Articles

Dynamics of Food Production Before and After the Economic Crisis

Nikolay Sterev[*]

Dimitar Blagoev[**]

Ilia Gatovski[***]

Summary:

Historically, food industry is one of the oldest industries in Bulgaria, with more than 150 years of development. In recent years it is one of the industries that has decreased its share very fast. It is interesting to investigate the size and scope of its decline and to identify the main reasons for Bulgarian food producers to register loss of their traditional markets (local and European ones).

The paper explores the changes of food processing in the last five years. The structure of the paper covers the following basic points: the first section is Introduction. It gives a brief summary of the current state of food industry in Bulgaria. A brief theoretical background is given in the next section. It summarizes the evolution of industrial dynamics in economic theory. A detailed methodological approach is presented in third paragraph. Results from data analysis are given in the fourth section. It is based on a statistical analysis of enterprise data. A key issue of this analysis is a comparative analysis of the dynamic functions of Bulgarian food production before and after the 2008 crisis arose. Finally, the outcomes and conclusions are summarized.

Key words: industrial dynamics; crisis effects; food industry

JEL Classification: D24; L23; O14

1. Introduction

Food industry is one of the most important industrial sectors as it is related to one of the primary consumer needs as "hunger". In addition, the lack of raw resources as well as the agrarian specialization of Bulgaria have suggested the huge importance and have determined the development of food production in the last two centuries. But, the future development of this industry is connected to the answer of the following question: Is there enough potential for food industry growth?

The analyses made by many institutions and research teams stated that the development of the Bulgarian food industry

[*] Corresponding author, Associate Professor, Ph.D., Industrial Business Department, University of National and World Economy, e-mail: ind.business@unwe.acad.bg

[**] Associate Professor, Ph.D., Industrial Business Department, University of National and World Economy, e-mail: dmblagoev@abv.bg

[***] Senior Assistant Professor, Ph.D., Economics of Transport Department, University of National and World Economy, e-mail: gatovski@unwe.bg

has become faster after the year 2000. It is not only connected with the production and growth of the turnover but also with the improvement of techniques and technology inside the industry entities. Nevertheless,

- Number of employees;
- Employees' productivity indices.

Some basic conclusions could be drawn by analysing the figures:

1. Most of the indices show worsening of

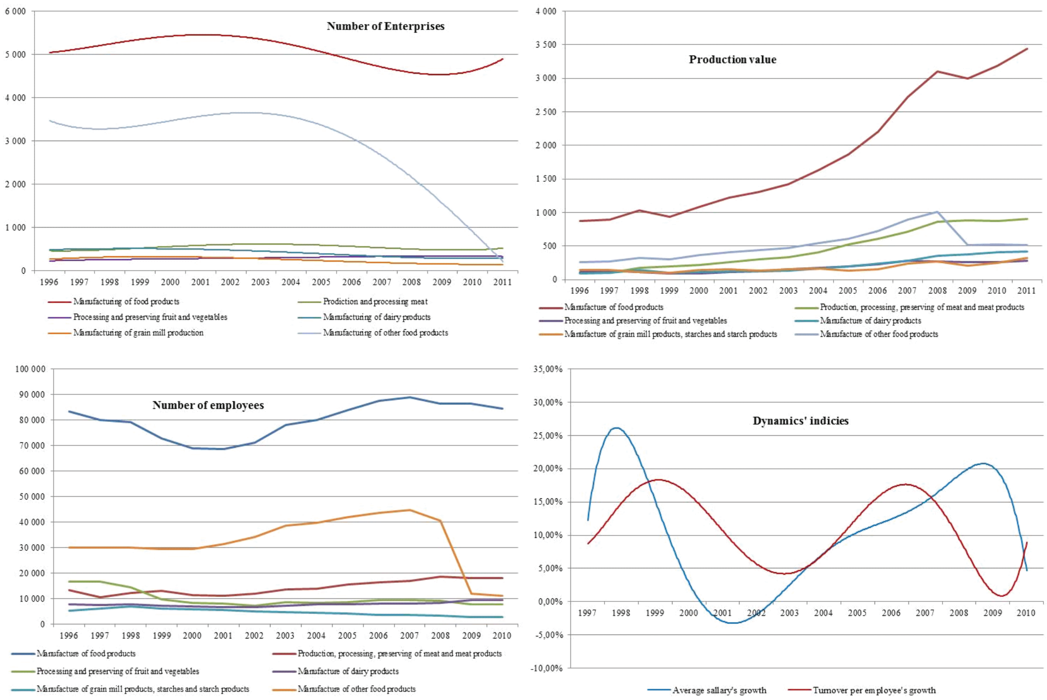

Fig. 1. Changes of Food sector in 1995-2011

Source: Eurostat and own calculations

there are a lot of authors[1] who report the decreasing growth potential of the Bulgarian food sector not only nowadays but also as a continuous process in the past 20 years.

To explore the state of the food production we had to compare the figures. We analyse the most basic indices of industrial dynamics as follows (Figure 1):

- Number of enterprises;
- Production value;

the situation of food production in Bulgaria. There has been a decrease in the number of entities as well as in the number of employees in the food industry for the last 4 years since 2007. Only the growth of the production value is positive.

2. The overall number of food producers has gone down by more than 10-15% in 2009 compared to 2001. This is a result of the huge drop down of dairy and meat processing entities, as well as the decline of farmers.

[1] See Noev N. 2003; Mishev Pl. (2003; 2003a); Ivanov B. (2005; 2009) and others.

3. As result of the global crisis, the number of employees has dropped by 8% in the last few years. The smaller the entity, the bigger the employment reduction. Thus even though there is a decrease in the number of dairy and meat processors, the number of their employees has not changed dramatically.

4. The greatest negative trend is in the labour productivity. The average salary overlaps with the average productivity growth in the period 2003 - 2010. Thus the labour produces less than it costs to enlarge.

5. Nevertheless, the overall production value has significantly increased since 1995. Even though the grouwth rate has slowed down since 2008, the overall grouwth amounts to 7 times for 20 years. But researchers are sceptic about the food industry growth.

Figure 1 shows some of the problems of food processing in Bulgaria as follows:

- The production value grows steadily as the price goes up by the inflation push-up;
- The production value declines only for the traditional Bulgarian food products as follows: meat processing and meat products; milk processing and dairy products;
- The dynamics indices are too unstable as they move up and down for the whole period;
- The change of workers' salary exceeded the production growth for half of the years.

To identify what happens behind the change of the figures we had to analyse some reported problems for the decline in food production as follows:

1. The food production is dependent on the development stage of food resources. The production of basic food resources from the agrarian sector has been declining in the last 20 years as many agri-food specialists show[2]. Therefore, the level of quality and quantity of food supplies is continuously falling as a result of the changing agrarian structures in Bulgaria. This continuous fall is observed by the Bulgarian Ministry of Agriculture and Food and has been reported in many annual reports of the ministry during the last decade.

2. The food producers had to fulfil the increasing requirements of food safety as well as the growing numbers of food quality standards. It is good for the consumers, but it is not good for the producers as they are not prepared for such high standards. For example, many producers were pressed to implement the requirements of ISO 9000 as well as the HACCP standards at the beginning of 2007[3]:

3. Food producers are small and medium enterprises (SMEs) in a market with low entry and exit barriers. Thus, many of these entities did not do anything for their sustainable development and just operated on the crest of the wave. Therefore, researchers report deteriorating conditions of doing business.

4. Last but not least, the food producers have to fight with the worsening national infrastructure.

2. State of the art

The analysis of changes in the dynamics of the food industry needs a brief presentation of the development of the dynamics approach in economic thought.

Basically, the concepts of growth and dynamics have emerged in the middle of the

[2] See Mishev Pl. (2003; 2003a); Ivanov B. (2009), Noev N. (2003) and others.

[3] See Shterev, Kopeva & Blagoev (2011b) and Blagoev, Sterev, Kopeva (2011)

20th century as part of the understanding of the strategic development of the business. However, the understanding of the enterprise's growth as a macroeconomic phenomenon dates back to the beginning of the 2000's.

Nevertheless, the basics of growth are connected to Forrester way back in 1961, when he gave a definition of industrial dynamics. He said that industrial dynamics is a **result of the increasing ability to enforce the industry evolution** (Forrester, 1988) for long-term periods.

