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CHANGES IN PRODUCTIVITY OF SELECTED BRANCHES OF THE POLISH FOOD SECTOR IN THE YEARS 2004–2013

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Abstract. The aim of this paper is to specify changes in productivity of the Polish food sector as a whole and its selected branches in the years 2004–2013. Analyses were conducted based on the Malmquist Productivity Index (MPI). In the MPI model the following variables were adopted: the output – sold production (million PLN), inputs – average number of employees (thous) and gross value of fixed assets (million PLN). It was confirmed that productivity of the Polish food sector improved in the years 2004–2013. Results of analyses showed that changes in technical efficiency had a greater effect on changes in food sector productivity in Poland – particularly in the first period following Poland's accession to the EU and starting from 2009, i.e. the outbreak of the economic crisis. Technical change had a considerable effect on the improvement of productivity in the food sector only in the years 2006–2008. The greatest mean annual improvement in productivity in the analysed period was observed in meat and milk processing and beverage production.

Key words: food sector, productivity, Malmquist Productivity Index

INTRODUCTION

Following Poland's accession to the European Union the Polish agriculture and food sector have been operating under different economic conditions than it was in the past. Being part of the European Single Market results in the process of price equalisation and provides new potential sources of income for agriculture and the food sector connected with higher demand and price levels (Poczta, 2008). Positive changes related to Poland's integration with the EU are indicated by selected indexes, e.g. the value of production sold, exports, investment or profitability of the food sector. Apart from the increase in production volume, exports and investments in food processing, changes have also been observed in the production structure based on the increasing importance of highly processed food, with such food supplied to a considerable extent to consumers in the EU countries (Michalczyk, 2011).

On the other hand, as it was observed by Drożdż and Urban (2012), we may observe variability and intensification of external restrictions on operations in production of food and beverages. We face a decrease in domestic demand, increasing raw material shortages, considerable price fluctuations and adverse trends for processors. Recently the embargo imposed by Russia on agri-food products has also significantly affected selected branches in the Polish food sector. This has resulted in marked fluctuations in production volumes in the food sector and financial outcomes, with the deterioration of the economic situation in individual branches typically being temporary.

For this reason it may be assumed that one of the challenges faced by the Polish food sector is connected with improving its competitiveness on the international market, the capacity of companies to adapt to the continuously changing environment and constant improvement of operation efficiency. For this reason it

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is becoming crucial to ensure on-going monitoring and identification of changes in efficiency and productivity of the food sector both at the sector level and within its individual branches, which will facilitate a more reliable assessment of opportunities and barriers for development of the Polish food sector.

According to the definition adopted by OECD, productivity is a relation of the quantitative measure of production to the quantitative measure of inputs (Zielińska-Głębocka, 2003). Productivity facilitates determination of efficiency of inputs, substitution of resources and technical change. In empirical studies indexes of factorial productivity are used, referring to the efficiency of individual production factors, and overall productivity reflecting total effects of efficiency of all factors (Łukiewska, 2014). It is particularly crucial to control the level and the rate of changes in industry productivity when searching for sources of production increase, i.e. assessment to what extent observed changes result from technical change and to what extent they are a consequence of accumulation and substitution of labour factors and capital (Zielińska-Głębocka, 2003; Łukiewska, 2014).

Organisations investigating productivity of individual sectors in terms of their competitiveness include e.g. OECD and the European Commission. Analyses of food sector productivity may also be found in studies by Baran and Pietrzak (2007), Michalczyk (2011), Drożdż and Urban (2012) or Łukiewska (2014).

In this paper changes in total productivity of the food sector were assessed using the Malmquist Productivity Index (MPI). The aim of this study was to determine changes in productivity of selected branches in the food sector from the time of Poland's accession to the EU to 2013. Within these investigations it was decided to verify the following research hypothesis. The primary factor in the improvement of productivity of the food sector in Poland in the years 2004–2013 was connected with changes caused by technical change (technological progress).

