Acta Sci. Pol.
Oeconomia 16 (1) 2017, 53–62
acta_oeconomia.sggw.pl ISSN 1644-0757 eISSN 2450-4602 DOI: 10.22630/ASPE.2017.16.1.06

ORIGINAL PAPER

Received: 16.12.2016
Accepted: 07.02.2017

THE TECHNOLOGY SHOCK AND THE POLISH FOOD SECTOR MARKUPS

Justyna Kufel-Gajda✉

Institute of Agricultural and Food Economics – National Research Institute

ABSTRACT

The aim of the paper is to investigate an impact of a technology shock on a market power exerted in the Polish food industry, measured by monopolistic markups calculated based on a labor input margin with developments, as well as the Roeger markup, in the period 2002–2013. A structural vector auto regression model (SVAR) with productivity and hours in the Polish economy, and markups, was built. It was assumed that in the long-term only technology shock influences productivity, whereas shocks in markups make no impact on labor demand. After including labor markups developments, the technology shock seemed to increase the competition level, and the exerted market power rises over time. The positive sign of movement is opposed to results regarding unconditional cyclicality of markups in the food industry and in the whole Polish economy.

Key words: exogenous shock, monopolistic markups, business cycle

INTRODUCTION

A technology shock means a sudden change in technology. Its impact on economic activity is predominantly positive, as technology rarely moves backwards. Because during a technology shock an output for a given inputs increases, a technology shock comes down to changes in productivity. Nowadays, especially significant role technology shocks play in real business cycle (RBC) models, which after the work of Kydland and Prescott [1982], who showed that fluctuations in the US after the World War II may be explained by a neo--classical growth model with a labor – leisure choice and exogenous technology shocks, as well as its further successful empirical performances, became very popular. On the other hand, an especially big influence this type of shocks plays in regards to manufacturing companies, which are particularly dependent on technology.

One of the first ones, who highlighted the primary role of technology shocks in shaping business cycles, was Schumpeter. In his view, business cycles are caused by technological innovations. Fluctuations in innovation cause fluctuations in investment, which lead to cycles in aggregate activity. Introduction of new technologies were perceived by him as a process consisting of inventions, innovations, diffusion paths and investment activities. Inventions are rather primitive, of poor performance and higher production costs, as compared with existing technologies. When a production technology appears, inventions become innovations. Afterwards, they diffused at a speed depending on an actual and expected trajectory of a performance improvement and a cost reduction [Mansfield 1983]. As entrepreneurs perceive that risk and returns warrant innovative commitments, periods of acceleration in aggregate growth are generated [Rosenberg 1994]. Interestingly, along with the role of innova-

✉justyna-kufel@wp.pl

tion and entrepreneurship in shaping business cycles, Schumpeter emphasized the role of market power. In his opinion an innovation-originated market power may be even more important than the invisible hand or price competition. Technological innovations are followed by temporary monopolies gaining abnormal profits, which are then taken by rivals and imitators. Nevertheless, these possessing market power monopolies are necessary to encourage firms to develop new products and processes [Pol and Carroll 2006].

In such a framework, the aim of the paper is to investigate the impact of a technology shock on the market power exerted in the Polish food industry. Particularly, as a measure of an exerted market power, monopolistic markups were utilized[1]. They were calculated based on a labor input margin with developments including: overhead labor, CES production function, marginal wage. The Roeger markups were considered too. The research hypothesis was as follows: a positive technology shock causes a short-term increase of the Polish food sector markups. This seems to be in accordance with a Schumpeter view. Thus, taking into consideration a positive reaction of the business cycle to a technology shock, markups should behave procyclical.

On the other hand, both theoretical models and empirical studies aren't unanimous regarding markups cyclicality. Countercyclical markups are present in the new-Keynesian models, being caused by sticky prices combined with procyclical marginal costs, e.g. Smets and Wouters [2003] or Christiano et al. [2005]. Also Kalecki pointed that during downturns in order to make prices sticky and save profits, firms create cartels, while prices of raw materials decrease [Lopez and Assous 2010]. There are as many studies, in which markups proved to be countercyclical [e.g. Bils 1987, Rotemberg and Woodford 1999], procyclical [e.g. Domowitz et al. 1986, Nekarda and Ramey 2013], or acyclical [Marchetti 2002]. Regarding the Polish economy, Gradzewicz and Hagemajer [2007] indicated countercyclical behavior of markups, whereas author showed that markups in the Polish food sector appeared to behave unconditionally countercyclical.

