K} \right) \right]$.

Using the differential calculus for two variables, we can observe that our NSR is the approximation of the following equation: $\Delta \ln(Y \cdot P) - \sum_i \theta_i \Delta \ln(X_i \cdot w_i) - (1 - \sum_i \theta_i) \Delta \ln(K \cdot w_K) = \left(1 - \frac{1}{\mu} \right) [\Delta \ln(Y \cdot P) - \Delta \ln(K \cdot w_K)]$, and estimating the expression $\left(1 - \frac{1}{\mu} \right)$ we can finally obtain μ .

The second method applied concerns single input margins, and it was developed by Rotemberg & Woodford (1999). Because marginal cost of increasing production by increasing any of the production factors should be equal, markups may be measured using only the one chosen. The source of such a reasoning lies in the fact that: $MRP_i = MR \cdot MP_i$, where MRP_i is a marginal revenue of production factor i , and MP_i is a marginal product of production factor i (see Samuelson & Marks, 2009, pp. 234–235). Since the profit maximization condition is: $MR = MC$, the optimal markup can be expressed as follows: $\mu = \frac{P \cdot MP_i}{MRP_i}$. Consequently, the minimizing cost firm should cover the marginal cost of increasing production, taking into account all possible margins (compare Nekarda & Ramey, 2013, pp. 1–47).

According to Rotemberg & Woodford (1999), the most appropriate measure of marginal cost concerns increasing production by changing labour input, with other costs constant. In particular, they considered the number of hours per worker, which was explained by the fact that while there are adjustment costs of changing a number of workers and capital stocks, there are no adjustment costs of changing working hours³. If the production function is as follows: $Y = F(ZhN, \dots)$, where N is a number of workers, Y is an output, Z is a labour augmenting technology, h is a number of hours per worker, and W_A is an average hourly wage, we obtain: $MC = \frac{W_A' h + W_A}{F_1(ZhN, \dots) Z}$, where F_i is a derivative of production function against effective labour ZhN (see Nekarda & Ramey, 2013, pp. 1–47). We can notice that in the numerator we have marginal revenue of increasing hours per worker and in the denominator – marginal product per worker.

Assuming that production function is of the Cobb-Douglas type, and marginal wage equals average wage, we get: $\mu = \frac{P}{W_A / \left[\alpha \left(\frac{Y}{hN} \right) \right]} = \frac{\alpha}{s}$, where

³ This choice can be also explained by the fact that it is regarded that in the short period capital costs are stable, the cost of materials increases proportionally to the production value, and only labour costs may vary (Samuelson & Marks, 2009, pp. 278–280).

α is an exponent in the production function (elasticity of output against labour input), and s is a labour share in production value. The change in inversed labour share indicates the change of markup. Although this method is appropriate for a situation of increasing production by increasing working hours, it was also applied to labour costs calculated with no consideration of working hours (see Klein, 2011, pp. 1–22). Moreover, markups were approximated by the ratio of price of final product to a labour input price (see Phelps, 1994, pp. 678–711).

A few important problems are connected with labour markups (Nekarda & Ramey, 2013). The first one concerns not excluding overhead labour, which consists of all activities necessary for firm functioning, which cannot be connected with products or services offered by the firm. In other words, these activities do not generate profits directly. Overhead expenses include e.g. costs of accounting, advertisement, insurance, legal fees, taxes, rent, repairs, telephone bills. The second problem is not allowing the elasticity of substitution between production factors to deviate from unity, whereas the third one concerns using average wages, not marginal ones. Although in the standard New Keynesian literature it was assumed, that average wage is a proper measure of marginal increase in working hours, this assumption was neglected by Bils (1987), who argued that average wage could increase in average hours per worker because of the costs of overtime hours.

Consequently, the labour method was further developed. Rotemberg and Woodford (1999) presented corrections of their method by taking into account: non-Cobb-Douglas production function, non-overhead labour, marginal wage not equal average wage, costs of labour input adjustment, labour hoarding, and variable capital utilization. An attempt to deal with some of these problems and apply the results to real data was undertaken by Nekarda and Ramey (2013).

