DYNAMICS AND INTENSITY OF STRUCTURAL CHANGES IN AGRICULTURAL OUTPUT: THE CASE STUDY OF THE REPUBLIC OF SERBIA

Jelena Dimovski[1], Vladimir Radivojević[2], Tamara Rađenović[3]

**Corresponding author E-mail: jelena.dimovski@pr.ac.rs*

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ABSTRACT

Agriculture as a primary sector is constantly subject to structural changes – adjustments in product features, production and consumption, technology, size of farms and agricultural holdings, manufacturing models, etc. Given the most dramatic changes occurring in the production sector, structural changes in agricultural output are precondition for understanding country's food production and food security. Accordingly, the paper analyses the agricultural output in the Republic of Serbia in the period from 2007 to 2019. The aim of the research is to examine an intensity and dynamics of structural changes, in order to determine the most dynamic agricultural branches and period when these changes are the most intensive. The research has been conducted using Michaely Index and Lilien Index as the indicators of structural changes. Research results can be beneficiary for policy makers in developing a strategy, aiming to ensure food security and further development of key agricultural branches.

Introduction

Economic development of a country, reflected in a change of sectors' relative importance in the economy, implies reallocation of resources from agricultural to other activities. While majority of authors agree that productivity growth leads to these transformations, there is still not consensus is technological progress more important in agriculture or in industry

1 Jelena Dimovski, PhD, Teaching Assistant with Doctorate, Faculty of Economics, University of Priština in Kosovska Mitrovica, Address: Kolašinska 156, 38220 Kosovska Mitrovica, Serbia, Phone: +381642967067, E-mail: jelena.dimovski@pr.ac.rs, ORCID ID (https://orcid.org/0000-0002-1353-4349)

2 Vladimir Radivojević, PhD, Assistant Professor, Faculty of Economics, University of Priština in Kosovska Mitrovica, Address: Kolašinska 156, 38220 Kosovska Mitrovica, Serbia, Phone: +381641468356, E-mail: vladimir.radivojevic@pr.ac.rs, ORCID ID (https://orcid.org/0000-0002-3928-0623)

3 Tamara Rađenović, PhD, Assistant Professor, Faculty of Occupational Safety, University of Niš, Address: Čarnojevića 10a, 18000 Niš, Serbia, Phone: +38163424365, E-mail: tamara.radjenovic@znrfak.ni.ac.rs, ORCID ID (https://orcid.org/0000-0003-1632-7772)

(Boehlje, 2013). Considering the absolute importance of agriculture in the economy of a country, understanding key driving forces of structural changes is crucial (Johnston, 1990). Those determinants are diverse and complex, including: demand changes, invention of new products and processes, technology, financial and value chain forces, human capital performances, farm life cycle, etc. (Kenneth et al., 1992).

Agriculture in Serbia traditionally plays a vital role in the national economy. In addition to its main role in providing food and raw materials for industry, agriculture in Serbia still employs a significant part of rural population and thus alleviates higher unemployment in rural area. Agricultural products with their significant share in the balance of payment, mainly in export of Serbia, notably contribute to the economic development of the country. Beside its economic importance, agriculture has a key social role reflected in ensuring the living standards of population and in reducing poverty (Ćurčić at al., 2021).

The paper evaluates agricultural output of the Republic of Serbia in terms of dynamic and intensity of structural changes in agricultural goods output (crop and animal production) and agricultural services. The aim is to determine the most dynamic and intensive changes of agricultural output, as well as years when these changes occur. The research results can serve as guidelines for economic and agriculture policy makers to focus on the most dynamic and intensive agricultural branches and encourage a development of others.

The paper is structured in four parts. The first part deals with the theoretical background and literature review on structural changes and their driving forces. Research methodology and research questions are defined in the second part. The empirical analysis and discussion of the research results are elaborated in the third part. The last part is dedicated to concluding remarks and recommendations for improving the efficiency of agricultural production in Serbia.

Literature review

Changes in the structure of production and employment, during the development process of certain sectors at the expense of others, were recognized as a feature of modern economic growth by economists Forasti and Simon Kuznets (Raiser et al., 2003). Both authors observed, based on historical data of industrialized countries, a decline in the relative importance of agriculture, a rapid growth of industry and a gradual increase in the significance of the service sector in the economy as a pattern of development.

