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DYNAMIC CHANGES OF FOOD PRODUCERS IN BULGARIA*

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Abstract. The food and beverage production in Bulgaria has dramatically changed after the full EU membership in 2007. This change has affected not just the production structure, but also the import and export structure as well as overall production potential of the agri-food sector. The aim of the paper is to look inside the changes from the perspective of the single producer. This means to answer to the question: why has the Bulgarian agri-food production been getting worse? The analyses showed that food industry does not have the ability to move over the 1980s values. Partially this state is a result of misunderstanding by food processors how to manage their production more efficiently. The greatest potential for dynamic change of Bulgarian food industry is in the innovation inputs (development of new products and technologies improvement overall marketing). For food sector the major role, among all types of innovations, is played by product innovations.

Key words: food and beverage industry (FBI), industrial dynamics, agri-food development

INTRODUCTION

Bulgarian food industry has developed very fast after the year of 2000. This development has been connected not just with production and turnover's growth but with improvement of technics and technology inside the industry entities.

Nevertheless, there are a lot of authors [Noev 2003, Mishev et al. 2003a, Mishev et al. 2003b, Ivanov et al. 2005, Ivanov 2009] that report on decrease of the growth potential of the Bulgarian food sector not just recent days but for long-time period during the last 20 years. Thus, the analysis of dynamics of food production in Bulgaria needs to look inside the changes of food production not for 20-year-period, but through a century.

The analysis on the food industry includes the analysis of a change of the overall food production as well as total food products turnover in Bulgaria over time. To ensure that there is no statistically confidential autocorrelation we use the time log-function of the production and turnover for constructing the industry dynamic index – IDI [Kopeva et al. 2011, Blagoev et al. 2013] – Figure 1.

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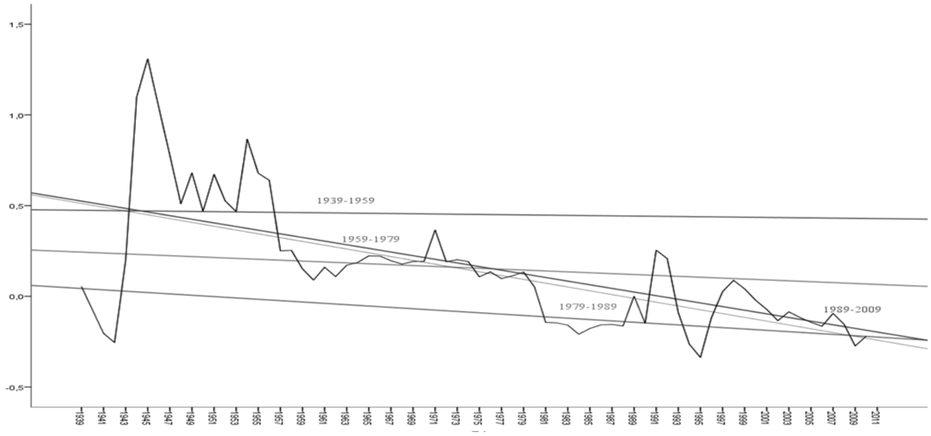

Fig. 1. Industry dynamic index of food industry in Bulgaria
Source: Blagoev et al. 2013.

The data show not just the stages of development of food production and consumption in Bulgaria, but also give a picture of overall dynamic growth of the food industry in Bulgaria for the last century.

This industry dynamic index has a negative value for the Bulgarian food industry. As the Figure 1 shows, the food turnover exceeds the food production in Bulgaria for the whole period. But this was not so sufficient in the middle of the 1950s than in nowadays.

Thus, it is very important for understanding the figures that the food consumption in Bulgaria grows much faster than the food production. This could be percept as a first demonstration of growth potential loss of the food producers in Bulgaria. This could be pointed to these authors who showed Bulgarian food production as declining one.

Therefore, such negative dynamic change is a result of the lost connection between production growth and business competitiveness. In addition, the factors for the lost connection are:

- deterioration of food industry competitiveness – in this meaning the added value of the food production is lower than the added value of other industries;
- deterioration of international competitiveness – in this meaning Bulgaria has lost its competitive advantage in food specialization since 1990s. So, the Bulgaria has changed its position and from the food exporter became a food importer for the last 10–20 years.

