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*Vladimir Popović**

The impact of the age structure of active population on agricultural activity rate: The case study of the Timok Krajina region

Abstract

As agricultural activity is primarily linked to rural areas, negative demographic trends characterising them present as one of the basic factors of size and age structure changes in the agricultural population. On the other hand, the modernisation of agricultural production, combined with various stimulating mechanisms, impacts its attractiveness, thus influencing the number and age structure of agricultural producers. Change in the overall agricultural activity rate reflects these two processes, making it suitable to be analysed by quantification of effects that produce these changes by applying Das Gupta's decomposition method. The Timok Krajina region is chosen as a characteristic example due to the recent and relatively significant rise in the overall activity rate in agriculture, in contrast to the national level, where a constant decline in this rate is present. This research focuses on the difference that occurred in the last intercensal period (between 2002 and 2011), aiming to determine the impact of changes in the age structure of the active population that performs an occupation on the change of overall activity rate in agriculture in the Timok Krajina region. The research results depict that the changes in activity rate in agriculture in the examined period almost

* Geographical Institute "Jovan Cvijić" of the Serbian Academy of Sciences and Arts, Djure Jakšića 9, 11000 Belgrade, Serbia, vpopovic.za@gmail.com. ORCID ID: 0000-0001-9463-0473

completely occurred under the influence of demographic factors, while other factors, marked as the rate effects, had a symbolic impact.

Keywords: Republic of Serbia; Timok Krajina region; rural area; agriculture; population structure changes; decomposition method

Introduction

Agricultural activity, especially in less developed areas, undergoes intensive changes that stand in a cause-effect relationship with the size and structure of the agricultural population. Although each area is characterised by a series of development specificities, unfavourable demographic trends in most cases can be observed as their common determinant. In several regions, these trends are closely linked to population ageing processes (Martínez-Filgueira et al. 2017). The authors indicate that long-term migrations in the past left several imbalances that might lead to a loss of population in the upcoming decades, regardless of the absence of migration today. Moreover, the consequences of population decline are often self-reinforcing (Elshoff et al. 2014), implying that their intensification might be expected in the future.

With rural areas occupying 85% of the national territory and almost half of the national population, the Republic of Serbia ranks among the most agrarian European countries (Bogdanov et al. 2007). Until the mid-20th century, rural areas had a population of more than three-quarters of the total population of Serbia, which mainly based its existence on agriculture. Subsequent processes of industrialisation and urbanisation, as well as deagrarisation and deruralisation, have resulted in the marginalisation and devaluation of the rural areas (Derić & Perišić 1995; Mitrović 1997). These areas thus experienced the characteristics of rural exodus during the 1960s, beginning from the eastern and south-eastern parts towards the other parts of the country (Todorović 2007). Rural depopulation, induced mostly by urban-based industrialisation, became one of the largest development problems of Serbian society (Radovanović 1999; Martinović & Ratkaj 2015). In recent times, it is found to be the most pronounced in eastern and south-eastern Serbia, which lost 11% of its population from 2002 to 2011 (Spasovski & Šantić 2012). One of the basic consequences of these trends is the long-term and intense ageing of

the Serbian population, especially in less-developed rural areas. This process has become a topic of increasing significance a sit represents more than just a demographic change, with implications that cannot be precisely predicted due to their socio-economic variability (Pantić & Živanovnić-Miljković 2010; Stojilković 2011). The first implication, most often, is a decrease in flexibility in the agricultural labour market. Additionally, there is an expectation that older farmers are less motivated to invest in innovation due to the shorter amortisation period to experience the full advantage (Stloukal 2000). Moreover, with unchanged activity rates, the ageing process leads to a decrease in the size of the labour contingent (Radivojević & Nikitović 2010), which clearly indicates that the ageing process is one of the basic causes of changes that occur to the agricultural activity in the Republic of Serbia.

On the other hand, it is not only the ageing of the workforce that affects the rate of economic activity. There is growing evidence that certain rural areas perform much better than others, and in some cases, even better than urban areas (Bryden & Munro 2000). The effects of agricultural modernisation and other incentives for agricultural production have been also brought to the limelight with a common goal to increase the profitability and attractiveness of agricultural production. In addition, Stloukal (2000) points out that older farmers are not necessarily less productive, and the level of their efficiency depends not only on their age but also on external circumstances, such as the level of technological development and incentive mechanisms.

In the Republic of Serbia, a large improvement in that field has been achieved in terms of legislation, while the financial capacities remain insufficient, such as compatibility with the regional and local context (Vasiljević et al. 2016). However, recent times have observed an increasing trend of agriculture share in the national GDP (Bogdanov et al. 2007; Đuričin & Behara 2014). The same authors agree that the undertaken measures provide positive results, yet the relatively high employment rate in agriculture is mostly a consequence of the transition and privatisation processes that caused fewer opportunities for different options.