In order to achieve the goal of the paper, the material and methods will be presented. Particularly, for creating a series for a technology level, three methods may be used. The first one relies on TFP growth series, so standard Solow residuals, the second – on the utilization adjusted TFP growth series, whereas in the third, a technology series levels are created based on a SVAR model proposed by Gali [1999]. The third method was chosen as the newest and to make results comparable to the ones obtained for the US economy by Nekarda and Ramey [2013]. Afterwards, the preliminary analysis of cyclical components will be performed, what will be followed by describing and discussing the results of the SVAR analysis. Finally, the conclusions will be drawn, taking into account main limitations of the study, future research areas, as well as adequate policy recommendations.

MATERIAL AND METHODS

The SVAR model used in the analysis is the same as constructed by Nekarda and Ramey [2013], who, in order to estimate markups cyclicality, added markups to the Gali [1999] SVAR, with which he estimated shocks in technology. The Gali SVAR included two variables – labor productivity and hours, where a shock in productivity means a technology shock, whereas a shock in hours means a non-technology shock. A long-term restriction, which is satisfied by a broad range of RBC and new-Keynesian models, saying that only technology shocks may have a permanent effect on the productivity level, was incorporated. This means constant returns to scale. In other words, technology shocks are those that have permanent effects on labor productivity, whereas changes in productivity caused by changes in utilization are excluded. Moreover, in order to achieve identification, another long-term restriction was imposed, saying that the food sector markups make no impact on a labor demand.

In order to calculate productivity, quarterly indexes (2010 = 100) of a real labor productivity per hour worked were utilized. They were calculated as a real GDP (measured in chain-linked volumes with a reference year

[1] For a discussion on five economic meanings of markups, which include measuring degree of exerted market power, see Kufel [2016b].

2010) per unit of labour input (measured by the total number of hours worked). It was deducted that this measure provides a better picture of productivity developments in the economy than labour productivity per person employed, as it eliminates differences in the full/part time composition of the workforce across years. Afterwards, in order to obtain an index of hours worked, an index of quarterly real GDP (2010 = 100) was multiplied by a labor productivity index. Data series come from the Eurostat database. Markups levels were obtained from Kufel [2016]. Specifically, the Roeger markups, as well as four out of seven labor markups measures were taken, each representing a separate methodology development. Eventually, used markup measures were as follows: a baseline markups measure that is the log of inversed labor share (1), a measure excluding overhead labor (2), a measure including marginal wage (3), a measure including CES instead of Cobb-Douglas production function (4), the Roeger markup. They were calculated based on yearly data from the Central Statistical Office of Poland (CSO) and interpolated from a yearly to a quarterly frequency with the Chow and Lin [1971] procedure. Because of data availability, markups levels could be calculated only for the period 2002–2013. Consequently, also the remaining two data series were limited to that period. All three variables were seasonally adjusted with the TRAMO-SEATS procedure and logarithmized. Because an ADF test [Tsay 2010] indicated a unit root in each data series, trends were removed with the Hodrick-Prescott (HP) filter, with a parameter $\lambda = 1{,}600$[2]. Expansionary shocks were considered. The maximal number of lags was set on 5. Majority of information criteria (Akaike, Schwartz-Bayesian and Hannan-Quinn) pointed 4 lags as an optimal lag order in each of analyzed models. Therefore, for uniformity and because of markups data interpolation, 4 lags were chosen.

The causal impact of a technology shock on markups and real GDP was summarized with an impulse response functions (IRFs) analysis [Lütkepohl and Krätzig 2007]. The conclusions on markups cyclicality, conditional on technology shocks, and during discussion also conditional on non-technology shocks, were drawn. The VAR model dynamics was also assessed by both historical and forecast error variance decompositions (FEVD) [Lucchetti 2015]. The first indicated the historical contributions of structural shocks regarding each of three variables to the observed trajectory of markups. The second described the share of uncertainty of markups that can be attributed to shocks in each of three variables after 1–20 quarters. Because of taking into account series after HP filtering, the SVAR formula was as follows [Kusideł 2000]:

$$Bx_t = \Gamma_1 x_{t-1} + \Gamma_2 x_{t-2} + \Gamma_3 x_{t-3} + \Gamma_4 x_{t-4} + \xi_t$$

where: $x_t = [x_{1t}, x_{2t}, x_{3t}]'$ – a vector of observations on current values of three variables in the model,
B – a matrix by non-delayed variables of a vector,
Γ_I ($i = 1, 2, 3, 4$) – matrixes of parameters by delayed variables of a vector,
ξ_t – a () vector of random disturbances of a structural model.