In addition, we can find that the industrial dynamics is the process of investigation of the information-feedback character of the industrial system and the use of models for design to improve the organizational forms and guiding policy (Forrester, 1999). Therefore, industrial dynamics analyses the forces and directions of changes in the industry architecture and may lead to evolution of markets (Mattig, 2009). Moreover, the industrial dynamics does not only describe and analyse the current industrial structure, but these market driven factors can change the economic structures over time as well. (see: Krafft, 2006; Dietrich, 2006).

Forrester's concept is developed by Carlsson and Eliasson (2001) who said that economic growth is a result of the interaction of all market actors. Thus, the early theoretical and empirical analysis of industrial growth is based on the assumption of perfect competition and constant returns to scales and uses a general production function (Formula 1):

$Y=A.\ f(K,L,M)$, where (1)

A – is Hicks' (1961) index of natural technological progress,

$f\ (K,\ L,\ M)$ – is a continuous twice differentiable function that is homogeneous of degree on capital and labour, and material.

Madani (2001) differentiates (Y) and obtains an expression for output growth as the growth of weighted shares in factors and inputs plus total factor productivity.

To define an industrial growth we need to explore the potential and strength of market competition. Thereby, industrial growth is associated with industrial dynamics, with the rates of market newcomers and market exits, and respectively with the rates of the birth and death of new market entrances (Dosi at al., 2004).

According to the competition approach Dosi et al. (2004) present the requirements for defining industrial growth:

- Relatively stable Pareto-type sized distribution of firms (measured by the number of employees or turnover).
- Broad statistical aggregates that allow finding relatively homogeneous groups of firms.

Both requirements allow identifying time-dependant distributions and thus identifying some sort of technological (market) life-cycle. Thus, industrial growth is both a quantity and quality enlargement of industrial sales in terms of continuous competition. It depends on productivity and the usage of production factors (such as labour, capital etc.) that characterise the level of overall market production.

In summary, industrial growth is equal to a continuous enlargement of the present and potential markets. Therefore, the growth is measured by the growth of GDP in many cases (Ju, Lin and Wang 2009).

3. Methodology

According to the state of art, the dynamics analysis of the food industry includes the analysis of a change of the food production. Even though there are some practical instruments for dynamic analysis we use instruments of Industrial dynamics function to study the changes in dynamics. The study is based on the Cobb-Douglas production function and Solow-Sven growth model[4].

So, the production function is represented as a multiplication of all factors of production (labour, capital and resources) (Formula 2)[5]:

$$P=f(L,K,R,M)=b_1.L.K.R.e^M+b_0+\varepsilon, \quad (2)$$

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 resources 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 – free article (expresses the influence on unreported outside factors of production in the model);

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

To ensure that there is no statistically confidential autocorrelation we use the log-function of the production value as well as the total productivity factors[6]. Thus in order to focus on the dependence of different variables of the production function we further develop the production function by putting it to a logarithmic base. This results in the next Formula 3:

$$Y'=\ln P=a_1^L\ln L+a_1^K\ln K+a_1^R\ln R+a_1^M M+a_0+\varepsilon \quad (3)$$

Furthermore, the impact of any single variable on the dependent Production function could be found as the following Formula 4 – 7.

- Labour inputs:

$$\ln L=\frac{\ln P-a_1^K\ln K-a_1^R\ln R-a_1^M M-a_0-\varepsilon}{a_1^L} \quad (4)$$

or $\ln L=c_1^L\ln P-c_0^L-\varepsilon$, 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).

- Material inputs:

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

or $\ln R=c_1^R\ln P-c_0^R-\varepsilon$, 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:

$$\ln K=\frac{\ln P-a_1^L\ln L-a_1^R\ln R-a_1^M M-a_0-\varepsilon}{a_1^K} \quad (6)$$

or $\ln K=c_1^K\ln P-c_0^K-\varepsilon$, 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 capital intensity respectively (K).

- Innovations inputs:

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

or $M=c_1^M\ln P-c_0^M-\varepsilon$, 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).

According to the abovementioned, the different indices $c_1^i, \in\{L,R,K,M\}$ could be

[4] See Kuznetsov and Michasova (2007)
[5] A similar explanation is done by Vezzani A. and S. Montresor (2013)
[6] See Kopeva 2011a and Blagoev 2013

used for evaluation of the resource capacity and respectively – the potential of the food producers to use different production factors for growth.