Within these two processes with essentially opposite effects on agricultural production, the aim and hypothesis of this research were defined and tested on a characteristic example of the Timok Krajina region, chosen due to its specific population development characteristics and agricultural activity rate change in comparison to the Republic level.

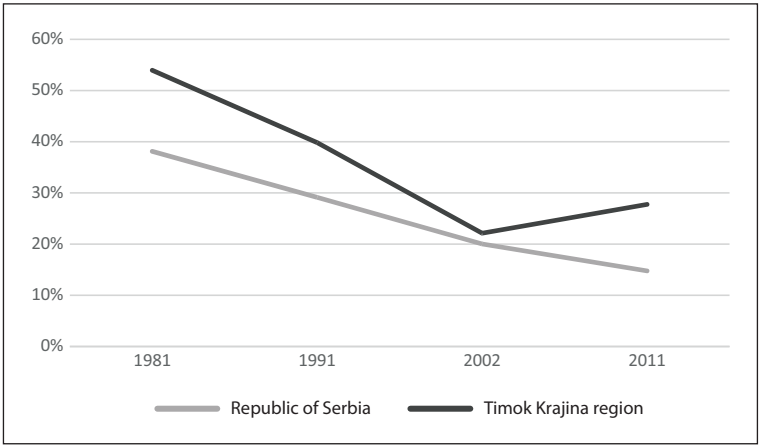

Figure 1: Comparative view of overall agricultural activity rate changes at the Republic and the Timok Krajina region level

Data source: Statistical Office of the Republic of Serbia, 1981, 1991, 2004, 2014:2.

The Timok Krajina region is characterised by a recent and relatively significant rise in the overall activity rate in agriculture (Figure 1) in contrast to the Republic of Serbia, where a constant decline has been observed. This research focuses on the difference that occurred in the last intercensal period (between 2002 and 2011), aiming to determine the impact of changes in the age structure of the active population that performs an occupation on the change of overall activity rate in agriculture in the Timok Krajina region. According to the research aim and previous research, the hypothesis of this paper states that the changes in the age structure of the active population that performs an occupation are a dominant factor in the changes in the overall activity rate in agriculture during the last intercensal period in this region.

Research Methodology

In everyday life, many social, economic, political, and health behaviours, as well as the consequences or outcomes of these behaviours, are often measured by rate, percentage, or proportions (Wang et al. 2000). In population studies,

standardisation and decomposition of rates are commonly used techniques for adjusting the confounding effect of population composition on rates (Kitagawa 1955, 1964; Bongaarts 1980).

Demographers have developed a variety of techniques for the standardisation and decomposition of rates. In general, the methods of standardisation and decomposition are grouped into two broad categories (Gupta 1991). In the first category, a crude rate is expressed as a function of one or several factors (Bongaarts 1978; Nathanson & Kim 1989; Pullum et al. 1989; Wojtkiewicz et al. 1990). In the second and more common category, standardisation and decomposition are performed on cross-classified table data (Kitagawa 1955, 1964; Cho & Retherford 1973; Kim & Strobino 1984; Liao 1989; Gupta 1991).

According to the aim of the research and available cross-classified data, quantification of the impact of changes in the age structure of the active population that performs an occupation on the change of overall activity rate in agriculture (i.e., a percentage share of the active population that performs an occupation in agriculture in a total number of active population that performs an occupation) is conducted by applying Das Gupta's decomposition method. This method has several advantages that explain its great popularity. Mathematical precision, simplicity and logic of the interpretation of the results, practically unlimited number of variables, their induction without a specific order and considering the interdependence of factors in the sum of the main effect are a few of the attributes of this demographic technique (Vaupel & Romo 2002; Romo 2003). According to Gupta (1993), the decomposition in the case of cross-classified data, along with the demographic effect that appears as a consequence of population recomposition by age (Gligorijević & Vasić 2018), involves the effect of population behaviour, i.e. the effect of the differences in the cell-specific rates, also known as the rate-effect. Radivojević & Nikitović (2010) point out that specific activity rates according to age change over time due to the individual factors and institutional and macroeconomic conditions that determine the supply and demand for work. The results of several recent studies have also shown that behavioural factors affect labour market indicators and that in some cases, they are even more significant than demographic factors (Johnson 2002; Prskavetz et al. 2005; Prskavetz et al. 2008; Garloff et al. 2013; Loichinger & Prskavetz 2017).