RESULTS

Figure 1 illustrates the cyclical components of data utilized in SVARs. Deviations from its long-term stochastic trends in case of real GDP didn't exceed 2.5%, whereas in case of productivity and hours – 4%. Markups deviations didn't exceed 5%, apart from the third method of markups calculation, which gave markups deviated by even more than 10% from the long-term stochastic trend. Markups calculated with the first, second and third methods appeared to be the most variable – standard deviations amounted to respectively 232, 312 and 445%

[2] In Nekarda and Ramey [2013], in order to obtain cyclical components, deterministic trends and first differences were utilized. In this study however, the author chose a HP filter in order to keep heterogeneity with the previous studies on the Polish food markups [Kufel 2016].

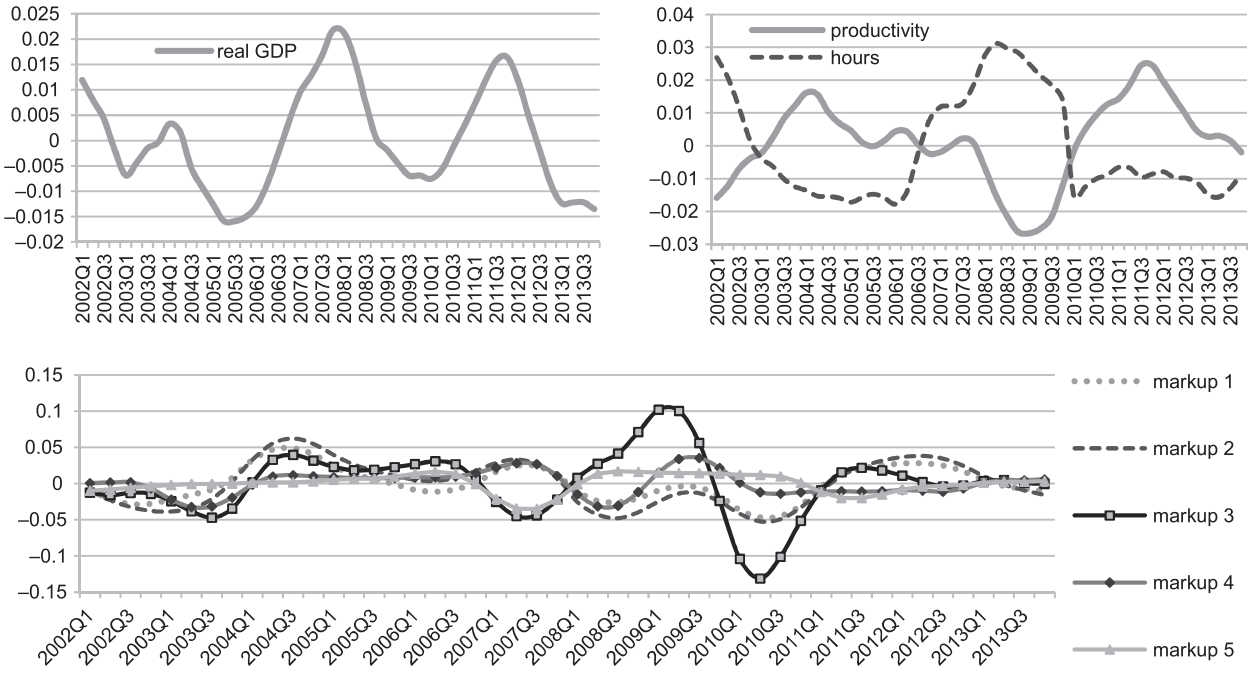

Fig. 1. Cyclical components of used variables

Source: Own elaboration.

whereas in case of other two methods it was 165 and 128%. Standard deviations for productivity and hours were quite similar and amounted to 126 and 158%, whereas for real GDP it was the lowest, amounting to 104%. Importantly, the correlation between productivity and hours was high and negative (–0.764), what is against predictions received from the basic RBC models, where macro fluctuations result from changes in the labor demand caused by technology shocks, together with an upward-sloping labor supply [Gali 1999]. This may mean that the non-technology shocks play more significant role in the Polish economy, as their role is to shift the labor supply, what induces a negative comovement between productivity and hours, as was shown by e.g. Christiano and Eichenbaum [1992][3].