MATERIAL AND METHODS

Source materials for analyses comprised GUS (Central Statistical Office) data for the years 2004–2013 concerning the following nine branches of the food sector:

- B1 – meat processing and preservation and production of processed meats,
- B2 – fish processing and preservation,
- B3 – fruit and vegetable processing and preservation,
- B4 – production of plant and animal origin oils and fats,
- B5 – dairy production,
- B6 – production of cereal milling products, starch and starch products,
- B7 – production of baked and farinaceous products,
- B8 – production of beverages,
- B9 – production of other foodstuffs.

Adoption of this division into branches results from the used sources of input materials (GUS) and it is consistent with the Polish Classification of Economic Activities. The branches, for which data for the years 2004–2013 were incomplete, were excluded from this study.

In order to verify the proposed research hypothesis based on data concerning the food sector the Malmquist Productivity Index (MPI) was applied. This index is constructed by comparing relations of several inputs to outputs of a given object at various time points. The Malmquist index for a given object is a product of the index of changes in technical efficiency (EFCH) and the technical change index (TECH) according to the following formula (Färe et al., 1994):

$$M(y_{t+1}, x_{t+1}, y_t, x_t) = \underbrace{\frac{D^t(y_{t+1}, x_{t+1})}{D^t(y_t, x_t)}}_{EFCH^{t+1}} \times \underbrace{\frac{D^t(y_{t+1}, x_{t+1})}{D^{t+1}(y_{t+1}, x_{t+1})} \times \frac{D^t(y_t, x_t)}{D^{t+1}(y_t, x_t)}}_{TECH^{t+1}}^{\frac{1}{2}}$$

where $D^t(y_{t+1}, x_{t+1})$ is efficiency obtained using technology of year t for data from year $t + 1$. $D^t(y_t, x_t)$ is efficiency of an entity in year t using technology available at that time and for data from period t. $D^{t+1}(y_{t+1}, x_{t+1})$ shows efficiency of an entity in the years t+1. $D^{t+1}(y_t, x_t)$ is efficiency obtained using technology of year t+1 for data from year t.

For values of the Malmquist productivity index greater than 1 we assume that productivity increased in the analysed period from t to $t + 1$. When the value of this index is less than 1, this indicates a decrease in productivity, while the value of 1 indicates maintenance of efficiency at the same level. A similar interpretation of index values is used for EFCH and TECH.

Decomposition of the Malmquist Index for object P (Fig. 1) will take the following form (Cooper et al., 2007):

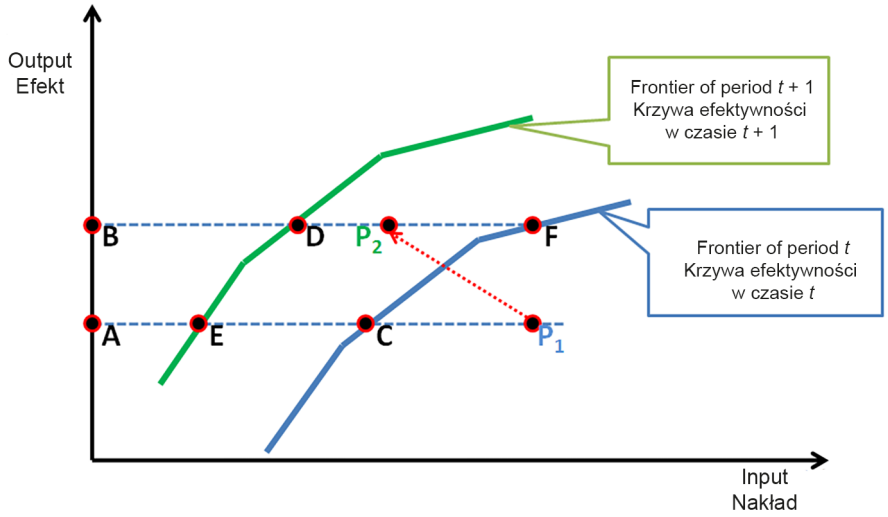

Fig. 1. The Malmquist Productivity Index
Source: Cooper et al., 2007.
Rys. 1. Ilustracja graficzna indeksu Malmquista
Źródło: Cooper et al., 2007.

