Regional Aspects of Transformations in Agriculture: The Case of the Republic of Bulgaria

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Article

Regional Aspects of Transformations in Agriculture: the Case of the Republic of Bulgaria

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Abstract: Transformations in agriculture not only change the ways in which natural resources and social capital are used, but are also a prerequisite for different opportunities to create added value and improve the viability of rural areas. The purpose of the article is to assess the differences and effects of transformations in agriculture in the Bulgarian regions. Based on statistical data from the Censuses of agricultural holdings in 2010 and 2020, the DEA analysis method was applied. Six models (3 input oriented and 3 output oriented) were constructed and tested, and the efficiency coefficients were assessed on regional level. The degree of structural changes and efficiency of the used production and other resources were evaluated and conclusions were drawn. In the majority of the models, differences are observed between the northern regions of the country and the South Western and South Central regions. The most significant are the efficiency coefficient of the labor force used and the output produced, the gross value added and the net mixed income. In the other models, multidirectional changes are observed. North Western is the region in which all calculated efficiency coefficients increase, and in North Eastern and South Eastern, the most calculated coefficients decrease.

Keywords: transformations; DEA analysis method; relative efficiency; regions

1. Introduction

More than 30 years, substantial and significant transformations have been taking place in Bulgarian agriculture, which fundamentally changed its production structure, the markets for realization, the number and characteristics of agricultural holdings, employment in the sector, the place of agriculture in the local economy, etc. The parameters and consequences of these transformations have been explored and discussed in different contexts and aspects. If at the end of the last century the center of research interest was the process of conducting land and organizational structural reforms [1–3], then after 1999 with the creation of State Fund "Agriculture" came to the fore the consequences of the implemented reforms [4–6], the ongoing restructuring and the significant problems that occurred in the production structure.

Production and organizational restructuring (before and after our country's accession to the EU) have different dimensions in regional terms. Under the influence of the common agricultural policy, part of the crop production received additional incentives for development, which had a positive effect on the incomes of those employed in them. The increased productivity and efficiency of labor in the areas where these industries prevail led to the concentration of production, the rapid reduction of agricultural holdings and the acceleration of negative demographic trends in rural areas [7,8]. In other crop growing and most animal breeding productions, tendencies are in reduce the number of produced products, liquidation of agricultural holdings, which created prerequisites for significant transformations in the economy of rural areas [9,10], to increase unemployment in them and to intensify migration processes. These trends continue, regardless of the adopted and implemented national programs for the development of a number of vulnerable sectors.

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In this regard, arises the question how agricultural holdings with different specializations and size affect the development of rural areas. In which areas are the natural resources and comparative advantages of local conditions used to a greater extent?

The purpose of the article is to assess the distinctions and effects of transformations in agriculture in different regions of the country. In practice, this means identifying in comparative terms the areas where transformations have improved the use of natural resources, social capital and contributed to regional development.

The thesis of the research is that transformations in agriculture not only change the ways of using natural resources use and social capital, but also are a prerequisite for different opportunities for creating added value and for the improvement of the viability of rural areas.

The article has the following structure: literature review, methodology, analysis of regional differences and changes in production, characteristics of production structures, discussion and conclusion.

2. Literature Review

Geographical conditions and location strongly influence various socio-economic processes in society. Among these processes are the problems of the regions where agriculture is developed and various regional specializations have been formed. Scientific interest in these problems' dates back to the first half of the 19th century, when Tünen published The Isolated State in 1826. His theory of the location of agricultural production with five rings of different types of production around the city as a single, centrally organized market was further developed by Dickinson (1964). The author examines concentric rings of farms that show decreasing intensity as they move away from the city. Alfred Weber added the role of two sets of location factors - regional factors (eg transport or labor costs) and local factors (eg processes of agglomeration and de-agglomeration). A number of researchers consider that due to the peculiarities of agriculture as an economic activity, location theories fail to fully explain the location of agricultural production [11,12]. Agricultural production requires not only land, technology, capital, institutions, infrastructure and skills, but also depends on the necessary natural conditions to produce agricultural output [13]. Natural, environmental and climatic conditions can be very heterogeneous within individual countries, allowing them to diversify their agricultural production baskets. In this context, an important topic is the production specialization of agricultural holdings and regions, to use their comparative advantages and natural resources, to produce with lower unit production costs and with higher labor productivity. As many studies show, the spatial diversity of the quantity and quality of the main production factors are the fundamental determinants of the spatial distribution of activities and their efficiency. In addition, agriculture is a sector with unique characteristics that cannot be regulated by market principles alone, such as its problems affected by the structural characteristics of world markets and market distortions due to intervention policies [14].

In recent decades, there has been a growing number of researchers who not only recognize the multifunctional characteristics of agricultural production and their impact on territorial development [15–17], but also empirically analyze and evaluate them [18,19]. Some authors [20] interpret the multifunctionality of agriculture as a cornerstone of sustainable territorial development, emphasizing the importance of public goods and ecosystem services as new opportunities for development of the rural economy.

