doi: 10.17221/317/2015-AGRICECON

Factors affecting farm size on the European level and the national level of the Czech Republic

Vratislava Janovska[1]*, Petra Simova[2], Josef Vlasak[1], Petr Sklenicka[1]

[1]*Czech University of Life Sciences Prague, Faculty of Environmental Sciences, Department of Land Use and Improvement, Prague, Czech Republic*
[2]*Czech University of Life Sciences Prague, Faculty of Environmental Sciences, Department of Applied Geoinformatics and Spatial Planning, Prague, Czech Republic*

*Corresponding author: janovska@fzp.czu.cz

Janovska V., Simova P., Vlasak J., Sklenicka P. (2017): **Factors affecting farm size on the European level and the national level of the Czech Republic**. Agric. Econ. – Czech, 63: 1–12.

Abstract: Extreme differences in agricultural holding size, existing not only among the countries within the EU as a whole but also within the farm structures of the individual countries, create a considerable uncertainty for establishing the optimal political and economic instruments to support sustainable rural development. The study explores the determinants influencing the spatial volatility of agricultural holding size at both the EU scale and the national scale of the Czech Republic, the latter of which has the largest mean agricultural holding size in the EU. While some factors are identical for both the EU and the Czech Republic, other effects can only be evaluated at the European or international scale, and still others can be evaluated only at the national scale. The only factor found in this study to be significantly associated with the agricultural holding size on the European scale was the wheat production. On the Czech national scale, land consolidation, unemployment rate, and soil fertility were significantly associated with the agricultural holding size. The study found that in the Czech Republic, the number of farms was increasing, while at the same time the agricultural holding sizes were decreasing. This is an opposite trend in comparison to the EU as a whole, where the number of farms is diminishing and the sizes increasing.

Keywords: agricultural holding size, farm structure, land consolidation, land management, rural development

Agricultural holding sizes (AHS) are subject to a variety of changes (Smithers and Blay-Palmer 2001). It is clear that the number of farmers and the size of holdings will never be constant (D'Antona et al. 2006). The mean AHS is 26 ha in the EU, however, the range of this indicator is immense, with Romania (mean AHS = 3.6 ha) and the Czech Republic (mean AHS = 91 ha) representing extreme values within the EU as of 2007 (Eurostat 2014). In Southern countries, agricultural holding sizes are generally small and with an extreme fragmentation. In Northern European countries, by contrast, the medium-sized and large farms have a dominant position (Zolin and Caldogno 2012). Although farms with less than 5 ha are numerous, they manage only 7% of the total farmland within the EU, while the small group of enterprises with more than 100 ha manages 50% of all farmland. This structural dualism is particularly marked in certain Eastern European countries (e.g. Bulgaria, Romania) (Pilvere 2013; European Commission 2013). The structure of agricultural holdings within the Czech Republic displays also an extreme dualism in its spatial distribution. According to the data from the Eurostat (2014), 88% of the utilized agricultural area is managed by agricultural entities with the AHS exceeding 100 ha and constituting just 11% of the total number of agricultural holdings.

The average agricultural holding size is an inverse of the expression of the land-user density, and it reflects the current global trend of the decreasing numbers of people working in agriculture. This rapid decrease is a result of the past changes in the farming style

Supported by the Czech Science Foundation as a part of the project GA14-09212S – Farmland Rental Paradox: A New Cause of Economic Land Degradation (2014-2016, GA0/GA).

doi: 10.17221/317/2015-AGRICECON

and methods, such as the shift to a more intensive mechanization during the 1960s and 70s (Bos et al. 2013; Firbank et al. 2013), and the effects of the collectivization and its reversal in the former centrally planned economies of the Central and Eastern Europe (CEE) countries (Hartvigsen 2014). But what factors cause the mean agricultural holding size (AHS) to differ so considerably across different countries in the EU? Moreover, why is that so frequently the case even in the countries that are politically, socio-economically, and environmentally similar?

The search for the factors affecting the landowners' behaviour in disposing with farmland (i.e. determining whether they farm their land, sell or rent their farms, or hand the farm down to future generations of their families) is an important indicator of the current state and trends in the agricultural economy (Latruffe et al. 2013). The decision to farm is a complex question for a landowner. It can be impacted by such factors as the alternative, non-farm employment opportunities in the given location (Jančák and Götz 1997; Dannenberg and Kuemmerle 2010; Dries et al. 2012; Bartolini and Viaggi 2013), low economic returns from the agricultural production and a high necessary labour intensity of agriculture (Jančák and Götz 1997; Forbord et al. 2014). The most endangered group are young farmers, who are by far more susceptible to the changing employment outside of the agricultural sector (Breustedt and Glauben 2007; Roberts and Key 2008).

Two important factors in the stability of a farm, particularly for the new farmers, are the price and availability of land. In many regions, the land price and the efficiency of land markets have an effect, relating not only to active users but also to those owners who do not farm their holdings (van Dijk 2003; Beyene et al. 2006; Vranken and Swinnen 2006; Sklenička et al. 2013). A key factor in maintaining the stability of the agricultural economy is, therefore, the establishment of programmes to support not only the existing farmers but also to provide opportunities to start farming and support programmes to continue in their enterprise (Piet et al. 2011).

One such type of a support programme are land consolidation programmes. They are among the programmes supporting owners in their efforts to farm efficiently, since they lead to a decrease in the number of plots per owner, increase the plots' mean size, create a favourable plot shape, and ensure the access to those plots for the agricultural machinery (Sklenicka 2006). The land tenure reorganization that results from consolidation is a long-term solution for the structure of the agricultural landscape (e.g., Hladík and Číhal 2005; Cay et al. 2010; Pašakarnis and Maliene 2010; Lisec et al. 2014).

Another important support programme for farmers and new entrants within the EU is the Common Agricultural Policy (CAP). However, Petrick and Zier (2012), who studied the effect of the CAP direct payments and the rural development measures on unemployment in agriculture, determined that the CAP has a very limited impact on either the agricultural job creation or maintenance. Although, Ahearn et al. (2006) or Bartolini and Viaggi (2013) have emphasized the CAP's substantial effect – particularly in relation to its direct payments – on changes in the agricultural structure.

