IMPACT OF FOOD INDUSTRY MARKUPS ON SECTORIAL BUSINESS CYCLE AND FOOD INFLATION IN POLAND

Szczepan Figiel[1], Mariusz Hamulczuk[2], Justyna Kufel-Gajda[3] ✉

[1] University of Warmia and Mazury in Olsztyn
[2] Warsaw University of Life Sciences – SGGW
[3] Institute of Agriculture and Food Economics – National Research Institute

ABSTRACT

The main goal of this paper was to examine relationships between markups, output, and food inflation in the Polish food sector in the period 2000–2013. Levels of the monopolistic markups were calculated as an inversed labor share in the output value with a modification regarding overhead labor, whereas value of production was used as an indicator of sectorial business cycle. In order to analyze the relationships in question such methods as cross-correlations, Granger test, and VAR analysis were employed. It turned out that markups have behaved procyclically regarding the sectorial business cycle, and can be regarded as a lagged indicator for output and as a predictor for food inflation. A positive impact of the markups on the food inflation is likely to be one of the reasons for relatively weak joint changes of output and inflation, what may affect responses of the Polish economy to the monetary policy measures.

Key words: markups cyclicality, inflation, food sector

INTRODUCTION

A monopolistic markup, which is a gap between a price that firm charges and its marginal cost, has various economic meanings. While in microeconomics it indicates market power, represents a welfare loss to society, or is an incentive for investment and technological change, in macroeconomics it is mostly used as an argument in discussions about the character of cyclicality of real wages and is a key exogenous variable in the inflation models and general equilibrium models. Consequently, three main dimensions of markups impact on monetary policy can be considered.

Firstly, the assumption about markups cyclicality is present in the majority of DSGE models build in the New Keynesian spirit used by central banks when making decisions on directions of monetary policies. They assume that if prices are sticky, an increase in demand should raise prices less than marginal cost, leading to a fall in markups. Even with sticky wages, most New Keynesian models still predict a fall in markups [Nekarda and Ramey 2013]. For example, in the model by Rotemberg and Woodford [1992], an increase in government spending causes both hours and real wages to rise, because imperfect competition generates countercyclical markups. In a textbook New Keynesian model, sticky prices combined with procyclical marginal cost imply that an expansionary monetary shock, or government spending shock, lowers the average markup [Goodfriend and King 1997]. Such result also holds in the leading New Keynesian models with both sticky prices and sticky wages [Smets and Wouters 2003, Christiano et al. 2005]. Also the National Bank of Poland (NBP)

relies on the result of a DSGE model assuming that monetary policy and government spendings influence the economy through their impact on markups [Grabek et al. 2007].

Secondly, markups can be useful in elaborating business cycle barometers. The first one was developed by Axe and Flinn [1925], and afterwards Burns and Mitchell [1946] distinguished three different types of business cycle indicators such as leading, coincident, and lagging indicators of economic activity. A leading indicator informs about future development of economic activity. It usually shows increases and decreases in the activity few months ahead with regard to GDP or other measures of economic activity. A coincident indicator measures current level of economic activity and is lagged by a few months compared to a leading indicator. A lagging indicator of economic activity is such a set of statistics, which with some delay relative to GDP, or the coincident indicator shows changes in economic activity. Although a lot of studies proved cyclical behavior of markups, there is no agreement if they are pro, counter, or acyclical (see an overview in Nekarda and Ramey [2013]). Also, the economic theory does not provide a definite answer (see more: Phelps and Winter [1970], Rotemberg and Saloner [1986] or Chevalier and Sharfstein [1996]). This is probably because the relative stickiness of wages and other costs to prices differs among countries, reflecting the different structures of labor and product markets [Klein 2011]. Regarding Polish studies, Gradzewicz and Hagemejer [2007] indicated procyclical behaviour of markups in the case of the sectorial cycle and countercyclical regarding the macro cycle. Moreover, a price to labor costs ratio is enumerated among leading indicators for the Polish economy.