The deeper explanation of the dynamic changes inside the Bulgarian food industry needs to use a clear methodological instrument for dynamic analysis.

METHODOLOGY

Even though there are some practical instruments for dynamic analysis we use to study the dynamic changes by instruments of Industrial dynamic function.

The study is based on Cobb-Douglas production function and Solow-Swan growth model [Kuznetsov and Michasova 2007].

Production function is represented as a multiplication of all factors of production at business level (labour, capital and resources)[1]:

$$P = f(L, K, R, M) = b_1.L.K.R.e^M + b_0 + \varepsilon \tag{1}$$

where: L – labour (expresses the influence of the labour as a factor of production);

K – capital (expresses the influence of the capital as a factor of production);

R – resources (express the influence of the use of material resources and services as a factor of production);

M – scientific and technological development (expresses the influence of the R&D as a factor of production);

b_1 – function parameter (expresses the degree of influence of variables – factors of production: labour L, capital K and use of resources R on production function P);

b_0 – intercept – constant (expresses the influence of unreported outside factors of production in the model);

ε – random variable (expresses the influence of changing production conditions over time).

In order to focus on the dependence of different variables of production function, respectively labour inputs (L), material inputs (R), capital inputs (K), innovation inputs (M), we could further develop production function by putting it to logarithmic base. This results in the Formula 2:

$$\ln P = a_1^L \ln L + a_1^K \ln K + a_1^R \ln R + a_1^M M + a_0 + \varepsilon \tag{2}$$

Furthermore, the impact of any single variable on the dependent: Production function could be found as the Formulas 3–10.

– Labour inputs:

$$\ln L = \frac{\ln P - a_1^K \ln K - a_1^R \ln R - a_1^M M - a_0 - \varepsilon}{a_1^L} \tag{3}$$

or

$$\ln L = c_1^L \ln P - c_0^L - \varepsilon \tag{4}$$

where: $c_1^L = 1/a_1^L$;

c_0^L – reflects the degree of dependence of K, R and M of a given company on its labour activities (L).

[1]A similar explanation is done by A. Vezzani and S. Montresor [2013].

– Material inputs:

$$\ln R = \frac{\ln P - a_1^L \ln L - a_1^K \ln K - a_1^M M - a_0 - \varepsilon}{a_1^R} \tag{5}$$

or

$$\ln R = c_1^R \ln P - c_0^R - \varepsilon \tag{6}$$

where: $c_1^R = 1/a_1^R$;

c_0^R – reflects the degree of dependence of L, K and M of a given company on its material usage (R).

– Capital inputs:

$$\ln K = \frac{\ln P - a_1^L \ln L - a_1^R \ln R - a_1^M M - a_0 - \varepsilon}{a_1^K} \tag{7}$$

or

$$\ln K = c_1^K \ln P - c_0^K - \varepsilon \tag{8}$$

where: $c_1^K = 1/a_1^K$;

c_0^K – reflects the degree of dependence of L, R and M of a given company on its fixed assets usage and respectively capital intense (K).

– Innovations inputs:

$$M = \frac{inP - a_1^L \ln L - a_1^R \ln R - a_1^K \ln K - a_0 - \varepsilon}{a_1^M} \tag{9}$$

or

$$M = c_1^M \ln P - c_0^M - \varepsilon \tag{10}$$

where: $c_1^M = 1/a_1^M$;

c_0^M – reflects the degree of dependence of L, R and K of a given company on its innovation activities (M).

As mentioned earlier, the different indices $c_1^i, i \in \{L, R, K, M\}$ could be used for evaluation of the resource capacity and respectively – resource potential of the food producers for growth of entities' total production output.

DATA ANALYSIS

Analysis of dynamic changes of Bulgarian food industry is based on business data from 515 food processors. The data is collected[2] by National statistical office from their annual financial books.