Studies in different rural areas have concluded that farming patterns are formed and they influence the farmer's choice to expand in the direction of agricultural production or to multifunctionality and the related networking with other local entrepreneurs and consumers [21,22]. This confirms the need to take into account the specific conditions and to apply adapted territorial approaches and strategies for the development of agriculture in a regional context [23–25].

3. Methodological Framework

In the article, the assessment of changes in agriculture is made in a temporal and regional context. Changes between 2010 and 2020, when farm censuses were conducted, are analyzed.

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Regional differences are examined at the statistical region level (NUTS-2), and for some indicators at the district level (NUTS-3).

Some of the main statistical indicators are the object of research interest: number of agricultural holdings, average size of used agricultural land per farm, used agricultural land, animal units, annual work units; standard production volume, relative shares of the main sectors in the total output, gross added value per annual work unit, gross added value per unit of used agricultural land, etc.

The comparison between the regions and districts is made using the data envelopment analys (DEA), which is widely applied in research in the field of agricultural economy [26,27] and tracking the transformations in agriculture [28]. In her research, Zaimova [29] prepared a DEA analysis to assess the economic efficiency of 130 producers registered in the South Central and South Eastern regions and members of producer organizations for the period 2005 - 2008. Gospodarović [30] analyzed the technical efficiency of high commodity farms in Poland, including indicators such as used agricultural area, labor input in agriculture, durable material assets and the amount of commodity production. The efficiency was calculated for four selected years in the period 1992 - 2005. Optimizing the technical efficiency of agricultural farms in mountain areas by a DEA analysis is carried out in the research of Kaneva [31], where in order to make the comparison, the analysis is applied with and without the use of subsidies. Toma et al. [32] used DEA analysis to compare and analyze the agricultural efficiency in plain, hilly and mountainous areas in thirty-six countries.

In this paper, the comparison between the statistical regions and the changes that occurred in them for the period 2010 - 2020 is made by using DEA analysis. The method is suitable for the purposes of the article, as it enables the assessment of the relative efficiency of the Decision Making Units (DMU) from the sample [33]. This lead to determination of the most effective unit, which is located on the efficiency border by linking inputs to outputs [33]. To carry out the DEA analysis, input oriented models are used, looking for the coefficient of technical efficiency of production resources [29,34] and output oriented models, by calculating the coefficient of technical efficiency of the final product. The DEA models used in the article assume one level of efficiency for optimal (Constant Return to Scale – CRS). One ratio between output and used resources is defined as 100 % efficient and all units are compared with it. It is possible for several units to get 100 % if it is true for all of them that the input and output indicators are exactly in this ratio – the most optimal possible ratio for the efficiency of the production process [35]. For the comparative analysis between the regions, three input oriented models (for 2010 and 2020) and 3 output oriented models were constructed. The data for the indicators used were taken from the National Statistical Institute - Infostat database [36].

Input oriented models aim to evaluate the effectiveness of the inputs used and the output obtained. The used indicators in the models are presented on Table 1.

Table 1. Input oriented models.

Models	Input indicators (million BGN)	Output indicators (million BGN)
Model 1	costs for fuels and oils veterinary costs feed additives	manufactured products from animal husbandry
Model 2	seeds and planting material fuels and oils fertilizers and soil improvers plant protection preparations	crop production
Model 3	used agricultural area (ha) annual work units (number) intermediate consumption consumption of fixed capital	gross added value at basic prices

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Output oriented models evaluate the efficiency of the input resource used and the results obtained. The output oriented models are presented on Table 2.

Table 2. Output oriented models.

Models	Input indicators	Output indicators (million BGN)
Model 4	annual work units (number)	agricultural production gross added value net mixed income
Model 5	used agricultural area (ha)	agricultural production gross added value net mixed income
Model 6	average agricultural land used per farm (ha)	average total farm production (BGN) average gross value added per holding (BGN) average net income per farm (BGN)

4. Analysis of Changes and Regional Differences

One of the main results of the restoration of ownership and use of agricultural land in Bulgaria was the creation of an extremely large number of agricultural holdings. In the years of transition to a market economy, these holdings quickly began to decline, forming a structure including a very high relative share of small sized holdings and a small share of very large holdings. A dualistic structure of agricultural holdings is observed even now, regardless of the effects of direct payments and other CAP measures for priority financing of small agricultural holdings. If in 2010, 94.1% of farms were up to 10 hectares and used 8.5 % of the agricultural land, and the remaining 5.9% cultivated 91.5 %, then in 2020 farms with a size of over 10 ha are 13.5 % and they use 94.8 % of the agricultural land [37,38].