Clark, Kuznets and Sirkin (Alvarez-Cuadrado, Poschke, 2011) have documented a process of structural changes: a decline in the share of agriculture in total income and employment, followed by a long-term increase in per capita income. As an example, among other analyzed countries, they stated that in the US economy in 1800, three quarters of workers were employed in the agricultural sector when agriculture recorded almost more than half of the total income. Two hundred years later, only 2.5% of the total workforce is engaged in agriculture, and the share of agricultural production in GDP has fallen to just 1%. Over the course of these two centuries, per capita income in the US has increased by almost more than 25 times (Alvarez-Cuadrado, Poschke, 2011).

Structural changes between the primary and secondary sector can be explained by two models. Lewis (1954) develops a *"laborpull"* model indicating that capital accumulation in the modern industrial sector reflects wage growth in urban areas and attracts extra labor from agriculture (Alvarez-Cuadrado, Poschke, 2011). Reinvestment of profits maintains the continuity of the process. Harris and Todaro (1970) confirmed through a two-sector model that rural-urban migration results from a positive difference between the expected urban income and agricultural output per worker. These theories indicate that productivity in industry affects income growth and leads to structural changes. In this case, higher earnings in industry attract lower paid workers or unemployed population from agriculture to industry (Alvarez-Cuadrado, Poschke, 2011). On the other hand, some of theorists find the agricultural productivity as one of the driving force of structural changes. Nurks emphasizes that the spectacular industrial revolution would not have been possible without prior agricultural revolution (Alvarez-Cuadrado, Poschke, 2011). Progress in agriculture enabled solving the food problem so resources could be reallocated from primary to secondary sector, and this model is known as "*laborpush"*. Additionally, movement of labor force from agriculture to non-agricultural activities can be also affected by reduction of reallocation costs (Ashraf, Öztürk, 2012). It is assumed that the equilibrium in the labor market is established by equalizing the marginal labor product in agriculture and marginal labor product in non-agricultural activities increased by reallocation costs. Those costs include costs of gaining additional working skills in non-agricultural activities, costs of migration from rural to urban environment, etc. (Lu, Lin, 2013).

Huge differences in the productivity level between sectors in the economy are mostly recognized in developing countries as indicators of allocative inefficiency that reduces general labor productivity. However, this inefficiency can also be considered as an important driving force (Comin at al., 2021). When labor and other resources are moved from less to more productive activities, the economy grows even when there is no productivity growth within the sectors. This type of development structural changes can significantly contribute to the economic growth (European Commission, 2014). Highly developed economies have experienced this kind of structural changes. Big polarity in development between Asian countries on one hand and African and Latin American countries on the other, stems from a variant contribution of these structural changes to the overall economic development. Structural changes in African and Latin American countries rather led to a slowdown in economic growth at the end of the 20th century (McMillan, Rodrik, 2011). It is also considered by Diao, McMillan and Rodrik (2019) that growth acceleration is reflected in rapid growht in productivity within sector (Latin Amirica) or in structural changes that contribute to the growth (Africa), but very rear in both at the same time.

The dual economic model, developed by Arthur Lewis, emphasis the distinction in productivity between rural (traditional) and urban (modern) sectors (McMillan, Rodrik, 2011). Though, the distinction in productivity can also exist within the sector. The gap can occur as well among firms and their facilities within the same sector.

Another theory that deals with structural changes in agriculture is the "*polarization theory*", with its roots in the time of Lenin. Back in the 1960s, Lenin pointed to rapid

development of rural capitalism, disappearance of small scale farmers and polarization of agrarian structure. However, there are contrary opinions to what this theory advocated that the so-called small farmers are more resistant to changes (Djiirfeldt, Gooch, 2002). The polarization theory starts from the hypothesis that those who can accumulate capital (big scale farmers, capitalists) are able to turn their wealth into land and property alienated from less successful farmers. Nevertheless, relevant research and practice of numerous countries have not confirmed that the agrarian structure was polarized in the way predicted by theorists. Namely, the survival of small and medium-size farmers can be explained in a different way from large-size farmers. They ensured a certain degree of independence from the market, both in terms of production and consumption, by hiring workers from their families on farms. In that way, they were spared from frequent market fluctuations, especially during the crisis period (Djiirfeldt, Gooch, 2002).