$$\text{EFCH (P)} = \frac{\frac{BD}{BP_2}}{\frac{AC}{AP_1}}, \quad \text{TECH} = \sqrt{\frac{AC}{AE} \bullet \frac{BF}{BD}},$$

i.e. $$\text{MPI} = \frac{AP_1}{BP_2}\sqrt{\frac{BF}{AC} \bullet \frac{BD}{AE}}$$

RESULTS

Changes in total productivity of production factors in individual branches of the food sector were determined using the input-oriented Malmquist productivity index (MPI). In view of the EU legislation concerning environmental policies and implemented principles of sustainable development, an increase in agricultural production through innovation and disintensification of inputs is currently the only available option for development of Polish agriculture (Bieńkowski et al., 2012). The following variables concerning individual branches were assumed for the calculated model:

- output y_1 – production sold (million PLN),
- input x_1 – average number of employees (thous),
- input x_2 – gross value of fixed assets (million PLN).

Mean annual increase in the Malmquist productivity index in the years 2004–2013 for the Polish food sector was 3% (Fig. 2). The greatest increase in food sector productivity (11%) was recorded in the years 2006–2007. It may be assumed that such a situation was caused by Poland's accession to the EU and numerous changes taking place at that time to adapt the Polish food sector to EU standards, as well as the opening of new markets and the particularly advantageous economic situation both in Poland and in primary foreign customers buying Polish food products. It also needs to be stressed that in the first years after Poland's accession to the EU (2004–2006) productivity of the food sector was basically the consequence of improvement in technical efficiency, while until the economic crisis (2006–2008) a greater effect on improvement in productivity of the food sector was found for technical change. In turn, from 2009 the Malmquist index was again improved mainly by changes in technical efficiency (Fig. 2).

When analysing the mean annual Malmquist index (MPI) in the years 2004–2013 in individual branches we need to state that except for the production of plant and animal origin oils and fats all the branches improved their total productivity. The greatest mean annual increase in total productivity was recorded in the following branches: meat processing and preservation (6%), production of beverages (5%) and dairy production

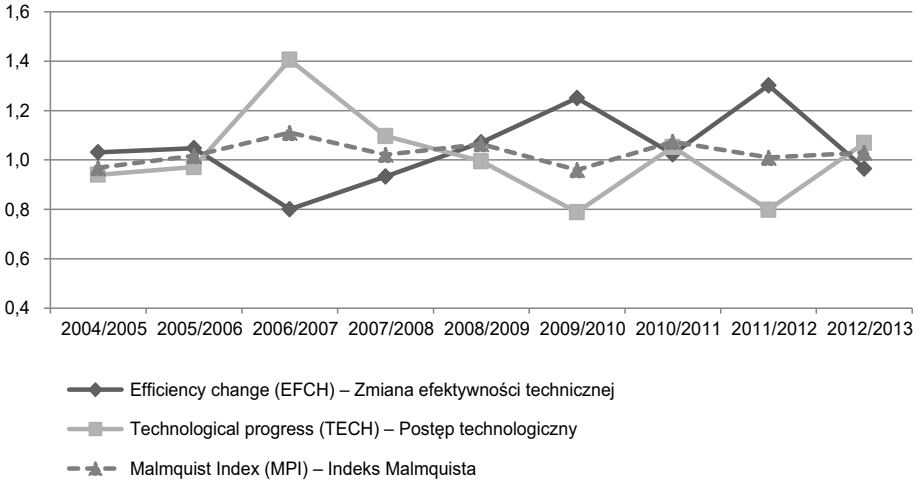

Fig. 2. Malmquist Productivity Index, changes in technical efficiency and technical change calculated for food industry in Poland
Source: own research.
Rys. 2. Indeks produktywności Malmquista, zmiany efektywności technicznej, postęp technologiczny w przemyśle spożywczym w Polsce
Źródło: badania własne.