Agricultural subsidies are also closely linked with the regions belonging to the Less Favoured Areas (LFAs), and often these are associated with a large proportion of grasslands. An increased percentage of grasslands considerably influences the user density within the area and especially the users' economic self-sufficiency (Mathieu and Joannon 2003). Farm operations in the LFAs are at a disadvantage compared to those in the agriculturally favourable areas due to their lower profits caused by the increased costs, the latter relating primarily to shorter growing seasons, a lower soil quality, and steeper slopes; the crop structure in these areas is limited and the yields are generally lower (Střeleček et al. 2008). A study by Aubert and Perrier-Cornet (2009) confirmed that providing financial support for farming in the LFAs affects the decisions of a considerable number of farmers as to whether they choose to start or continue farming in such locations. On the other hand, Breen et al. (2005) questioned the effect of economic incentives, stating that these farmers' decisions are not crucially affected by the agricultural policy and that they are impacted also by each farmer's individual needs. Those needs, in turn, combine with the national administrative and economic conditions which establish the rules for agricultural enterprises (Bürgi et al. 2004).

The objective of our study is to identify factors underlying the spatial volatility of the AHS among the individual EU countries. Based upon the example of the Czech Republic, a country with extremely high AHS values within the EU, we are looking, too, for those factors associated with the variability of the AHS values on the scale of a single country. The factors to be tested within our analysis were selected based upon research of the scientific literature and

doi: 10.17221/317/2015-AGRICECON

personal consultations with leading experts in the field and the data availability. While some evaluated factors are identical for both scales (unemployment, ownership fragmentation), other factors' effects can only be evaluated at the European or international scale (the political regime before 1989, the CAP direct subsidy), and still others can only be evaluated at the national scale due to the differences in the data formats (the effect of the land consolidations, the travel time to a larger city, soil fertility, the proportion of LFAs, the proportion of grassland). The hypothesized relationships of the individual factors with the AHS as the dependent variable are given in Tables 1 and 2.

METHODS

Input data

The spatial units for the analysis at the European scale were the territories of the individual EU countries. All data were generated from the Eurostat database and we used as the response variable the AHS in 2007, except for the values for Romania and Bulgaria, which joined the EU only in 2007. In their case, the values from 2010 were used.

The EU contains both the so-called transitional countries, where farming was affected by a state controlled regime for decades, and the countries of traditional market economies. The potential effect of these circumstances of political regime on the AHS was included into the subsequent analysis in the form of the categorical variable Communism (Comm), expressing whether or not farmers' operations were still burdened by the previous political regime. Other selected variables at the EU scale encompassed the production (i.e. Wheat Production) and socio-economic factors (i.e. Gross Domestic Product, Unemployment, Agricultural Subsidy, and Population Density; see Table 1). We then created hypothesized relationships of the individual factors with the AHS as the dependent variable.

A second part of the study, focused on the national scale, is based on a sample of 190 administrative units within the Czech Republic. The main reason for selecting these administrative units was the municipality management, which is directly related to the cadastral territory. We randomly selected 95 of the 400 administrative units in which the land consolidations had already been implemented and 95 administrative units without the land consolidation (Figure 1). To minimize the potential spatial autocorrelation of socio-economic and environmental conditions, we set the minimum distance between the sampling units' centroids to 5 km as a spatial restriction for the random selection.

He mean AHS for an administrative unit with the completed land consolidations was calculated at two time points: the AHS at the starting year (AHS0),

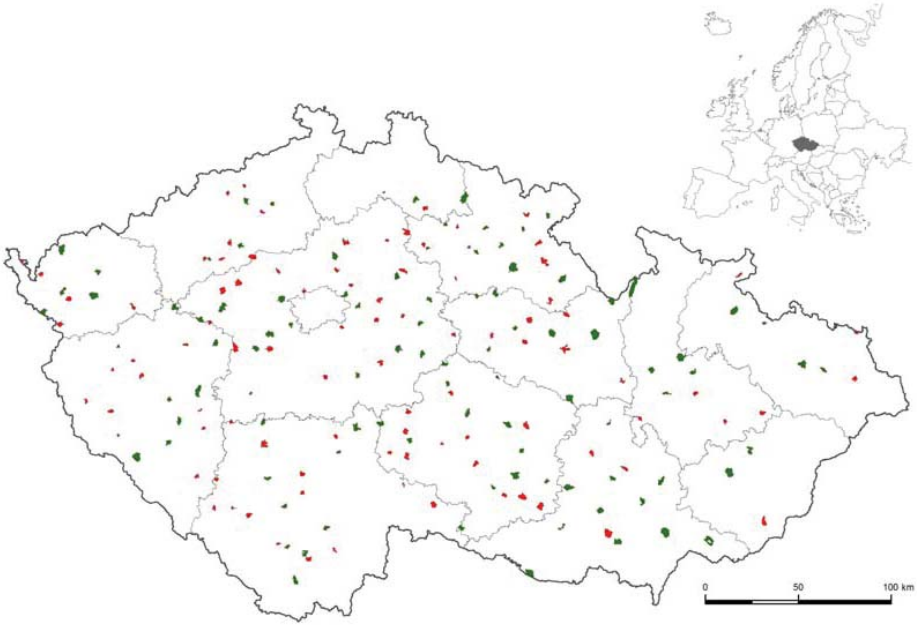

Figure 1. The cadastres analysed in the Czech Republic. Cadastres with the land consolidation are marked in green and those without the land consolidation are in red

doi: 10.17221/317/2015-AGRICECON

Table 1. Factors potentially influencing the final mean holding size on the European scale