The impact of each factor can best be seen when the difference in the value of the overall rate, recorded over a period, is decomposed into the effect of ageing and the effect of behaviour. In this specific case, when there is only one observed factor (age-I) besides the behavioural (rate-R), the best way to see the impact of each factor is to decompose the difference between overall activity rates in agriculture in the years 2002 (population 1) and 2011 (population 2), which can be expressed in the following manner:

$$t-T = \mathrm{R}_{effect} + I_{effect} = \left[R(\bar{t}) - R(\bar{T}) \right] + \left[I(\bar{a}) - I(\bar{A}) \right] \quad (1)$$

where

$t–T$ is the difference between overall activity rates

$R(\bar{T})$ is I-standardised rate in population 1

$$R(\bar{T}) = \sum_i \frac{\frac{n_i}{n_0} + \frac{N_i}{N_0}}{2} T_i \quad (2)$$

$I(\bar{A})$ is R-standardised rate in population 1

$$I(\bar{A}) = \sum_i \frac{t_i + T_i}{2} A_i \quad (3)$$

$R(\bar{t})$ and $I(\bar{a})$ have the same expressions, with a difference that they refer to the population 2, i.e. T_i is replaced by t_i, while A_i is replaced by a_i.

Based on the data provided in Table I, the difference between overall activity rates, i.e. the change of overall activity rate in agriculture during the period 2002–2011 and standardised activity rates according to two possible standards: the average population of ten-year age groups (I-standardisation) and the average values of cell-specific rates by age (R-standardisation) are calculated. I-standardisation produces values of standardised activity rates that are necessary to calculate the R-effect (rate-effect), whereas R-standardisation produces values necessary to estimate the composition effect (age-effect) (Gligorijević & Vasić 2018). The changes in agricultural activity rates and their causes are examined separately on the local, district and regional levels. Due to the previously mentioned unfavourable demographic processes and to acquire clearer results, changes in contingent sizes of the active population that

performs an occupation and active population that performs an occupation in agriculture during the 2002–2011 period are examined in parallel.

Research Area

Thema in reason why the Timok Krajina region (Figure 2) is considered suitable for this research, besides the traditional significance of the agricultural economy and unfavourable demographic processes in the rural area, is the recent rise in overall agricultural activity rate, in contrast to the national level.

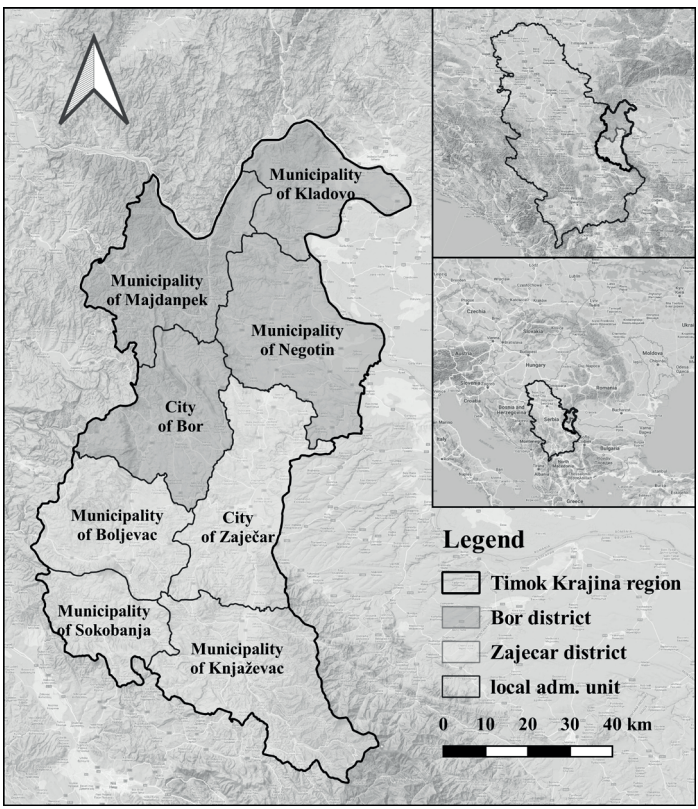

Figure 2: Spatial extent and position of the research area.