For the period 2010-2020 farms decreased by more than 64 % from 370 thousand farms (2010) to 132.7 thousand farms in 2020. Number of farms decreased the most in the North Western region (3.36 times), followed by the South Eastern region (3.1 times) (Figure 1). The changes are smaller in the South Central and South Western regions, where farms decreased by 2.56 and 2.6 times, respectively. At the NUTS-3 level, the dimensions of the changes are even more significant. In the regions of Lovech (over 4.2 times), Varna and Stara Zagora (over 3.7 times) and Silistra (3.5 times).

The changes in the number of holdings lead to a significant increase in the average size of the used agricultural land of the holdings (Figure 2). With an average increase of the indicator by 3.27 times for the country, its value varies between 4.1 times for the North Western region and 3.1 times for the North Eastern region. Differences between regions are increasing. If in 2010 the difference in average size between the highest and the lowest rate in statistical regions was 14 hectares (between the North Eastern and South Western regions), then in 2020 the difference reached 49 hectares (between the North Western and South Central regions).

One of the main reason for such changes is the deepening specialization of the North Western and North Central regions, in which the relative share of crop products reaches 88 % in 2020 compared to 52 % in 2010 and in the North Central - 80.7 % compared to 39 % in 2010.

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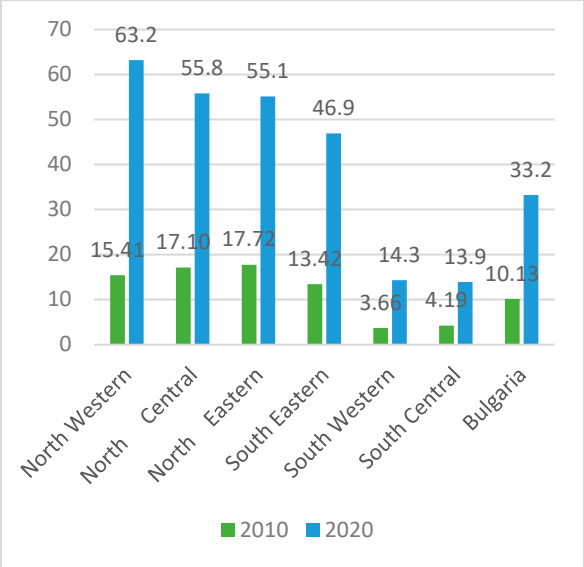

Figure 1. Number of agricultural holdings. Source: [37,38].

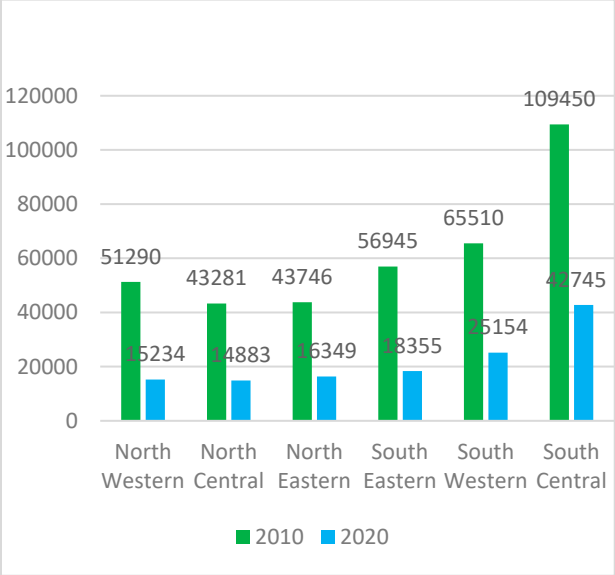

Figure 2. Average size of agricultural holdings, ha Source: [37,38].

The relative share of livestock production is highest in the South Eastern and South Central regions, respectively 36.11 % and 33.07 % (45.2 % and 43.1 % in 2010). Animal units are also the most numerous in these two statistical regions. In the South Central region, they practically maintained their numbers during the period. The North Western region not only has the smallest number of livestock units, but they also decreased the fastest by more than 26 % over the ten-year period (Table 3). This process takes place despite the fact that the multiplier effect of the livestock sector has been shown to be greater than that of the crop sectors: [40]. When livestock production does not use regional comparative advantages, the accompanying effects in a regional context are not realized either.

 doi:10.20944/preprints202410.1733.v1

Table 3. Changes in the number of animal units and annual work units (2010 and 2020).

Regions	Animal units			Annual Work Units (AWU)		
	2010	2020	2020/2010	2010	2020	2020/2010
North Western	158420	115867	73.14	50723	21159	41.71
North Central	193610	164774.5	85.11	51895	23288	44.87
North Eastern	182504	157639	86.38	53141	23376	43.99
South Eastern	219276	217131	99.02	59342	26054	43.90
South Western	122180	122042	99.89	64,607	27122	41.98
South Central	273745	247652	90.47	126811	46641	36.78
Bulgatia	1149737	1025106	89.16	406519	167639	41.24

Source: [37,38].