The third area of the markups impact refers to their positive correlation with price inflation [Chirinko and Fazzari 2000, Bowlder and Jansen 2004], which appeared also in the New Keynesian models, e.g. Steinsson [2003], although some studies indicate negative sign of correlation, e.g. Banerjee and Russell [2005]. Markups cyclicality is enumerated among causes of lack of a clear link between production and prices, next to a high inflation persistence partly caused by inflation expectations, changes in exchange rates and their relatively strong and fast pass-through on prices, the fact that downturns (upturns) of business cycle are often connected with downturns (upturns) of exchange rates as well as an evolution of goods' prices [Klein 2011]. During business cycle downturns, the fact that inflation does not fall so much as it would without markups changes, diminishes influence of decreasing the interest rates on economic activity, what may deepen the economic downturn and delay the recovery. On the contrary, during business cycle upturns a decrease in markups reduces inflation pressure, letting central banks delay introduction of a more restrictive monetary policy. From this perspective, studying the relationship between markups and inflation seems to be particularly important for food prices forecasting as well as predicting the effects of monetary policy. Considering such a framework, the research question addressed in this paper is whether the Polish food sector markups influence related output and inflation.

The food sector was chosen for analysis as being – not only in Poland – one of the most regulated, traditional, and considered to be strategically important for the whole economy. The Polish food sector is characterized by high shares in employment, exports and the GDP. In 2012, 17% of the employed in the whole manufacturing industry worked in this sector. In the period 2003–2012 food exports increased 5 times, from 4 to 20 billion EUR, of which three fourths were directed on the EU markets. Considering total value of agricultural production, Poland is at the 7th place in the EU.

The market structures in the agro-food sector constantly change. They are carefully monitored and analyzed because of their importance in terms of incomes of agricultural producers and welfare of food consumers. Especially, the concentration processes are the matter of interest, because they may potentially lead to the uncompetitive behavior of entities dominating certain branches, such as exercising market power in the price setting process. In 2010 large companies (hiring more than 250 workers) constituted only 1.7% of all 16 thousands companies in the Polish food sector, but they had a share of 36.9% in the total employment and provided 54.1% of the total production value [Szczepaniak 2012]. Examining the relationships between levels of markups and phases of the business cycle and inflation levels seems to be particularly important for food

prices forecasting as well as predicting effectiveness of monetary policy, especially when taking into account that in 2013 a share of food products and non-alcoholic beverages in the CPI basket in Poland amounted to 24.33%.

DATA AND METHODS

Markups were calculated with a method that uses a labor input margin to estimate marginal cost, as this method produced the strongest evidence of countercyclical markups and has been the most popular in the New Keynesian literature [Nekarda and Ramey 2013]. Under an assumption of Cobb–Douglas production function and excluding overhead labor as not increasing with the number of working hours and therefore not influencing markups, labor markup is expressed as follows:

$$\mu = \frac{P}{MC} = \frac{P \cdot MPL}{W_A} = \frac{P \cdot \frac{Y}{hN - \overline{hN}} \alpha}{W_A} = \frac{\alpha}{s'}$$

where: MPL – the marginal productivity of labor;
 W_A – an average wage;
 Y – production;
 h – number of hours per worker;
 N – number of workers.

The expression $\overline{hN}$ represents overhead hours, hence $s' = \dfrac{W_A\left(hN - \overline{hN}\right)}{PY}$ is a labor share of non--overhead labor. Because knowing the markups dynamics is sufficient for answering the research question, it was assumed that elasticity of output with respect to labor remains fixed over time, so only natural logarithms of inversed labor shares were calculated. In order to calculate non-overhead labor, the costs of wages and salaries was multiplied by the ratio of all costs minus costs of management and sales, to the total costs. Afterwards, in order to measure inversed labor share, value of production was divided by calculated in this way cost of non-overhead labor. Markups were estimated using data provided by the Central Statistical Office of Poland (CSO) regarding operations of companies hiring more than 9 workers reported using special forms the (SP and Z-O6) and aggregated at the food processing sector level. The data have been collected on annual basis for the period 2000–2013.