Moreover, Rotemberg and Woodford (1999) analyzed three single input markups measures, alternative to labour markups. The first one relies on indirect inputs, like energy and materials. The conditions for its use were that the production technology does not utilize these inputs proportionally to the primary production factors (see Basu, 1995, pp. 512–531), and that these inputs are not included in the labour adjustment costs. What is interesting, if a production function is isoelastic with respect to labour and materials, a markup is proportional to the both labour share and materials share, so both shares should move proportionally to each other, and their sum should be a multiple of a markup (see Domowitz *et al.*, 1986, pp. 1–17). The second one relies on stocks of final goods, where it was assumed that for a firm minimizing costs, marginal cost of decreasing stocks has to be

equal to marginal cost of additional production. The third one relies on cost of capital stocks including adjustment costs.

Because of a lack of data on working hours and because we have some doubts if firms in our converging economy actually equalize the marginal cost of rising output across all possible margins, the Roeger markups were assumed as the reference indicators of market power execution in the Polish food sector. Consequently, in order to answer the question if labour markups changes were good indicators of market power execution changes in the Polish food sector in the period 2003–2012, the changes in labour markups will be compared with results received with the Roeger method.

Polish food sector in the period 2002–2013

Individual or sectoral approaches may be distinguished regarding markups calculation (compare Nekarda & Ramey, 2013, pp. 1–47). The first one relies on the data from individual entities coming from the firms' financial statements and the sectoral data concerns separate branches or sectors of the economy. The major advantage of the first one is their appropriateness for the impulse response analysis, which is monetary shocks or government spending shocks because of their higher frequency, whereas the second one enables to take advantage of the instruments identifying demand and supply shocks typical for a certain branch. There is also the third option concerning aggregation of individual data to the branch level. In our analysis, because of the data confidentiality, we could only get the data of the third type. They come from the F-01 financial statements prepared on the voluntary basis by the companies hiring more than 9 workers at the end of the fourth quarter and concerning the whole calendar year.⁴

The way of calculation of categories used for markup estimation are presented in Table 2. The analysis covered a period 2002–2013. The yearly data were acquired from the IAFE-NRI, and from the portal www.obligacjeskarbowe.pl. They cover divisions: 10 — food, 11 — non-alcoholic beverages of section C — manufacturing of the Polish Activity Classification 2007. The data from 11 main groups and 32 classes were analyzed. Regarding labour markups, because of no access to data on working hours in food sector branches, the labour share was calculated as the ratio of labour costs to production value.

⁴ Because some of the needed categories are lacking in this statement, we were forced to calculate them in an indirect way.

Figure 3 presents the values of each category, as well as agricultural products prices indices. Table 4 presents the main characteristics of the data. Although the food sector in Poland is often treated as a traditional one, and of diminishing importance, we could observe the enormous growth of the production value of analysed companies in the period of 2002–2013. In 2013 it reached its maximum of 212.93 bn PLN. Comparing to 2002, a growth by 127.22% took place. The main reason was undoubtedly joining the EU and an accompanying export growth. It should be noticed that in the period 1995–2013 export of the whole Polish agro-food sector increased from 3 to 14 bn euro, and for example in 2012 almost 77% of it went on the EU markets (see Łopaciuk, 2013, pp. 7–14).

Also all the series of distinguished cost categories can be characterised by growing trends, which explained more than 90% of their variability, apart from capital, changes of which were more of the cyclical character. Comparing to the production value, materials costs were growing at a faster pace, and labour costs were growing one-third slower. While energy was increasing the fastest, the weakest growing trend could be observed in capital cost data. Consequently, while the share of the cost of materials in the production value increased, the shares of labour and capital costs decreased.

Looking at the correlations between analysed data series, we can observe that the capital costs correlations with the rest of variables were the weakest (0.34–0.39), whereas correlation between other variables was between 0.95 and 0.99. The drop in capital costs in 2009 may be an effect of the world economic crisis. As early as in 2010 companies seemed to rebuild their capital costs. Simultaneously, with the high worldwide inflation of agricultural products in 2010 and 2011 (of 0.16 and 0.12 respectively), which influenced food prices, the food production value started to increase faster. Moreover, probably because of the higher market uncertainty and restructurings, the pace of rising of labour costs wasn't so high.

Roeger markups

Figure 4 presents the estimated Roeger markups in the period 2003–2013⁵. The average markup amounted to 1.10, which can be seen as rather moderate. The standard deviation from the mean was also relatively low — 0.12, and the coefficient of variation amounted to 0.11. What is interesting, how-

⁵ Although all the regression results were statistically significant (at the level 0.1), the set of explanatory variables was not always sufficient. Especially in years 2003, 2006, 2012 some other factors mattered.

ever, is that elimination of the first observation, which is an outlier, increases the mean to 1.13, decreasing the standard deviation to 0.06 and the coefficient of variation to 0.05. Although since the accession to the EU markups decreased by 0.01 (from 2003 it was an increase by 0.51 p.p.), no linear trend was found in the data. Particularly, its negative sign in 2003 was caused by the high increase in costs of materials (agricultural products prices) before the entrance.