The formed regional production structures are also the basis of the differences in the number of annual work units. They have decreased in all regions, but most significantly in the South Central and South Western statistical regions. The smallest changes are in the North Central, North Western and South Western regions.

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A comparison of standard production volumes in 2010 and 2020 shows an increase in all regions. On average for the country, the indicator increased by 66.44 %, ranging from 86.37% for the North Western to 41.07 % for the South Central region. In the three regions of Northern Bulgaria, a greater increase was registered compared to the southern regions.

As a result of the established production structure of regional agriculture, significant differences are observed in the gross added value and in the net income of one hectare (Table 4). These indicators are highest in the South Central region, followed by the North Eastern region in 2010, and in 2020 the two districts have swapped places. Gross value added per hectare increased in five of the regions, ranging from 232.6 % in the South Eastern region to 118.17 % in the North Central region. Only in the South Central region the value of the indicator remained.

Table 4. Average value added per hectare and average net income per farm.

Regions	Average gross value added per hectare (BGN)			Average net income per farm (BGN)		
	2010	2020	2020/2010	2010	2020	2020/2010
North Western	742,50	1148,33	154,66	418,85	389,03	92,88
North Central	922,28	1089,88	118,17	469,60	261,36	55,66
North Eastern	1039,31	1278,12	122,98	508,30	603,76	118,78
South Eastern	695,78	1618,50	232,62	397,05	1004,31	252,94
South Western	792,45	1250,74	157,83	277,92	402,20	144,72

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South Central	1416,17	1414,56	99,89	825,52	1058,06	128,17

Source: [39]

Authors should discuss the results and how they can be interpreted from the perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted.

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The formed regional production structures are also the basis of the differences in the number of annual work units. They have decreased in all regions, but most significantly in the South Central and South Western statistical regions. The smallest changes are in the North Central, North Western and South Western regions.

5. DEA—Results and Discussion

5.1. Input Oriented Models

Data from the DEA analysis regarding the three types of costs related to livestock production - fuels and oils, veterinary costs, feed additives and animal production in 2010 and 2020 show the effectiveness of the costs incurred for the unit of production in the six statistical regions (Table 5). In 2010, the South Central region was determined to be the most inefficient in terms of livestock production costs, followed by the South Wester. The efficiency of the costs of fuels and oils, veterinary costs, feed additives and livestock production is the highest in the North Central and in the North Eastern region, as the efficiency ratio is 1. The efficiency of all three types of costs is high in 2010 and in the South Eastern and in the South Western region. For the period 2010-2020, the calculations show that there is an increase in the effectiveness of the costs incurred in the South Western and South Central regions, which is due to the reduction of the considered three types of costs in both regions with an increase in animal production in 2020 compared to 2010. There is a slight increase in cost efficiency in the North Western region as well. It can be concluded that in 2020 the efficiency ratio of the costs incurred in relation to the production of output in animal husbandry is high in all planning regions.

Table 5. Efficiency coefficient of the used fuels and oils, veterinary costs, feed additives and the obtained production in animal husbandry by statistical regions (Model 1).

DMU	2010	Rank	2020	Rank	Change
North Western	0,91	3	0,92	3	0,01
North Central	1	1	1	1	0
North Eastern	1	1	0,96	2	-0,04
South Eastern	0,95	2	0,87	4	-0,08
South Western	0,77	4	1	1	0,23
South Central	0,52	5	1	1	0,48

Source: own calculation

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The results from the DEA analysis also show the efficiency ratio in terms of the costs of seeds and planting material, fuels and oils, fertilizers and soil improvers, plant protection preparations and the produced output in crop production in 2010 and 2020 (Table 6). Both in 2010 and 2020, the efficiency of realized costs for plant production is above average. It is the lowest in the North Western region – 0.68, but in 2020 the coefficient reaches a value of 1, which can be explained by the more than two times increase in production with a decrease in the costs of fuels and oils and a slight increase in the costs of seeds and planting material. In 2010, the South Central region was determined to be the most inefficient in terms of livestock production costs, followed by the South Western. The efficiency of the costs of fuels and oils, veterinary costs, feed additives and livestock production is the highest in the North Central and in the North Eastern region, as the efficiency ratio is 1. The efficiency of all three types of costs is high in 2010 and in the South Eastern and in the South Western region. For the period 2010-2020, the calculations show that there is an increase in the effectiveness of the costs incurred in the South Western and South Central regions, which is due to the reduction of the considered three types of costs in both regions with an increase in animal production in 2020 compared to 2010. There is a slight increase in cost efficiency in the North Western region as well. It can be concluded that in 2020 the efficiency ratio of the costs incurred in relation to the production of output in animal husbandry is high in all statistical regions.

Table 6. Efficiency coefficient of the used seeds and planting material, fuels and oils, fertilizers and soil improvers, plant protection preparations and the obtained crop production by region (Model 2).