Structural changes in agriculture were constant when it comes to the number of agricultural holdings and their size. Parallel to the decrease in number, although less proportionally, the size of agricultural holdings grew. Agricultural ventures have also changed over time (Comin at al., 2021). Agriculture uses inputs, finance, processing, packaging and transport services that come from outside the agricultural enterprises. Although the number of both agricultural and industrial enterprises is decreasing, the timing of their reduction does not coincide. Decrease in the number of agricultural enterprises preceded the decrease in the number of industrial enterprises associated with them (Johnston, 1990). Structural changes in agriculture, followed by advanced agricultural technologies, financial challenges, etc. resulted in adjustment in advisory services as well (Radić at al. 2022). More often, especially with new information and communication technologies, a crucial role in technology diffusion have farmer communities and virtual networks (Norton, Alwang, 2020, Calicioglu at al., 2021). Despite all changes, agriculture, as the sector related to the people essential needs, still present a stabilizer in the economy, contributing to the economic growth and supporting employment in rural areas (Loizou et al. 2019).

Methodology and research questions

Changes in the sectoral structure of the economy, along with changes within its sectors, can be examined by several statistical methods available in the relevant literature from this field (Monda, Standaert, 2019; Pardez, Alston, 2019; Dietrich, 2012). The subject of the analysis, given the three-sector model of the economy, is to measure the sectoral transformation between two points in time, aiming to calculate a structural change index for agricultural sector.

With this aim, two indicators have been applied and elaborated in the research. The fist indicator has often been used in the research due to the smooth implementation. *Norm of Absolute Values (NAV)* is also known in theory as Michaely-Index or Stoikov-Index (Dietrich, 2012).

$$NAV_{s,t} = 0.5 \cdot \sum_{i=1}^{n} \left| x_{[it]} - x_{[is]} \right|$$

where:

NAV_{st} – Norm of Absolute Values or Michaely-Index for the given time frame, respectively between period s and period t,

x_{it} – share of the agricultural branch in the overall agricultural output at the end of period (t)

x_{is} – share of the agricultural branch in the overall agricultural output at the beginning of period (s).

In order to calculate the *Norm of Absolute Values*, the differences between the share of branches in agricultural output for the given time frame need to be calculated, and then add up the absolute value of those differences. Given the double calculations of all changes, standardization in this method takes place by dividing with two, resulting with NAV. As for the Norm of Absolute Values, the size of structural changes equals to the share of branches' movements as a percentage of the agricultural output.

The value for this index ranges between 0 and 1. The unchanged structure will result with the value 0. On the other hand, in the completely transformed structure of the agricultural output the value of NAV equals 1 (Dietrich, 2012).

The second most often applied indicator of structural changes is *Lilien-Index.* Aiming to measure the structural change where "x_{it}" indicates the share of the sector "i" in the period "t", this indicator requires certain conditions to be fulfilled (Dietrich, 2012):

(1) The index has to be equal zero due to the unchanged sectoral composition:

$$SCI_{[s,t]} = 0 \Leftrightarrow x_{i_s} = x_{i_t} \forall i \in \{1,...,n\}$$

(2) Structural changes between two periods (two points in time) need to be independent regarding the change direction, given the relevance of the only scope of changes. Accordingly, the structural change index depends only on the scope of changes and remain the same regardless of whether the changes between period s toward period t have been analyzed, or vice versa (from period t towards period s):

$$SCI_{[s,t]} = SCI_{[t,s]}$$

(3) Structural changes of one period in time cannot be greater than sum of calculated structural changes of at least two sub-periods:

$$S_{[s,t]} \leq S_{[s,q]} + S_{[q,t]} \text{ for } s < q < t.$$

(4) The index should be a measure of dispersion;

(5) Index should take into consideration the sector size.

When it comes to the evaluation of structural changes in agricultural output, Lilien index

measures standard deviation of the growth rate of agricultural output, from period s to period t.

$$LI_{s,t} = \sqrt{\sum_{i=1}^{n} x_{[it]} \cdot \left(\ln \frac{x_{[it]}}{x_{[is]}} \right)^2}, x_{[is]} > 0, x_{[it]} > 0$$

where:

$LI_{s,t}$ – Lilien-Index for the certain time frame, i.e. between period s and period t,

x_{it} – share of the agricultural branch in the overall agricultural output at the end of the period (t)

x_{is} – share of the agricultural branch in the overall agricultural output at the begging of the period (s).

Given that Lilien-Index does not fulfill the conditions (2) и (3), a slight modification of the index was carried out in order to meet all the aforementioned conditions for the index of structural changes. Thus, the index was increased by the weighted participation of the sector in both periods. The influence of the sector i has grown proportionally to its size, but also proportionally to its relative growth. Modified Lilien-Index (MLI) is as follows:

$$MLI_{s,t} = \sqrt{\sum_{i=1}^{n} x_{[is]} \cdot x_{[it]} \cdot \left(\ln \frac{x_{[it]}}{x_{[is]}} \right)^2}, x_{[is]} > 0, x_{[it]} > 0$$

Considering the previously elaborated methodology, the research goal in the paper is to comprehensively evaluate structural changes in agricultural output of RS in the thirteen years' period, focusing on intensity and dynamics of those changes. The information base of the research are data available in the publications of the Statistical Office of the Republic of Serbia (Statistical Yearbook and Economic Accounts for Agriculture). Following the main goal, the research questions are:

1) Have the structural changes in agriculture of Serbia been reflected in the same degree of intensity among crop, animal production and agricultural services?