The observation sample includes more than 10% of Bulgarian food entities (compared to their number in 2010) in six major food specializations that are very important for Bulgarian food industry as follows: a) processing and preserving of meat and production of meat products; b) manufacture of dairy products; c) manufacture of grain mill products, starches and starch products; d) manufacture of bakery and farinaceous products; e) processing and preserving of fruit and vegetables; f) manufacture of other food products.

The distribution of observation by their food specialization is given in the Table 1.

Table 1. Number of enterprise and their share in total of observed food processors

Specification	Number of enterprises (for 2010)	Share (%)	Number of enterprises of observation	Share of observation (%)
Manufacture of food products	4 829	100.0	515	10.6
Processing and preserving of meat and production of meat products	491	10.2	65	13.2
Processing and preserving of fruit and vegetables	329	6.8	62	18.8
Manufacture of dairy products	296	6.1	26	8.8
Manufacture of grain mill products, starches and starch products	155	3.2	49	31.6
Manufacture of bakery and farinaceous products	2 652	54.9	163	6.1
Manufacture of other food products	583	12.1	148	25.4

Source: Eurostat, Trade Register of the Registry Agency and own calculations.

The biggest share in observation is given by the most important products as: bakery and confectionery (other food products) as well as dairy and meet processing products. Observation covers food processors from five major regions on NUTS 2 as follows: South East, South Central, South West as well as North Central and North West regions. In addition, different regions have different food specialization according to the resources.

The dynamic analysis is based on the basic book results of the observed entities that are connected to the production function as the next: labour costs (L); material costs (R); investments costs (K); value of fixed assets; innovation costs (M); total production costs ($L + R$); total costs ($L + R + K + M$ + administrative costs = P); turnover (To); profit (To-P); number of employees (N_{empl}); labour efficiency (To/N_{empl}); labour intensity (L/P).

The analysis of food producers' business data (Table 2) allows identifying different groups of entities divided by their product specialization.

[2]Data is collected by research under project INI DMU 02 – 24/2009.

Table 2. Distribution of major business activities by food specialization

Product Specialization	Personnel Cost: L (€ 1,000)	Fixed assets (mln €)	Investment cost: K (€ 1,000)	Material cost: R (mln €)	Innovation cost: M (€ 1,000)	Production cost (mln €)	Total cost: P (mln €)	Turnover: To (mln €)	Profit: $To\text{-}P$ (mln €)	Number of Employees: N_{empl}	Labour efficiency (€ 1,000/ /empl.)	Labour Intensity
Manufacture of grain mill products, starches and starch products	152.26	0.74	4.15	1.391	0.00	1.421	1.268	1.614	0.2	17.8	36.1	0.31
Manufacture of bakery and farinaceous products	229.34	1.02	0.85	1.490	0.00	1.576	0.674	1.78	0.95	42.9	139.2	1.25
Production of sugar and sugar products	749.30	12.26	0.00	4.873	0.00	5.270	13.60	16.14	0.79	146.3	56.4	0.28
Processing and preserving of fruit and vegetables	231.52	1.02	1.53	1.017	0.00	1.165	0.949	1.5	0.18	35.4	54.5	0.27
Processing nuts and spices	165.03	0.70	0.00	0.72	0.00	0.856	0.830	1.010	0.12	21.5	54.6	0.27
Production, processing, preserving of meat and meat products	481.52	2.91	2.76	5.196	0.00	5.441	6.289	6.89	0.33	91.8	73.6	0.33
Manufacture of dairy products	524.40	4.27	0.00	4.988	0.00	5.250	5.691	6.37	0.39	85.8	82.0	0.13
Manufacture of other food products	281.83	1.15	0.00	0.799	0.00	1.080	1.225	1.58	0.35	31.8	47.0	0.58
Production of sweets and confectionery products	380.17	235.5	0.00	0.348	0.00	0.729	47.66	0.11	0.06	11.16	17.53	3.00
AVERAGE	332.62	2.401	1.22	2.217	0.00	2.414	3.017	3.78	0.44	52.63	78.60	0.74

Source: Project data and own calculations.

