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Exploitation of Agricultural Land in the Czech Republic and EU Countries

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Abstract

The primary objective of the paper is to assess the extent and exploitation of agricultural land in the CR and EU countries based on selected macro-socioeconomic indicators in order to determine the position of the CR and future desirable exploitation, protection and stabilisation of agricultural land in the CR.

The following methods will be employed in order to meet the objective: (1) The Coefficient of Geographical Association (CGA) and my own modified coefficients of association reflecting the impact of exploitation of agricultural land on indicators of the country's economic level. (2) Comparison (shrinkage of agricultural land, workforce in agriculture and market price of agricultural land in selected countries). (3) The Coefficient of Ecological Stability to assess the extent of stable and unstable areas in EU-27 countries. The following data are used for calculations: Eurostat (2009, 2015), World Bank and FAOSTAT (1993-2014). The extent of agricultural land in the CR (2014/1993) has been decreasing more slowly than in the detailed comparison countries (5 countries with the lowest CGA). The price of the agricultural land (2014) is lower than in France, Germany and Poland; nevertheless, the actual price rates are not as contrasting against these countries if purchase parity is considered. The Coefficient of Ecological Stability ranks the Czech Republic in the second half of the list of EU-27 countries (22nd place). While the ecological stability of land has decreased slightly in Germany and France (2009-2015), an improvement has occurred in the CR.

Keywords

Agricultural land fund, the Coefficient of Geographical Association, agricultural land loss, the Coefficient of Ecological Stability, land price.

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Introduction

The primary objective of the paper is to assess the extent and exploitation of agricultural land in the CR and EU countries based on selected macro-socioeconomic indicators in order to determine the position of the CR and future desirable exploitation, protection and stabilisation of agricultural land in the CR.

Secondary objectives are to: (1) determine EU countries with natural conditions and macroeconomic results in the agricultural sector similar to those in the CR. (2) describe the development of extent and price of agricultural land with the five "most similar countries". (3) determine how ecologically stable the Czech Republic is within the EU.

According to the European Environment Agency (EEA), Europe is one of the most intensively exploited continents in the world. Its method of exploitation presents one of the fundamental causes of environmental change, which has a considerable impact on quality of life and ecosystems and on infrastructure management. However, the management of extent of agricultural land and its numerous functions – food production, nature protection, recreation and housing – is important (EEA, online 2013). The total area of agricultural land in the EU decreases in time in favour of construction and other areas, and partly even forest. In spite of the agricultural overproduction, this is a trend that different countries gradually try to prevent by means of various legislative measures, primarily because the knowledge and awareness of non-productive functions of soils have been increasing (MoA, 2015). The shrinkage of agricultural land in the Czech Republic as a consequence of climate change is studied by Lorencová et al. (2013).

Long-term shrinkage of agricultural land in selected areas of Poland is highlighted by Bucała-Hrabia (2017). Schwaab et al. (2017) study the rapid decrease in fertile soils in large urban areas and search for compromises that will not endanger urban development in Switzerland.

German authors (Steinhäußer et al., 2015) have found out: Within just a few years, land-use conflicts have become considerably more acute in Germany, mainly due to recent changes in the national energy policy. Land users have become much more aware that land is a limited resource, and this has led to competition among the following land-use sectors: settlements/transportation, agriculture, forestry and conservation.

Land use changes are the result of a complex interplay of drivers and processes operating at different spatial and temporal levels. Landowners play a crucial role in land use changes and are the target of many policy interventions and instruments. Yet, we lack a full understanding of the relationship between different drivers and how they influence landowners' decision-making processes and strategies.) Kristensen (2016). Agricultural landscapes safeguard ecosystem services (ES) and biodiversity upon which human well-being depends. However, only a fraction of these services are generally considered in land management decisions, resulting in trade-offs and societally inefficient solutions. The study indicate that the continued decrease of ES and biodiversity in Germany can be explained by implementation deficits within a well-established nature conservation system (Albert at al., 2017).