Explanatory variable	Abbreviation	Description	Hypothesized influence	Data range (Mean ± SD; Min–Max)
Communism	Comm	Communist regime (Yes/No)	+	Yes/No
Gross Domestic Product	GDP	Gross domestic product (per capita in PPS)	+	99.20 ± 46.89; 40.00–274.00
Unemployment	UnE	Average unemployment in the country (%)	–	6.27 ± 2.00; 3.60–11.20
Population Density	Dens	Population density (people/km^2)	–	116.48 ± 94.75; 14.97–393.17
Subsidies	Pillar	Pillar 1 – Single Area Payment Scheme for each country (EUR/ha)	+	199.89 ± 147.69; 27.27–606.6
Wheat Production	Wheat	Wheat production in the country (t/ha)	+	4.49 ± 1.96; 1.54–8.46

The table lists and describes those factors used as explanatory variables in the statistical analysis. Each factor's hypothesized influence on the mean AHS is marked: + = higher AHS5 values expected with higher values of the explanatory variable (or with "Yes" in the case of Communism); – = the opposite trend. Factors are listed in the order in which they entered the model.

which means in the year when the land consolidation was completed (2005–2008 in those administrative units under study), and AHS 5 years after completion of the land consolidations (2010–2013, hereinafter AHS5). Administrative units without land consolidation were selected for the AHS calculations so as to have a corresponding distribution. For each administrative unit in the sample, we calculated the values of those factors describing the attractiveness for farming (Mean Plot Size, Mean Farmland Price connected with land fertility, Less Favoured Areas, Grassland), offer of other work opportunities (Unemployment, Travel Time to the nearest district capital), and the economic situation (GDP within the broader region).

Table 2. Factors potentially influencing the final mean agricultural holding size (AHS5) on the national scale

Explanatory variable	Abbreviation	Description	Hypothesized influence	Data range (Mean ± SD; Min–Max)
Starting Mean Agricultural Holding Size	AHS0	Mean agricultural holding size in the cadastre in years related to completion of land modifications (ha)	+	61.99 ± 40.48; 7.4–307.2
Land Consolidation	LC	Whether land consolidation was implemented in the cadastre (Yes/No)	–	Yes/No
Gross Domestic Product	GDP	Gross domestic product in regions (CZK 1000 per capita = EUR 37)	+	288.00 ± 17.75; 250.16–311.72
Travel Time	TT	Travel time to a district capital (min)	–	24.13 ± 11.06; 5–62
Unemployment	UnE	Average unemployment in surrounding villages (%)	–	10.37 ± 3.45; 0–22.65
Mean Farmland Price	MFP	Soil productivity expressed as mean administrative farmland price within the cadastre (CZK/ha)	–/+	6.59 ± 3.34; 1.23–14.41
Mean Plot Size	MPS	Mean parcel size in the cadastre (ha)	+	0.85 ± 0.54; 0.14–2.96
Less Favoured Areas	LFA	Proportion of farmland in the cadastre included in LFAs (%)	+	37.58 ± 47.82; 0–100
Grassland	Gra	Proportion of meadows and pastures in farmland in the cadastre (%)	–	22.98 ± 25.89; 0–100

The table lists and describes those factors used as explanatory variables in the statistical analysis. The factor's hypothesized influence on the mean AHS is marked: + = higher AHS5 values expected with higher explanatory variable values (or with "Yes" in the case of Land Consolidation); – = the opposite trend. Factors are listed in the order in which they entered the model. LFA and Gra were omitted from modelling due to their high correlation with MFP.

doi: 10.17221/317/2015-AGRICECON

We then created hypotheses regarding their potential influence on the AHS5 (see Table 2 for details).

All calculations of all variable values were based on publicly available sections of databases from the Czech Statistical Office; the Czech Office for Surveying, Mapping and Cadastre; and the Land Plot Information System. Spatial analysis was performed using ArcGIS 10.1.

Statistical analysis

We analysed data for the European and national scales separately in order to reveal the factors' potential association on the mean AHS. Prior to further analysis, the Pearson correlations were computed among all predictors within each scale to eliminate those with strong correlation ($r > 0.6$). On the national scale, Grassland and LFA were found to be highly and negatively correlated with the Mean Farmland Price ($r = -0.67$ and $r = -0.72$, respectively, $P < 0.05$) and also positively correlated with one another ($r = 0.64$, $P < 0.05$). As the farmland price can be considered a complex factor expressing the soil fertility, we chose the Mean Farmland Price for further modelling, while omitting Grassland and LFA. The values of response variables (in the European countries, the AHS in 2007 and in the Czech Republic, the AHS5) were log-transformed to approach normality (Shapiro-Wilk test) and homoscedasticity (Bartlett's test). As there was no reason to reject the hypotheses of normality and homoscedasticity of the response variables ($P > 0.05$), the analysis of covariance was employed on both scales.

For each scale, we constructed an initial model. The initial model on the European scale included all main factors (Table 1) and two-way interactions of the continuous variables with Communism to explore the potentially differing trends in the AHS dependence on the predictors between the transitional countries and the countries where farming opportunities were not influenced by the previous political regimes. Similarly, the model for the national scale included all the main factors given in Table 2 and two-way interactions of the continuous variables with the categorical LC, as we hypothesized that the trends of the remaining explanatory variables' effects on the AHS might differ due to the effect of the land consolidation. From these models, we deleted all non-significant terms ($P > 0.05$) using a backward stepwise selection procedure to achieve the minimal adequate models following the procedure described by Crawley (2007). Adequacy of fit of the resulting minimal adequate models was explored by examining the quantile–quantile plots of residuals, the plots of residuals versus the fitted values, and a test of the residuals' normality (Shapiro-Wilk test). The whole analysis was performed using the R software.

RESULTS

On the European scale, the resulting minimal adequate model contains only one explanatory variable, but this still explains more than one half (50.37%) of the total variability in the farmland's AHS in the EU countries. This single significant factor was Wheat Production ($F = 23.34$, $P < 0.0001$). The interaction between wheat production and the former political regime (Comm) was not significant. Although none of the transitional countries were among the countries with the highest wheat production (Figure 2), it cannot be concluded from this that the trend of the European AHS dependence on wheat production is different in the transitional countries than in the countries for which the farming continuity was not interrupted by a communist regime. The remaining factors were not demonstrated as having any effect, and all other two-way interactions between Comm and the remaining factors were also non-significant.