Comparing with the level of the Polish food sector markups estimated for the period 1996–2004 by Gradzewicz and Hagemajer (2007b), the average Roeger markup over *MC* decreased (from 0.22 to 0.10), and its variability increased (from 0.56 to 1.25). Higher variation of markups could be related to the convergence processes taking place in the Polish economy after entering the EU, as well as with the effects of the 2007 crisis.

Additionally, the average markups over *MC* in the food sector branches in the period 2003–2013 were calculated. But only for 11 out of 32 categories the results were statistically significant. They are presented in Figure 5. Extremely high markups were observed in sugar production amounting to 0.51. Relatively high markups were reached in the production of starch and starch products (0.21) and ready food for domestic animals (0.20). The lowest markup food industry branches were as follows: production of oils and fats (0.05) and production of ready-made meals and dishes (0.05).

Labour input markups changes

Figure 6 presents the labour markups changes calculated for the period 2002–2013, assuming constant elasticity of output with respect to labour input. The coefficient of variation amounted to 0.09. In the whole period these indexes were increasing on average by 0.03 yearly, which means that labour markups were increasing by 3.0% yearly, and R^2 amounted to 0.88, what implies the existence of a strong growing trend. Growing labour input markups means that the share of costs of labour in the value of production was decreasing in the analyzed period.

Three subperiods can be identified: the first one between 2002 and 2004 characterized by the fast increase, the second, quite stable between 2004 and 2010, and the third from 2010 to 2013, with again faster increase in labour markups. We suppose the changes were caused by the shocks connected with the EU accession and the world financial crisis. Comparing the labour markup growth with the Roeger markup growth, we can observe that while the Roeger markups from 2003 increased by 60.36% (and by only 4.86% from 2004), the change in labour markups amounted to 40.62%

(20.21% from 2004). Excluding 2003 as the year which stands out (regarding the Roeger markups), we can state that the labour markups change was higher. Consequently, in comparison with Roeger markups, the Rotemberg & Woodford markups seem to overestimate the change in the market power execution in the Polish food sector in the period 2004–2012. This could mean that the assumption of constant elasticity of output with respect to a labour input may not be appropriate for this period (it decreased) and the positive change in labour productivity in the Polish food sector after joining the EU took place.

Moreover, in order to assess, if our labour markups changes were good indicators of market power changes in the Polish food sector, we compared their variability with the one of the Roeger markups (data in logs) in the period 2004–2013. The results are presented in figure 7. It appeared, that the correlation between the data is very weak and it amounted to -0.06. Surprisingly, it was very high until 2007 (0.97) and in the period 2008–2013 it amounted to -0.09. These results might show then, that the Rotemberg and Woodford markups changes were quite relevant for the part of the analyzed period. The discrepancies regarding period 2008–2013 might indicate that the wages in the Polish food sector were too rigid in this period and should have grown faster, which could be a sign of unions weaknesses in the Polish food companies.

Conclusions

The main aim of the article was to depict changes of monopolistic markups in the Polish food sector in the period 2002–2013 as indicators of the market power execution. The theoretical background was presented in order to prove that the markup can be considered as a symptom of market power. The Roeger and Rotemberg & Woodford methods were applied. The average Roeger markup (above MC) amounted to 0.10, which can be seen as rather moderate, and in 2013 it equalled 0.15. The differences in results for the branches indicate a substantial heterogeneity in the Polish food industry companies pricing practices.

Because from 2004 to 2012 the change in Roeger markups (-0.01%) was lower than in the labour markups (+20.21%), the labour markups changes seem to overestimate the change in market power execution in the Polish food sector. Also because of the weak correlation between detrended series, we considered simple inversed labour input as insufficient indicator of the market power execution changes in the Polish food sector in the period 2004–2013. The application of this method for the Polish conditions needs

further improvements, e.g. additional data on hours per worker are needed (no adjustment cost), and the values of elasticity of output with respect to labour input will enable calculation of absolute markups values. Additionally, the following possible developments should be included: CES production function, non-overhead labour, marginal wage. Nevertheless, because of the restructurings in the Polish food sector and because of the crisis, the assumption that a cost minimizing firm equalizes the marginal cost of rising output across all possible margins may be too strong.

