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## Land fragmentation and efforts to prevent it in Slovak legislation

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**Abstract:** Agricultural land represents a country's natural heritage. Therefore, land protection is an issue that is the subject of various legislative measures, also including those that affect land fragmentation. Land fragmentation is a problem that hinders the effective use of land. In 1995, Slovak lawmakers adopted Law 180/1995 Coll., which prevents the fragmentation of land under a minimum size. The aim of this paper was to determine whether Slovak legislation concerning land fragmentation is effective and prevents this phenomenon. We compare the Slovak legislation with the legislations of other countries, and, further, we describe the existing situation with respect to land fragmentation in the individual regions of the country according to the requirements of Slovak legal regulations. The results include proposals for the potential amendment of the legal regulation to ensure the effective prevention of land fragmentation.

**Keywords:** land fragmentation, legal regulation, minimum plot size

Land fragmentation is usually defined as a situation in which a single farm consists of numerous, spatially separated plots (e.g., Binns 1950; McPherson 1982 and Van Dijk 2003) or as decrease in the average size of farm holdings, an increase in the scattering of each farmer's land, or a decrease in the size of the individual plots in a farm holding (Agarwal 1971). Land fragmentation is a fundamental rural, spatial problem concerned with farms which are poorly organised at locations across space (King and Burton 1982). Land fragmentation is linked with other problems such as the lack of a road network providing access to a parcel; this is a primary factor favouring abandonment or determining why parcels remain uncultivated (Karouzis 1977). Moreover, this problem causes conflicts among neighbouring landowners (Demetriou 2014).

Most experts argue that land fragmentation is a result of institutional, political, historical and sociological factors, e.g., inheritance, collectivisation, transaction costs, urban development policies or personal valuation of land ownership (Blarel et al. 1992; Bizimana et al. 2004 and Latruffe and Piet 2013); other factors include population growth, cultural perspectives and land markets (Demetriou 2014).

There is no single consensus on the value of land fragmentation among experts from various fields of

study. A negative point of view is likely to be taken by economists, European geographers and policy makers mainly because of the ineffective use of technology and higher costs for cultivation; conversely, non-European geographers, anthropologists, ethnographers, and environmentalists are likely to look favourably upon land fragmentation, because farmers can in this way cultivate many environmental zones and optimise the schedule for cropping activities. Although land fragmentation is not a problem by definition, it is considered by most commentators to be a serious obstacle, which prevents rational agricultural development and, in general, sustainable rural development. Its main disadvantages are that it hinders mechanization, causes inefficiencies in production and hence reduces the income of farmers. Land fragmentation is a universal phenomenon in the EU and other continents (Demetriou 2014). Latruffe and Piet (2013) argue that land fragmentation generates both positive and negative externalities (e.g., increasing biodiversity, an increase in a society's economic value of a landscape, offset by extra road works, greenhouse gas emissions, etc.); however, the effects on a farmer's production decisions tend toward the negative, because of the time wasted in traveling from one plot to another, potential increases in production costs, restriction

of choice of production, higher investments for soil quality improvement (e.g., drainage). Nevertheless, land fragmentation may offer greater opportunities for risk diversification.

There are many studies investigating the effects of land fragmentation in European as well as non-European countries. Most studies have concluded that there is a negative relationship between land fragmentation and economic indicators (such as production growth, yields or technical efficiency). Schultz (1953) saw land fragmentation as a source of inefficiency. Jarabin and Epplin (1994) argued that land fragmentation increases production costs and that continuous land fragmentation would lead to decreasing efficiency in Jordan. However, in China, Nguyen et al. (1996) argued that to reduce economic costs, land consolidation should be undertaken with less government intervention; more attention should be given to the establishment of markets for land and improvements in rural credit and grain markets. Wan and Cheng (2001) posited that existing economies of scale appear to be too small to suggest radical land policy changes in China. Tan et al. (2010), meanwhile, found that land fragmentation is an important determinant of technical efficiency in rice production in China. Kawasaki (2010) confirmed that land fragmentation is an impediment to efficient rice production also in Japan because fragmentation increases production costs and offsets economies of size, and although fragmentation does reduce production risk, its monetary value is far below the cost of land fragmentation. In Pakistan, Parikh and Shah (1994) found that fragmented holdings are one of the causes of inefficiency. Manjunatha et al. (2013) concluded that land fragmentation in India is positively and significantly associated with inefficiency. These findings confirmed those of Deininger et al. (2014), who determined that fragmentation increases production costs and fosters the substitution of labour for machinery, especially for small and medium farmers in India. However, according to results from Rwanda, Ali et al. (2015) argued that fragmentation tends to reduce the incidence of crop shocks and increases yields and productive efficiency; therefore, in Rwanda, interventions to reduce fragmentation may be ineffective or counterproductive. In Nigeria, Awotide and Agbola (2010) concluded that there existed a statistically significant and positive relationship between land fragmentation and the productivity of maize farmers.