On the national scale, the AHS decreased over time. In the years related to the completion of the

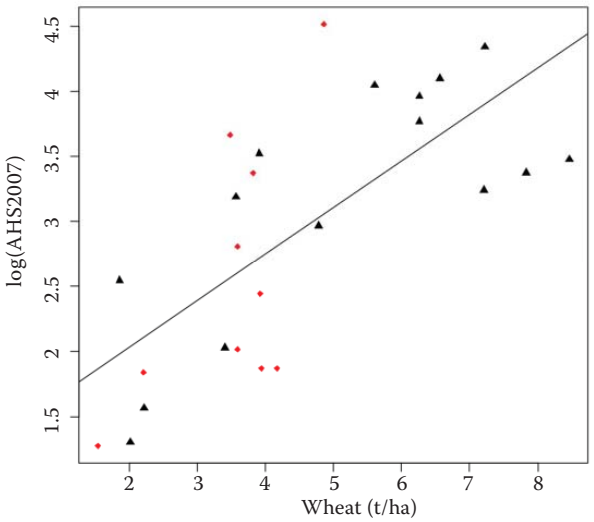

Figure 2. The association of the average holding size in the EU countries in 2007 (AHS2007) on wheat production (Wheat) as a proxy variable for fertility. Red dots represent transitional countries and black triangles represent countries with the traditional market economies

doi: 10.17221/317/2015-AGRICECON

land consolidations (AHS0), the mean AHS in the monitored 190 administrative units was 62.0 ha; by 5 years later (AHS5), it had decreased to 51.4 ha (i.e. by 10.6 ha). In the administrative units with the completed land consolidation, the mean AHS decreased from AHS0 63.4 ha to AHS5 50.5 ha (i.e. by 12.9 ha), while in the administrative units without the land consolidation, it fell from 60.6 ha to 52.3 ha (i.e. by 8.3 ha). Factors significantly associated with the AHS5 on the national scale are given in Table 3.

The resulting minimal adequate model explains 82.62% of the variability in the AHS5 values. According to the hypotheses, the AHS5 values would be strongly affected by the holding size at the starting time. Therefore, the AHS0 needed to be included within the model even though its significance was not the subject of research. Although the AHS0 explains the largest proportion of the resulting AHS5 (see *F* values in Table 3), the model includes also other factors: Land Consolidation (LC), Unemployment Rate (UnE), and soil fertility expressed as Mean Farmland Price (MFP). The resulting estimates of the dependence of the AHS5 model parameters on the combination of explanatory factors for the administrative units with the LC and those without LC are expressed in the following equations:

Administrative units without LC:

$$\log(\text{AHS5}) = 0.042 + 0.944^{*}\log(AHS0) - 0.019^{*}UnE + 0.032^{*}MFP \quad (1)$$

Administrative units with LC:

$$\log(\text{AHS5}) = 0.681 + 0.819^{*}\log(AHS0) - 0.019^{*}UnE + 0.004^{*}MFP \quad (2)$$

Table 3. The minimal adequate model resulting from the analysis of covariance on the national scale

	Df	Sum of squares	*F*-value	*P*
log(AHS0)	1	38.067	509.324	< 2.2e-16
LC	1	0.486	6.506	0.0115
UnE	1	0.749	10.018	0.0018
MFP	1	1.041	13.924	0.0003
LC: MFP	1	0.357	4.782	0.0300
LC: log(AHS0)	1	0.311	4.168	0.0426

Response variable: log-transformed mean holding size 5 years after the land consolidation (AHS5). Probabilities of Type I error are reported based upon Type III sums of squares resulting from a linear model in R. The quality of the model was examined using the Shapiro-Wilk test of the residuals' normality, $P > 0.33$.

Land consolidation affected the AHS5 both as the main effect and in interaction with the AHS0 and MPF. In administrative units without the land consolidation and in those with the completed land consolidation, higher initial AHS0 values corresponded with higher resulting AHS5 values. In the administrative units with the land consolidation, however, the given initial AHS0 value corresponded with a smaller resulting AHS5 value than the value in the administrative units without the land consolidation. The AHS5 also increased slightly with higher Mean Farmland Price values, which represent fertility in the model. Mean Farmland Price manifested significantly both as the main effect and in interactions with the LC, while an increase in the AHS5 was clearer in those administrative units with the completed land consolidation. This result is in accordance with the trend on the European scale, whereby higher fertility also corresponded with a larger holding size.

Another important factor was Unemployment, under the influence of which the AHS slightly decreased. The result, therefore, indicates that, as hypothesized, a higher unemployment may lead to a slight increase in the number of entities farming on the farmland. Given the non-significant interaction between UnE and LC, the trend can be considered to be the same in all administrative units regardless of whether or not the land consolidations were performed within the territory. The results of the statistical analysis do not demonstrate that the change in the AHS on the national scale over time was affected by the remaining studied factors (i.e. Gross Domestic Product in the region, Travel Time to the nearest district capital, and Mean Plot Size) within the administrative unit.

Examples of the main scenarios for how LC, MFP, and UnE could influence the resulting AHS5 depending on the initial AHS0 are given in Figure 3. We used the formulas resulting from the minimal adequate model to describe the change in the AHS over 5 years for three combinations of Mean Farmland Price and Unemployment (Figure 3).