Figure 2 illustrates IRFs regarding technology shocks with a size of one standard error. It might be observed that the direction of an impact of the technology shock on the market power exerted in the Polish food industry depends on the method of markups calculation. Labor markups are about to drop just after a technology shock, and increase afterwards. The magnitude of a decrease is higher when including marginal wage and CES production function than in scenarios both without developments and with overhead labor, while the magnitude of an increase is *vice versa* – higher for the first and second methods of markups calculation. The Roeger markups on the contrary firstly increase, then decrease, but the long-term effect is positive. Thus, a long-term reaction is here also positive. Eventually, taking into account the improved methodology (labor markups with developments), it might be concluded, that the research hypothesis wasn't confirmed. Market power in the Polish food sector in the period 2002–2013 after technology shocks was decreasing. Although such a result seems to be not in accordance

[3] This however is against the Gali [1999] results. Taking advantage of his new-Keynesian model including monopolistic competition, sticky prices and variable effort, he indicated a negative correlation in case of technology, and positive – in case of non-technology shocks.

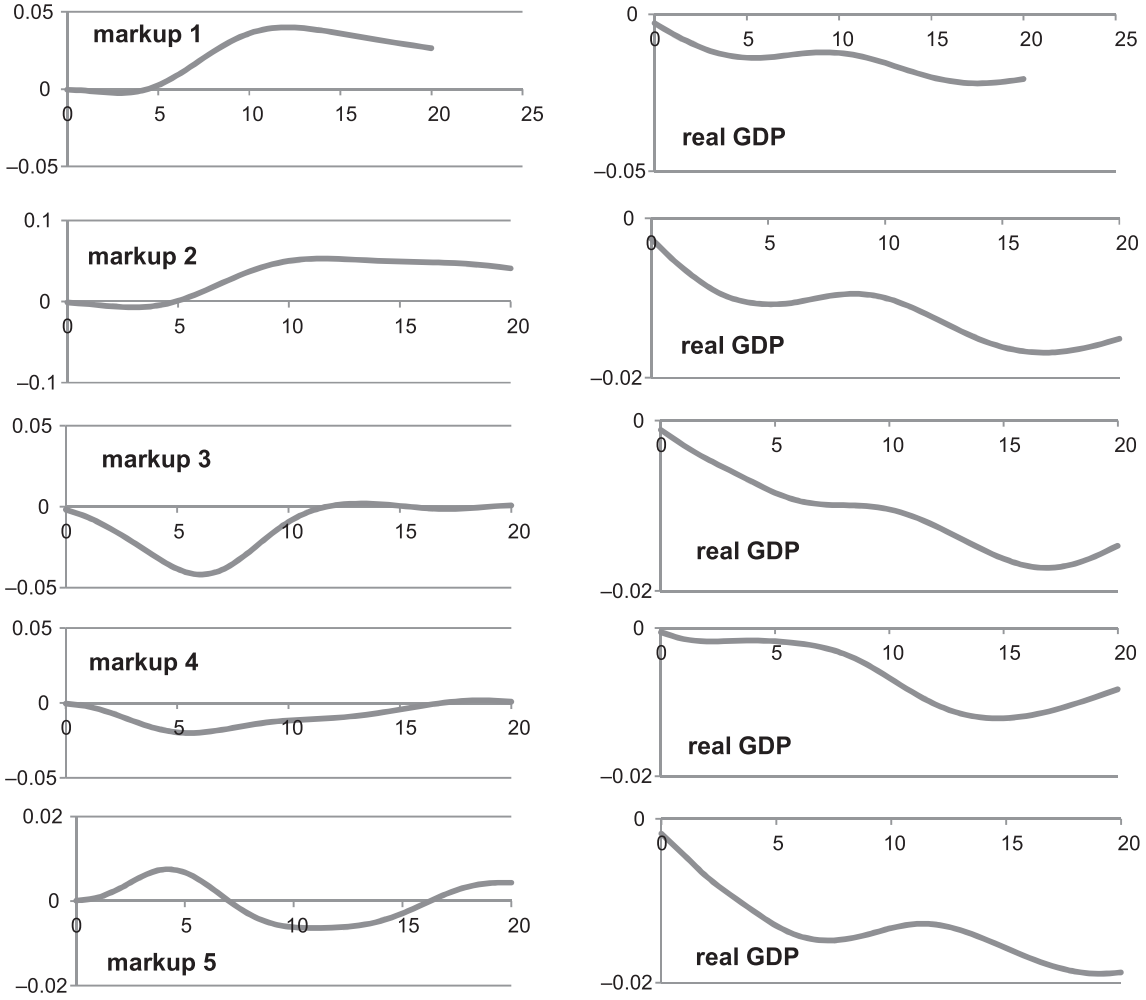

Fig. 2. Cumulative impulse response functions of markups and real GDP for the technology shock

Source: Own elaboration.

with a Schumpeter view, the character of a short term cyclicality is. Surprisingly, in each out of five models, GDP decreases in response to a positive shock in technology, what is against the results obtained by Gali [1999], as well as Nekarda and Ramey [2013]. Consequently, markups cyclicality conditional on the technology shock is positive – markups behave procyclical. Interestingly, because of the real GDP drop after the technology shock, this final result is in accordance with latest results obtained for the US by Nekarda and Ramey, where markups increase in response to this kind of shock, although the response was small and statistically not significant.