Based on the research cited above, we can conclude a certain level of land fragmentation is necessary; however, this “certain” level must be carefully deter-

mined according to the character and needs of each country and even region. Indeed, Van Dijk (2003) suggested that a land policy applied in one country may not be applicable in the same way in another country. Therefore, before adopting a land policy in a given country, the government should take into account the character, particularities and specific circumstances of that country.

While Todorova and Lulcheva (2005) confirmed a negative effect of the land fragmentation in Bulgaria in stating that fragmentation continues to exist and exerts a negative impact on the sustainable development of rural regions, the results of Di Falco et al. (2010) did not make definite positive or negative conclusions on land fragmentation in Bulgaria. They argued that, on the one hand, land fragmentation reduces farm profitability, but on the other hand, that land fragmentation fosters crop diversification and, moreover, they also found that crop biodiversity plays a beneficial role in farm profitability.

However, in European countries, researchers have usually confirmed the negative effects of land fragmentation. Del Corral et al. (2011) evaluated the increase in profits that could be obtained by reducing land fragmentation in Spain. Platonova and Jankava (2013) reported that land fragmentation in Latvia not only makes land management difficult, but also increases transport costs. In Romania, Vijulie et al. (2012) described the effects of land fragmentation as follows: due to the scattered distribution of plots and the long distances between holdings, many fields have been turned into fallow land and consequently productivity has dropped. Hartvigsen (2014) investigated land fragmentation in Central and Eastern Europe and found that when both land ownership and land use is highly fragmented, agricultural and rural development are often negatively affected. Bentley (1987) also pointed out that land fragmentation is considered by agricultural policy makers as a source of ineffective agriculture and, thus, must be prevented by legislative actions.

Latruffe and Piet (2013) differentiate five dimensions of land fragmentation covering the number of plots farmed, plot size, the shape of plots, the distance of the plots from farm buildings and the distances between plots (or plot scattering). However, according to the findings of King and Burton (1982) land fragmentation is associated with six factors: the landholding size, the number of parcels belonging to the holding, the size of each parcel, the shape of each parcel, the spatial distribution of parcels, and

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the size distribution of the parcels. Demetriou et al. (2013) also distinguish six factors when constituting an index of land fragmentation; however, they are partially different from the factors defined by King and Burton, and include the spatial distribution of parcels, the size of parcels, the shape of parcels, the accessibility of parcels, a type of ownership which is twofold (the case when land and trees or water belong to different landowners) and shared ownership (where the land belongs to different landowners).

According to Van Dijk (2004) there are more types of land fragmentation: fragmentation of land ownership (refers to the number of landowners who use a given piece of land), land use (refers to a high density of land users and the consequent small farm size), internal fragmentation (considers parcel size, parcel shape, and parcel distance as well), separation of ownership and a situation where there is a discrepancy between ownership and use.

For Slovakia, the first, third and fourth type of land fragmentation is commonplace. Although Slovakia is a typical country with a high level of fragmentation of ownership of agricultural land, there is a low level of fragmentation of land use. This is caused by the negligible impact of land reforms after 1990 on land use and farm structure, which are both characterised by a dominant position of large corporate farms and agricultural cooperatives. In this paper, we are interested in the third type of land fragmentation, also called technical land fragmentation. This type of land fragmentation does not prohibit land use in large corporations or cooperatives; however, it does represent a problem for landowners who want to use their own land plots after the termination of land use contracts. Such landowners are deprived of access to their many very scattered, small pieces of land and, therefore, are not able to use their land plots. In spite of this problem, the parcel size of land plots is decreasing year by year in spite of Slovak legislation that should prevent or stop the land fragmentation. The aim of this study was to determine whether the legislation fulfils its role. If our analysis indicated that this was not the case, we aimed to propose amendments to the law that would make it fit for purpose.