(5%) – Fig. 3. It may be stated that these branches are characterised by the greatest competitive potential. Processed meat products show a high comparative advantage both in the EU and world markets, while dairy products – in the EU market. These results are confirmed by findings of other researchers, e.g. Pawlak (2009, p. 22), Kacperska (2010, p. 162), Szczepaniak (2012, p. 50) and Łukiewska (2014).

Based on the index of changes in technical efficiency (EFCH) for individual branches it was observed that three of them (i.e. production of beverages, dairy production and production of other foodstuffs) showed mean annual improvement in technical efficiency at 8%. The lowest mean annual indexes of changes in efficiency (below 1) were found in the production of plant and animal origin oils and fats (Fig. 4). The branch of plant and animal origin oil and fat production in the analysed period showed the greatest dynamics of increase in the number of employees and the value of fixed assets, exceeding the dynamics of production sales, which was manifested e.g. in lower productivity and efficiency in relation to the other branches of the food sector.

The greatest mean annual increases in the index of technological progress (TECH) were recorded in fish processing and preservation (7%) and meat processing and preservation (3%). In the other branches the mean annual index of technical changes fluctuated around 1, while in the production of beverages and dairy production it was below 1 (Fig. 5).

In the next stage of the study the mean annual indexes of technical change (TECH) and changes in efficiency (EFCH) for the branches of the food sector were compared with mean values for the whole sector (Fig. 6). Within this comparison four groups were distinguished:

- the leader, i.e. meat processing (B1), in the years 2004–2013 showing changes both in the mean annual technical change and technical efficiency above average for the food sector,
- branches distinguished by the dynamics of technical change above the mean for the food sector (fish processing – B2),
- a group of branches showing the dynamics of changes in technical efficiency exceeding the national mean, e.g. fruit and vegetable processing – B3, dairy production – B5, production of beverages – B8, production of cereal milling products, starch – B6,
- a group of losing branches – with below sector average levels of technical change and efficiency (production of plant and animal origin oils and fats – B4, production of baked and farinaceous products – B7).

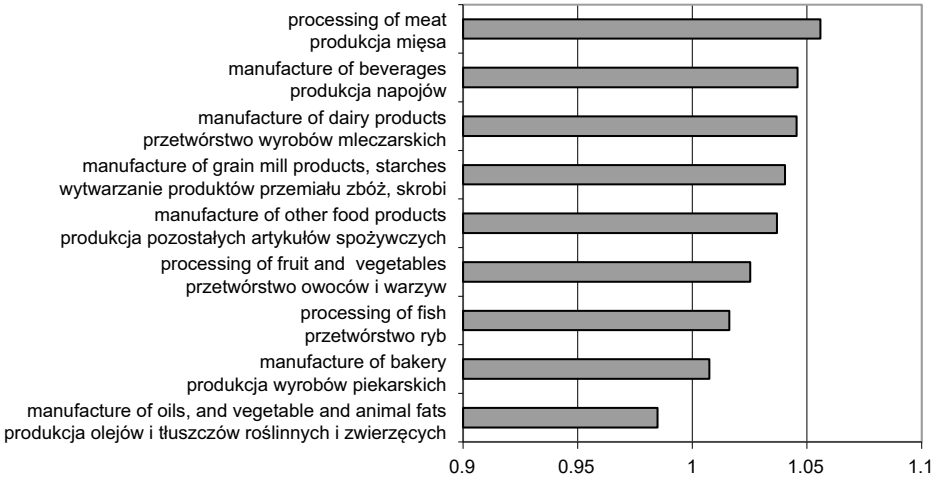

Fig. 3. Mean annual Malmquist Productivity Index (MPI) calculated for individual food sectors
Source: own research.
Rys. 3. Średnioroczna wartość indeksu produktywności Malmquista (MPI) dla poszczególnych branż
Źródło: badania własne.