According to the earlier mentioned data, two groups of food processors are identified as follows:

- **First group** covers the food producers with the highest enterprise activities, including personnel costs, material costs, turnover and fixed assets as well they have the greater number of employees and average levels of labour efficiency. Their labour intensity is not high too. In this group we find production specialization as follows: a) manufacture of dairy products; b) production, processing, preserving of meat and meat products; c) production of sugar and sugar products.
- **Second group**, as opposite to the first one, covers the enterprises with the lowest enterprise activities, inclucing personnel costs, material costs, turnover and fixed assets as well they have the smallest number of employees and lower labour efficiency. They could be divided just by the labour intensity as the next: a) with low level of labour intensity: processing and preserving of fruit and vegetables, and processing nuts and spices; b) with average level of labour intensity: manufacture of other food products; c. with highest level of labour intensity: manufacture of bakery and farinaceous products, and production of sweets and confectionery products.

Therefore, authors did a cluster analysis of the observed sample that helped them to analyze more sufficiently the dynamic changes of the Bulgarian food industry. The basic elements of the cluster analysis are given in the next:

- **independent variables**: personnel costs; investments costs; number of employees; labour efficiency; labour intensity; administrative code; product code;
- **parameters of clustering** are as follows: clustering method: increase of sum of squares; number of cases: 515; number of variables: 7; proximate coefficient: squared Euclidean distance; randomize tree by proximities; randomize tree: at 515 cluster levels; number of random trials: 120; evaluate and display: 10 final fusions; save validation results: 50 final fusions; significance test: 2.57 t-test;
- **tree cut** and **tree validation** (Fig. 2).

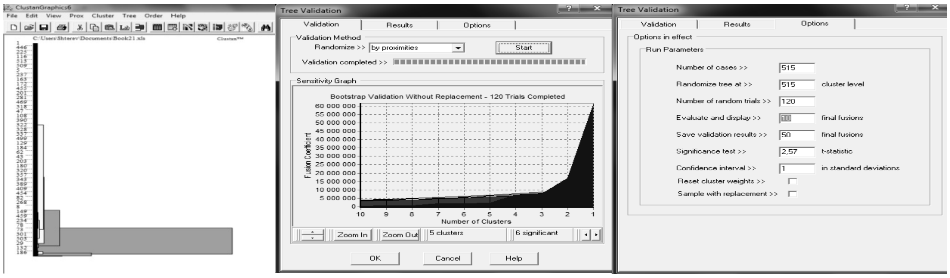

Fig. 2. Distribution of observation by region at NUTS 2 (right) and by their product specialization (left)

Source: Project data and own calculations (by Clustan Graphics 1.0).

According to the best tree cut, the number of clusters is set to 3.

The distribution of the enterprises among different clusters is not equal and the figures are given in Tables 3 and 4:

- **Cluster Distribution** (Table 3)

Table 3. Distribution of identified three clusters

Cluster	Number of members	Share of members
1	484	94%
2	16	3%
3	15	3%

Source: Project data and own calculations

- **Cluster Table** (Table 4)

Table 4. Mean of independent variables by clusters

Cluster	Personnel costs	Investment costs	Number employees	Labour efficiency	Labour intense	Administrative code
1	113.58	0.96	17.13	28.66	0.49	3.05
2	1 423.43	Missing	132.44	94.56	0.09	2.94
3	3 734.90	Missing	536.08	94.90	0.08	3.15

Source: Project data and own calculations.

The final test of clustering is the correlation table (Table 5) that helps to understand what explains the cluster membership.

Table 5. Correlation between all variables and clusters' membership

Cluster	personnel Cost: L	Fixed assets	Investment cost: K	Material cost: R	Innovation cost: M	Production cost	Total cost: P	Turnover: To	Profit: To-P	Number of employees: N_{empl}	Labour efficiency: To/N_{empl}	Labour intensity: L/P
Pearson Correlation	.878**	.602**	.[a]	.799**	.[a]	.838**	.588**	.597**	.132*	.546**	.299**	-0.05
Sig. (2-tailed)	0.000	0.000	0.000	0.000	.	0.000	0.000	0.000	0.015	0.000	0.000	0.454

**Correlation is significant at the 0.01 level (2-tailed).
.[a]Cannot be computed because at least one of the variables is constant.
Source: Project data and own calculations.