DMU	2010	Rank	2020	Rank	Change
North Western	0,68	4	1	1	0,32
North Central	1	1	1	1	0
North Eastern	0,85	3	0,62	3	-0,2267
South Eastern	0,90	2	0,88	2	-0,0179
South Western	1	1	1	1	0
South Central	1	1	1	1	0

Source: own calculation

Table 7 presents the results of an efficiency analysis in terms of used agricultural area, annual work units, intermediate consumption and consumption of fixed capital and GVA at base prices. In 2010, the statistical region that is the most efficient in terms of the use of production factors is the North Central region, followed by the North Eastern, South Western, North Western and South Eastern regions, where the efficiency coefficient is high - over 0.8. In the South Central region, the coefficient is above average. In 2020, a significant change in efficiency was observed in the North Eastern region, with the efficiency ratio decreasing from 0.97 to 0.55, and the region from second place in 2010 ranked fifth in 2020. A significant increase in land use efficiency, labor and capital and the resulting GVA is observed in the South Central region, and it went from the last place in 2010 to the first place in 2020. In the remaining four regions, the efficiency coefficient related to the analyzed indicators does not undergo a significant change.

Table 7. Efficiency coefficient of the used agricultural area, annual work units, intermediate consumption, consumption of fixed capital and received GVA (Model 3).

DMU	2010	Rank	2020	Rank	Change
North Western	0,87	4	1	1	0,13
North Central	1	1	0,84	2	-0,16
North Eastern	0,97	2	0,55	5	-0,42
South Eastern	0,82	5	0,61	4	-0,21

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South Western	0,88	3	0,70	3	-0,18
South Central	0,55	6	1	1	0,45

Source: own calculation

5.2. Output Oriented Models

Table 8 presents the efficiency coefficient of the labor force used and the output produced, the gross added value and the net mixed income in 2010 and 2020. In 2010, the efficiency coefficients were high in the three northern and South Eastern regions, and in the South Western and South Central regions they are below the average level, which defines both regions as inefficient in terms of the labor force used and the resulting output. In 2020 in the North Western region, the efficiency increases and reaches the maximum level. Despite the fact that, in the South Western and South Central regions, the coefficient of efficiency increases slightly, they remain ineffective. In the remaining three regions, the efficiency ratio decreases, with the largest decrease in the North Eastern region.

Table 8. Efficiency coefficient of the labor force used and the output produced, the gross value added and the net mixed income (Model 4).

DMU	2010	Rank	2020	Rank	Change
North Western	0,86	3	1,00	1	0,14
North Central	1,00	1	0,81	2	-0,19
North Eastern	0,96	2	0,70	3	-0,26
South Eastern	0,77	4	0,65	4	-0,12
South Western	0,26	6	0,27	6	0,01
South Central	0,29	5	0,36	5	0,06

Source: own calculation

The data from the DEA analysis in terms of the agricultural area used and the output produced, the gross added value and the net mixed income show that in 2010, the North Central and South Central regions are the most efficient, and in the rest of the regions the values of the coefficient are above 0.80 (Table 9). In 2020, the North Central region maintains its leadership position, and in the North Western region, efficiency increases and reaches the maximum level. The leading positions of these two regions in terms of the efficiency of the used agricultural area can be explained both by the increase in the average size of farms in them for the period 2010-2020, (which is the highest compared to the value of this indicator in the other statistical regions) and with production specialization (the relative share of crop production reaches 88 % in 2020). In the remaining four regions, the efficiency ratio decreases, with the largest decrease in the South Western region.

Table 9. Efficiency coefficient of the used agricultural area and the obtained output, gross value added and net mixed income (Model 5).

DMU	2010	Rank	2020	Rank	Change
North Western	0,80	3	1	1	0,2
North Central	1	1	1	1	0
North Eastern	0,95	5	0,80	3	-0,15
South Eastern	0,83	4	0,79	4	-0,4
South Western	0,87	2	0,54	5	-0,33
South Central	1	1	0,90	2	-0,10

Source: own calculation

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In the remaining four regions, the efficiency ratio decreases, with the largest decrease in the South Western region.

The results of the DEA analysis regarding the efficiency coefficient of average agricultural land used per farm and the obtained average total farm production, average gross value added per farm, average net income per farm in 2010 and 2020 (Table 10) show that as in 2010 so in 2020, the efficiency of average agricultural land used per farm in all statistical regions is above average level. In 2010, it was the lowest in the North Western region – 0.54, and in 2020 in the South Western region – 0.68. The highest efficiency of average agricultural land used per farm in 2010 was in the South Central region – 1, and in 2020 in the South Western. For the period 2010-2020, the calculations show that an increase in the efficiency of average agricultural land used per farm is imminent in the three northern statistical regions and in the South Eastern. In the South Western and South Central regions, the efficiency of average agricultural land used per farm decreases. The South Western region changes its place from second in 2010 to sixth in 2020, and South Central from first place in 2010 to fifth in 2020. The decrease in efficiency in these statistical regions is due to the disproportionate growth of indicators included in model 6.