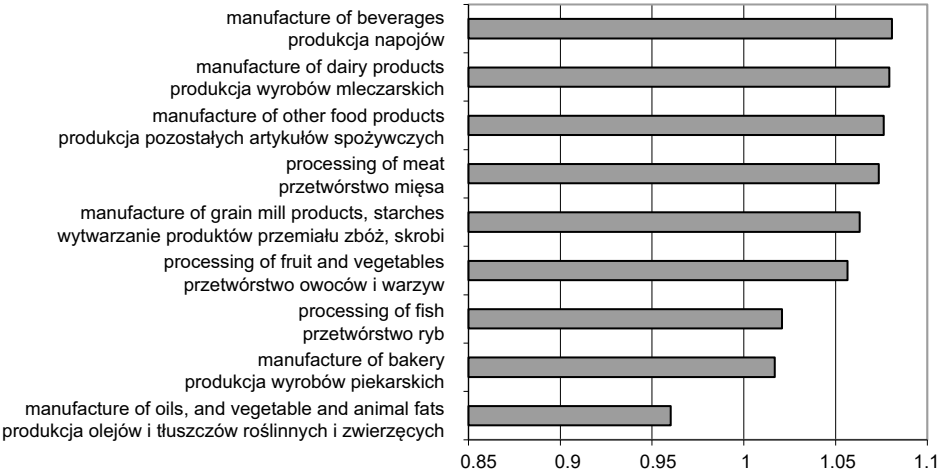

Fig. 4. Mean annual changes in technical efficiency (EFCH) for food sectors
Source: own research.
Rys. 4. Średnioroczna zmiana efektywności technicznej (EFCH) branż przemysłu spożywczego
Źródło: badania własne.

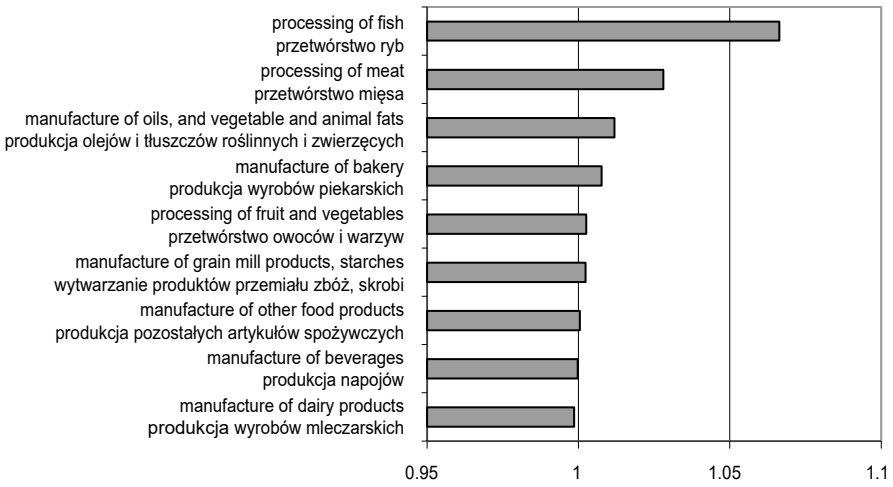

Fig. 5. Mean annual variation in technical change (TECH) for food sectors
Source: own research.
Rys. 5. Średnioroczna zmiana postępu technologicznego (TECH) w branżach przemysłu spożywczego
Źródło: badania własne.