The figure indicates that the land consolidation had a greater effect on the AHS in those locations where the initial holding size was larger. For the mean values of Unemployment and Mean Farmland Price, the modelled decrease in the AHS due to the land consolidation is particularly clear in the administrative units where the initial holdings exceeded 100 ha (Figure 3a). A similar trend, albeit with smaller differences between those administrative units with and without the land consolidation, can be seen under maximum

doi: 10.17221/317/2015-AGRICECON

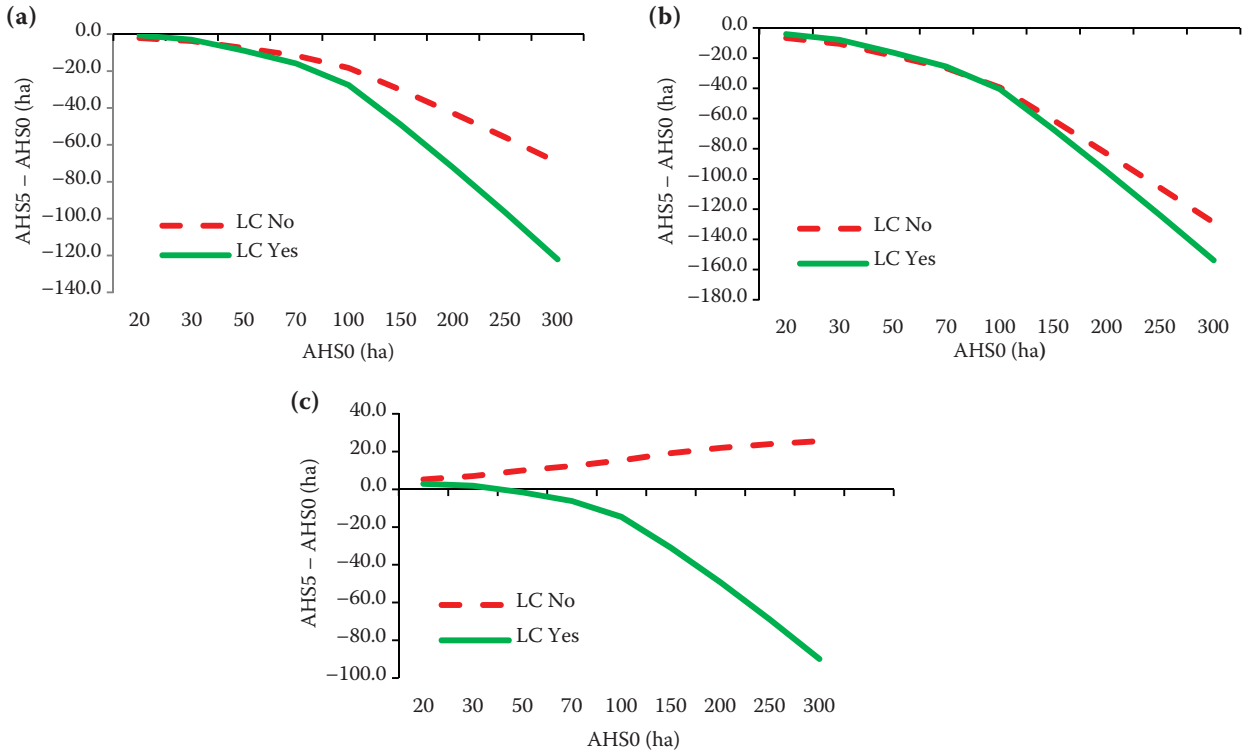

Figure 3. The national scale model in the Czech Republic for the dependence of the change in the AHS values over 5 years (AHS5 minus AHS0) on the initial holding size and the land consolidation implementation. Three scenarios are shown based on Equations 1 and 2: (a) changes under the mean values of Unemployment and Mean Farmland Price, (b) changes under the maximum Unemployment and the minimum Mean Farmland Price, and (c) changes under the minimum Unemployment and the maximum Mean Farmland Price. In most situations, the AHS decreased over time, and the effect of the land consolidation on the said decrease is clearer in those cadastres with larger initial holdings. Nevertheless, the AHS grew slightly even without the land consolidation in cadastres with a low Unemployment and a high Mean Farmland Price.

Unemployment and minimum Mean Farmland Price (Figure 3b). The change in the AHS depending upon the initial holding size was most marked in the situation where there was minimum Unemployment and high Mean Farmland Price (Figure 3c). The land consolidation effect on the AHS, therefore, was generally manifested rather more in the administrative units with larger initial holdings. The most marked effect of the AHS change through the land consolidation occurred at low Unemployment and high Mean Farmland Price (high fertility). Overall, the models, therefore, indicate that the influence of the land consolidation on the AHS is most marked on the most fertile farmland arranged into large user blocks. This dominant effect of the combination of the LC and soil fertility is also demonstrated under a sufficient employment in the region. The models in Figure 3 further lead to the conclusion that the shape of the AHS decrease following the land reform was similar regardless of the unemployment rate and soil fertility, while without the land consolidation, the curve of the AHS change depended more on other factors. The land consolidation, therefore, made the AHS behaviour more predictable over time.

DISCUSSION

Situation in the EU member states

In 2007, the mean AHS in the selected EU countries was 26.8 ± 23.37 ha. Romania had the lowest AHS (3.6 ha), as well as one of the lowest GDP values. Low AHS values were also found in other countries with the low GDP, such as Bulgaria, Hungary and Poland. This group of countries also had higher Unemployment values and lower Wheat Production than the countries with high AHS values, such as the United Kingdom, Denmark, and France. The highest AHS in the EU was seen in the Czech Republic (91.4 ha), which is

doi: 10.17221/317/2015-AGRICECON

an extreme size in comparison to the mean AHS elsewhere within the EU.

The results of the study indicate that the only factor from the analysed ones significantly associated with the AHS at the European scale was Wheat Production. The mean Wheat Production within the EU ranged around 4.49 ± 1.96 t/ha. Wheat Production was the highest in Ireland (8.46 t/ha), with the AHS of 32.3 ha, and the lowest in Romania (1.54 t/ha), with the AHS of 3.6 ha. As Popescu (2010) stated, the AHS in Romania is notably affected by the structure of its fields for wheat production, which are small and fragmented, thereby putting Romania at a disadvantaged position in comparison to other EU countries. Jabarin and Epplin (1994) also determined how the farm size and the land block fragmentation affect the economics of wheat production in Jordan. They confirmed that variable costs for wheat production are substantially dependent not only on the holding size but also on the land block size. It can generally be said that the Southern European countries have a lower Wheat Production, which is affected by the climatic conditions and a considerable fragmentation, as it is known that certain soil types and climates are more favourable for certain types of crops.