## DATA AND METHODS

Land fragmentation is a problem in Slovakia because of the ineffective use of land by landowners. However, in 1995, Slovak lawmakers adopted Law

180/1995 Coll., which prevents the fragmentation of land under a minimum size of land plots. The aim of this paper is to determine whether Slovak legislation against land fragmentation is effective. We compare the Slovak legislation with the legislations of other countries; further, we describe the existing land fragmentation situation in the individual regions of the country according to the requirements of Slovak legal regulations. In the results section, there is a brief overview of the historical purposes of land fragmentation in Slovakia, a comparison of Slovak legislation on prevention of land fragmentation with the legal regulations of other countries, an overview of the development of existing land fragmentation in Slovakia with reference to Slovak legislation and a comparison of land fragmentation among the different regions of Slovakia. We assumed that statistically significant differences in land fragmentation among different regions would necessitate a special approach for the prevention of land fragmentation in Slovakia.

The material consists of scientific literature, legislation from different countries and statistical data received from the statistical yearbooks of the Slovak Land Fund for the years 2006–2016.

The methods are related to the comparison of legal regulations in Slovakia and other countries regulating the minimum size of land plots and the analysis using statistical methods. Time series analysis was used to predict the development of land fragmentation over the next three years according to the 2006–2016 data, using logarithmic transformation of Holt's linear exponential smoothing model and logarithmic transformation of the additive Winters Method, parametric ANOVA and the non-parametric Kruskal-Wallis test to investigate potential statistically significant differences among the different regions of Slovakia. Statistical tests were carried out in the SAS software suite.

We take into account the size of the agricultural and forest land; most of these parcels are situated in non-developed areas (the aqueous area and the remaining land are of negligible size) where parcels of type "E" predominate. "E" denotes a parcel of land that has no delimitation to its boundaries but is a part of a greater parcel of land. Therefore, land use is not affected by land fragmentation when the land is used by large corporations or cooperatives. The problems arise when landowners want to use their land themselves. The legislation regulating the minimum size of land plots encompasses only those agricultural and forest land plots situated in non-developed areas.

## RESULTS

### A short historical overview of land fragmentation in Slovakia

The roots of land fragmentation in Slovakia lie in the country's inheritance system: properties are distributed among all entitled heirs. This results in a decrease in land plot size and an increasing number of landowners (Štefanovič 2006). After the First World War, the landowners tried to solve the problem of land fragmentation themselves by exchanging their land plots; however, their effort were nullified by land reforms. The first land reform consisted of two laws: according to the first law, the agricultural land of landowners with more than 150 ha of agricultural land or with more than 250 ha of total land was occupied; according to the second law, the occupied land was distributed among small land users (Kolesár et al. 1980). The Second World War interrupted these land reforms. After the war, land reform continued in a revised form, but it was not finished because of the establishment of the socialist system of economy. The new system also brought its own new land reform with it. This new reform was more radical than the first one and stipulated the occupation of the land of landowners with over 50 ha if this land was farmed, and all the land of landowners who did not farm their land (Fábry et al. 1977). The occupied land was then to be distributed among new owners; however, this objective was also not achieved because of the commencement of the collectivisation process. Except for these land reforms, land fragmentation was further promoted by laws stipulating the seizure of land owned by Jews, enemies of the state and traitors (Drobník 2005).

In the period of 1964–1989, state notaries were tasked with preventing land fragmentation by obliging the heirs to choose one from among them who would be the sole inheritor of the ownership of the land. Moreover, heirs gave up their land ownership even without the intervention of the notaries, because land ownership did not have any value.