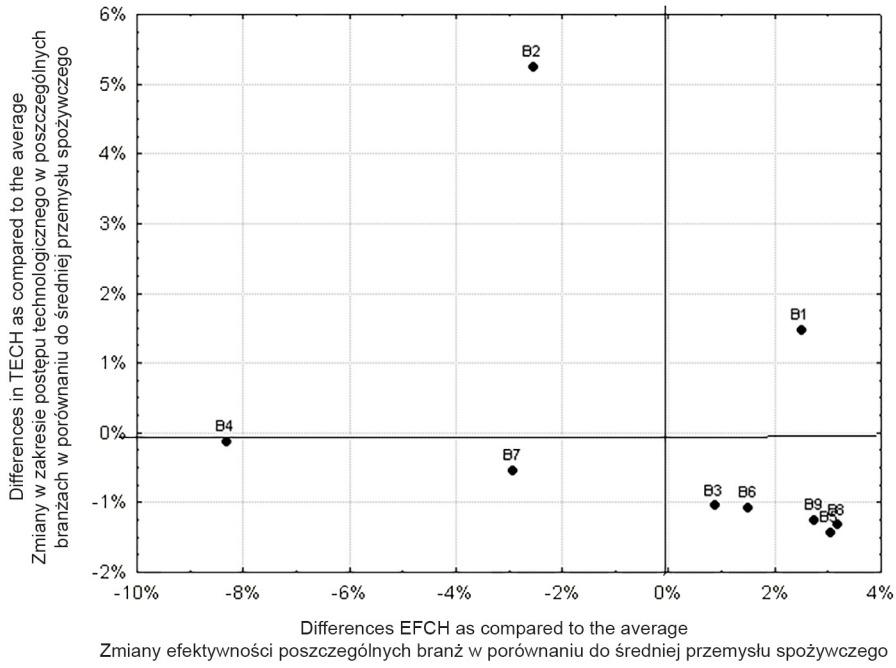

Fig. 6. Variation in EFCH and TECH in food industry branches compared to sector mean
Source: own research.
Rys. 6. Zróżnicowanie efektywności i postępu technologicznego w branżach przemysłu spożywczego w porównaniu do średniej całego sektora
Źródło: badania własne.

CONCLUDING REMARKS

The paper presents an analysis of changes in productivity of the Polish food sector in the years 2004–2013 based on the Malmquist productivity index. Results made it possible to identify the general trend for changes in productivity for the entire food sector and its individual branches. Results of this analysis indicate that in the years 2004–2013 productivity of the food sector was improving. In the entire sector the mean annual MPI for the analysed period was above 1, showing approx. 3% mean annual increase in productivity for the whole sector. In turn, between individual periods productivity was found both to increase and decrease.

The highest mean annual MPI values were recorded in meat processing, dairy production and production of beverages. Additionally, meat processing in comparison to the other branches was characterised by changes greater than the sector average both in the mean annual technical change and technical efficiency.

Decomposition of the calculated Malmquist indexes made it possible to identify factors determining changes in productivity of the food sector in Poland. It was found that the primary factor affecting changes in productivity of Polish agriculture in the first period following Poland's accession to the EU (2004–2006) was connected with improvement of technical efficiency. Next in the years 2006–2008 technological progress had a significant effect, while from the onset of the economic crisis (2008/2009) again improvement of technical efficiency in individual branches gained in importance for the improvement in productivity. These analyses thus only partially confirmed the proposed hypothesis, since technical change was the primary factor for the improvement in productivity of the food sector in Poland only in the years 2006–2008. In the first years following Poland's accession to the EU and from 2008 the main factor for the improvement of productivity was connected with an increase in technical efficiency of individual branches.

REFERENCES

Baran, J., Pietrzak, M. (2007). Analiza efektywności wybranych branż polskiego agrobiznesu bazująca na metodzie DEA. Rocz. Nauk. SERiA, 9, 3, 15–19.

Bieńkowski, J., Jankowiak, J., Dąbrowicz, R., Holka, M. (2012). Porównanie produkcyjności ogólnej polskiego rolnictwa na tle krajów Unii Europejskiej. Rocz. Nauk. SERiA, 15, 2, 35–40.

Cooper, W. W., Seiford, L. M., Tone, K. (2007). Data Envelopment Analysis, A Comprehensive Text with Models, Applications, References and DEA-Solver Software. New York: Kluwer Academic Publishers.