4. Data Analysis

The analysis of the change in the dynamics of Bulgarian food industry is based on business data from 138 food processors. The data is collected[7] by the National Statistical Institute from their annual financial books and interviews with their executive managers and/or their owners.

The observation sample includes almost 3% of the Bulgarian food entities (compared to their number in 2010) in 6 major food specialisations that are very important for the Bulgarian food industry as follows:

a. Processing and preservation 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 preservation of fruit and vegetables;
f. Manufacture of other food products.

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

The biggest observed share is given to the most important products as: bakery and confectionery (other food products) as well as to the dairy and meat processing entities (Figure 2, left).

The observation covers food processors from all 6 regions on NUTS 2. Their distribution is not equal as it is not equal at the national level. Therefore, the biggest share of observation is given to South

Table 1. Number and share of all observed food processors

	Number of enterprises (for 2010)	Share (%)	Number of enterprises of observation	Share of observation (%)
Manufacture of food products	**4 829**	**100,0%**	**138**	**2,9%**
Processing and preservation of meat and production of meat products	491	10,2%	19	*3,9%*
Processing and preservation of fruit and vegetables	329	6,8%	5	*1,5%*
Manufacture of dairy products	296	6,1%	12	*4,1%*
Manufacture of grain mill products, starches and starch products	155	3,2%	10	*6,5%*
Manufacture of bakery and farinaceous products	2 652	54,9%	48	*1,8%*
Manufacture of other food products	583	12,1%	44	*7,5%*

Source: : Eurostat, project data and own calculations

[7] The data are collected by empirical research at project № INI DMU 02 – 24/2009: Structural changes of Food and beverage industry after 1991; that is financed by the National Science Fund of the Bulgarian Ministry of Education and Science.

Central as well as to South West regions. The fewer shares are given to the less developed regions in Bulgaria like the North Central and North West regions. In addition, different regions have different food specialisation according to the resources available (Figure 2, right).

4.1. Production factor dynamics analysis

The dynamics analysis is based on the basic book results of the observed entities that are connected to the production function as the following:

- Labour costs (L);
- Material costs (R);

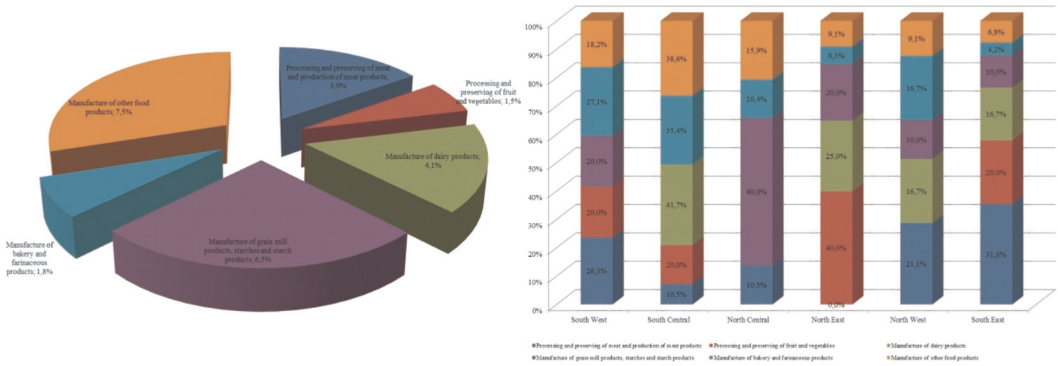

Fig. 2. Distribution of observation by their product specialisation (left) and region at NUTS 2 (right)
Source: Project data and own calculations

- Investment costs by value of Long-term assets (K);
- Innovation costs (M)[8];
- Total costs (L+R+K+M+administrative costs = P);

The data analysis is done in 2 stages:

1. Total Production Factor Dynamics analysis by years: 2007, 2009 and 2011.
2. Comparative analysis of Dynamics change.

Table 2. Correlation coefficients between production function and production factors