2) Have the structural changes in agriculture of Serbia intensified over the analyzed period, contributing to its smoother adjustment to the changed market environment?

3) To which extent the intensity match direction and speed of structural changes in agricultural output, as well as in crop and animal production?

Research results and discussion

The research results have been divided into two parts in accordance with the main research goal: direction and intensity of structural changes. The information base for the both parts, respectively Michaely-Index and Lilien-Index is the value of agricultural goods and

services, reflected in the value of crop and animal production and value of agricultural services. Therefore, when calculating these indexes, x_i indicates the participation of a certain agricultural branch in the total production value of agricultural goods and services.

The agricultural output at producers' prices for the period from 2007 to 2019, that represent the bases for evaluation of structural changes in agriculture of RS, are presented in table 1. According to these data, agricultural services are 2-3% of total agricultural output in Serbia in the whole analyzed period, while crop production accounts for two third and animal production for one third of agricultural goods output.

Table 1. Agricultural output at producers' prices of the current year, 2007–2019

	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Agricultural output	330,174	417,832	407,851	466,811	519,960	502,684	565,521
Agricultural goods output	320,756	407,406	396,221	455,753	509,125	491,597	552,079
Crop production	217,274	278,825	265,101	328,981	359,103	324,451	378,833
Cereals	90,749	134,575	110,384	146,733	175,221	138,325	174,602
Industrial crops	26,549	32,309	30,737	44,619	46,655	52,806	51,487
Forage plants	12,761	14,147	14,586	17,601	17,184	18,693	16,626
Vegetables and horticultural products	22,585	24,879	28,753	42,903	27,246	28,986	27,375
Tomato	8,318	8,314	9,747	17,695	17,870	12,342	19,102
Fruits	33,929	39,324	37,040	41,159	50,860	53,932	61,567
Wine	21,796	24,758	33,316	17,873	23,713	18,925	27,535
Other crop product	587	521	538	399	355	443	540
Animal productions	103,482	128,581	131,119	126,772	150,022	167,146	173,246
Animals	69,001	87,759	95,853	89,606	102,774	113,463	118,893
Cattles	21,439	24,736	26,670	24,797	29,059	31,377	32,407
Pigs	32,955	46,734	51,192	45,392	48,768	58,642	60,983
Equines	129	118	105	61	61	377	203
Sheep and goats	6,524	6,771	7,363	8,516	9,315	7,801	8,121
Poultry	7,954	9,401	10,523	10,839	15,572	15,266	17,179
Other animals	34,482	40,822	35,266	37,166	47,248	53,684	54,353
Milk	25,352	30,397	25,480	26,943	34,212	36,777	38,018
Eggs	8,288	9,704	8,649	8,608	10,810	14,678	13,395
Other animal products	842	721	1,137	1,615	2,226	2,229	2,940
Agricultural services	9,418	10,426	11,630	11,058	10,834	11,087	13,443

Source: Statistical Yearbook 2003-2020 & Economic Accounts of Agriculture, Statistical Office of the Republic of Serbia

Note: The last years have not been included considering the changed methodology of agricultural production in the Statistical Yearbook since 2020

Table 1. Agricultural output at producers' prices of the current year, 2007–2019 (continued)

	2014	2015	2016	2017	2018	2019
Agricultural output	584,300	534,780	589,818	543,747	589,704	605,291
Agricultural goods output	569,276	520,966	574,818	529,890	574,704	589,978
Crop production	390,748	351,927	419,400	357,056	398,514	414,529
Cereals	178,776	139,584	164,832	113,760	157,004	158,829
Industrial crops	54,393	48,501	58,940	59,443	62,531	63,157
Forage plants	23,688	17,553	27,063	20,985	28,649	33,557
Vegetables and horticultural products	28,813	35,588	40,579	32,538	26,097	31,554
Tomato	13,025	13,642	13,892	11,687	13,218	11,805
Fruits	56,880	73,670	74,991	76,995	68,816	67,045
Wine	34,621	22,795	38,569	42,112	41,579	48,249
Other crop product	552	595	535	538	620	533
Animal productions	178,528	169,038	155,418	172,834	176,190	175,450
Animals	123,133	111,012	104,281	120,478	114,530	121,969
Cattles	32,114	31,703	30,353	31,040	33,687	32,412
Pigs	65,765	57,098	54,272	66,199	57,503	63,583
Equines	151	77	367	383	36	320
Sheep and goats	10,108	8,971	5,998	8,416	8,299	10,612
Poultry	14,995	13,163	13,291	14,441	15,006	15,043
Other animals	55,396	58,026	51,137	52,356	61,660	53,481
Milk	38,459	37,310	35,048	35,388	44,261	37,192
Eggs	14,971	15,507	13,741	14,504	13,357	13,559
Other animal products	1,966	5,209	2,349	2,465	4,042	2,730
Agricultural services	15,024	13,814	15,000	13,856	15,001	15,313