Source: author

The Timok Krajina region covers 8% of the national territory, with 2.83% of the population, including the Autonomous Province of Kosovo and Metohija (Statistical Office of the Republic of Serbia, 2014:1). According to the current Regional Spatial Plan of the Timok Krajina region (2011), approximately 52% of the total territory is agricultural land (3669.6 km^2). It is heterogeneous in terms of usage and quality. Households that own an agricultural holding participate by 41.7% of the total number of households and are mostly characterised by small capacities and land areas that are not sufficient to provide for the living costs or for the investments for the improvement or development of agricultural production. Homesteads with mixed economies that deal with both crop and livestock production are more common than on the national level (Aničić et al. 2017). A high share of the active population that performs agricultural activities in the total agricultural population, especially in hilly and mountainous areas, indirectly indicates advanced stadiums of senilisation of the agricultural population and problems with ensuring successors for agricultural activities in the following decades. According to the latest data, approximately 15% of the total agricultural land area in the Timok Krajina region is uncultivated. However, the share of agriculture in the total income of the Timok Krajina region (about 44% of the total income) is significantly higher than the national level (about 17%) (Regional Spatial Plan of the Timok Krajina region, 2011; Regional Development Strategy of the Timok Krajina region, 2011). Moreover, the overall activity rate, traditionally higher than the national, is on the rise (Statistical Office of the Republic of Serbia 2004, 2014: 2).

Results

A comparative view of the age distribution of the active population that performs an occupation for the years 2002 and 2011 (N_i, n_i) and the cell-specific agricultural activity rates (T_i, t_i) for the same observed years is given in Table 1. The age distribution was done by ten-year groups, noting that the population older than 65 years is considered as a unique category, according to the available data and the fact that the upper age limit is not defined.

The comparison of overall activity rates in agriculture in the years 2002 and 2011 shows an increase of 5.62 percentage points. Standardisation and

Table 1: Age distribution of active population that performs an occupation and cell-specific agricultural activity rates for the years 2002 and 2011.

		2002 (population 1)		2011 (population 2)	
Age categories	**i**	**Ni**	**Ti**	**ni**	**ti**
15-24	1	5.58	26.58	4.70	19.90
25-34	2	20.59	13.37	18.52	11.65
35-44	3	27.18	11.82	25.40	13.46
45-54	4	32.00	17.03	25.51	18.34
55-64	5	9.59	49.05	17.09	46.69
65+	6	5.06	89.46	8.78	97.71
Overall		100.00	22.13	100.00	27.75

Data source: Statistical Office of the Republic of Serbia, 2004, 2014: 1, 2014: 2.

decomposition of the causes of the change are illustrated in Table 2. The same procedure is done at the level of districts and local administrative units (municipalities and cities) within the Timok Krajina region, and the results are concisely depicted in Figure 3 and Table 3.

If the cell-specific activity rates in agriculture remained constant during the examined period and the age structures of the population varied as between the years 2002 and 2011, the overall activity rate in agriculture would increase by 5.23 percentage points, since in the years 2002 and 2011, it would amount

Table 2: Standardisation and decomposition of the difference between overall activity rates in agriculture in the years 2002 and 2011 at the level of the Timok Krajina region.

Rates in agricultural activity	**Standardisation**		**Decomposition**	
	2011 (population 2)	**2002 (population 1)**	**Difference (effects)**	**Percent distribution of effects**
R (rate) – standardised rates	27.53	22.30	5.23 (age-effect)	93.10
I (age) – standardised rates	25.11	24.72	0.39 (rate-effect)	6.90
Overall rate	27.75	22.13	5.62	100.00

Source: author

22.30% and 27.53%, respectively. This implies that 93.10% of the difference between overall activity rates in agriculture in the years 2002 and 2011 is achieved due to the difference in the age structures of the populations in the two examined years. In the case where the age structure of the active population that performs an occupation would remain the same, and the cell-specific agricultural activity rates would alter as between the years 2002 and 2011, the overall activity rate in agriculture would be 24.72% and 25.11%, respectively. The difference in percentage points would be 0.39, i.e. 6.90% of the difference between the overall activity rates in agriculture. The following cartographic representation (Figure 3) and Table 3 provide an insight into the significance of the age-effect (the impact of changes in the age structure) and the rate-effect (the impact of changes in the age-specific activity rate in agriculture) for the change of overall activity rates in agriculture on different sub-territorial units within the Timok Krajina region.