Efforts to prevent land fragmentation since 1990 have failed due to the adoption of laws regulating land ownership restitutions. The first restitution law was aimed at the reversal of property damages caused to landowners and the owners of agricultural property during the period of 1948–1989. According to this law, the entitled persons (original owners or their heirs) had the right to reclaim their occupied agricultural

land until the end of 1992. The period allowed for reclaiming and finding the relevant documents to prove ownership rights was very short. Moreover, many of the entitled persons were not able to fulfil the condition of permanent residence in Slovakia. Therefore, about 20% of land did not find its owners (Bandlerová et al. 2011). The problem of so-called unknown owners negatively affects the agricultural land market to the present date, in spite of the fact that Slovak lawmakers adopted a second restitution law with easier conditions to finish the restitution process in 2003. The third restitution law entitled churches and parishes to reclaim their land property. Moreover, the fourth restitution law enabled the restoration of succession (from 1964 to 1989) to the heirs who had given up their share of the agricultural or forest land. The heirs were interesting in pursuing such claims because land property was once gain valuable after 1990. Thus, land fragmentation continued.

Only in 1995 was law no. 180/1995 Coll. stipulating certain measures for the arrangement of land ownership adopted. It includes legal rules on minimum size of land plots and concerns agricultural and forest land plots that are situated outside the developed areas of municipalities. The law stipulates three levels of prevention of land fragmentation. The first and second one discourage land fragmentation by way of fees when that landowners must pay when they want to subdivide their land into plots of smaller than 20 000 m<sup>2</sup>. The first level stipulates fees of 10% of the agricultural land value. This level affects new land plots created after the subdividing of land that are smaller than 20 000 m<sup>2</sup> but greater than 5000 m<sup>2</sup>, in the case of agricultural land, and smaller than 20 000 m<sup>2</sup> but greater than 10 000 m<sup>2</sup>, in the case of forest land. The second level stipulates fees of 20% of the agricultural land value. This level concerns new land plots created after the subdividing of land that are smaller than 5000 m<sup>2</sup> but greater than 2000 m<sup>2</sup>, in the case of agricultural land, and smaller than 10 000 m<sup>2</sup> but greater than 5000 m<sup>2</sup>, in the case of forest land. For the calculation of fees, agricultural land value is stipulated by a special legal regulation – order of the Ministry of Agriculture No. 38/2005 Coll. on the determining of the value of land plots and their groves for the purposes of land consolidation. The fees represent revenues to the state budget.

The third level of prevention for land fragmentation prohibits the subdividing of agricultural land plots under the size of 2000 m<sup>2</sup>, and forest land plots under size of the 5000 m<sup>2</sup>, in all cases. Thus, such subdivid-

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ing is prohibited not only for the landowners in their contracts but also for state bodies such as courts and notaries. Moreover, the law also prohibits the co-ownership of land plots if the co-ownership shares are smaller than the minimum size of plot stipulated by law. This law leads to many disputes among heirs, and especially renders any agreement among them almost impossible. Such cases are decided on by a court that takes into account the heir who will be most likely be able to take care of the land; other heirs are then entitled to financial compensation from the heir who receives the land property. However, there are some exemptions in the law that enable to the creation of a land plot that is under the minimum legal size: (1) the land is subdivided for the building – or for other purposes that allow expropriation of the land, or for the purposes of land consolidation; (2) the land is subdivided because of restitutions; (3) the land plot is separated from the land to join it with another land plot (i.e., no new land plot is created); (4) the land is subdivided for the establishment of plots for the purposes of gardening or recreation in accordance with the plans of a particular municipality.

### Land fragmentation and legal regulations in some European countries

Slovakia is not the only country in Europe that regulates the minimum size of land plot. There exists a legal minimum size in five countries: Germany, Bulgaria, Estonia, Lithuania and Slovakia (Swinnen et al. 2014). However, the level of fragmentation of land ownership is medium or high in these countries (Hartvigsen 2014). This may suggest that a legally-determined minimum size of plot does not prevent land fragmentation. However, these legal norms can only prevent further land fragmentation, and cannot change a situation that was created before they were adopted; this is mainly the role of land consolidation. On the other hand, land consolidation can solve enormous problems of land fragmentation, but cannot prevent further land fragmentation when no legal norm prevents further land fragmentation. Therefore, both legal measures are necessary; land consolidation for settling the current state of land fragmentation and a minimum size of land plot to maintain this state after land consolidation.