Source: Statistical Yearbook 2003-2020 & Economic Accounts of Agriculture, Statistical Office of the Republic of Serbia

Note: The last years have not been included considering the changed methodology of agricultural production in the Statistical Yearbook since 2020

Based on the agricultural output data, for the purpose of analyzing the intensity of structural changes in agriculture, Michaely-Index has been calculated for the whole thirteen years' period (2007-2019), for two sub-periods (2007-2012, 2013-2019) and for each year individually (table 2).

Table 2. The intensity of structural changes in agricultural output of Serbia, based on the Michaely-Index (Norm of Absolute Values - NAV)

	2008-2007	2009-2008	2010-2009	2011-2010	2012-2011	2013-2012	2014-2013
Agricultural output							
Agricultural goods output	0.00357	0.00356	0.00483	0.00285	0.00122	0.00171	0.00194
Crop production	0.00925	0.01732	0.05474	0.01410	0.04520	0.02445	0.00114
Cereals	0.04723	0.05143	0.04368	0.02266	0.06182	0.03357	0.00278
Industrial crops	0.00308	0.00196	0.02022	0.00585	0.01532	0.01400	0.00205
Forage plants	0.00479	0.00190	0.00194	0.00466	0.00414	0.00779	0.01114

	2008-2007	2009-2008	2010-2009	2011-2010	2012-2011	2013-2012	2014-2013
Vegetables and horticultural products	0.00886	0.01096	0.02141	0.03951	0.00526	0.00926	0.00091
Tomato	0.00529	0.00400	0.01401	0.00354	0.00982	0.00923	0.01149
Fruits	0.00865	0.00330	0.00265	0.00964	0.00947	0.00158	0.01152
Wine	0.00676	0.02243	0.04340	0.00732	0.00796	0.01104	0.01056
Other crop product	0.00053	0.00007	0.00047	0.00017	0.00020	0.00007	0.00001
Animal productions	0.00568	0.01376	0.04992	0.01696	0.04398	0.02616	0.00080
Animals	0.00105	0.02499	0.04307	0.00570	0.02806	0.01548	0.00050
Cattles	0.00573	0.00619	0.01227	0.00277	0.00653	0.00512	0.00234
Pigs	0.01204	0.01367	0.02828	0.00345	0.02287	0.00882	0.00472
Equines	0.00011	0.00002	0.00013	0.00001	0.00063	0.00039	0.00010
Sheep and goats	0.00355	0.00185	0.00019	0.00033	0.00240	0.00116	0.00294
Poultry	0.00159	0.00330	0.00258	0.00673	0.00042	0.00001	0.00471
Other animals	0.00674	0.01123	0.00685	0.01125	0.01592	0.01068	0.00130
Milk	0.00403	0.01028	0.00476	0.00808	0.00736	0.00593	0.00141
Eggs	0.00188	0.00202	0.00277	0.00235	0.00841	0.00551	0.00194
Other animal products	0.00082	0.00106	0.00067	0.00082	0.00015	0.00076	0.00183
Agricultural services	0.00357	0.00356	0.00483	0.00285	0.00122	0.00171	0.00194
NAV (Agricultural output)	**0.00357**	**0.00356**	**0.00483**	**0.00285**	**0.00122**	**0.00171**	**0.00194**
NAV (Crop production)	**0.00463**	**0.00866**	**0.02737**	**0.00705**	**0.02260**	**0.01222**	**0.00057**
NAV (Animal production)	**0.00284**	**0.00688**	**0.02496**	**0.00848**	**0.02199**	**0.01308**	**0.00040**
NAV (Agricultural services)	**0.00179**	**0.00178**	**0.00241**	**0.00143**	**0.00061**	**0.00086**	**0.00097**