Table 10. Efficiency coefficient of average agricultural land used per farm and the obtained average total farm production, average gross value added per farm, average net income per farm (Model 6).

DMU	2010	Rank	2020	Rank	Change
North Western	0,54	6	0,78	4	0,24
North Central	0,65	5	0,81	2	0,16
North Eastern	0,71	3	0,79	3	0,08
South Eastern	0,56	4	1	1	0,44
South Western	0,87	2	0,68	6	-0,19
South Central	1	1	0,73	5	-0,27

Source: own calculation

6. Conclusions and Summaries

This section is not mandatory but may be added if there are patents resulting from the work reported in this manuscript.

Table 11 summarizes the results of the DEA analysis and the efficiency coefficient, with red marking the positions where the efficiency coefficient is low and takes values from 0 to 0.35, yellow marks the results in which the coefficient of efficiency is around the average level (values from 0.36 to 0.65) and in green are the positions where the efficiency coefficient has high values from 0.66 to 1. The results of the performed DEA analysis show:

- Efficiency ratios are around and above the average levels for most of the statistical regions in terms of fuels and oils used, veterinary costs, feed additives and livestock output, seeds and planting material used, fuels and oils, fertilizers and soil improvers, preparations for plant protection and the obtained crop production, the agricultural area used, annual work units, intermediate consumption and consumption of fixed capital of land, the GVA obtained, the agricultural area used and the produced output obtained, gross value added and net mixed income.
- South Western and South Central regions are not efficient in labor utilization and output, gross value added and net mixed income.
- For the period 2010 - 2020, there are changes regarding the efficiency coefficient of the used fuels and oils, veterinary costs, feed additives and the obtained production in animal husbandry in the South Central region, the efficiency coefficient of the used seeds and planting material, fuels and oils, fertilizers and soil improvers, plant protection preparations and the resulting crop production in the North Eastern, the efficiency coefficient of the agricultural area used, annual work units, intermediate consumption and consumption of fixed capital of land, the resulting GVA in the North Eastern, South Eastern and South Central regions, the coefficient of efficiency of the labor

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force used and the output produced, gross added value and net mixed income in the South Eastern region and the efficiency coefficient of the agricultural area used and the output produced, gross value added and net mixed income in the South Western region.

- The results of the sixth model have the smallest differences in all regions of the country.

Table 11. Measurements of efficiency coefficients for the constructed models.

	North Western		North Central		North Eastern		South Eastern		South Western		South Central	
	2010	2020	2010	2020	2010	2020	2010	2020	2010	2020	2010	2020
Model 1												
Model 2												
Model 3												
Model 4												
Model 5												
Model 6												

Source: own study

For the period 2010 – 2020, the efficiency of used fuels and oils, veterinary costs, feed additives and the production in animal husbandry increased in the North Western, South Western and South Central regions, decreased in the North Eastern and South Eastern regions, and remained unchanged in the North Central region.

The effectiveness of the used seeds and planting material, fuels and oils, fertilizers and soil improvers, plant protection preparations and the resulting crop production increases in the North Western and North Central regions, decreases in the North Eastern and South Eastern regions and keep their levels in the South Western and South Central regions (Table 12). The coefficient of efficiency of the used agricultural area, annual work units, intermediate consumption and consumption of fixed capital of land received GVA increases only in the North Western and South Central regions, and decreases in the other four regions. The efficiency of the agricultural area used and the output produced, gross value added, and net mixed income decreases in the three southern and North Eastern regions, increases in the North Western, and remains the same in the North Central region.

Table 12. Change in efficiency for the period 2010 – 2020 by statistical regions.

Models	North Western	North Central	North Eastern	South Eastern	South Western	South Central
Model 1	↑	↔	↓	↓	↑	↑
Model 2	↑	↑	↓	↓	↔	↔
Model 3	↑	↓	↓	↓	↓	↑
Model 4	↑	↓	↓	↓	↑	↑
Model 5	↑	↔	↓	↓	↓	↓
Model 6	↑	↑	↔	↑	↓	↓

Source: own study

North Western is the region in which all calculated efficiency coefficients increase, and in North Eastern and South Eastern, the most calculated coefficients decrease. Changes are mixed in the South Western and South Central regions, while the North Central region maintains its positions in 33 % of the models.

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Researches of agricultural transformations in different regions of Bulgaria and changes in the efficiency of agricultural production have shown that there are differences between statistical regions. Although overall agricultural production efficiency and agricultural GDP showed an increasing trend, there were still other related agricultural resource variables that needed to be adjusted to achieve better resource allocation and production efficiency. The North Western and North Central regions perform relatively better. The efficiency of the agricultural area used and the output produced, gross value added and net mixed income decreased in four of the regions.

In this context, it is advisable to take into account regional differences and adapt programs and measures to local conditions, to use the effect of agglomeration and the effect of diffusion and to increase political support. The uneven distribution of resources between regions creates various challenges in decision-making.