Agriculture is the largest type of land use in the UK, accounting for about 77 per cent of the total area, compared with an average 50 per cent for the EU27. It seems likely that over the next 50 years, the UK's land area will be required to deliver an increasingly diverse range of private and public goods to meet growing human needs and aspirations. This will require a balance of policy-driven goals and market forces. It will also need a much improved understanding of the trade-offs between food production and environmental goals and of the institutional arrangements required to achieve a balance of economic, social and environmental outcomes (Angus, 2009). Land use optimization is a prerequisite for sustainable development, regardless the characteristics of the zone before and after industrial intervention. The results show special need for developing artificial wetlands (42%), followed by Agriculture (23%) and Forestry (12%). The results for "Do Nothing" (23%) relate to the actual situation of the recovered zone after mining intervention with agriculture applications which had been proved to be successful in attaining Sustainable Development (Palencia-Aguilar, 2015). Agriculture is the primary land use across Europe, hence future European land use is largely a function of the activity chosen for this sector. The main driving factor that determines how agricultural land is managed is profitability (Rounsevell et al., 2003). A low profit can lead to land abandonment. Conversely a large profit can lead to forest and land that is otherwise unsuitable, being converted to agriculture. The changes in relative profit between enterprises (whether due to technology, subsidy or economics) can lead to large areas of single crops, landscapes of brightly coloured crops, and arable crops replacing permanent grassland on slopes. All these changes in agricultural land use have profound impacts on the quality of the landscape and the environment through, for example, nutrient dynamics, soil erosion, ecological diversity and food resources for birds and other wildlife. In the second half of the 20th century technology and socio-economic change have driven rapid changes in land use (Ewert et al., 2005).

The dynamic ability of ecosystems to constantly maintain and renew conditions for their existence with self-regulatory mechanisms is referred to as ecological stability of landscape. It is characterised by steadiness, resistance and flexibility to disrupting influences of both natural and anthropogenic origin. The ecological stability of a country can be regarded as a basis for assessment of all conditions and prerequisites for landscape exploitation. If a certain degree of land exploitation is exceeded, the stabilisation, recovery and production functions of soil are reduced or even halted completely. With inappropriate land management, this brings numerous risks in the form of degradation of landscape and its components (Zaušková and Midriak, 2007). Forman and Godron (1993) understand the stability of land and its resistance to disruption and its ability to recover after disruption. Vološčuk and Míchal (1991) refer to ecological stability as the ability of an ecosystem to restore its dynamic equilibrium or its "normal" development direction by means of its internal mechanisms. The faster an ecosystem recovers and the smaller deviations it shows, the more stable it is.

Materials and methods

The objective will be attained by using the following mathematical formulas, described procedure and data.

Materials

Information about production factors (soil, labour) will be taken from the FAOSTAT database and then I will use it for the calculation of economic level indicators (for 1993-2014). Information about the division of agricultural land for the EU-27 (data from Croatia absent) will be taken from the EUROSTAT database (Land cover overview by NUTS 2 regions) for 2009 and 2015. Addition economic indicators: "Agriculture, value added (% of GDP)" and "Employment in agriculture" will be taken from the World Bank database (2014, online 2017). Calculations will be made with data for 1993-2014 and 2015. The year 1993 corresponds to the Czech Republic's independence and the years 2014 and 2015 are the latest available years in the international databases at the time of writing.

Procedure nad formulas

The Coefficient of Geographical Association (*CGA)* (equation 1) will be used to determine the similarity in structure of agricultural land in EU countries. The calculation will include indicators comprising components of agricultural land (AL). The calculation consists in a sum of absolute differences of selected AL indicators between the selected country and the other compared countries. The lower the sum of differences, the greater the similarity between the countries examined. I intend to identify 5 countries with the most similar AL exploitation.