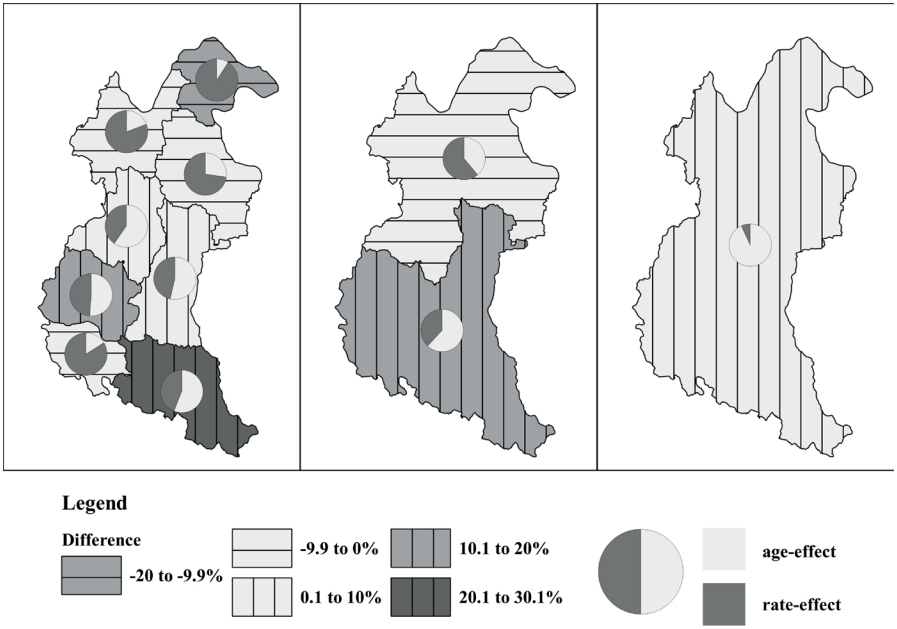

Figure 3: Differences between the overall activity rates in agriculture in the years 2002 and 2011 at the subterritorial levels within the Timok Krajina region and their causes.

Source: author

At the local administrative unit (cities and municipalities) level, a heterogeneous structure is present, both in terms of intensity of activity rate in agriculture changes and terms of their causes (i.e. effects). The municipalities in the northern part of the region (Negotin, Majdanpek and Kladovo) and the Municipality of Sokobanja in the south-west are characterised by a decrease of the overall activity rates in agriculture with the dominance of the rate-effect, where as the rest of the region demonstrates different characteristics, i.e. in

Table 3: Decomposition of the difference between overall activity rates in agriculture in the years 2002 and 2011 at the level of the Timok Krajina region subterritorial units and the changes in the size of the examined population contingents.

Territorial unit	**Difference between overall activity rates in agriculture in the years 2002 and 2011**	**Age-effect**	**Rate-effect**	**Size change of the contingent of the active population that performs an occupation (%)**	**Size change of the contingent of the active population that performs an occupation in agriculture (%)**
Municipality of Kladovo	–12.22	9.56	90.44	–15.61	–65.93
Municipality of Majdanpek	–9.46	19.12	80.88	–45.28	–74.60
Municipality of Negotin	–4.64	27.69	72.31	–26.20	–34.48
The City of Bor	7.65	59.77	40.23	–22.52	48.03
Bor district	–1.42	38.87	61.13	–26.73	–31.56
The City of Zaječar	6.46	53.03	46.97	–20.77	10.79
Municipality of Boljevac	13.46	50.56	49.44	–6.75	25.80
Municipality of Knjaževac	30.10	55.94	44.06	2.89	218.59
Municipality of Sokobanja	–6.20	16.23	83.77	–24.27	–34.53
Zaječar district	12.36	61.86	38.14	–13.69	33.13
The Timok Krajina region	5.62	93.10	6.90	–20.65	–0.50

Source: author

crease inthe rate with the dominance of the age-effect. Data on the district level additionally present the differences between the southern and northern parts of the region. In the Bor district, the overall activity rate in agriculture has slightly decreased with a dominance of the rate effect, while the Zaječar district is characterised by the opposite trend with an increase of the overall rate by 12.36 per cent points.

According to the fact that the changes in overall activity rate in agriculture stand in a cause-effect relationship with size changes of contingents of people whose ratio forms the examined rates, Table 3 also concisely presents the changes in the size of these contingents during the examined period on the level of each sub-territorial unit and the Timok Krajina region.

The common characteristic of all examined territorial units is a decrease in the size of the contingent of the active population that performs an occupation, except for the Municipality of Knjaževac, where a slight increase close to stagnation can be observed. The Timok Krajina region in total has reduced the size of this contingent by 20,860 people during the examined period. On the other hand, the size of the contingent of the active population that performs an occupation in agriculture varies in both directions in a wide range on the level of the sub-territorial units, as it stagnates at the level of the Timok Krajina region.

Discussion and Conclusion

Observing the Timok Krajina region, the hypothesis of this paper is found to be true. With 93.10% participation of the age-effect in the overall agricultural activity rate growth and only 6.90% of the difference caused by the changes in age-specific activity rates, the achieved increase is almost completely a consequence of the age recomposition of the active population that performs an occupation.

For the achieved increase in the overall activity rate in agriculture from 22.13% to 27.75%, it can be stated that it is in contrast with the expected trend present at the national level. Therefore, it is necessary to put this increase in relation to the changes in the size of the examined population contingents. Namely, the observed increase is achieved mainly due to the decrease in size of the contingent of the total active population that performs an occupation

by 20.65%, while the size of the contingent of the total active population that performs an occupation in agriculture remains identical. Hence, it would be incorrect to conclude that the achieved increase in the overall activity rate in agriculture is a result of growing interest in agricultural production.