Source: Authors' calculations

Table 2. The intensity of structural changes in agricultural output of Serbia, based on the Michaely-Index (Norm of Absolute Values - NAV) (continued)

	2015-2014	2016-2015	2017-2016	2018-2017	2019-2018	2012-2007	2019-2013	2019-2007
Agricultural goods output	0.00012	0.00040	0.00005	0.00005	0.00014	0.00647	0.00153	0.00323
Crop production	0.01067	0.05299	0.05441	0.01913	0.00906	0.01262	0.01496	0.02678
Cereals	0.04495	0.01845	0.07025	0.05703	0.00384	0.00032	0.04634	0.01245
Industrial crops	0.00240	0.00924	0.00939	0.00328	0.00169	0.02464	0.01330	0.02393
Forage plants	0.00772	0.01306	0.00729	0.00999	0.00686	0.00146	0.02604	0.01679
Vegetables and horticultural prod.s	0.01724	0.00225	0.00896	0.01559	0.00788	0.01074	0.00372	0.01627
Tomato	0.00322	0.00196	0.00206	0.00092	0.00291	0.00064	0.01427	0.00569
Fruits	0.04041	0.01061	0.01446	0.02491	0.00593	0.00453	0.00190	0.00800
Wine	0.01663	0.02277	0.01206	0.00694	0.00920	0.02837	0.03102	0.01370
Other crop product	0.00017	0.00021	0.00008	0.00006	0.00017	0.00090	0.00007	0.00090
Animal productions	0.01055	0.05259	0.05436	0.01908	0.00892	0.01909	0.01649	0.02356
Animals	0.00315	0.03078	0.04477	0.02735	0.00729	0.01673	0.00873	0.00748
Cattles	0.00432	0.00782	0.00562	0.00004	0.00358	0.00251	0.00376	0.01138
Pigs	0.00578	0.01475	0.02973	0.02423	0.00753	0.01685	0.00279	0.00523
Equines	0.00011	0.00048	0.00008	0.00064	0.00047	0.00036	0.00017	0.00014
Sheep and goats	0.00052	0.00661	0.00531	0.00140	0.00346	0.00424	0.00317	0.00223
Poultry	0.00105	0.00208	0.00402	0.00111	0.00059	0.00628	0.00552	0.00076

	2015-2014	2016-2015	2017-2016	2018-2017	2019-2018	2012-2007	2019-2013	2019-2007
Other animals	0.01370	0.02181	0.00959	0.00827	0.01621	0.00236	0.00776	0.01608
Milk	0.00395	0.01035	0.00566	0.00998	0.01361	0.00362	0.00578	0.01534
Eggs	0.00338	0.00570	0.00338	0.00402	0.00025	0.00410	0.00129	0.00270
Other animal products	0.00638	0.00576	0.00055	0.00232	0.00234	0.00188	0.00069	0.00196
Agricultural services	0.00012	0.00040	0.00005	0.00005	0.00014	0.00647	0.00153	0.00323
NAV (Agricultural output)	**0.00012**	**0.00040**	**0.00005**	**0.00005**	**0.00014**	**0.00647**	**0.00153**	**0.00323**
NAV (Crop production)	**0.00533**	**0.02649**	**0.02720**	**0.00956**	**0.00453**	**0.00631**	**0.00748**	**0.01339**
NAV (Animal production)	**0.00527**	**0.02629**	**0.02718**	**0.00954**	**0.00446**	**0.00955**	**0.00824**	**0.01178**
NAV (Agricultural services)	**0.00006**	**0.00020**	**0.00003**	**0.00002**	**0.00007**	**0.00323**	**0.00076**	**0.00161**

Source: Authors' calculations

Michaely-Index, with its values from 0 (unchanged structure) to 1 (completely changed), has confirmed in the research that structural changes in the agricultural output of Serbia occur over time. However, the intensity of these changes is stronger at the beginning of the analyzed period and getting weaker in recent years. Among the observed annual structural changes in agricultural output, the most intense are those in 2010, while the mildest changes are in 2017 and 2018. Accordingly, the first sub-period (2007-2012) shows more intense changes than the second (2013-2019). In addition to overall agricultural output, more intense structural changes in the first sub-period are recognized also for animal production and agricultural services, while only crop production strengthens the intensity of changes in the second sub-period. For both crop and animal production, the most intensive years are 2010, 2012, 2013, 2016 and 2017. On the other hand, with the lowest value of Michaely-Index, agricultural services in the entire analyzed period show only minor changes which almost disappear in recent years. In both sub-periods animal production has Michaely-Index higher than crop production. When it comes to the structural changes of the entire period (2007-2019), crop and animal production have almost the same degree of intensity, higher than intensity of overall agricultural output and agricultural services, as well as higher than intensity of sub-periods.