		Production (P)	Material Costs (R)	Labor costs (L)	LTA (K)	Production Function (Y)
Production (P)	Pearson Correlation	1	,877**	,693**	,764**	,891**
	Sig. (2-tailed)		0,000	0,000	0,000	0,000
Material Costs (R)	Pearson Correlation	,877**	1	,677**	,759**	,843**
	Sig. (2-tailed)	0,000		0,000	0,000	0,000
Labor costs (L)	Pearson Correlation	,693**	,677**	1	,666**	,471**
	Sig. (2-tailed)	0,000	0,000		0,000	0,000
LTA (K)	Pearson Correlation	,764**	,759**	,666**	1	,564**
	Sig. (2-tailed)	0,000	0,000	0,000		0,000
Production Function (Y)	Pearson Correlation	,891**	,843**	,471**	,564**	1
	Sig. (2-tailed)	0,000	0,000	0,000	0,000	

*** Correlation is significant at the 0.01 level (2-tailed).*
Source: Project data and own calculations (by SPSS 17.0)

[8] The Innovation costs are 0 for the entire observed sample and they are reduced from the dynamic model analysis.

- Production function (**Y** – Formula 1 – 2)

Dynamics analysis starts with a verification of the production function (Formula 1) for the sample. We use statistical analysis by parametric correlation. As expected, there is a high statistical correlation between the production factors and the production function (Pearson's correlation coefficient is over 0.693 and significance coefficient – 0.000) as well as between the different production factors (Pearson's correlation coefficient is over 0.471 and significance coefficient – 0.000) (Table 2).

The figures verified the consistency of the dynamics model. Thus, it allows us to focus our attention on the analysis of log-functions (Formula 3 – 7).

Thus, the following test is a correlation analysis between log-value of production costs and log-values of elements of the production function as follows (Table 3):

- Material costs, respectively LOG of Material costs ***(LogR)***;
- Labour costs, respectively LOG of Labour costs ***(LogL)***;
- Capital costs, respectively LOG of Capital costs ***(LogK)***;
- Total costs, respectively LOG of Total costs ***(LogP)***;
- Production function, respectively LOG of Production function ***(LogY)***;
- Function of LogProduction factors (***Y'*** - Formula 3)

The correlation analysis verified that food processors are resource intense ones. Therefore, we found that there is a high

Table 3. Correlation coefficients between production function and production factors

		Production (LogP)	Material Costs (LogR)	Labor costs (LogL)	LTA (LogK)	Production Function (LogY)	LogProduction function (Y')
Production (LogP)	Pearson Correlation	1	,793**	,843**	,642**	,818**	,777**
	Sig. (2-tailed)		0,000	0,000	0,000	0,000	0,000
Material Costs (LogR)	Pearson Correlation	,793**	1	,775**	,659**	,898**	,785**
	Sig. (2-tailed)	0,000		0,000	0,000	0,000	0,000
Labor costs (LogL)	Pearson Correlation	,843**	,775**	1	,689**	,869**	,902**
	Sig. (2-tailed)	0,000	0,000		0,000	0,000	0,000
LTA (LogK)	Pearson Correlation	,642**	,659**	,689**	1	,848**	,661**
	Sig. (2-tailed)	0,000	0,000	0,000		0,000	0,000
Production Function (LogY)	Pearson Correlation	,818**	,898**	,869**	,848**	1	,959**
	Sig. (2-tailed)	0,000	0,000	0,000	0,000		0,000
LogProduction function (Y')	Pearson Correlation	,777**	,785**	,902**	,661**	,959**	1
	Sig. (2-tailed)	0,000	0,000	0,000	0,000	0,000	

*** Correlation is significant at the 0.01 level (2-tailed).*

Source: Project data and own calculations (by SPSS 17.0)

Table 4. Model summary and parameters estimates Dependent Variable: Toatal Costs v (LogP)

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Material Costs (LogR)	0,629	444,306	1	262	0,000	2,377	0,793
Labor Costs (LogL)	0,711	648,403	1	263	0,000	0,684	1,151
LTA (LogK)	0,413	186,871	1	266	0,000	2,317	0,657
Production function (LogY)	0,670	526,723	1	260	0,000	1,401	0,333

Source: Project data and own calculations (by SPSS 17.0) dependence of Production by Labour input (Pearson's correlation is 0.843) as well as Materials input (Pearson's correlation is 0.793). In addition, even though the overall production value depends on the investments' inputs, the dependence is insignificant as the Pearson's correlation is lower than the other factors and it is 0.642.