Finally, in order to assess a relative impact of shocks in productivity, hours and markups on the Polish food sector markups, the variance error decompositions were applied (Fig. 3). Regarding historical data, it appears that shocks in markups and hours played a major role in shaping the observed trajectory of markups, whereas the role of technology shocks was the smallest. In the horizon of 20 quarters the share of uncertainty on markups that can be attributed to shocks in technology is about to increase, to shocks in markups – decrease, whereas the significance of the non-technology shock seems to be quite stable apart from the scenarios with markups obtained with developments (2, 3, 4), in which it increases.

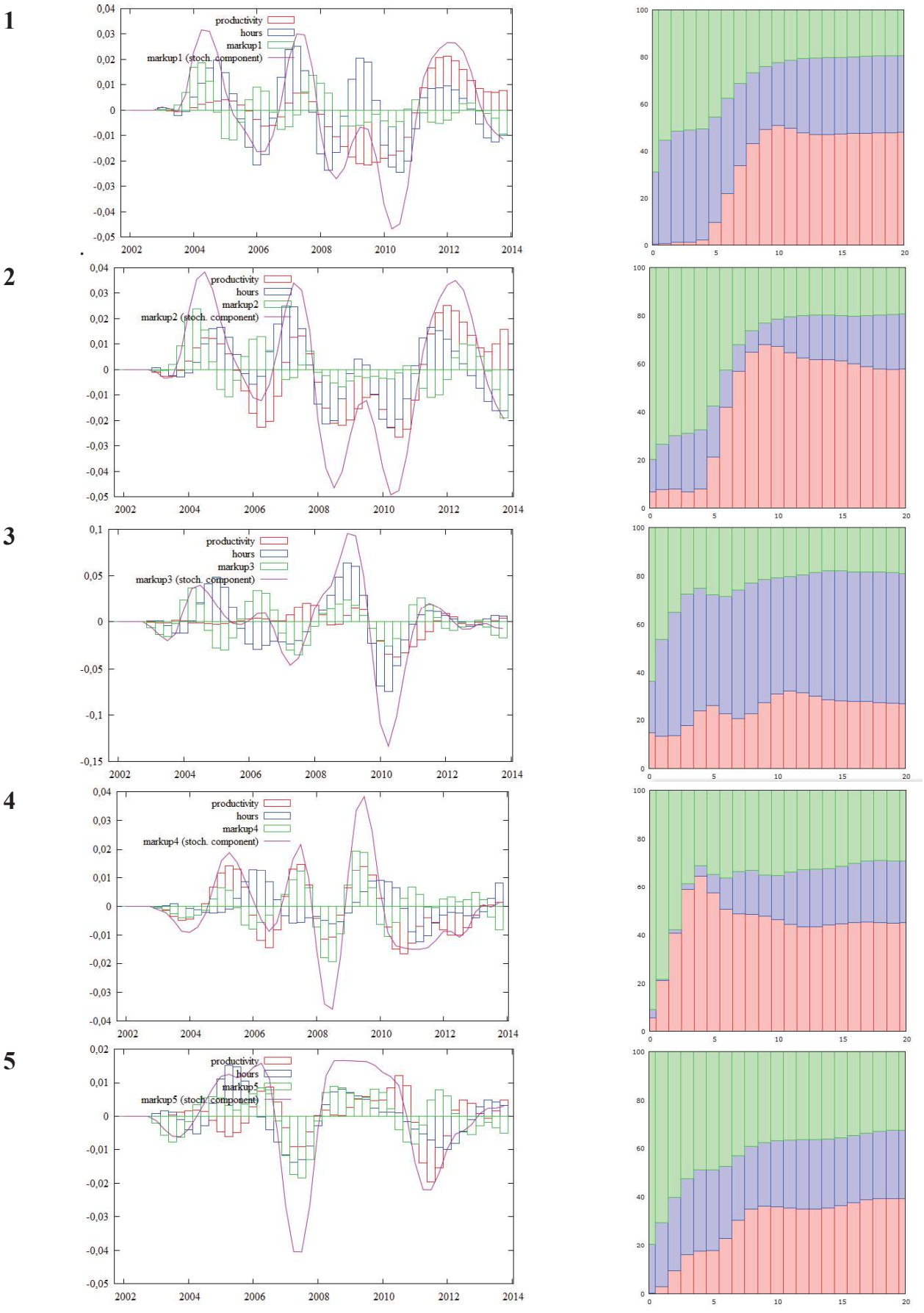

Fig. 3. Historical and future error variance decomposition – FEVD for markups (1, 2, 3, 4, 5 – scenarios, a – markups, b – hours, c – productivity)

Source: Own elaboration.