The business cycle, similar to Gradzewicz and Hagemejer [2007], was considered at both the sectorial and macroeconomic levels. Single indicators regarded as the most popular and appropriate for analyzing the considered relationships were used. Specifically, at the sectorial level this was value of production expressed in real terms (yearly data), whereas at the macro level it was real GDP (quarterly data). Inflation was expressed with two kinds of indices calculated on the quarterly basis, namely, food inflation index and consumer price index (CPI). All these data were sourced from the CSO. Because of temporal inconsistency and statistical properties of the collected time series data some transformations of them were made. Both the markups and the sectorial output numbers (value of production) were interpolated into quarterly data with the use of Chow and Lin method [1971], so that the analysis could be performed with the quarterly observations.

Such variables as the GDP, and inflation have exhibited significant seasonal components, therefore their time series were adjusted for seasonality with the use of X-12-ARIMA method [*X-12-ARIMA…* 2011]. All the variables were transformed into logarithms (natural logs). Before estimation of the examined relationships, the Augmented Dickey–Fuller test (ADF) was employed to check the order of integration of the time series [more

about test can be found in: Tsay 2010]. The obtained ADF test statistics indicated that all the variables were non stationary[1], thus trends were eliminated from the logs of the seasonally adjusted data. Cyclical components[2] were extracted applying two different methods, that is by taking first differences and using the Hodrick–Prescott (HP) filter with a parameter $\lambda = 1{,}600$.

In order to explore interactions between the cyclicalities of markups, food sector output, the GDP, and inflation rates the cross-correlations were calculated as well as the VAR modeling was applied. The cross correlations allowed to capture connectedness between markups and the sectorial and macro business cycle indicators lagged by a certain number of periods. General formula for a VAR model is as follows [Tsay 2010]:

$$Y_t \;=\; A_0 \;+\; A_1 Y_{t-1} \;+\; A_2 Y_{t-2} \;+\; ... \;+\; A_p Y_{t-p} \;+\; B_i X_t \;+\; \varepsilon_t$$

where: Y_t – stochastic processes collected in $n \times 1$ vector;
A_0 – deterministic variables parameters;
A_i, B_i are coefficient matrices;
p – order of the VAR model;
X_t – exogenous variables.

The number of lags was chosen using the Akaike's Information Criterion (AIC). Causal impacts were depicted with the impulse response functions (IRF). Results of testing for the Granger causality are summarized with the F-statistic values. The VAR models dynamics were also assessed by the variance error decomposition (VED).

RESULTS AND DISCUSSION

Cyclical fluctuations appeared to be present in all the analyzed seasonally adjusted time series. Figure 1 presents cyclical components obtained using the HP filter. It can be noticed that the length of the cycles is about four years. The years of relative prosperity for the sector (measured by output) and the whole economy (measured by the GDP) were: 2000, 2004–2005, 2007, and 2011–2012. Fluctuations in economic activity in the food industry are greater than the fluctuations in the whole economy. This is particularly visible since 2008, that is after the financial world crisis emerged.

Cross-correlation coefficients between cyclicality of food sector markups and both the macro and the sectorial business cycles as well as with consumer price inflation (CPI) and changes in the price levels of the food basket (CPIFood) are depicted in Figure 2. The sectorial business cycle is positively correlated with the macro business cycle, and the highest cross-correlation coefficient (0.56) refers to the simultaneous relationship. As expected a strong relationship exists between the CPI and CPIFood. Cross-correlation coefficient between the deviations from the HP trends of the CPI and the CPI Food is the highest with no lag, amounting to 0.82. This observation suggests that looking for how the sector markups are connected with its output and food inflation may lead to some interesting findings in the context of shaping monetary policy in Poland.

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[1] ADF test statistics with corresponding p-values for model with constant and for model with constant and trend are as follows: l_Markup ($\tau = -0.80$, $p = 0.82$ and $\tau = -2.19$, $p = 0.49$); l_GDP ($\tau = -0.44$, $p = 0.89$ and $\tau = -1.57$, $p = 0.79$); l_Output ($\tau = -0.32$, $p = 0.91$ and $\tau = -3.29$, $p = 0.07$); l_CPI ($\tau = -0.72$, $p = 0.84$ and $\tau = -3.04$, $p = 0.12$); l_CPIFood ($\tau = -0.06$, $p = 0.96$ and $\tau = -2.69$, $p = 0.24$). Further analysis performed on the first differences of logged series allows us to conclude that all series are integrated in order 1 at the 0.05 significance level.