According to the figures, the cluster membership is strongly connected with the enterprise activities level as well as not so strong with the labour efficiency and labour intensity. The cluster membership is not dependent on the region of the production neither the product specialization. The differentiation by the cluster membership is given in on Figure 3.

The next step of analysis is the verification of production function (Formula 1) for the whole sample. We use statistical analysis by parametric correlation.

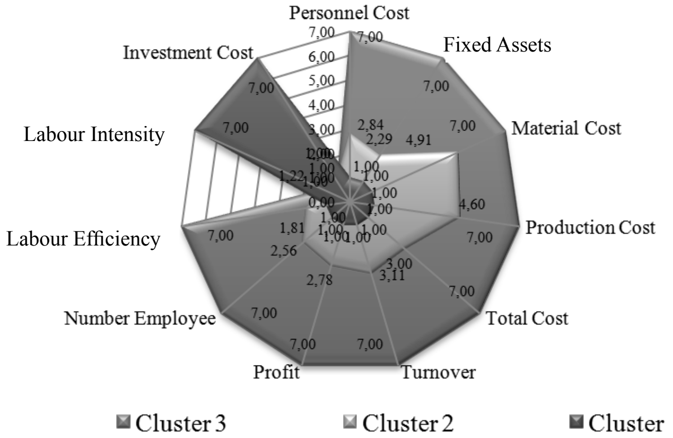

Fig. 3. Cluster profile by analyzed variables
Source: Project data and own calculations

The analysis gave us back that the production function could be evaluated as significant as the Pearson correlation coefficient is bigger than 0.67 as well as the significant coefficient is 0.00 (Table 6).

Table 6. Correlation between production value (total costs = *P*) and production function ($Y = F(P)$)

Specification	Correlation	Production value: *P*	Production function: *Y*
Production value: *P*	Pearson Correlation	1	.676**
	Sig. (2-tailed)		0.000
Production function: *Y*	Pearson Correlation	.676**	1
	Sig. (2-tailed)	0.000	

**Correlation is significant at the 0.01 level (2-tailed). The evaluation is done with significance coefficient $\alpha < 0.05$.
Source: Project data and own calculations (by SPSS 19.0).

In addition, the statistical analysis verified the cubic model (Table 7 and Figure 4) of production function as all of its parameters are dependent of each other.

Table 7. Model summary and parameters estimates

Equation	Model summary					Parameter estimates			
	R Square	F	df_1	df_2	Sig.	Constant	b_1	b_2	b_3
Cubic	0.785	439.772	3	362	0.000	1 238.830	0.000	0.000	0.000
Quadratic	0.749	542.271	2	363	0.000	1 376.398	0.000	0.000	
Linear	0.457	306.273	1	364	0.000	1 748.985	0.000		

Dependent variable: production value: *P*; independent variable is production function: *Y*.
Source: Project data and own calculations (by SPSS 19.0).

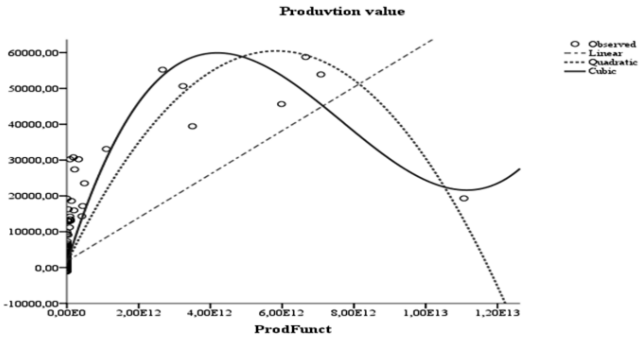

Fig. 4. Production function's graphic models
Source: Project data and own calculations

This allows us to concern our attention on analysis of log-functions (Formulas 3–10). Thus, the first test is a correlation analysis between log-value of production costs: *P* and log-values of elements of production function separately as follows (Table 8): material costs: R, respectively LOG of material costs; labour costs: *L*, respectively LOG of labour costs; capital costs: *K*, respectively LOG of capital costs; innovations' costs: *M*, respectively LOG of EXP innovations' costs.