In Germany, when a landowner wants to split a plot of one hectare, he/she needs to have permission from the local authority, which can prevent the proposed action. In Bulgaria, the minimum plot size for agri-

cultural land is 0.3 ha. Vineyards and pastures have minimum plot sizes of 0.1 ha and 0.2 ha, respectively. In Lithuania, the legal minimum plot size is 0.01 ha (Swinnen et al. 2014). In Estonia, according to the § 16 of the Land Cadastre Act the minimum size of a cadastral unit is 30 m<sup>2</sup>; cadastral units which are smaller than the minimum size may be formed by a decision of the local government council. In Slovakia, the legal minimum sizes of agricultural land plots and forest land plots are 2000 m<sup>2</sup> and 5000 m<sup>2</sup>, respectively.

According to the research of Hartvigsen (2013), the average size of land plots in the countries of Central and Eastern Europe differs widely; however, data from many countries are not available (Figure 1).

According to Figure 1 and the above-mentioned legal minimum size of land plots in some states, we can compare the results in Bulgaria, Lithuania and Slovakia, because only in these states is there a regulated minimum size of land plots and data on average size of land plots available. In Bulgaria, the legal minimum size is 0.3 ha; the average size is 0.45 ha. In Lithuania, the legal minimum size of land is 0.01 ha; the average size of land plots is 2.90 ha. In Slovakia, the legal minimum size is 0.02 ha of agricultural land; the average size of agricultural land plot is 0.45 ha (OECD 1997; Dale and Baldwin 2000). The question arises as to what role the law of minimum legal size fulfils when the average size of land plot is higher. Laws stipulating a minimum size of land do not abolish opportunities for further land fragmentation. Moreover, such regulations can be regarded as an infringement of property rights, which should be regarded as one of the human rights. A limitation of human rights is possible if it is in the public interest. Agricultural land and forest land plots are not only economic entities; they also represent natural resources. Therefore, there is public interest in their protection achieved by legal regulations that limit

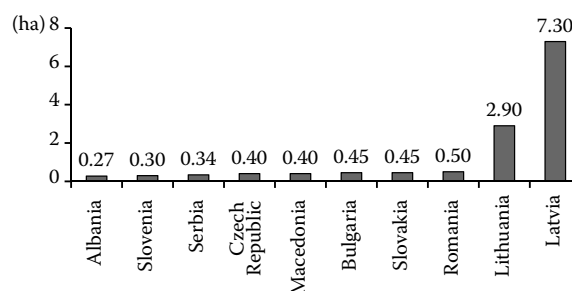
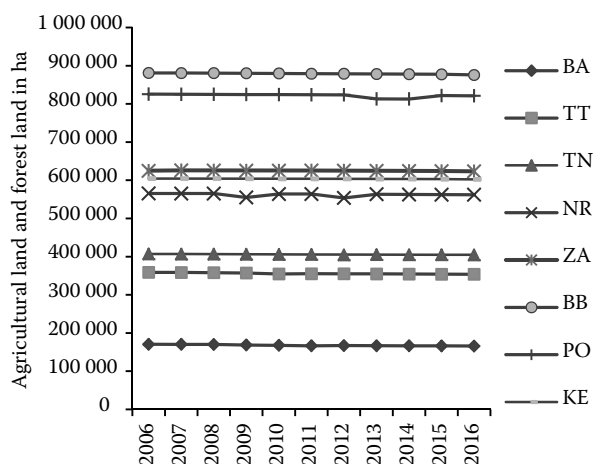


Figure 1. Average size of agricultural land plots in different European countries

Source Hartvigsen (2013) and own processing



BA – Bratislava region, TT – Trnava region, TN – Trenčín region, NR – Nitra region, ZA – Žilina region, BB – Banská Bystrica region, PO – Prešov region, KE – Košice region

Figure 2. Development of agricultural and forest land in different regions of Slovakia (NUTS III) 2006–2016

Source: Statistical yearbook of the Slovak Land Fund for 2006–2016 and own processing

property rights. However, the legal regulation needs to fulfil its role of protection; otherwise it is contrary to the legal regulations that protect human rights.

### Land fragmentation and the current situation in Slovakia

To determine whether the Slovak law on the legal minimum size of land fulfils its role, it is necessary to compare the legal minimum size of land and the actual sizes of land in the country. Moreover, it is advisable to compare the different sizes in the different regions of the country. Differences in land fragmentation between regions may indicate a requirement for special legal regulations.