The last conclusion is verified by constructing the dependency models (Table 4 and Figure 2).

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. In addition the model explains over 70% of the observations (as the R-square is around 0.7). These figures show how strong the material as well as the labour intensity of the Bulgarian Food processors is. Nevertheless, the correlation

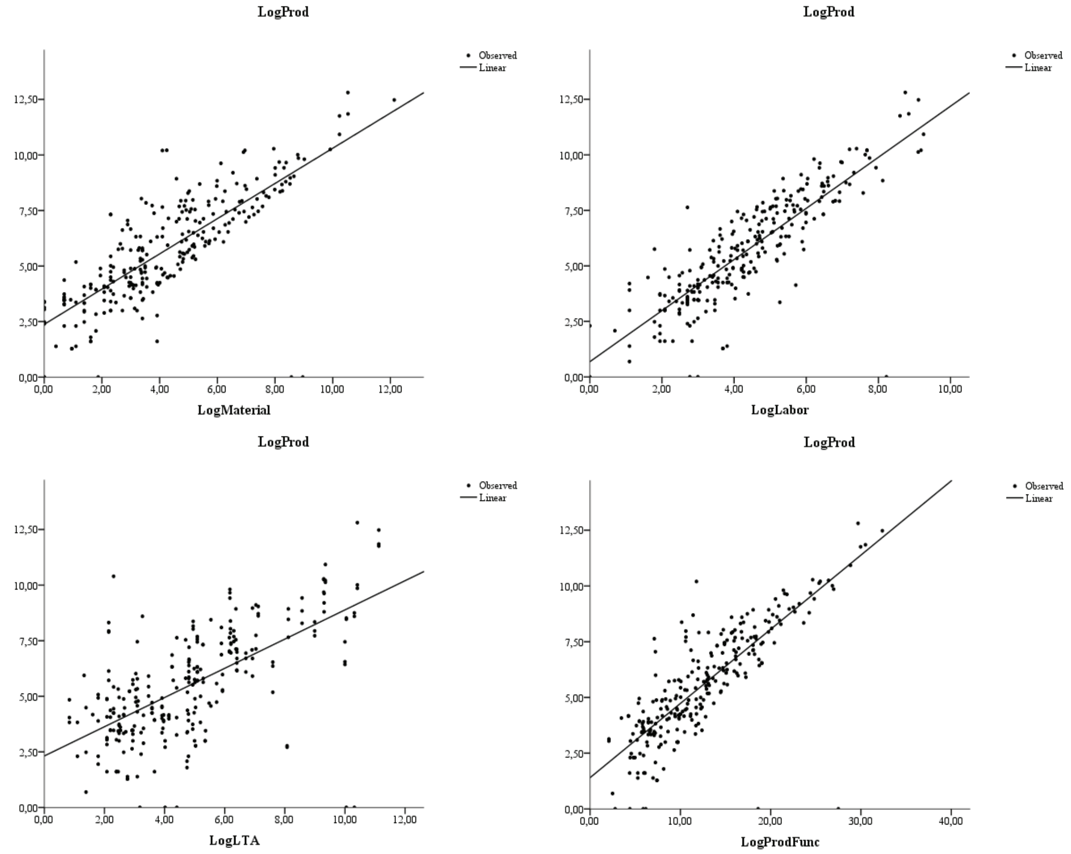

Fig. 3. Graphic models of LOG of Production function and its independent variables
Source: Project data and own calculations (by SPSS 17.0)

As the figures show, the higher level of Material or Labour inputs gives a higher level of production. This state is not so obvious for the capital inputs, where the between production value and capital input is significantly strong, the dependence between production and its independent variable: capital inputs, is not as strong as the variance of the LOG function is greater as well as the Parameter estimation for b_1 is below 0.70 and R-square is around 0.4.

The dynamics analysis gives a point of view to compare the dynamics models between different years.

The first step is a correlation analysis to check out if the values of the variables depend on the year. We use statistical analysis by non-parametric correlation (Table 5).