Regarding data, some drawbacks should be highlighted. Firstly, the main obstacle was no access to data on the firm level and consequently no possibility to clean the database. Secondly, the data frequency was too low (yearly basis) to analyse the cyclical properties of markups.

Finally, some rather general conclusions regarding competition policy in the food sector can be formulated. It should still focus on the antitrust laws execution, but most effort should be put on creating strategic trade policy, which will contribute to a broader and faster development of the Polish food sector and especially on the more intense international trade promotion. Regarding regulation and deregulation, a special focus should be put on regulations promoting vertical arrangement between firms as well as vertical integration, both in the framework of the CAP and the national agricultural policy. In particular, special attention should be paid to the concentration processes and pricing practices in the production of sugar starch and starch products, ready food for domestic animals, homogenized groceries and dietary food, as well as bakery and floury products.

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Annex

Table 1. Lerner index in different market structures*

Market structure	$\mathcal{L}$
Perfect competition	0
Bertrand oligopoly	0
Cournot oligopoly	$1/(n \cdot \varepsilon)$
Cartel	$1/\varepsilon$
Monopoly	$1/\varepsilon$

* ε – the absolute value of the price elasticity of demand, n – the number of firms with perfectly homogenous

Source: Tremblay & Tremblay (2012, pp. 314).

Table 2. The data used in the analysis

Variable	Characteristics
Production value	Sales revenue adjusted for the change in inventories and taxes levied on the company costs (excise tax, property tax, tax on means of transport and nondeductible VAT)
Materials costs	Costs of materials, external services and commodities and materials purchased for resale
Labor costs	Wages and salaries, social security contributions paid by the employer, other generic costs (staff costs – including travel expenses, death benefit, accident compensation and others, e.g. property insurance)
Energy costs	Extracted as a separate production factor
Capital costs	Instead of the assets value the following value of a flow of capital services in branch i is used: $k_i = (r - \pi + \delta_i) \cdot K_i$, where: r is the rate of return defined as expected return on capital employed in the alternative project, measured by the interest rate of government bonds; π is a value added deflator; δ_i is a depreciation rate (the ratio of depreciation to the assets value); K_i is the fixed and intangible assets value (see Jorgenson & Griliches, 1967, pp. 249-283; Oulton and Srinivasan, 2003, pp. 1-88)

Source: own elaboration based on the Gradzewicz & Hagemajer (2007b, pp. 11-27).

Table 4. Main characteristics of analysed categories

Item	Production value	Cost of materials	Labour costs	Energy costs	Capital costs
Mean (in bn PLN)	148.83	116.81	16.94	2.61	5.64
Minimum (in bn PLN)	93.71	64.82	13.08	1.55	2.79
Maximum (in bn PLN)	212.93	172.65	21.14	3.59	8.73
Coefficient of variation (in %)	25.17	27.66	16.61	28.57	26.54
Growth (in %)	127.22	166.37	61.58	129.85	27.97
Yearly growth (in %)	7.34	8.12	4.84	8.42	3.19
Change of share in production value (in %)	-	17.23	-28.89	1.16	-43.68
Variability explained by growing linear trend (in %)	97.37	96.49	98.36	95.92	17.92

Source: own calculations based on IAFE-NRI (2014), www.obligacjeskarbowe.pl.

Figure 1. Market power in monopoly and perfect competition*

*AC – average costs

Source: own elaboration based on Marks & Samuelson (2009, pp. 436-440, 468-479).

Figure 2. DWL on the monopolistic market

Source: own elaboration based on Church & Ware (2000, pp. 33-36).

Figure 3. Production value and costs of production factor costs (in bn PLN) in the Polish food sector and prices of the world agricultural products (2010=100, real 2005 US dollars) in the period 2002–2013

Source: own calculations based on IAFE-NRI (2014), www.obligacjeskarbowe.pl.

Figure 4. The Roeger mark-ups (over MC) in the Polish food sector in the period 2003–2013

Source: own calculations based on IAFE-NRI (2014).

Figure 5. The Roeger markups (over MC) in selected branches

Source: own calculations based on IAFE-NRI (2014), www.obligacjeskarbowe.pl.

Figure 6. Labor markups changes in the Polish food sector in the period 2002–2013 (2002=100)

Source: own calculations based on IAFE-NRI (2014).

Figure 7. Detrended Roeger and labour markups in the period 2004–20013 (HP filter)

Source: own calculations based on IAFE-NRI (2014), www.obligacjeskarbowe.pl.