In Slovakia, statistical data on land fragmentation in different regions are missing. Therefore, we substituted the missing data with data related to the size of agricultural and forest land and the number of (above-mentioned) “E” parcels. We analysed data from 2006 to 2016. The analysis starts with some presumptions: we suppose firstly, that the agricultural and forest land is situated only outside of developed areas; secondly, that the above-mentioned “E” parcels are situated only outside of the developed areas of a municipality; thirdly, that there are only minimal changes to agricultural and forest land area, and that these do not influence the results (according to ANOVA there are no statistically significant changes

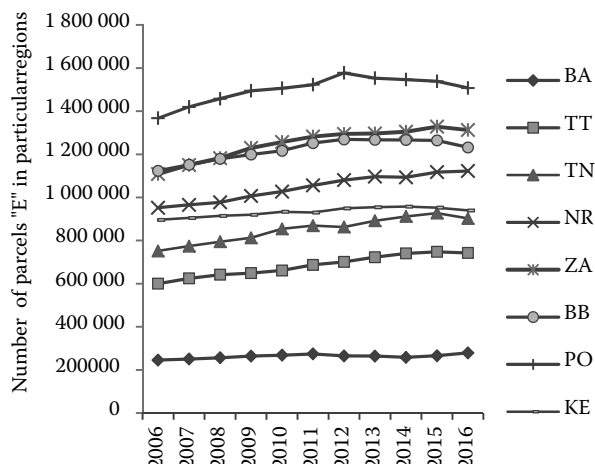


Figure 3. Development of the number of “E” parcels in particular regions (NUTS III) 2006–2016

Source: Statistical yearbook of the Slovak Land Fund for 2006–2016 and own processing

in agricultural and forest land acreage during the period of 2006–2016 in the particular regions (NUTS III); moreover, the development of acreage in the agricultural and forest land is documented in Figure 2).

Figure 2 and the results of the ANOVA test ( $P$ -value = 0.7196 > 0.05) confirm our supposition that there are no statistically significant changes in the development of land acreage during the period of 2006–2016. However, statistically significant differences are evident in the development of the number of “E” parcels in particular regions (NUTS III) during the period of 2006–2016. This is confirmed by the ANOVA test ( $P$ -value =  $5.33 \times 10^{-5}$  < 0.05) as well as in Figure 3.

According to Figures 2 and 3, we can conclude that the average size of “E” parcels is decreasing in spite of the legal regulation stipulating a minimum size of land, and so land fragmentation is not being eliminated or stopped. The decreasing average size of “E” parcels is documented in Figure 4.

If the legal regulation does not fulfil its role, but rather limits the property rights of the landowners (mainly the right to disposition of land), the public interest is missing and the law is inconsistent with the Constitution of the Slovak Republic (article 20) as well as with Article 1 of the Convention for the Protection of Human Rights and Fundamental Freedoms signed in Rome on 4 November 1950. We suggest that the legal minimum size of land plots should be derived from the existing size of “E” parcels. Otherwise, there

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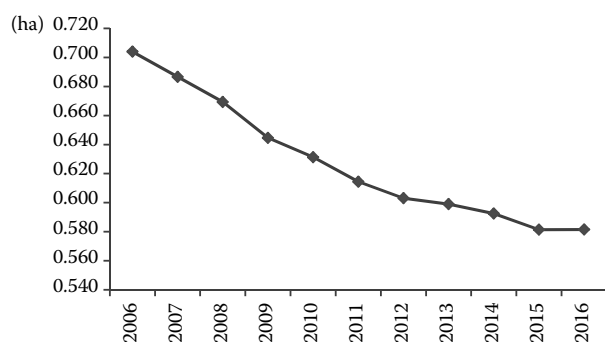


Figure 4. Development of the average size of “E” parcels in Slovakia in 2006–2016 in ha

Source: Statistical yearbook of the Slovak Land Fund for 2006–2016 and own processing, 2016

is a space for further land fragmentation; this is also confirmed in Figure 4.