Table 8. Correlation between LOG Production value and LOG Labour, LOG Materials, LOG Investments, LOG Innovations

Specification	Correlation	LogProd	LogLabour	LogMat	LogInv	LogexpInnov
LogProd	Pearson Correlation	1	.781**	.860**	.219**	.[a]
	Sig. (2-tailed)		0.000	0.000	0.004	.
LogLabour	Pearson Correlation	.781**	1	.897**	.250**	.[a]
	Sig. (2-tailed)	0.000		0.000	0.001	.
LogMat	Pearson Correlation	.860**	.897**	1	.248**	.[a]
	Sig. (2-tailed)	0.000	0.000		0.001	.
LogInv	Pearson Correlation	.219**	.250**	.248**	1	.[a]
	Sig. (2-tailed)	0.004	0.001	0.001		.
LogexpInnov	Pearson Correlation	.[a]	.[a]	.[a]	.[a]	.[a]
	Sig. (2-tailed)	.	.	.	.	

**Correlation is significant at the 0.01 level (2-tailed). The evaluation is done with significance coefficient $\alpha < 0.05$.
[a]. Cannot be computed because at least one of the variables is constant.
Source: Project data and own calculations (by SPSS 19.0).

The correlation analysis verified that food processors are resource intensive ones. Therefore, we found that there is a high (Pearson correlation above 0.78) dependence of production on labour input as well as materials input. In addition, even though the overall production value depends on investments' inputs, the dependence is insignificant as the Pearson correlation is below 0.25. This conclusion is verified by constructing the dependency models (Table 9).

Table 9. Model summary and parameters estimates

Independent variable	Model summary					Parameter estimates			
	R Square	F	df_1	df_2	Sig.	Constant	b_1	b_2	b_3
LogLabor	0.616	194.371	3	363	0.000	0.473	0.416	0.227	–0.018
LogMaterial	0.743	348.807	3	362	0.000	0.295	0.808	0.012	0.001
LogInv	0.072	4.240	3	164	0.006	3.074	7.124	–3.798	0.558
LogProdFunct	0.720	311.020	3	362	0.000	0.165	0.391	0.015	0.000

Dependent variable: Log production value.
Source: Project data and own calculations (by SPSS 19.0).

As the results show, the higher level of material or labour inputs gives a higher level of production. This is not so obvious for the capital inputs, where the higher investment rate does not mean a higher production value.

In addition, the variance of LOG-function of material inputs is lowest as the parameter estimation for b_1 is above 0.8. These figures show how strong is material intensity of the Bulgarian food processors. Even though, the correlation between production value and labour input is significantly strong, the dependence between production and its independent variable: labour inputs, is not so strong as the variance of the LOG-function is greater as well as the parameter estimation for b_1 is below 0.45.

The final step of our dynamic analysis is the verification of production function's differentiation between different clusters. As the above analysis gave us back that the production function could be evaluated as significant there is significant difference between different clusters (Table 10).

Table 10. Model summary and parameters estimates

Equation	Model summary					Parameter estimates			
	R Square	F	df_1	df_2	Sig.	Constant: c	b_1	b_2	b_3
Cluster 1	0.545	134.72	3	338	0.000	402.375	9.17E-07	–2.98E-17	3.22E-28
Cluster 2	0.658	10.585	2	11	0.003	9770.434	4.86E-08	–1.11E-20	0
Cluster 3	0.805	9.661	3	7	0.007	11582.305	1.86E-08	–2.29E-21	6.11E-35

Dependent variable: production value; independent variable is production function.
Source: Project data and own calculations (by SPSS 19.0).

The relation "production value – production function" gives the different starting point of the function parameters. Taken the values of the estimated parameters (resp. b_1, b_2, b_3 from Table 10) of the variable: production function, the differentiation is given by the value of the constant: $c_0^1 = 402$; $c_0^2 = 9{,}770 = 24\ c_0^1$; $c_0^3 = 11{,}582 = 29\ c_0^1$.