The empirical analysis in this study highlights the interrelationship between the allocation and use of agricultural production resources and its outcomes across regions of the country, as well as the importance of agricultural economic development policies. The obtained results can contribute to new perspectives for the study of the use of resources for agricultural production and regional development, as well as for the formulation and implementation of future regional agricultural policies contributing to ensuring food security and sustainable development.

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References

1. Kanchev, I.; Doichinova J. Problems of Organizational Structures in Bulgarian Agriculture, *Bulgarian Journal of Agricultural Science*, **1996**, 3, p.289-297.
2. Trendafilov, R.; Kr. Kaneva; Mihailov M. Post War Agrarian Reform in Bulgaria and Agrarian Policy in the Follow-up Period, pp. 1-26 - In: Trendafilov, R. (ed.) *Economic Transformation and Land Use System in Bulgaria (Case study in Blagoevgrad Municipality)*, 1996, FAO, 72 p.
3. Kanchev, I.; Doichinova, J. Structural Transformation in the Agriculture in Bulgaria, *Bulgarian Journal of Agricultural Science*, **1999**, Volume 5, Number 2, pp.247-253.
4. Popov R. Agricultural development and policy for the period 1989-2010, *Economics and management of agriculture*, **2012,** 57,1, 3-12.
5. Kopeva, D.; Noev, N.; Evtimov, V. Land fragmentation and Land Consolidation in the agricultural sector: A Case Study from Bulgaria. – In: *International FAO Symposium Land Fragmentation and Land Consolidation in the CEEC*, Munich, Germany, **2002**, FAO.
6. Doitchinova J.; Kanchev, I.; Stojanova, Z. Twenty years of changes: Organizational restructuring of the agrarian sector in Bulgaria, IAMO Forum 2009, Halle. **2009**.
7. Miteva, A.; Doitchinova, J. Agriculture in the southwestern region of Bulgaria and its impact on rural development, *Economics of Agriculture*, **2022**, Year 69, No. 4, pp. 1003-1016.
8. Doitchinova, J.; Lazarova, E. Demographic changes and inequalities: regional differences with a focus on rural area in Bulgaria, *Scientific papers series „Management, Economic engineering in agriculture and rural development"* , **2023**, vol. 23, issue 4, pp.261-269.
9. Doitchinova J.; Stoyanova Z.; Miteva A. Changes in agriculture and their impact on rural areas, *Bulgarian Journal of Agricultural Economics and Management*, **2022**, vol. 4, pp. 3-11.
10. Atanasov, D.; Ivanova, B.; Beluhova-Uzunova, R.; Shishkova, M.; Hristov, K.; Sharipov, S.; Khasanov. Regional transformations in Bulgaria and challenges for sustainable development ,E3S Web of Conferences 386, 05002, **2023**, *GISCA 2022 and GI 2022,* https://doi.org/10.1051/e3sconf/202338605002
11. Bórawski P. Wykorzystywanie teorii lokalizacji Johanna Heinricha Von Thünenna do oceny efektywności gospodarstw z alternatywnymi dochodami (Using the location theory of Johann Heinrich Von Thünenn to