[2] ADF test allows us to reject the null hypothesis of a unit root in all seasonally and trend adjusted series at the 0.05 significance level.
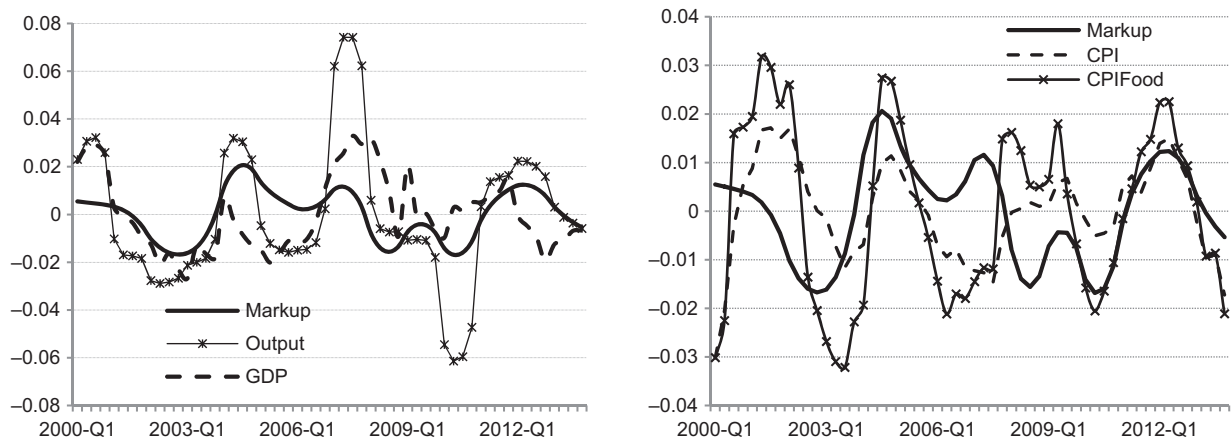
Fig. 1. Cyclical behavior of the Polish food sector markups, the sectorial and macro business cycles and the sectorial and macro inflation rates in the period 2000–2013 (HP filter)

Source: Own elaboration based on the CSO data.

It appeared that markups are positively correlated with calculated in real terms production value of the food sector. The highest positive coefficient (regardless the method of data transformation applied) is for 0 lag (0.71). The contemporaneous correlation of the food markups cyclicality with the sectorial business cycle is much stronger than with the macro business cycle and markups (0.18).
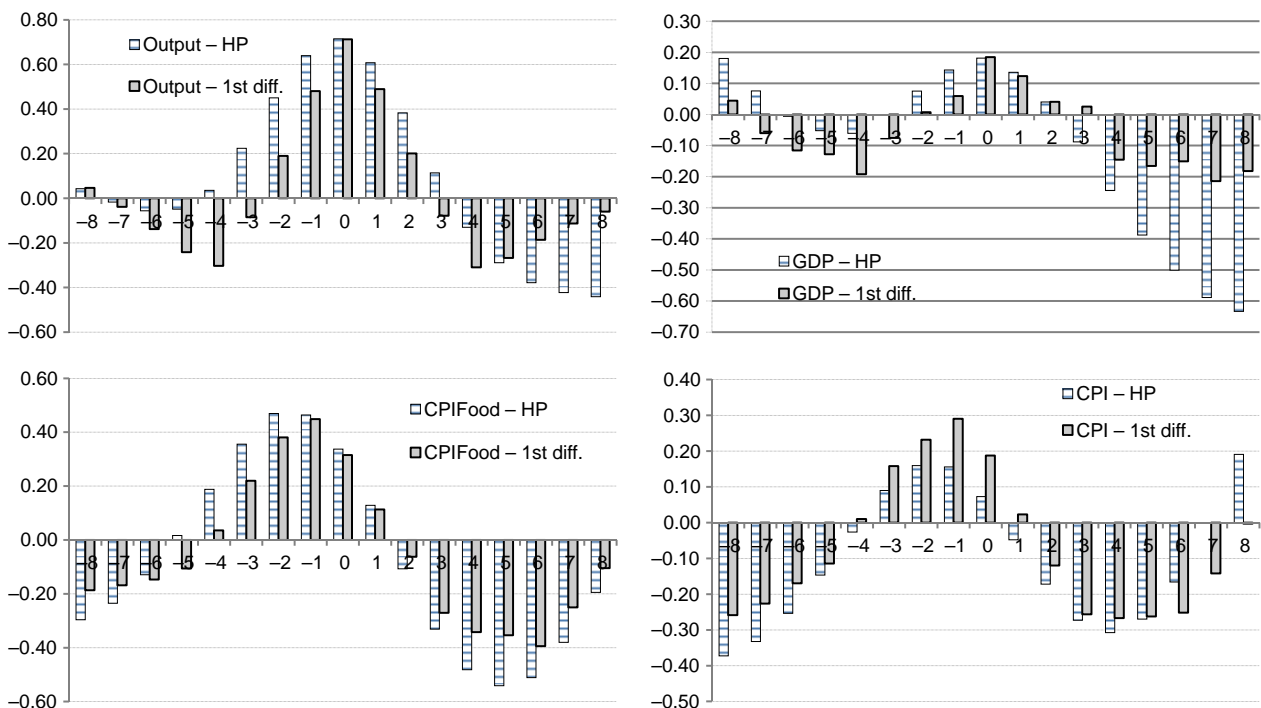
Fig. 2. Cross-correlations of the food sector markups to the leads and lags of business cycles indicators and inflation rates