Naturally, it does not necessarily mean that only Wheat Production causes the changes of the AHS. The base data from the Eurostat are very general, therefore, the results are affected by the lack of detailed information and additional data sets. Other various factors affect the agricultural holding sizes and they need a further testing. In addition to the analysed factors, it is therefore necessary to focus on others, for example, such as the use of the modern mechanization, which leads to significant changes in the agricultural structure. For example, the main determining factor can be the type of the agricultural technology (Hermans et al. 2010). Large enterprises frequently have a tendency to adjust the size of land production blocks to fit the new mechanization, which contributes to an increased farming efficiency or to the proportion of the rented farmland (Dramstad and Sang 2010). The requirement for large, regular blocks of land is advantageous not only for the agricultural machinery but also for the chartered surveyors and tax authorities, who prefer regular plots where the areas are easy to measure and value (Vejre et al. 2015).

Moreover, there are other factors that could be included in a more comprehensive future study. Both the individual farms and the regional agricultural systems are influenced by the biophysical conditions, including the climate, soil resources and biological phenomena (Smithers and Blay-Palmer 2001). It is also known that the topography is one of the main factors affecting the crop yield and the farm size (Kumhálová and Moudrý 2014). In addition to the regional, natural, and climatic differences, other factors affecting the AHS include the age and maturity of the cultural landscape, the farmers› characteristics or the cadastral subdivisions (Argent et al. 2006). Changes in the farm size and continuation in farming are also affected in particular by the profitability of farming, primarily measured through productivity and financial returns, by the human capital as characterized by the farmers' age and education, and by the programmes in support of farming (Piet et al. 2011). It is likely that the laws and customs that govern the inheritance land have a big influence on the field size, depending on whether or not the fields are likely to be divided up when they are passed to heirs or sold out (Skaloš et al. 2012).

Situation in the Czech Republic

Although the AHS0 explains the largest proportion of the resulting AHS5, of all the studied factors, Land Consolidation (LC), Unemployment Rate (UnE), and soil fertility expressed as Mean Farmland Price (MFP), had a significant effect on the AHS value within the Czech Republic.

In most cases, Land Consolidation (LC) significance for agricultural structure is that it helps to confront the extreme ownership fragmentation through the consolidating and improving the access to fragmented lands within the administrative units, thereby creating more efficient plot sizes for the independent owners (e.g. van Dijk 2003; Hladík and Číhal 2005; Cay et al. 2010; Pašakarnis and Maliene 2010; Lisec et al. 2014). The types of land fragmentation significantly vary across Europe (Hartvigsen 2014). The Central European countries mainly suffer from two types, the ownership fragmentation and the separation of ownership from the land use (van Dijk 2003; Sklenička et al. 2014). Prior to the land consolidation, the owners frequently cannot efficiently farm their plots which are "locked" inside large blocks of land (Bański 2011; Sklenička et al. 2014), and they are, therefore, compelled to rent their lands to the established agricultural entities. This frequently results in extremely large blocks of land (van Dijk 2003; Demetriou et al. 2013) which are economically efficient but also contribute to the degradation of agricultural ecosystems (Popescu

doi: 10.17221/317/2015-AGRICECON

2010; Sklenička et al. 2014). This circumstance was of fundamental importance in shaping the landscape of the Czech Republic as it exists today, because it affected the large imbalance between the number of landowners and the actual number of farmland users (Zeithaml et al., 2009; Sklenička et al., 2014).

The study also showed the AHS to be decreasing on the scale of the Czech Republic over the examined period while the numbers of agricultural entities were increasing. It is the similar situation as in Slovenia (Bojnec and Latruffe 2013). Data from the Czech Statistical Office confirm the increasing trend: in 2008 there were 44 833 agricultural entities, while at the end of 2012, there were 47 903. This is the opposite trend in comparison to the EU as a whole, where the number of farms is decreasing. The results of this study have confirmed the main potential of the land consolidation, namely that of creating the conditions for new agricultural entities to be established through such means as ensuring the conclusion of new rental or purchase contracts between the landowners and new agricultural users. Additionally, it contributes to the improved productivity, efficiency and competitiveness within the agricultural sector, thereby supporting rural development and the balanced regional development while simultaneously supporting the environmental protection and natural resource management (Lisec et al. 2014).

In conjunction with the Land consolidation, the AHS values within the individual administrative units are also affected by the values of Mean Farmland Price and the mean Unemployment. In our study Unemployment and Mean Farmland Price mainly affect the AHS in the administrative units where the original holdings were approximately exceeding 100 ha. This confirms the view that in the times of the increased unemployment, the land consolidation can open a path for people newly interested in farming and increase the efficiency of farmland use (Piet et al. 2011). As evidenced in the study of Roseman (2013), which examined the effect of youth unemployment on rural development in Galicia, youth unemployment in particular is one of the most serious issues, and so it is important to seek instruments to help reducing unemployment in rural areas. The considerable problem with unemployment particularly among young people has also been studied by Möllers and Fritzsch (2010) in Croatia, where they found evidence that despite a considerable interest among young people to start farming, they frequently face problems due to the insufficient education, the lack of farm family traditions, and problematic approaches to access the land.

Nevertheless, the land consolidation is, therefore, important from the perspective of employment and rural development, as the fewer farm employment opportunities the given region has, the more people will leave such region and will need to find work in other regions. The potential to increase the number of new entrants into the agricultural sector (Zagata and Sutherland 2015) exists especially in the countries with a high level of the rented land (e.g. 11 of the 28 EU countries).