assess the efficiency of farms with alternative incomes). Roczniki Nauk Rolniczych, **2010**, Seria G 97 (2): 176-183.
12. Baer-Nawrocka A.; Barczak , W. Production potential of holdings specializing in cow milk production in macroregions of the European Union – a typological analysis, *Annals of the Polish association of agricultural and agribusiness economists*, **2020**, Vol. XXII, No. (1) doi: 10.5604/01.3001.0013.7982
13. Campi, M.; Dueñas, M.; Fagiolo, G. How do countries specialize in agricultural production? A complex network analysis of the global agricultural product space, *Environmental Research Letters*, **2020**, 15 124006 https://doi.org/10.1088/1748-9326/abc2f6
14. Darnhofer, I., Bellon, S., Dedieu, B. *et al.* Adaptiveness to enhance the sustainability of farming systems. A review. *Agron. Sustain. Dev.* 30, **2010**, pp. 545–555. https://doi.org/10.1051/agro/2009053
15. OECD, Multifunctionality: Towards an Analytical Framework, **2001**, Paris.
16. Doitchinova, J. Multifunctional Agriculture – An Opportunity for Development of Rural Areas, *Trakia Journal of Sciences*, **2005**, Vol. 3, No.2 pp.41-43.
17. Ploeg, van der, J.D., Roep, D. Multifunctionality and rural development: the actual situation in Europe. In: Huylenbroeck van, G., Durand, G. (Eds.), *Multifunctional agriculture: a new paradigm for European agriculture and rural development,* Ashgate, Hampshire, **2003**, pp. 37-53.
18. OECD, Multifunctionality in Agriculture: What role for private initiatives? OECD, **2005**, Paris.
19. Knickel, K., Lehmann, M., Kroger, M. Multifunctionality in agriculture and rural development: an empirical analysis based on survey data from eleven European regions. In*: Towards Sustainable Rural Regions in Europe. Studies in Development and Society.* Bryden et al, J. (Ed.), Routledge, New York, **2011**, pp. 82-113.
20. Bryden, J.M., Efstratoglou, S., Johnson, T., Ferenczi, T., Knickel, K., Refsgaard, K., Thomson, K.J.. Multifunctionality, Sustainable Territorial Development and Rural Policies in Europe: Some Concluding Reflections. Europe. *Studies in Development and Society* , Routledge, New York, **2011**, pp. 302-320.
21. Huttunen, S. Revisiting agricultural modernisation: Interconnected farming practices driving rural development at the farm level, *Journal of Rural Studies*, **2019**, Volume 71, pp. 36-45.
22. Doitchinova, J., Miteva, A. (2023). Rural Development in the Context of Agricultural Models: Evidence from Bulgaria. In: Bilgin, M.H., Danis, H., Demir, E., Wincenciak, L., Er, S.T. (eds) *Eurasian Business and Economics Perspectives. EBES 2022. Eurasian Studies in Business and Economics*, vol 25. Springer, Cham, **2023**, p.155-166.
23. Kato, K.Y.M.; Delgado, N.G.; Romano, J.O. Territorial Approach and Rural Development Challenges: Governance, State and Territorial Markets. *Sustainability* **2022**, *14*, 7105. https://doi.org/10.3390/su14127105
24. Nikolova, M.; Linkova, M.; Pavlov, P.; Lazarova, E. Theoretical and methodological basis in the management of sustainable development of rural territories in the republic of Bulgaria. Agricultural Sciences journal, **2022**, Vol. 14 (34), pp. 37-48.
25. Slaveva, K.; Naydenov, S.; Nikolova, M.; Pavlov, P. The economic centers in Bulgaria - an opportunity to discover additional potential in the regional development of rural territories , Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 24, Issue 2, **2024**, pp. 847-856
26. Streimikis, J., Saraji M.K. Green productivity and undesirable outputs in agriculture: a systematic review of DEA approach and policy recommendations, *Economic Research - Ekonomska Istraživanja*, **2022**, 35:1, 819-853, DOI: 10.1080/1331677X.2021.1942947
27. Domagała, J. Economic and Environmental Aspects of Agriculture in the EU Countries, *Energies* **2021**, 14, 7826. https://doi.org/10.3390/ en14227826
28. Zhong S, Li Y, Li J, Yang H. Measurement of total factor productivity of green agriculture in China: Analysis of the regional differences based on China. PLoS ONE, **2021**, 16(9): e0257239. https://doi.org/10.1371/journal. pone.0257239
29. Zaimova D. Methods for evaluating the economic efficiency of agricultural holdings, *Economic Thought*, **2011**, vol. 2
30. Gospodarowicz, M.Analysis of the technical efficiency of high-productivity farms in Poland in the period 1992-2005 by using the DEA method, *Agricultural Economics and Management*, **2011**, 56, 3-4.
31. Kaneva, K. Optimizing the technical efficiency of agricultural holdings in mountainous regions, *Economics and Management of Agriculture*, **2018**, 63, 3.
32. Toma E., Dobre, C., Dona I., Cofas, E. DEA Applicability in Assessment of Agriculture Efficiency on Areas with Similar Geographically Patterns, *Agriculture and Agricultural Science Procedia*, **2015**, Volume 6, p. 704-711.
33. García-Valiñas, M. A., M. A. Muñiz (2010), "Is DEA useful in the regulation of water utilities?, A dynamic efficiency evaluation (a dynamic efficiency evaluation of water utilities)", *Applied Economics* , **2010**, 39.2, Business Source Premier.
34. Zaimova D., Zheliazkov, G., Doitchinova J. Efficiency analysis of agricultural cooperatives in Trentino-alto Adige, *Iconomic research*, **2018**, vol. 4, pp.176-203. ISSN: 0205-3292.

 doi:10.20944/preprints202410.1733.v1

35. Harizanova-Bartos, H., Stoyanova, Z., Todorova, K., Terziyska, R. Agricultural impact on environmental pollution on district level, *Trakia Journal of Sciences*, **2019**, Vol. 17, Suppl. 1, pp 445-450.
36. National Statistical Institute, Infostat database, **2024**, Sofia, Bulgaria.
37. Ministry of Agriculture, Food and Forestry, **2012**, Census of Agriculture 2010.
38. Ministry of Agriculture, Food and Forestry, **2023**, Census of Agriculture 2020.
39. Ministry of Agriculture, Food and Forestry, FADN, 2010, 2020.
40. Loizou, E., Karelakis, C., Galanopoulos ,K., Mattas, K. The role of agriculture as a development tool for a regional economy , *Agricultural Systems*, 2019, Volume 173, pp. 482-490.