So, the dependence of the production value on the change of different production factors is sometimes greater for the enterprises of clusters 2 and 3 than the enterprises of cluster 1. In addition, the dependence of the production value on the production factors is greatest for the enterprises of cluster 3. The range of activities of cluster 1 members is greatest. Nevertheless, there are critical points of production and respectively – material and labour inputs, that do not allow transition from cluster to cluster. Thus, the variations of LOG-functions are greatest for the cluster 1 members and these variations are shrinking for the other two clusters. But the function model was kept one and the same.

CONCLUSIONS

Bulgarian food industry does not stand at a good position at present. As the results of the research show, this traditional Bulgarian industry sector was unable to move over the 1980s values. Partially this state is a result of misunderstanding by food processors how to manage their production more efficiently.

In addition, food consumption in Bulgaria grows much faster that the food production. That situation presents not just decline of food industry in Bulgaria but demonstrates how great is the loss of growth potential of the food producers in Bulgaria. Thus, we need to explore inside these negative processes. So, authors' study was based on Cobb-Douglas production function that was represented as a multiplication of all factors of production (labour inputs – L, material inputs – R, capital inputs – K, innovation inputs – M). In order to focus on the dependence of different variables of production function, authors used logarithmic value of the production function. This approach could be used as a prognostic tool as well as serve as a basis for time dependent comparative analyses for a variety of companies from Bulgarian food industry.

According to used business data for sample consisting 10% of food producers in Bulgaria, with higher level of material or labour inputs the higher is the level of overall production. But this is not the same as for the capital inputs as well as the innovation inputs. So, this gives the very high importance of the resource intensity of Bulgarian food industry.

As the different types of entity (resp. clusters) were tested, authors received a significant difference between them. Nevertheless, the production model was one and the same for the different clusters.

In summary, the greatest potential for dynamic change of Bulgarian food industry is in innovation inputs. Even though, the innovations have always been an important factor for the development and growth of companies, they are particularly important for the observed food processors. And for food sector the major role, among all types of innovations, is for product innovations.

Although the innovation capacity of Bulgarian food and beverage companies is relatively low, more and more companies had to realize the crucial role of innovations for their competitiveness. Moreover, innovations explicitly could re-define the margins of production capacity, and higher capacity means higher productivity and lower resource consumption.

The evaluation of innovation capacity for Bulgarian food entities, according to the suggested approach, could be of use in different strategy building. For example, the food processors could use enlarges of their innovative potential for basic aims:

- First, as process of utilization of basic innovation, they could raise their expenses for development of new products and technologies;

- Second, as result of general development of the entities, they could improve their overall marketing as well as the total turnover;
- Third, as result of the improvement of overall innovation capacity at national level, they could improve the overall technology level as well as found the next generation one.

Finally, the proposed approach of dynamic change analysis could be used to analyze the annually-based change of the importance of different production factors. This approach could help to learn in deep the change of any of the production variables as well as the production function.

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ZMIANY DYNAMICZNE PRODUCENTÓW ŻYWNOŚCI W BUŁGARII

Streszczenie. Produkcja żywności i napojów w Bułgarii zmieniła się dramatycznie po pełnym przystąpieniu do UE w 2007 roku. Zmiana ta wpłynęła nie tylko na strukturę produkcji, ale także na strukturę eksportu i importu jak też na całkowity potencjał produkcji sektora rolno-spożywczego. Celem artykułu jest wejrzenie w te zmiany z perspektywy pojedynczego producenta. Oznacza to odpowiedź na następujące pytanie: dlaczego bułgarska produkcja rolno-spożywcza pogorszyła się? Analiza pokazała, że przemysł spożywczy nie ma zdolności do przekroczenia poziomu produkcji z lat osiemdziesiątych XX wieku. Ważną przyczyną jest niezrozumienie przez przetwórców, że powinni zarządzać bardziej efektywnie produkcją. Największy potencjał dla zwiększenia dynamiki zmian w bułgarskim przemyśle spożywczym kryje się w innowacjach (rozwój nowych technologii i produktów, poprawa marketingu). Dla sektora spożywczego najważniejsze są innowacje produktowe.

Słowa kluczowe: przemysł spożywczy, dynamika przemysłu, rozwój przemysłu rolno-spożywczego

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