According to the table, we have to expect a relatively strong dependence between material costs change and year as well as not a very strong variation of the production function according to the different years of observation. This could be verified by constructing the year-based dependency models (Table 6 and Figure 3)

The figures only verified the above conclusions as they allow us to summarise the following:

- There is no big difference of the model construction. Moreover, the overall tendency is for improvement of resource usage. Thus, 2011 is better than the

Table 5. Correlation coefficients between Logarithmic values of production function and its factors, and the year of observation

			Production (LogP)	Material Costs (LogR)	Labor costs (LogL)	LTA (LogK)	Production Function (LogY)	LogProduction function (Y′)
Spearman's rho	Year	Correlation Coefficient	0,071	,358**	-0,007	-0,008	,160**	,119*
		Sig. (2-tailed)	0,224	0,000	0,905	0,877	0,008	0,019

*** Correlation is significant at the 0.01 level (2-tailed).*
** Correlation is significant at the 0.05 level (2-tailed).*

4.2. Production factor dynamics analysis at annual rate

The second step of our analysis is based on the comparison of the dynamics models for three years as follows:

- Year before economic crisis – 2007;
- Year at the core of crisis – 2009, and
- Year at the end of crisis – 2011.

As the figures above give the consistency of the dynamics model for the observation sample, the comparative analysis covers only the dynamics change of the importance of the production factors.

Table 6. Model summary and parameters estimates
Dependent Variable: Total costs (LogP)

Independent variable	2007		2009		2011		Average	
	Constant	b1	Constant	b1	Constant	b1	Constant	b1
Material Costs (LogR)	2,310	0,966	2,232	0,970	1,276	0,844	2,377	0,793
Labor Costs (LogL)	-0,054	1,293	0,341	1,188	1,566	1,009	0,684	1,151
LTA (LogK)	1,665	0,733	1,680	0,757	3,345	0,515	2,317	0,657
Production function (LogY)	1,410	0,352	1,181	0,359	1,420	0,311	1,401	0,333

Source: Project data and own calculations (by SPSS 17.0)