Applying the same information base as for the Michaely-Index, Lilien-Index measures the direction and speed of structural changes in agricultural output of Serbia in thirteen years' period (2007-2019), two sub-periods (2007-2012, 2013-2019) and for each year individually (table 3).

Table 3. Direction and speed of structural changes in agricultural output of Serbia, based on the Lilien-Index

	2008-2007	2009-2008	2010-2009	2011-2010	2012-2011	2013-2012	2014-2013
Agricultural goods output	0.001551	0.001547	0.002096	0.001239	0.000530	0.000745	0.000843
Crop production	0.004019	0.007521	0.023769	0.006125	0.019626	0.010616	0.000494
Cereals	0.020489	0.022308	0.018953	0.009839	0.026801	0.014573	0.001207
Industrial crops	0.001339	0.000852	0.008760	0.002542	0.006646	0.006077	0.000889
Forage plants	0.002079	0.000827	0.000843	0.002021	0.001797	0.003374	0.004818

Vegetables and horticultural prod.	0.003845	0.004753	0.009269	0.016933	0.002284	0.004014	0.000394
Tomato	0.002294	0.001735	0.006030	0.001536	0.004243	0.003990	0.004953
Fruits	0.003754	0.001431	0.001150	0.004186	0.004113	0.000686	0.005001
Wine	0.002934	0.009701	0.018405	0.003174	0.003450	0.004782	0.004581
Other crop product	0.000229	0.000031	0.000200	0.000075	0.000086	0.000032	0.000004
Animal productions	0.002468	0.005973	0.021654	0.007363	0.019084	0.011358	0.000349
Animals	0.000456	0.010846	0.018672	0.002477	0.012175	0.006720	0.000217
Cattles	0.002488	0.002687	0.005320	0.001201	0.002836	0.002221	0.001017
Pigs	0.005225	0.005933	0.012248	0.001497	0.009910	0.003830	0.002049
Equines	0.000047	0.000011	0.000054	0.000006	0.000239	0.000166	0.000043
Sheep and goats	0.001541	0.000802	0.000083	0.000143	0.001040	0.000502	0.001274
Poultry	0.000691	0.001433	0.001121	0.002914	0.000183	0.000003	0.002045
Other animals	0.002925	0.004875	0.002975	0.004883	0.006909	0.004637	0.000567
Milk	0.001752	0.004458	0.002066	0.003507	0.003196	0.002576	0.000610
Eggs	0.000815	0.000876	0.001200	0.001020	0.003635	0.002390	0.000840
Other animal products	0.000356	0.000457	0.000291	0.000356	0.000066	0.000332	0.000791
Agricultural services	0.001550	0.001546	0.002093	0.001238	0.000529	0.000744	0.000843

Source: Authors' calculations

Table 3. Direction and speed of structural changes in agricultural output of Serbia, based on the Lilien-Index (continued)

	2015-2014	**2016-2015**	**2017-2016**	**2018-2017**	**2019-2018**	**2012-2007**	**2019-2013**	**2019-2007**
Agricultural goods output	0.000052	0.000174	0.000022	0.000020	0.000060	0.002809	0.000664	0.001401
Crop production	0.004632	0.023007	0.023623	0.008306	0.003933	0.005482	0.006496	0.011631
Cereals	0.019503	0.008011	0.030402	0.024707	0.001668	0.000139	0.020105	0.005407
Industrial crops	0.001041	0.004010	0.004078	0.001426	0.000736	0.010668	0.005771	0.010365
Forage plants	0.003346	0.005645	0.003162	0.004329	0.002976	0.000635	0.011121	0.007252
Vegetables and horticultural prod.	0.007457	0.000978	0.003888	0.006743	0.003417	0.004659	0.001617	0.007046
Tomato	0.001396	0.000849	0.000895	0.000401	0.001264	0.000278	0.006122	0.002464
Fruits	0.017462	0.004609	0.006276	0.010799	0.002575	0.001966	0.000824	0.003475
Wine	0.007189	0.009812	0.005230	0.003013	0.003995	0.012159	0.013338	0.005940
Other crop product	0.000073	0.000089	0.000036	0.000027	0.000074	0.000382	0.000032	0.000382
Animal productions	0.004580	0.022807	0.023572	0.008285	0.003873	0.008290	0.007159	0.010228
Animals	0.001368	0.013355	0.019401	0.011871	0.003165	0.007264	0.003791	0.003248
Cattles	0.001876	0.003394	0.002441	0.000017	0.001553	0.001091	0.001631	0.004937
Pigs	0.002512	0.006401	0.012869	0.010503	0.003271	0.007309	0.001212	0.002273
Equines	0.000049	0.000190	0.000036	0.000220	0.000169	0.000153	0.000073	0.000060
Sheep and goats	0.000227	0.002839	0.002288	0.000610	0.001499	0.001838	0.001375	0.000967
Poultry	0.000456	0.000903	0.001745	0.000483	0.000258	0.002721	0.002395	0.000331
Other animals	0.005944	0.009450	0.004162	0.003592	0.007030	0.001024	0.003368	0.006976
Milk	0.001714	0.004488	0.002457	0.004329	0.005901	0.001574	0.002510	0.006648
Eggs	0.001465	0.002471	0.001466	0.001745	0.000109	0.001778	0.000559	0.001173
Other animal products	0.002643	0.002419	0.000239	0.001001	0.001011	0.000808	0.000299	0.000840
Agricultural services	0.000052	0.000174	0.000022	0.000020	0.000060	0.002802	0.000664	0.001400