The analysis of the sub-territorial levels within the Timok Krajina region showed different and significant deviations compared to the collective values and trends that characterise this region. Despite that, it is possible to derive a few regularities. All territorial units that show the decrease in the overall activity rate in agriculture concurrently show a decrease in the contingent size of the active population that performs an occupation in agriculture, which is more intense than the decrease of the contingent size of the total active population that performs an occupation. On the other hand, the increase in the overall activity rate in agriculture on all territorial levels is followed by an increase in the contingent size of the total active population that performs an occupation in agriculture (except for the Timok Krajina region, where it stagnates). Further, the age effect is dominant in all cases as the rate increases; otherwise, it can be considered the rate effect. The wide variations on the sub-territorial levels assert their specificities, i.e. heterogeneity of the Timok Krajina region, which points out the imperfections of a generalised approach. Therefore, it is necessary to be as detailed as possible in order to get more credible and applicable information.

The results indicate a relative increase in the significance of agricultural production in this region, in the context of unfavourable demographic and economic trends. According to the fact that the reduction of the rural population on the national level exceeds the rate of the agricultural population reduction (Mitrović 2015), the trend observed in this research is expected to continue in the future period in the Timok Krajina region and to appear in more parts of the Republic of Serbia.

In general, the impact of population ageing on agricultural activity rate, such as other consequences of agricultural population ageing, is still not sufficiently recognised in national strategic documents and policies. With the adoption of the National Strategy on Ageing (2006), the phenomenon of ageing is promoted on the national level as a factor of all governmental sector policies, and the first strategic direction in this document was to animate the integrative adaptation to the social and economic consequences of ageing. A series of strategic documents subsequently adopted included this topic; however, their

adequate coordination remains absent (Pantić & Živanović-Miljković 2010). In addition, it is imperative to mention the non-compliance of the development documents for the Timok Krajina region with the latest national population census, conducted in 2011. Most of them, including the Regional Spatial Plan and the Regional Development Strategy, were created just before the latest population census. As a consequence, the latest observed data is from the year 2002; therefore, the rise of the overall agricultural activity rate in the Timok Krajina region is yet to be studied in detail and incorporated into the development strategies and policies.

One of the basic recognised obstacles to the further agricultural development of the Timok Krajina region is that it does not possess significant human capital for directing further agricultural development in accordance with contemporary ecological, economic and health standards (Regional Spatial Plan of the Timok Krajina region, 2011). Agricultural producers in the Timok Krajina region are not informed of the latest trends in management and production procedures, and their cooperation is insufficient, which leads to insufficient competitiveness in the national and international markets (Regional Development Strategy of the Timok Krajina region 2011). It is concluded that by facing such problems, the region will increase the local income of the agricultural producers, new jobs will be established, and the region's competitiveness will increase. In such conditions, it is essential to improve the quality of consulting services, cooperation of scientific organisations and collaboration of local administration, various associations, agricultural producers and other stakeholders interested in agricultural land management. As concluded by Stloukal (2001), in order to move from knowledge to concrete actions, providing objective scientific information regarding the specifics of the ageing process to decision-makers is of crucial relevance.

References

Aničić, J., Vukotić, S. and Maksimović, G. 2017 'The possibilities and limitations of entrepreneurship development in agriculture in Serbia', Ekonomika Poljoprivrede 64(1): 171–189. Retrieved from https://doi.org/10.5937/ekoPolj1701171A

Bogdanov, N. L., Đorđević-Milošević, S., and Clark, L. 2007 Mala ruralna domaćinstva u Srbiji i ruralna nepoljoprivredna ekonomija. Belgrade: UNDP.

Bongaarts, J. 1978 'A Framework for Analyzing the Proximate Determinants of Fer-

tility'. Population and Development Review 4(1): 105. Retrieved from https://doi.org/10.2307/1972149

Bongaarts, J. 1980 'The Methodology of Measuring the Impact of Family Planning Programmes on Fertility' (Manual IX). Population and Development Review 6(1): 164. Retrieved from https://doi.org/10.2307/1972673

Bryden, J., and Munro, G. 2000 'New approaches to economic development in peripheral rural regions', Scottish Geographical Journal 116(2): 111–124. Retrieved from https://doi.org/10.1080/00369220018737085

Canudas Romo, V. 2003 Decomposition Methods in Demography. Rijksuniversiteit Groningen. Population Studies.

Cho, L. J. & Retherford, R. D. 1973 'Comparative analysis of recent fertility trends in East Asia' in: Proceedings of IUSSP International Population Conference.