The size and the number of agricultural holdings in a region is, therefore, a proxy for an indicator of the sustainability and economic health of the agricultural economy. The AHS has a direct effect on the land-use changes (D'Antona et al. 2006), rural development, and the sustainability of the local population, economy and environment (Lisec et al. 2014). The role of the land tenure security in achieving the sustainable land use was studied for example by Sklenička at al. (2015). The size and the number of land plots, the tenancy structure and the organization of land stakeholders substantially influence the sustainability of agriculture in the individual communities, autonomous regions, and even entire countries (Garnett et al. 2013). AHS is also related to changes in the farmers' life cycles and the environments within which farmers are operating (Thenail and Baudry 2004; Leonard et al. 2011). These extreme differences in the AHS existing not only among countries within the EU, but even within the agricultural structure of the individual countries create a considerable uncertainty when establishing the optimal political and economic instruments to support the sustainable rural development (Zolin and Caldogno 2012).

CONCLUSIONS

As changes in the AHS are important causes of the changes in regional development, rural landscape maintenance, and protection of the agricultural land resource, it is necessary to continue in identifying those factors underlying the spatial volatility of the AHS. At the EU scale, the previous political regime demonstrated no effect on the AHS in spite of the fact that none of the transitional countries were among those with the highest wheat production, which did exhibit an effect on the AHS. At the scale of the Czech Republic, the association with the land consolidation

doi: 10.17221/317/2015-AGRICECON

on increasing the attractiveness of farming was demonstrated in all three scenarios, and in particular in the case of large farming blocks. In view of the fact that a considerable proportion of the Czech Republic territory consists of large farming blocks – for the most part rented – we regard the effect of the land consolidation on reducing the AHS to be considerable. In the case of an area with a high unemployment rate, LC may also be regarded as one of the instruments for economically revitalizing the region, even if only over a longer time horizon. The land consolidation is, therefore, an important instrument of the national agricultural policy in the interest of diversifying agricultural stakeholders of agricultural land. The result, therefore, supports the conclusion that the land consolidation heightens the farmland attractiveness for farming, which then manifests itself in an increased number of agricultural holdings. Determining the factors which affect the numbers of agricultural entities and the farm size on agricultural land is very important for efficiently formulating the environmental policy and agricultural consulting for the sustainable land management.

Acknowledgements

Special thanks to Gale A. Kirking from the English Editorial Services for editing and critical reading of the manuscript.

REFERENCES

Ahearn M.C., El-Osta H., Dewbre J. (2006): The impact of coupled and decoupled government subsidies on off-farm labor participation of U.S. farm operators. American Journal of Agricultural Economics, 88: 393–408.
Argent N.M., Smailes P.J., Griffin T. (2006): Tracing the density impulse in rural settlement systems: a quantitative analysis of the factors underlying rural population density across South-Eastern Australia, 1981–2001. Population and Environment, 27: 151–190.
Aubert M., Perrier-Cornet P. (2009): Is there a future for small farms in developed countries? Evidence from the French case. Agricultural Economics, 40: 797–806.
Bański J. (2011): Changes in agricultural land ownership in Poland in the period of the market economy. Agricultural Economics – Czech, 57: 93–101.
Bartolini F., Viaggi D. (2013): The common agricultural policy and the determinants of changes in EU farm size. Land Use Policy, 31: 126–135.
Beyene A., Gibbon D., Haile M. (2006): Heterogeneity in land resources and diversity in farming practices in Tigray, Ethiopia. Agricultural Systems, 88: 61–74.
Bojnec Š., Latruffe L. (2013): Farm size, agricultural subsidies and farm performance in Slovenia. Land Use Policy, 32: 207–217.
Bos J.F.F.P., Smit A.B.L., Schröder J.J. (2013): Is agricultural intensification in The Netherlands running up to its limits? NJAS – Wageningen Journal of Life Science, 66: 65–73.
Breen J.P., Hennessy T.C., Thorne F.S. (2005): The effect of decoupling on the decision to produce: an Irish case study. Food Policy, 30: 129–144.
Breustedt G., Glauben T. (2007): Driving forces behind exiting from farming in Western Europe. Journal of Agricultural Economics, 58: 115–127.
Bürgi M., Hersperger A.M., Schneeberger N. (2004): Driving forces of landscape change – current and new directions. Landscape Ecology, 19: 857–868.
Cay T., Ayten T., Iscan F. (2010): Effects of different land reallocation models on the success of land consolidation projects: Social and economic approaches. Land Use Policy; 27: 262–269.
Crawley M.J. (2007): The R Book. 2nd ed. Wiley & Sons, Chichester.
Dannenberg P., Kuemmerle T. (2010): Farm size and land use pattern changes in postsocialist Poland. The Professional Geographer, 62: 197–210.
D'Antona Á.O., VanWey L.K., Hayashi C.M., (2006): Property size and land cover change in the Brazilian Amazon. Population and Environment, 27: 373–396; doi: 10.1007/s11111-006-0031-4.
Demetriou D., Stillwell J., See L. (2013): A new methodology for measuring land fragmentation. Computers, Environment and Urban Systems, 39: 71–80.
Dramstad W.E., Sang N., (2010): Tenancy in Norwegian agriculture. Land Use Policy, 27: 946–956.
Dries L., Ciaian P., Kancs A. (2012): Job creation and job destruction in EU agriculture. Food Policy, 37: 600–608.
Eurostat (2014): Farm Structure Survey. Structure of Agricultural Holdings 2007. European Communities, Luxembourg. Available at http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ef_ov_kvftaa&lang=en (accessed Dec 1, 2014).
European Commission (2013): Structure and dynamics of EU farms: changes, trends and policy relevance. EU Agricultural Economics Briefs, 9: 1–15.
Firbank L.G., Elliott J., Drake B., Cao Y., Gooday R. (2013): Evidence of sustainable intensification among British farms. Agriculture, Ecosystems & Environment, 173: 58–65.

doi: 10.17221/317/2015-AGRICECON

Forbord M., Bjørkhaug H., Burton R.J.F. (2014): Drivers of change in Norwegian agricultural land control and the emergence of rental farming. Journal of Rural Studies; 33: 9–19.