DISCUSSION

The most controversial result undoubtedly concerns the negative impact of the technology shock on real GDP. It is against the result obtained by Pater [2010] while studying the Polish labor market. This discrepancy may be caused by utilizing a traditional method of analysing shocks in technology (Solow residuals), but more likely – by the earlier studying period (1997–2008), neither embracing the full effects of entering the EU, nor effects of the financial crisis. In fact, the negative impact is an outcome of a decrease in working hours higher than an increase in productivity, which it accompanied. Moreover, technology shocks may cause a snowball effect of agents changing their business partners, what makes a negative impact on GDP [Taghawi-Nejad 2010]. On the other hand, the hours drop may be only a statistical phenomenon, as during the transition and convergence of the Polish economy flexible forms of employment are taking place of more expensive full and part-time jobs.

From the other side, markups appeared to be procyclical, what is opposed to the results regarding unconditional cyclicality of markups in the Polish food industry and in the whole Polish economy [Gradzewicz and Hagemejer 2007]. Consequently, additional IRFs for real GDP and markups in regards to a non-technology shock were generated (Fig. 4). They confirm the results regarding unconditional behaviour of food sector markups. The non-technology shock decreases markups and increases real GDP, so markups conditional on the non-technology shock appeared to be countercyclical[4]. On the contrary to the technology shock, this result

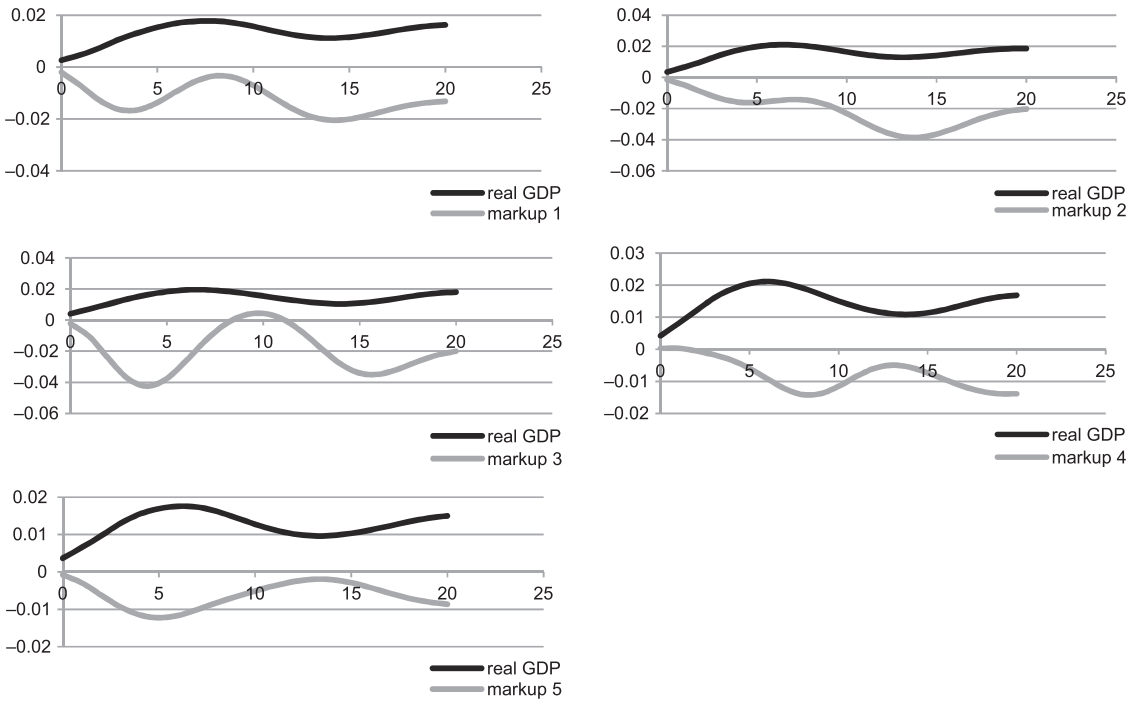

Fig. 4. Cumulative impulse response functions of markups and real GDP for the non-technology shock

Source: Own elaboration.