Derić, B., and Perišić, M. 1995 ,Territorialisation of regional development of Serbia' in: Prostorno planiranje, regionalni razvoj i zaštitaživotne sredine (Posebna izdanja no. 26). Institut za arhitekturu i urbanizam, Belgrade, p. 3-7.

Đuričin, S. & Behara, I. 2014 'Improving financial performance of agroindustrial sector based on the development incentives', Deindustrialization in the Republic of Serbia, p. 690–703. Retrieved from http://ebooks.ien.bg.ac.rs/68/1/sdj_2014_01.pdf

Elshoff, H., van Wissen, L. & Mulder, C. H. 2014 'The self-reinforcing effects of population decline: An analysis of differences in moving behaviour between rural neighbourhoods with declining and stable populations', Journal of Rural Studies 36: 285–299. Retrieved from https://doi.org/10.1016/j.jrurstud.2014.09.006

Garloff, A., Pohl, C. & Schanne, N. 2013 'Do small labor market entry cohorts reduce unemployment?', Demographic Research 29: 379–406. Retrieved from https://doi.org/10.4054/DemRes.2013.29.15

Gligorijević, V. & Vasić, P. 2018 'Contribution of the aging to the decrease in the rate of economic activity: Quantification with the decomposition method', Matica Srpska Journal of Social Sciences 167: 525–535. Retrieved from https://doi.org/10.2298/ZMSDN1867525G

Government of the Republic of Serbia. 2006 National Strategy on Ageing 2006–2015.

Gupta, P. Das. 1993 Standardization and decomposition of rates: A users' manual. U.S. Bureau of the Census, Current Population Reports, Series P23–186. Washington, DC: U.S. Government Printing Office.

Gupta, P. Das. 1991 'Decomposition of the difference between two rates and its consistency when more than two populations are involved', Mathematical Population Studies, 3(2): 105–125. Retrieved from https://doi.org/10.1080/08898489109525329

Johnson, P. 2002 ,The impact of ageing: the supply of labour and human capital' in: H. Siebert (ed.) Economic Policy for Ageing Societies, p. 111–130.

Kim, Y. J. & Strobino, D. M. 1984 'Decomposition of the Difference between Two Rates

with Hierarchical Factors', Demography 21(3): 361. Retrieved from https://doi.org/10.2307/2061165

Kitagawa, E.M. 1955 'Components of a difference between two rates', Journal of the American Statistical Association 50: 1168–1194. Retrieved from https://doi.org/10.2307/2281213

Kitagawa, E.M. 1964 'Standardized comparisons in population research', Demography, 1(1): 296–315. Retrieved from https://doi.org/10.1007/BF03208469

Liao, T. F. 1989 ,A Flexible Approach for the Decomposition of Rate Differences'. Demography 26(4): 717. Retrieved from https://doi.org/10.2307/2061269

Loichinger, E. & Prskawetz, A. 2017 ,Changes in economic activity: The role of age and education', Demographic Research 36: 1185–1208. Retrieved from https://doi.org/10.4054/DemRes.2017.36.40

Martínez-Filgueira, X., Peón, D., and López-Iglesias, E. 2017 'Intra-rural divides and regional planning: an analysis of a traditional emigration region (Galicia, Spain)', European Planning Studies, 25(7): 1237–1255. Retrieved from https://doi.org/10.1080/09654313.2017.1319465

Martinović, M. & Ratkaj, I. 2015 'Sustainable rural development in Serbia: Towards a quantitative typology of rural areas', Carpathian Journal of Earth and Environmental Sciences 10(3): 37–48.

Mitrović, M., 1997 'Population development problems in Serbian villages' in: Zbornik radova "Balkansko selo u promenama i regionalni ruralni razvoj". Zavod za sociologiju sela, Belgrade, p. 589.

Mitrović, M. 2015 Villages in Serbia. Statistical Office of the Republic of Serbia, Belgrade. Retrieved from http://media.popispoljoprivrede.stat.rs/2015/11/Sela_u_Srbiji.pdf

Nathanson, C. A. & Kim, Y. J. 1989 'Components of Change in Adolescent Fertility, 1971–1979', Demography 26(1): 85. Retrieved from https://doi.org/10.2307/2061496

Pantić, M., and Živanović-Miljković, J. 2010 'Regional differences between rural areas of Serbia in population aging and agricultural activities: Case studies of the Indjija and Knjazevac municipalities', Spatium 22: 29–37. Retrieved from https://doi.org/10.2298/SPAT1022029P

Prskawetz, A., Zagaglia, B., Fent, T. & Skirbekk, V. 2005 'Decomposing the Change in Labour Force Indicators over Time', Demographic Research 13:163–188. Retrieved from doi: 10.4054/DemRes.2005.13.7.