Drożdż, J., Urban, R. (2012). Problemy sektora spożywczego w Polsce. Przem. Spoż., 66, 8/9, 24–28.

Färe, R., Grosskopf, S., Norris, M., Zhang, Z. (1994). Productivity Growth, Technical Progress, and Efficiency Change in Industrialized Countries. Am. Econ. Rev., 84, 1, 66–83.

Kacperska, E. M. (2010). Konkurencyjność polskich artykułów rolno-spożywczych na rynkach międzynarodowych w latach 2004–2009. Rocz. Nauk. SERiA, 12, 4, 158–163.

Łukiewska, K. (2014). Produktywność w przemyśle spożywczym w Polsce – poziom i międzybranżowe zróżnicowanie. Rocz. Nauk. Ekon. Roln. Rozw. Obsz. Wiej., 101, 1, 53–63.

Michalczyk, J. (2011). Przemiany w polskim przemyśle spożywczym po akcesji do Unii Europejskiej. Ekonomia, 4(16), 387–397.

Pawlak, K. (2009). Zdolność konkurencyjna polskiego sektora rolno-spożywczego w handlu wewnątrzwspólnotowym. Zagad. Ekon. Roln., 3, 15–31.

Poczta, W. (2008). Skala korzyści uzyskiwanych przez rolnictwo w wyniku wejścia Polski do UE (analiza uwzględniająca zróżnicowanie regionalne, główne kierunki produkcji rolnej i główne typy gospodarstw rolnych w pierwszym okresie akcesji – lata 2004–2006). In: R. Urban (Ed.), Wpływ integracji z Unią Europejską na polską gospodarkę żywnościową. Warszawa: IERiGŻ-PIB.

Szczepaniak, I. (2012). Wskaźnikowa ocena międzynarodowej konkurencyjności przemysłu spożywczego, In: I. Szczepaniak (Ed.), Monitoring i ocena konkurencyjności polskich producentów żywności (p. 38–50). Warszawa: IERiGŻ-PIB.

Zielińska-Głębocka, A. (Ed.). (2003). Potencjał konkurencyjny polskiego przemysłu w warunkach integracji europejskiej. Gdańsk: Wyd. Uniwersytetu Gdańskiego.

Baran, J. (2016). Changes in productivity of selected branches of the Polish food sector in the years 2004–2013. J. Agribus. Rural Dev., 3(41), 255–262. DOI: 10.17306/JARD.2016.52

ZMIANY PRODUKTYWNOŚCI WYBRANYCH BRANŻ POLSKIEGO PRZEMYSŁU SPOŻYWCZEGO W LATACH 2004–2013

Streszczenie. Celem artykułu jest określenie zmian produktywności całego polskiego przemysłu spożywczego i jego wybranych branż w okresie 2004–2013. Badania przeprowadzono, bazując na indeksie produktywności Malmquista (Malmquist Productivity Index, MPI). Do modelu MPI przyjęto jako zmienne: efekt – produkcję sprzedaną (mln zł) oraz nakłady – przeciętne zatrudnienie (tys.) i wartość brutto środków trwałych (mln zł). Potwierdzono, że w latach 2004–2013 polski przemysł spożywczy odnotował poprawę produktywności. Wyniki badań wykazały, że większy wpływ na zmianę produktywności przemysłu spożywczego w Polsce miały zmiany efektywności technicznej – szczególnie w pierwszym okresie po akcesji do UE oraz od 2009 r., czyli od momentu kryzysu gospodarczego. Postęp technologiczny znacząco wpływał na poprawę produktywności przemysłu spożywczego jedynie w latach 2006–2008. Najwyższą średnioroczną poprawę produktywności w badanym okresie osiągnęły branże przetwórstwa mięsa i mleka oraz produkcja napojów.

Słowa kluczowe: przemysł spożywczy, produktywność, indeks produktywności Malmquista

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