[4] This result is opposed to results regarding the character of the US markups conditional on monetary policy and government spending shocks performed by Nekarda and Ramey [2013], where both markups and real GDP rose in reaction to a positive non-technology shock encountering the US economy.

is robust to the markups calculation method. Moreover, as only the results for the non-technology shock confirmed the results regarding markups cyclicality, and taking into consideration the negative sign of comovement between productivity and hours, it could be concluded that non-technology shocks in the analyzed period 2002–2013 played more significant role in the Polish economy than the technology ones. Of course drawing such a conclusion is justified only after proving that the characters of cyclicality in the analyzed period were the same for the food and the whole Polish manufacturing sector, although it was so according to Gradzewicz and Hagemajer [2007] for the earlier period. Also the results of FEVDs indicated that the technology shocks contribution to the shape of the markups trajectory was lower as compared to that of non-technology shocks.

CONCLUSIONS

The aim of the paper is to investigate the impact of the technology shock on the market power exerted in the Polish food industry, which was measured by monopolistic markups calculated based on a labor input margin with developments including: overhead labor, CES production function, marginal wage, as well as taking advantage of the Roeger method. The period 2002–2013 was analyzed. Models of SVAR with impulse response functions and variance error decompositions were performed. Variables employed included logs of: labor productivity, hours worked and markups, with four lags. It was assumed that in the long-term only technology shocks affect labor productivity, and shocks in markups don't influence hours.

It was found that taking into account developments in markups calculation, markups react negatively to the positive technology shock, which decreases real GDP. Therefore, markups proved to be procyclical conditional on the technology shock. Downturns, caused by technology shocks, are accompanied by an increase in the level of competition in the Polish food industry, which however decreases over time. Such a result isn't in accordance with outcomes obtained for the US economy, where the markups reaction to the technology shock was positive and statistically not significant, although the direction of cyclicality was confirmed. On the other hand, procyclical markups are the result opposed to the results regarding unconditional cyclicality of markups in the Polish food industry and in the whole Polish economy. It appears that the reason of this inconsistence lay in the major role of non-technological shocks in shaping the Polish business cycle in the analyzed period. Moreover, the proven conditional in regards to non-technology shocks, and unconditional countercycliclity of the Polish food sector markup in regards to the Polish business cycle confirmed the basic mechanism of models in the new-Keynesian spirit, which assume that shocks are influencing the economy through affecting prices, at least for the food industry. When prices are sticky, an increasing demand causes a raise in prices smaller than in marginal costs, what results in a markups decrease. Before confirming assumptions behind the DSGE model utilized by the Polish Central Bank when making the decisions in the area of both monetary and government spending policy, such a study should be however carried out for the whole Polish manufacturing sector.

The results of FEVDs foresaw an increase in the role of technology shocks at an expanse of non-technology shocks, when some of the developments regarding markups calculation methods were taken into account. Consequently, there is a probability that the character of markups cyclicality in Poland will change, what may follow a revision of assumptions behind the DSGE model. Of course, this will be only the case when the character of cyclicality of food industry markups is in accordance of that of the whole manufacturing sector, what should be checked urgently. Further studies should be made in a search for the best way to estimate monopolistic markups. Particularly, a proper choice of the most adequate form of the production function for Poland and its food sector remains an interesting research topic. Moreover, the analysis of conditional cyclicality of markups taking advantage of branch data and panel regressions with the monetary policy, government spending and technology shock instruments will be desirable. The separate research topic is undoubtedly the impact of technology shocks on the Polish economy.

Finally, the trust in the results may be improved by overcoming limitations regarding data. The main drawback refers to a lack of access to data on the firm level and consequently a lack of possibility to clean the database. Secondly, the data frequency was to low (yearly basis) to analyze the cyclical proprieties of markups, and the interpolation to the quarterly frequency could have influenced the results. In future, instead of the interpolated, real quarterly data regarding individual entities should be utilized. Because such data couldn't be accessed from the Central Statistical Office of Poland, a proper quantitative analysis should be performed based on quarries prepared taking advantage of the representative method. Thirdly, although the study period of 12 years, which is equal to the length of approximately two business cycles, is enough to study the cyclical behavior of the food sector markups, drawing long-term conclusions would be less controversial when having a longer period. Finally, the results should be compared with the ones obtained utilizing data on hours worked also within flexible forms of employment.

REFERENCES

Bils, M. (1987). The Cyclical Behavior of Marginal Cost and Price. American Economic Review, 77 (5), 838–855.

Christiano, L., Eichenbaum, M. (1992). Current Real-Business-Cycle Theories and Aggregate Labor Market Fluctuations. American Economic Review, 82 (3), 430–450.