Source: Authors' calculations

Lilien-Index, measuring the growth rate of agricultural branches from period s to period t, ranges as well from 0 to 1. With regards to the annual structural changes in agricultural goods output, the highest value of this index is also recorded in 2010 and the lowest in 2018. Lilian-Index, the same as the Michaely-Index, achieves its highest values for crop and animal production in 2010, 2012, 2013, 2016 and 2017. Agricultural services record in all years the lowest value of this index. Also, based on the Lilian-Index, in both sub-periods animal production has higher values than crop production, while their index for the entire period is almost the same. The most dynamic changes within crop production have industrial crops, while for animal production are milk and cattles.

Conclusion

Agriculture has been facing many changes over years, due to the more challenging market environment, globalization, rapid technological development, climate changes, etc. Raising living standard of the population causes increased demand for more quality products with affordable prices, improved services, substantial information, expected flexibility, and timely response. Innovation, followed by constant use of the new technology, has been crucial for success of agricultural holdings. However, their size also was the subject of changes, as well as the average farmers' age. Accordingly, agricultural output has been affected and adjusted to these changes.

Aiming to assess the intensity and dynamic of structural changes in agricultural output of Serbia, the study employs the Michaely and Lilien indexes on data from Statistical Yearbook and Economic Accounts of Agriculture as publications of the Statistical Office of the Republic of Serbia, within the period 2007-2019. The conducted thirteen years' analyses of agricultural output in Serbia met the main research goal and responded to the established research questions. Structural changes in agriculture of Serbia, measured by Michaely and Lilien index, lead to the same conclusion regarding their intensity and direction. While agricultural services in the analyzed period from 2007 to 2019 show very mild changes, crop and animal production have slightly greater changes based on these indexes. On the annual basis, crop and animal production alternately have more intense changes, while in both sub-periods animal production has more intense structural changes. Even though the Michaely-Index achieves positive values over years, structural changes in the overall agricultural output are less intensive in the recent years than at the beginning of observed period. This is confirmed by annual values of Michaely-Index, as well as its higher values for the first sub-period compared to the second. This is result of fluctuations in changes of crop and animal production, but also impact of almost no changes in agricultural services.

Given the above research results, one could conclude that structural changes in the agricultural output has occurred over time, but in slight intensity. Moreover, these changes reduced the intensity in recent year indicating insufficient adjustment to the technological development, globalization, climate changes, etc. While industrial crops within crop production and milk and cattles within animal production have the most dynamic changes, other agricultural branches still have a room for a better and needed

response to a changed market environment. Also, agricultural services, not only with their very low share in the total agricultural output, they also are quite unchanged over years. The exploitation of potential improvements within agricultural production, and particularly some branches, would bring overall benefit for agriculture and the economy considering as a result a contemporary, efficient and flexible agricultural production.

The limitations of the research are related to the fact that the data of agricultural output cover only several years, which may affect the generalization. Additionally, the very last years (2020-2022) have been excluded in the research considering the changed methodology of the Statistical Office of RS when it comes to agriculture. Also, structural changes have been examined only based on two indicators, focusing on intensity and dynamics of structural changes in the analyzed period. Accordingly, the study could be further extended to respond to these challenges with the aim of enhanced quality of the research.

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Conflict of interests

The authors declare no conflict of interest.

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