Prskawetz, A., Fent, T. & Guest, R. 2008 'Workforce Aging and Labor Productivity: The Role of Supply and Demand for Labor in the G7 Countries', Population and Development Review 34: 298–323. Retrieved from http://www.jstor.org/stable/25434769

Pullum, T. W., Tedrow, L. M. & Herting, J. R. 1989 'Measuring Change and Continuity

in Parity Distributions', Demography 26(3): 485. Retrieved from https://doi.org/10.2307/2061608

Radivojević, B. & Nikitović, V. 2010 'Labour force sustainability under conditions of demographic ageing', Matica Srpska Journal of Social Sciences 131: 455–464. Retrieved from https://doi.org/10.2298/ZMSDN1031455R

Radovanović, S. 1999 'Basic tendencies in demographic development of rural population and revitalization-related issues', Stanovnistvo 37(1–4): 9–24. Retrieved from https://doi.org/10.2298/STNV9904009R

Regional Development Strategy of the Timok Krajina region. 2011 Regional Development Agency Eastern Serbia, Zaječar. Retrieved from http://invest.negotin.rs/resources/klerr/strateska_dokumenta/regionalna_strategija/Regionalna_strategija_razvoja_Timocke_krajine_31052011_SER.pdf

Regional Spatial Plan of the Timok Krajina region. 2011 Official Gazette of the Republic of Serbia, No. 51/2011.

Spasovski, M. & Šantić, D. 2012 'Distribution and concentrate trends of Serbian population – primary demographic challenge at the beginning of the 21st century' in: Zbornik radova „Problemi i izazovi savremene geografske nauke i nastave". Geografski fakultet, Belgrade, p. 57–72.

Statistical Office of the Republic of Serbia. 2014:1 Census of Population, Households and Dwellings in the Republic of Serbia. 2011, Census book no. 20: Comparative review of the number of population 1948–2011.

Statistical Office of the Republic of Serbia. 2014:2 Census of Population, Households and Dwellings in the Republic of Serbia 2011, Census book no. 15: Industry.

Statistical Office of the Republic of Serbia. 2004 Census of Population, Households and Dwellings in the Republic of Serbia. 2002, Census book no. 19: Total and agricultural population.

Statistical Office of the Republic of Serbia. 1991 Census of Population, Households and Dwellings in the Republic of Serbia 1991, Census book no. 8: Active population in the country that performs an occupation according to the industry.

Statistical Office of the Republic of Serbia. 1981 Census of Population, Households and Dwellings in the Republic of Serbia 1981: Active population performing occupation by place of work and activity (data by settlements).

Stloukal, L. 2000 'What Can Agricultural Censuses Tell us about Rural Population Aging in Developing Countries?', FAO Population Programme Service (SDWP). Retrieved from https://agris.fao.org/agris-search/search.do?recordID=GB2013202973

Stloukal, L. 2001 'Rural population ageing in poorer countries: possible implications for rural development', FAO Population Programme Service (SDWP). Retrieved from https://agris.fao.org/agris-search/search.do?recordID=GB2013202974

Stojilković, J. 2011 'Growing number of pensioners and population aging in Serbia',

Journal of the Geographical Institute Jovan Cvijić, SASA 61(2): 69–84. Retrieved from https://doi.org/10.2298/ijgi1102069s

Todorović, M., 2007 'Spatial frame, distribution and significant implications of depopulation in rural areas of Serbia' in: Zbornik radova, Prvi kongres srpskih geografa. Srpsko geografsko društvo, Geografski institut „Jovan Cvijić" SANU, Geografski fakultet Univerziteta u Beogradu, Belgrade, p. 645–653.

Vasiljević, Z., Zakić, V. & Kovačević, V. 2016 ,The recent legislature in the Republic of Serbia in area of incentives and financing of agriculture and rural development', Agro-Knowledge Journal 16(1): 33–45. Retrieved from https://doi.org/10.7251/AGRSR1501033V

Vaupel, J. W., & Canudas-Romo, V. 2002 'Decomposing demographic change into direct vs. compositional components', Demographic Research 7: 1–14. Retrieved from https://doi.org/10.4054/DemRes.2002.7.1

Wang, J., Rahman, A., Siegal, H. A. & Fisher, J. H. 2000 'Standardization and decomposition of rates: Useful analytic techniques for behavior and health studies', Behavior Research Methods, Instruments, and Computers 32(2): 357–366. Retrieved from https://doi.org/10.3758/BF03207806

Wojtkiewicz, R. A., McLanahan, S. S. & Garfinkel, I. 1990 'The Growth of Families Headed by Women: 1950–1980', Demography 27(1): 19. Retrieved from https://doi.org/10.2307/2061550