Source: Own elaboration based on the CSO data.

The food markups seem to be negatively correlated with the real GDP led by 2 years (–0.63), although a strong correlation is seen only regarding results obtained with the application of the HP filter. Also, the markups are stronger correlated to the CPIFood than to the CPI. The highest values of positive cross-correlation coefficients between markups and food inflation are for markups led by 1–2 quarters, what indicates procyclicality of the Polish food sector markups as regards to the sectorial business cycle.

The relationships between the markups and both the business cycle and inflation rates were analyzed also using VAR models with the GDP and CPI treated as control variables[3]. All the time series had a unit root, but the first differences as well as series of deviation from HP trends appeared to be stationary. The seasonal fluctuations were removed from the GDP, CPI and food inflation series using the X-12-ARIMA method. Twelve VAR models, representing different combinations of endogenous and exogenous variables as well as methods of cyclical components extraction were estimated. Their specifications and the results of Granger causality testing are presented in Table 1.

The basic VAR models include two endogenous variables, that is markups and business cycle (the sector output or the real GDP – model 1 and 2, respectively). Next, these models were extended by inflation in the sector (CPI_Food) or inflation in the whole economy (CPI) – model 3 and 4, respectively. Model 5 includes markups and the sectorial cycle as endogenous variables (Y_t) and GDP as an exogenous variable (X_t). Model 6 includes three endogenous series (sectorial) and two exogenous variables representing the macro business cycle and the consumer inflation.

Table 1. Specification of the alternative VAR models and results of the Granger causality testing[a]

| Model	Variables	First differences	HP filter adjustment	Additional remarks
1	Y_t (Markup, Output)	Output → Markup $F = 8.91$ (0.001) Markup → Output $F = 6.13$ (0.004)	Output → Markup $F = 6.24$ (0.001) Markup → Output $F = 3.02$ (0.039)	–
2	Y_t (Markup, GDP)	GDP → Markup $F = 0.87$ (0.427) Markup → GDP $F = 0.27$ (0.764)	GDP → Markup $F = 2.20$ (0.084) Markup → GDP $F = 0.230$ (0.878)	–
3	Y_t (Markup, Output, CPI_Food)	Output → Markup $F = 8.68$ (0.001) Markup → Output $F = 5.75$ (0,006)	Output → Markup $F = 8.03$ (0.000) Markup → Output $F = 2.34$ (0.086)	The CPI_Food is influenced by output and markups
4	Y_t (Markup, GDP, CPI)	GDP → Markup $F = 2.23$ (0.099) Markup → GDP $F = 0.19$ (0,901)	GDP → Markup $F = 2.32$ (0.074) Markup → GDP $F = 3.10$ (0.026)	The CPI is an effect of the GDP and markups
5	Y_t (Markup, Output) X_t (GDP)	Output → Markup $F = 11.423$ (0,000) Markup → Output $F = 6.71$ (0.003)	Output → Markup $F = 7.57$ (0.000) Markup → Output $F = 3.72$ (0.018)	Significant and positive impact of the GDP on output and markups
6	Y_t (Markup, Output, CPI_Food) X_t (GDP, CPI)	Output → Markup $F = 12.58$ (0.000) Markup → Output $F = 6.01$ (0.005)	Output → Markup $F = 7.75$ (0.000) Markup → Output $F = 3.55$ (0.023)	The CPI_Food is an effect of the GDP and markups