A further question is if particular regions need an individual approach to determining a legal minimum size of parcels, or whether this can be stipulated in general for the whole country in one law. In other words, the question is if there are statistically significant differences among the regions (NUTS III) and if an individual approach to stipulate a legal minimum size of parcels is necessary. We took into account the average size of parcels in each district (NUTS IV) in the particular regions (NUTS III); the numbers of districts are taken as the number of observations in each region (NUTS III) in 2016. We tested for statistically significant differences using parametric and non-parametric tests. On the one hand, the parametric tests give more precise results; on the other hand, the number of observations for

Table 1. Average size of parcels in particular regions (NUTS III) and the test results

Region	Mean	Variance	
Bratislava	0.558717	0.047524	
Trnava	0.480727	0.013837	
Trenčín	0.520041	0.035161	
Nitra	0.498309	0.011229	
Žilina	0.526974	0.058568	
Banská Bystrica	0.746079	0.022644	
Prešov	0.583533	0.029169	
Košice	0.621053	0.053126	
Test	P-value	Test statistic	Test critical
ANOVA test	0.0378	2.277	2.143
Kruskal-Wallis test	0.0294	15.564	14.067

Source: own processing

parametric tests is too small. The results are documented in Table 1.

According to the results of the statistical tests, there are statistically significant differences among the regions (NUTS III); however, this significance is quite small (e.g.,  $P$ -value = 0.0378 or 0.0294, which is smaller than 0.05 but greater than 0.01. In addition, according to the multiple range tests, there are statistically significant differences only between the Banská Bystrica region and all other regions (except Košice region). The results of the multiple range tests are documented in Table 2.

According to the results, we suggest that small number and size of statistically significant differences do not necessitate an individual approach in each particular region of Slovakia. This means that it is possible to regulate a legal minimum size on the state level, which is common for all regions (NUTS III). According to Table 2, the average size of “E” parcels is higher in most regions than the legal minimum size for forest land (5000 m<sup>2</sup>), and it is in all regions higher than the legal minimum size for agricultural land (2000 m<sup>2</sup>). If the average size of “E” parcels in particular regions are higher than the legal minimum size and, moreover, land fragmentation in Slovakia is very high, then it is necessary to consider increasing the legal minimum size of “E” parcels, at least for the average size of “E” parcels in the country (0.58 ha per “E” parcel). Otherwise, there is a high probability for further land fragmentation that is undesirable both for the agricultural land market as well as for land consolidation. The probability of land fragmentation in the future is revealed by a model of time series analysis that enables prediction of land fragmentation development over the next three years. We took into account the average size of land parcels from 2006 to 2016 in Slovakia, which we calculated as the sum of agricultural and forest land divided by the number

Table 2. Results of multiple range tests for statistical significance among the regions (NUTS III)

Region	Mean	Homogenous groups	
Trnava	0.481	x	
Nitra	0.498	x	
Trenčín	0.521	x	
Žilina	0.527	x	
Bratislava	0.559	x	
Prešov	0.584	x	
Košice	0.621	x	x
Banská Bystrica	0.746	x	

Source: own processing

Table 3. Forecast of average size of “E” parcels in Slovakia based on historical data from 2006 to 2016

Year	1 <sup>st</sup> model			2 <sup>nd</sup> model			3 <sup>rd</sup> model		
	predicted value	upper 95% confidence	lower	predicted value	upper 95% confidence	lower	predicted value	upper 95% confidence	lower
2017	0.575	0.586	0.564	0.575	0.581	0.568	0.575	0.581	0.571
2018	0.571	0.588	0.554	0.571	0.581	0.561	0.571	0.579	0.563
2019	0.567	0.593	0.541	0.567	0.583	0.551	0.567	0.579	0.555

Source: own processing

of “E” parcels (Figure 4). The forecast models were developed using the SAS software suite and the SAS Time Series Forecasting System was used to predict the development of the average size of “E” parcels in Slovakia, if legislation will be not changed, given the historical data in the period of 2006–2016. We choose the top three models: (1) the logarithmic transformation of Holt’s linear exponential smoothing; (2) the combination of three models: logarithmic transformation of Holt’s linear exponential smoothing, logarithmic transformation of the Winters additive model and Holt’s linear exponential smoothing; (3) the combination of five models: logarithmic transformation of damped trend exponential smoothing, damped trend exponential smoothing, logarithmic transformation of Holt’s linear exponential smoothing, logarithmic transformation of Winters additive model and Holt’s Linear exponential smoothing. The results of the predictions are documented in Table 3.