Garnett T., Appleby M.C., Balmford A., Bateman I.J., Benton T.G., Bloomer P., Burlingame B., Dawkins M., Dolan L., Fraser D., Herrero M., Hoffmann I., Smith P., Thornton P.K., Toulmin C., Vermeulen S.J., Godfray H.C.J. (2013): Sustainable intensification in agriculture: premises and policies. Science; 341 (6141): 33–34.

Hartvigsen M.B. (2014): Land reform and land fragmentation in Central and Eastern Europe. Land Use Policy, 36: 330–341.

Hermans C.M.L., Geijzendorffer I.R., Ewert F., Metzger M.J., Vereijken P.H., Woltjer G.B., Verhagen A. (2010): Exploring the future of European crop production in a liberalised market, with specific consideration of climate change and the regional competitiveness. Ecological Modelling, 221: 2177–2187.

Hladík J., Číhal L. (2005): Cost and performance analysis of land offices. Agricicultural Ecoomics – Czech, 51: 462–468.

Jabarin A.S., Epplin F.M. (1994): Impacts of land fragmentation on the cost of producing wheat in the rain-fed region of northern Jordan. Agricultural Economics, 11: 191–196.

Jančák V., Götz A. (1997): Územní diferenciace českého zemědělství a její vývoj (in Czech). KSGRR PřF UK, Praha.

Kumhálová J., Moudrý V. (2014): Topographical characteristics for precision agriculture in conditions of the Czech Republic. Applied Geography, 50: 90–98.

Latruffe, L., Dupuy, A., Desjeux, Y., 2013. What would farmers' strategies be in a no-CAP situation? An illustration from two regions in France. Journal of Rural Studies. 32, 10–25.

Leonard S.H., Deane G.D., Gutmann M.P. (2011): Household and farm transitions in environmental context. Population and Environment, 32: 287–317.

Lisec, A., Primožič, T., Ferlan, M., Šumrada, R., Drobne, S., 2014. Land owners' perception of land consolidation and their satisfaction with the results – Slovenian experiences. Land Use Policy. 38, 550–563.

Mathieu A., Joannon A. (2003): How farmers view their job in Pays de Caux, France: Consequences for grassland in water erosion. Environmental Science & Policy, 6, 29–36.

Möllers J., Fritzsch J. (2010): Individual farm exit decisions in Croatian family farms. Post-communist Economies, 22: 119–128.

Pašakarnis G., Maliene V. (2010): Towards sustainable rural development in Central and Eastern Europe: Applying land consolidation. Land Use Policy, 27: 545–549.

Petrick M., Zier P. (2012): Common Agricultural Policy effects on dynamic labour use in agriculture. Food Policy, 37: 671–678.

Piet L., Latruffe L., Le Mouel C., Desjeux Y. (2011): How do agricultural policies influence farm size inequality? The example of France. European Review of Agricultural Economics, 39: 5–28.

Pilvere I. (2013): Problems of small farms in Latvia. Economics and Rural Development, 9: 44–50.

Popescu M. (2010): Physical size of agricultural holdings in Romania. Gaps between Romania and the European Union member states. Agricultural Economics and Rural Development, New Series, 7: 17–36.

Roberts M.J., Key N. (2008): Agricultural payments and land concentration: a semiparametric spatial regression analysis. American Journal of Agricultural Economics, 90: 627–643.

Roseman S.R. (2013): Unemployment and labor migration in rural Galicia (Spain). Dialectical Anthropology, 37: 401–421.

Skaloš J., Molnárová K., Kottová P. (2012): Land reforms reflected in the farming landscape in East Bohemia and in Southern Sweden – Two faces of modernisation. Applied Geography, 35: 114–123.

Sklenicka P. (2006): Applying evaluation criteria for the land consolidation effect to three contrasting study areas in the Czech Republic. Land Use Policy, 23: 502–510; doi: 10.1016/j.landusepol.2005.03.001

Sklenicka P., Molnarova K., Pixova K.C., Salek M.E. (2013): Factors affecting farmland prices in the Czech Republic. Land Use Policy, 30: 130–136.

Sklenicka P., Janovska V., Salek M., Vlasak J., Molnarova K. (2014): The farmland rental paradox: extreme land ownership fragmentation as a new form of land degradation. Land Use Policy, 38: 587–593.

Sklenicka P., Molnarova K.J., Salek M., Simova P., Vlasak J., Sekac P., Janovska V. (2015): Owner or tenant: Who adopts better soil conservation practices? Land Use Policy, 47: 253–261.

Smithers J., Blay-Palmer A. (2001): Technology innovation as a strategy for climate adaptation in agriculture. Applied Geography, 21: 175–197.

Střeleček F., Lososová J., Zdeněk R. (2008): Economic results of agricultural holdings in less favoured areas. Agricultural Economics – Czech, 11: 510–520.

van Dijk T. (2003): Scenarios of Central European land fragmentation. Land Use Policy, 20: 149–158.

Vejre H., Vesterager J.P., Andersen P.S., Olafsson A.S., Brandt J., Dalgaard T. (2015): Does cadastral division of area-based ecosystem services obstruct comprehensive management? Ecological Modelling, 295: 176–187.

doi: 10.17221/317/2015-AGRICECON

Vranken L., Swinnen J. (2006): Land rental markets in transition: Theory and evidence from Hungary. World Development, 34: 481–500.

Thenail C., Baudry J. (2004): Variation of farm spatial land use pattern according to the structure of the hedgerow network (bocage) landscape: a case study in northeast Brittany. Agriculture, Ecosystems & Environment, 101: 53–72.

Zolin M.B., Caldogno A.R. (2012): Beyond the European rural areas: the need for strategic approaches. Transition Studies Review, 18: 613–629.

Zagata L., Sutherland L.-A. (2015): Deconstructing the "young farmer problem in Europe": Towards a research agenda. Journal of Rural Studies, 38: 39–51.

Zeithaml J., Pižl V., Skleničk a P. (2009): Earthworm assemblages in an ecotone between forest and arable field and their relations with soil properties. Pesquisa Agropecuária Brasileira, 44: 922–926.

Received on November 3, 2015
Accepted on December 29, 2015
Published online on November 3, 2016