[a] p-values are presented in parenthesis, number of lags was 2 or 3 for the first differences and 3 or 4 for HP adjustment case.
Source: Own elaboration based on the CSO data.

[3] VAR models were applied because of a lack of clear results regarding existence of a cointegration relationship among variables in different model specifications (Table 1). For models 1, 3, 4 the Johansen test indicates existence of one cointegration vector. In the remaining cases lack of cointegration was stated. This, and the fact that we are interested in cyclical behavior of series, justifies application VAR methodology.

It appeared that Granger causality between markups and the sectorial cycle is bidirectional and the F statistics indicated that the impact of the past shocks in the output on the markups seems to be stronger than vice versa. Moreover, both the markups and the sector output are Granger causes for the food inflation (CPI_Food). Consequently, the following direction of the Granger causality can be indicated: sectorial business cycle → markups → food inflation. The GDP variable was significant in all equations, while the CPI variable was significant only in the equation for the CPI_Food.

In the next step of the analysis, using ordering of the considered variables, the impulse response functions (IRF) were generated. Figure 3 presents cumulative IRF for the models estimated on the sectorial data transformed using the HP filter (results regarding control macro variables were omitted). IRF analysis indicates a positive reaction of output to a shock in markups, so the increase of profitability leads to the intensification of production (entries of new firms, an increase in efficiency). On the other hand, a positive shock in output
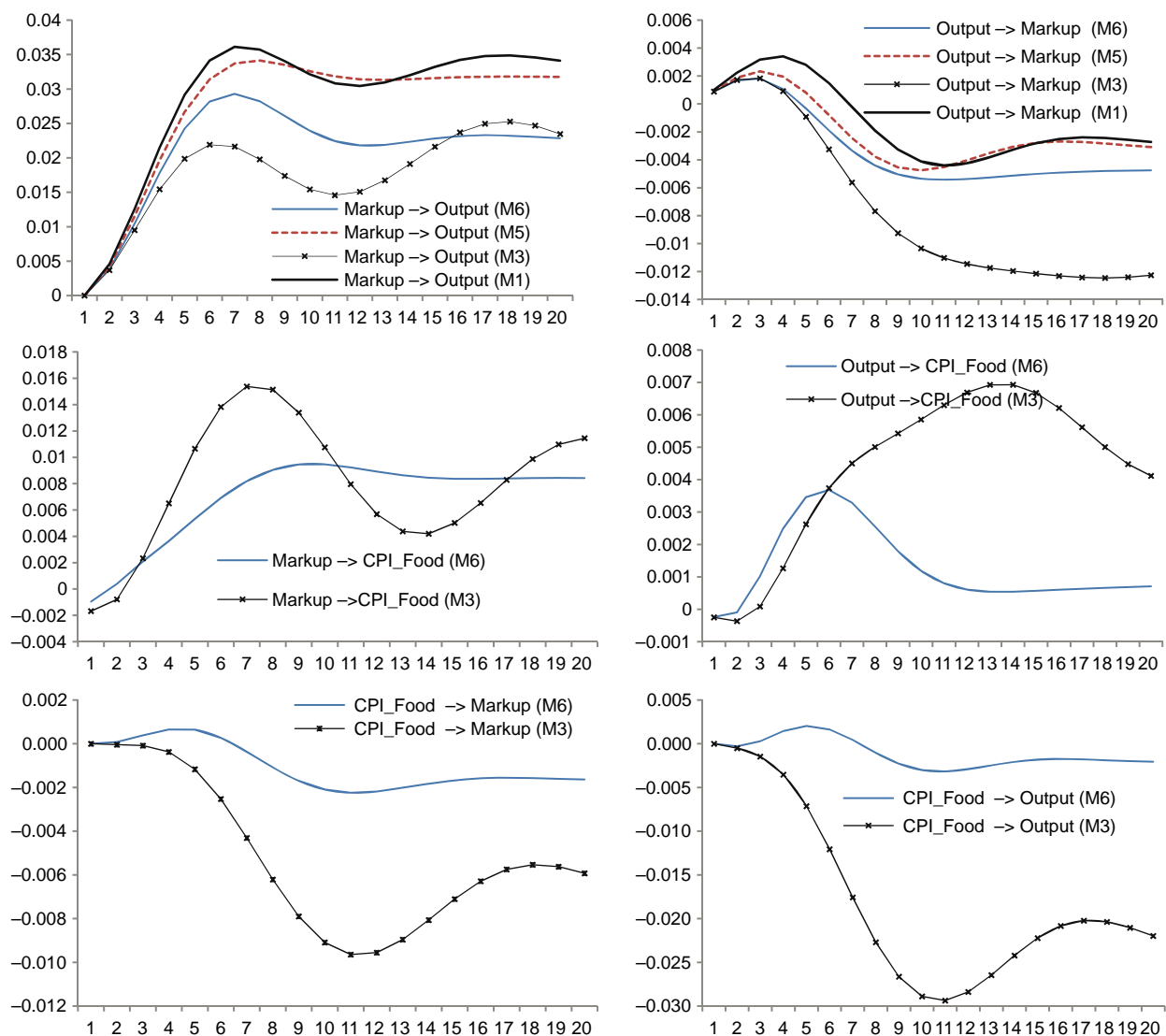
Fig. 3. Cumulative impulse response functions for selected models (based on deviations from the HP trends)