All three models were compared using mean absolute percentage error (MAPE), *R*-Squared, Akaike information criterion and Schwarz’s Bayesian information criterion. The results are presented in Table 4.

According to the results presented in Table 4, there are only small differences in the models; we can state that all three models are able to provide a forecast of the average size of “E” parcels. According to all three models, we can expect a decrease in the average size of “E” parcels in Slovakia by about 41 m<sup>2</sup> yearly. These results prove that the present legislation needs to be changed according to the current state of land fragmentation.

The legal minimum size of parcels is not the only measure to stop or eliminate land fragmentation.

Another measure is the rate of fees for land fragmentation under the size of 20 000 m<sup>2</sup> as mentioned above. The above-mentioned fees are stipulated, by the order of the Ministry of Agriculture no. 38/2005 Coll. on the determining of the value of land plots and their groves for the purposes of land consolidation, to constitute 10 and 20% of agricultural land value. According to the order, the highest land value for the highest quality land is 121 000 Slovak crowns per hectare (the land values are still given in Slovak crowns), which represents about 4016.46 euro per hectare. This means that the highest fee for the fragmentation of the highest quality land is 803.30 euro per hectare. We do not believe that this fee sufficient motivation to prevent land fragmentation. If the fee should be derived from the land value, then it is necessary to derive it from the market value or to amend the order of the ministry regulating the administrative land value.

Both measures (minimum size of land and fees) should be amended also because of the implementation of land consolidation in Slovakia. Land consolidation cannot continue to exert its effects if the special legislative measures will not fulfil their roles. If it remains possible to divide land plots after land consolidation according to the current legislative measures, then land fragmentation will again pose a serious problem only a few years after the implementation of land consolidation.

## CONCLUSION

High rates of land fragmentation are a serious problem mainly for landowners and young farmers starting

Table 4. The selected indicators for evaluation of a model’s quality

Models	MAPE	<i>R</i> -Square	Akaike Criterion	Schwarz-Bayssian Criterion
1 <sup>st</sup> model	0.72579	0.984	–112.00057	–111.20478
2 <sup>nd</sup> model	0.73442	0.984	–109.74308	–108.54941
3 <sup>rd</sup> model	0.68123	0.985	–106.32669	–104.33722

Source: own processing



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out in agriculture. The current situation is profitable for large agricultural corporations that use hundreds or thousands of hectares of agricultural land under land rent contracts. After the termination of land rent contracts, landowners are not able to withdraw their land plots because of land fragmentation. This means that they own very small, scattered land plots and that they are deprived of access to them. The costs for withdrawing their land plots are often higher than the actual market value of the scattered small land plots. On the other hand, the law does not allow them to withdraw their lands in the event that access is not possible. They have the right only to conclude a sub-rent contract for the land plots that are accessible when the land user is able to withdraw such land plots to the landowners. Thus, until the implementation of land consolidation, landowners will not be able to work on their land property and land fragmentation will remain a barrier for nascent agricultural businesses.

Lawmakers have tried to adopt various legislative measures to stop or eliminate land fragmentation, but often such measures violate human rights. Therefore, it must be proven that these legal measures are effective in promoting the public interest. Slovak lawmakers adopted two legislative measures: a minimum size of land plots and fees for land fragmentation under a specific size. The current average size of a plot is higher than the legal minimum size of land, and, therefore, the probability of further land fragmentation is high. This is also proven by the decreasing average size of land and models which forecast that land fragmentation will continue in the next few years at least. The legal minimum size of land plots should be based on the current status of fragmented land. We suggest that the legal minimum size of land plots should be derived from the current size of “E” parcels. Otherwise, there is a high probability for further land fragmentation, which is undesirable for both the agricultural land market as well as land consolidation. We did not observe statistically significant differences among the regions (NUTS III); therefore, an individual approach in the particular regions, while not excluded, is not deemed to be necessary. The second measure, fees for land fragmentation, should discourage landowners from land fragmentation. We suggest that the current level of these fees (the highest fee is 803.30 euro) does not act as a sufficient deterrent. The size of this fee should be derived from the market value, the order of the Ministry regulating administrative land value, which is a basis for the fee calculations, should be amended.

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