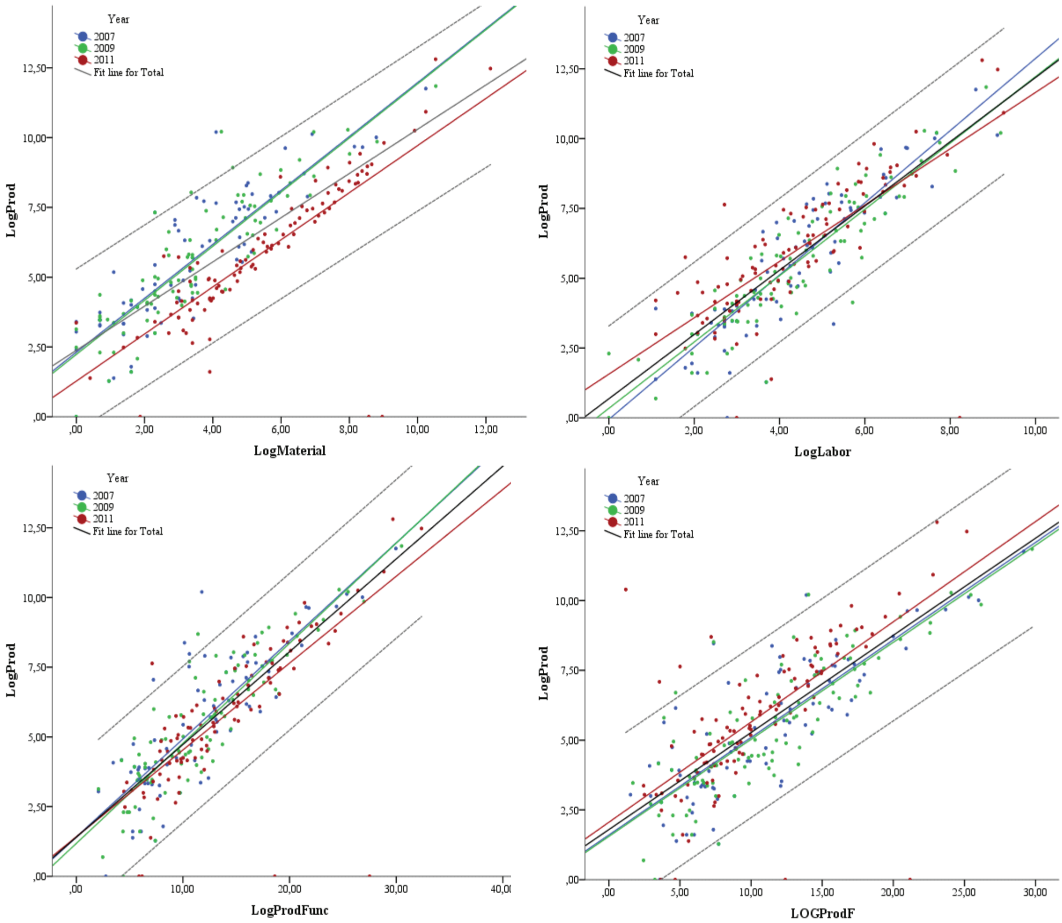

Fig. 4. Graphic models of LOG of the Production function and its independent variables according to the Year of observation

Source: Project data and own calculations (by SPSS 17.0)

previous periods. A very slight downward slope is observed for the crisis year – 2009.

- Nevertheless, the figures show that there is no statistical difference between the dynamics of production for 2007 and 2009. The input intensity are one and the same for these two periods. The biggest difference is observed for 2011 in the following directions:
  - The model of **material inputs** is kept, but the economic downturn is demonstrated by a downward movement of the dynamics model . This is a result of the increase of the material intense of the production. So not only did the food industry mark a decline, but also it was a result of the decline of less material intense food specialisations.
  - The model of **labour inputs** is modified as labour intense as well as labour importance. The final result of this transformation is: 20% more labour intense of the food production.

Finally, 2 years after the start of the

economic crisis, the food industry lagged behind. The result of this decline is increase of the labor-intense production specialisation and producing less food production with more material as well as labour inputs.

Conclusions

The Bulgarian food industry does not enjoy a stable development at present. As the figures show the overall dynamics of this traditional Bulgarian sector, food industry does not have the ability to move over the 1980s values. This state is partly the result of the fact that food processors do not know how to manage their production more efficiently.

In addition, literature preview shows that the Bulgarian food production is a resource intensive one. Thus, it produced low quality as well as low-value food products. But it is not enough to sell abroad and on the country markets. Therefore, it is true that "bigger means better" for the Bulgarian food processors. Thus, even when condition factors related to the conditions are improving, the biggest food processors rely more and more on the resource inputs rather than on material and labor inputs.

To verify these preliminary statements we conducted our study that is based on the Cobb-Douglas production function and represents food production as a multiplication of all factors (variables respectively) of production (labour inputs (L) respectively, material inputs (R), capital inputs (K), innovation inputs (M)). However, in order to focus on the dependence of different variables on the production function we used the logarithmic value of the production function.

According to the used business data for the 3% - sample of food producers in Bulgaria, the higher the level of material or labour, the higher the level of overall production. But this is not the same neither for the capital inputs nor for the innovation inputs. So, this state accounts for the very high importance of the resource intensity Bulgarian food industry.

In addition, the intensity is getting bigger for 2007-2011. Thus, there is not only an overall decline of the food production, but also there is an increase of the role of labour intense and material intense food specializations.

In summary, innovation inputs possess the greatest potential for dynamic change of the Bulgarian food industry. Even though the innovations have always been an important factor for the development and growth of companies, in the current state they are particularly important for the observed food processors. Furthermore, product innovations, among all types of innovations, play the major role in the food sector. Thus, although the innovation capacity of the Bulgarian food and beverage companies is relatively low, more and more companies have to realize the crucial role of innovations. Moreover, innovations explicitly could re-define the margins of production capacity, and higher capacity means higher productivity and lower resource consumption.

In conclusion, the figures show that there is an "outdated understanding" of the market and the market functions at the food markets. Thus, the food industry not only declines but it has lost also its competitiveness and growth potential as well. So, there is only one right decision: cooperation of food processors not only in the supply of resources but in the investments in innovation, in new food technologies and/or products, as well. If this does not happen, the free fall of the food industry will continue.

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