Source: Own elaboration based on CSO data.

after 5–7 quarters is followed by a decrease in markups. This shows a delayed countercyclical reaction of markups to changes in the sectorial business cycle, comparing to the procyclical simultaneous behavior. As to prices, it seems that they play an important role in shaping the relationship between markups and the business cycle. The IRF analysis shows that positive shocks in output as well as in markups lead to increase in sectorial inflation (model 3 and 6). Shocks in the food prices have a negative effect on markup and output, although according to model 6 a short run effect (up to six quarters) might be positive. Moreover, an inclusion of exogenous variables (GDP and CPI) in model 6 mitigates the effects of a shock in food prices as compared with model 3.

In order to assess a relative influence of an identified market shock, the variance error decompositions (VED) were performed. Results of the VEDs for chosen models are presented in Table 2. They show that the contribution of the markups shock to the variability of output in the horizon of 20 quarters varies between 19% in model 3 and 36% in model 1 and 6. In contrast, the contribution of the output shock to the variability of markups is lower and varies in the range of 11–25%. This confirms conclusions drawn from the causality testing. The VEDs also confirm an important role of markups in determining the food inflation. The contribution of a shock in markups to the variability of food inflation after 5 years amounts to ca. 37%, whereas a shock in output has a smaller impact on food inflation.

Table 2. Variance Error Decomposition for the selected models (based on deviations from the HP trends)

Model	Model 3			Model 6		
SE shock in	Markup	Output	CPIFood	Markup	Output	CPIFood
No of quarters			VED of Markup			
4	93.79	5.98	0.23	94.61	4.96	0.43
8	62.95	25.62	11.43	83.45	14.67	1.88
12	58.49	26.76	14.75	82.87	14.55	2.58
16	57.43	25.73	16.84	82.72	14.57	2.70
20	57.48	25.45	17.07	82.71	14.58	2.71
No of quarters			VED of Output			
4	17.04	81.84	1.12	28.21	71.36	0.44
8	16.83	67.96	15.21	34.35	64.49	1.16
12	16.90	66.11	16.99	35.64	62.80	1.56
16	18.51	63.48	18.01	35.68	62.68	1.64
20	18.83	63.07	18.10	35.69	62.67	1.64
No of quarters			VED of CPIFood			
4	20.40	1.11	78.49	25.21	10.89	63.90
8	30.73	2.84	66.42	38.11	12.48	49.41
12	34.48	2.60	62.91	37.36	14.64	47.99
16	35.19	2.65	62.16	37.52	14.61	47.87
20	36.49	2.98	60.53	37.52	14.62	47.86

Source: Own elaboration based on CSO data.