Christiano, L., Eichenbaum, M., Evans, C. (2005). Nominal Rigidities and the Dynamic Effects of A Shock to Monetary Policy. Journal of Political Economy, 113 (1), 1–45.

Domowitz, I., Hubbard, G., Petersen, B. (1986). Business Cycles and the Relationship between Concentration and Price-Cost Margins. The RAND Journal of Economics, 17 (1), 1–17.

Galí, J. (1999). Technology, Employment, and the Business Cycle: Do Technology Shocks Explain Aggregate Fluctuations? American Economic Review, 89 (1), 249–271.

Gradzewicz, M., Hagemejer, J. (2007). Wpływ konkurencji oraz cyklu koniunkturalnego na zachowanie się marż monopolistycznych w gospodarce polskiej. Bank i Kredyt, 1, 11–27.

Kufel, J. (2016a). Cykl koniunkturalny a wahania marż w polskim przemyśle spożywczym – wnioski z analizy spektralnej. Problemy Rolnictwa Światowego, 16 (31), 149–163.

Kufel, J. (2016b). Monopolistic markups in the Polish food sector. Equilibrium [in print].

Kufel, J. (2016c). Markups in the Polish Food Sector [in review].

Kusideł, E. (2000). Modele wektorowo-autoregresyjne VAR. Metodologia i zastosowania. Absolwent, Łódź.

Lopez, J., Assous, M. (2010). Michal Kalecki. Palgrave Macmillan, London.

Lucchetti, J. (2015). The SVAR package. Supplement to the GRETL software.

Lütkepohl, H., Krätzig, M. (2004). Applied Times Series Econometrics. Cambridge University Press, Cambridge.

Mansfield, E. (1983). Long Waves and Technological Innovation. The American Economic Review, 73 (2), 141–145.

Marchetti, D. (2002). Markups and the Business Cycle: Evidence from Italian Manufacturing Branches. Industrial and Labor Relations Review, 13, 87–103.

Nekarda, C., Ramey, V. (2013). The Cyclical Behavior of the Price-Cost Markup. NBER Working Paper, Washington.

Pater, R. (2010). Dynamiczne zależności na polskim rynku pracy w metodologii SVECM. Barometr Regionalny, 1 (19), 1–16.

Pol, E., Carroll, P. (2006). An Introduction to Economics with Emphasis on Innovation. Thomson, South Melbourne.

Rosenberg, N. (1994). Technological Innovation and Long Waves. In: Exploring the Black Box: Technology, Economics, and History. Cambridge University Press, Cambridge, 62–84.

Rotemberg, J., Woodford, M. (1999). The Cyclical Behavior of Prices and Costs. [In:] J. Taylor, M. Woodford (Eds), Handbook of Macroeconomics. Elsevier, Amsterdam, 1051–1135.

Smets, F., Wouters, R. (2003). An Estimated Dynamic Stochastic General Equilibrium Model of the Euro Area. Journal of the European Economic Association, 1 (5), 1123–1175.

Taghawi-Nejad, D. (2010). Technology Shocks and Trade in a Network. [In:] Progress in Artificial Economics. Computational and Agent-Based Models. Springer, Berlin, 101–112.

Kufel-Gajda, J. (2017). The technology shock and the Polish food sector markups. Acta Sci. Pol. Oeconomia 16 (1) 2017, 53–62, DOI: 10.22630/ASPE.2017.16.1.06

SZOK TECHNOLOGICZNY A MARŻE W POLSKIM PRZEMYŚLE SPOŻYWCZYM

STRESZCZENIE

Celem artykułu jest zbadanie wpływu szoku technologicznego na poziom siły rynkowej wywieranej w polskim przemyśle spożywczym, którą zmierzono za pomocą marż pracy z udoskonaleniami oraz marż Roegera w okresie 2002–2013. Zbudowano strukturalny model wektorowo-autoregresyjny (SVAR), w którym uwzględniono produktywność i liczbę godzin pracy w gospodarce oraz poziom marż. Założono, że w długim okresie tylko szoki technologiczne wywierają wpływ na produktywność, a marże nie oddziałują na popyt na pracę. Uwzględnienie udoskonaleń powoduje, że szok technologiczny skutkuje wzrostem poziomu konkurencji, przy czym z czasem poziom wywieranej siły rynkowej rośnie. Dodatni znak związku nie jest zgodny z wynikami badań dotyczących cykliczności bezwarunkowej marż w polskim przemyśle spożywczym, a także w polskiej gospodarce.

Słowa kluczowe: szok egzogeniczny, marże monopolistyczne, cykl koniunkturalny