The results regarding a relationship between food industry markups and the macro business cycle are not so obvious and clear. Model 2 estimates (based on first differences) suggest no linkage between markup and GDP (in the Granger sense). On the other hand, model 4 (in both variants) and model 2 with the HP deviations show an existence of a relationship between these variables. Three out four model specifications detected that the macro business cycle is in Grange sense a cause for the food industry markups at 0.1 significance level (in one case among the four there impact was opposite). It is worth mentioning that in the VAR model estimated for three endogenous variables: output, the GDP and markups (not presented here), the macro business cycle was not statistically significant and had no causal impact both on the output and markups. Therefore, we do not present a detailed analysis for models with GDP assuming no clear linkage.

CONCLUSION

The purpose of the paper was to investigate whether the Polish food sector markups influence output and inflation in the Polish food sector. Markups estimated as inversed non-overhead labor share appeared to be procyclical in regards to sectorial cycle, what is in accordance with the results obtained for the Polish industry markups by Gradzewicz and Hagemejer [2007]. In the period analyzed markups were predictors for changes in food inflation, but not in output, as the sectorial business cycle changes seem to precede changes in markups by 1–2 quarters. The indicated positive correlation between markups and inflation is in accordance with studies performed by Chirinko and Fazzari [1999] or Bowlder and Jansen [2004]. The mechanism is as follows: a positive shock in output causes a decrease in markups, and a negative shock in markups causes a decrease in food inflation, which is strongly correlated with CPI. Positive impact of markups on food inflation seems to contribute to a week joint movement of business cycle and inflation, because without the markups response the shock in output raises food inflation. As indicated Klein [2011], such behavior of markups may impact the monetary policy. More specifically, during downturns, when markups increase, inflation does not drop as much as it would have without markups movement, what weakens the efforts of the National Bank of Poland (NBP) to stimulate economic activity by lowering the interest rate, and eventually may delay a recovery. On the contrary, during upturns a decrease in markups limits inflation pressure, what lets the NBP to delay its actions. As the share of food in the CPI basket in Poland accounts for well above 20%, it seems important to take into account the behavior of the Polish food sector markups when making monetary policy decisions. The main limitation of the study is quarterly interpolation of markups due to the lack of primary quarterly data. Concerning future research checking whether markups in particular food sector branches can serve as indicators for the Polish business cycles would be an interesting finding.

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WPŁYW MARŻ MONOPOLISTYCZNYCH W PRZEMYŚLE SPOŻYWCZYM NA KONIUNKTURĘ SEKTOROWĄ I POZIOM CEN ŻYWNOŚCI W POLSCE

STRESZCZENIE

Celem głównym niniejszego opracowania było określenie związków między marżami monopolistycznymi, produkcją oraz inflacją żywności w polskim sektorze spożywczym w latach 2000–2013. Poziom marż monopolistycznych oszacowano jako odwrotność udziału pracy produkcyjnej w wartości produkcji. Wartość produkcji w przemyśle spożywczym przyjęto jako podstawę do oszacowania sektorowego wskaźnika cyklu koniunkturalnego. W celu oceny zależności wykorzystano współczynniki korelacji wzajemnych, test przyczynowości Grangera oraz model VAR. Z badań wynika, że marże zachowują się procyklicznie w odniesieniu do sektorowego cyklu koniunkturalnego i mogą być postrzegane jako opóźniony wskaźnik dla produkcji i jako predyktor cen żywności. Pozytywny związek marż i inflacji żywnościowej jest prawdopodobnie jedną z przyczyn relatywnie słabej współzależności zmian produkcji i inflacji, a tym samym słabych reakcji polskiej gospodarki na działania polityki pieniężnej.

Słowa kluczowe: cykliczność marż, inflacja, sektor żywnościowy