Coefficient of geographical association (*CGA*) by Bičík (1982):

$$CGA = |\Delta K_1|+|\Delta K_2|+|\Delta K_3|+ \ldots |\Delta K_n| \quad (1)$$

Where:

$|\Delta K|$ = Absolute difference of indicators (percentage points): The Czech Republic (%) to the comparative country (%).

n = number of indicators

In addition, I intend to identify the socioeconomic consequences of AL exploitation. I will therefore modify the *CGA* (Bičík, 1982) in my own way (equations 2, 3). Inclusion of different variables will be purely individual; and I will use my own names of the modified coefficients.

Coefficient of Basic Association (*CBA*) will be calculated from the following indicators: Agricultural land (% of land area) (K_1) and Arable land (% of agricultural land area) (K_2).

$$CBA = |\Delta K_1|+|\Delta K_2| \quad (2)$$

Coefficient of extended association (CEA). The coefficient of basic association will be extended with additional qualitative economic indicators: Agricultural land per capita (K_3), Agriculture, value added (% of GDP) (K_4) and Employment in agriculture (K_5) in %.

$$CEA = |\Delta K_1|+|\Delta K_2|+|\Delta K_3|+|\Delta K_4|+|\Delta K_5| \quad (3)$$

Countries with the lowest results will be identified based on equations 1, 2, 3. These will be countries with similar geographical conditions, producing similar agricultural outputs based on a similar extent of production factors used (labour, soil). These countries will then be included in the detailed comparison. I will compare the annual decrease in AL, the share of AL in the country area, the tilled land percentage, employment in agriculture (period 1993-2014), and the market price of agricultural land (2014). If countries with similar natural conditions attain better economic results, then there is room for improvement in the CR (e.g. size of businesses, ownership relations, shrinkage of agricultural land, amount of investment in agriculture, labour productivity, amount of subsidies received, etc.).

Effective agricultural policy should work in connection with environmental sustainability. Attention will be paid to ecological stability of landscape in the assessment of agricultural land in the EU countries. Míchal (1985) has defined the procedure for calculating the *Coefficient of Ecological Stability* (*CES)* (equation 4) and made a classification of results (Table 1).

$$CES = \frac{forest\ land + water\ areas\ and\ watercourses + permanent\ grasslands + wetlands + sets + hop\ gardens}{arable\ land + vineyards + anthropogenic\ areas + others\ areas} \quad (4)$$

Note: The *CES* expresses the stable areas ratio to unstable landscaping elements.

0.1 < CES < 0.30	The area is used above the average, with the distinct disruption of natural structures. The basic environmental functions must be continually replaced by the technical interventions.
0.3 < CES < 1.00	The intensively used area - mostly by agricultural activities. The weakened self-regulation processes can cause an ecological lability in ecosystems.
1.00 < CES < 3.00	Enough balanced landscape. Technical objects are relatively in compliance with natural structures
CES > 3.00	Nature with the strong predominance of ecologically stable structures and low intensity of landscape use by humans.

Source: Míchal (1985)

Table 1: The coefficient of ecological stability - classification (in CR).

The international databases follow the structure of agricultural land differently from those in the CR. I will therefore modify equation 4 according to the landscape character (stable/ unstable) to yield the CES_{EU} (equation 5).

$$CES_{EU} \frac{(\text{Woodland} + \text{Shrubland}) + (\text{Water} + \text{Wetland}) + \text{Grassland} + \text{Bareland}}{\text{Cropland} + \text{Artificial land}} \quad (5)$$

Note: The limits of CES_{EU} for inclusion of countries in categories of results are identical to those of CES Míchal (Table 1).

Source: Author by: Míchal (1985), CSO (2006) and "Land Cover" EUROSTAT

The next phase of identification of ecologically important landscape will employ equations containing weighted coefficients for different types of areas (Miklós, 1986; Löw et al., 1987). The objective is to find out how the assigned importance of cultivation influences the ranking of EU countries in the ecological assessment of landscape.

$$CES(Miklós) = \frac{p_n * k_{pn}}{p} \quad (6)$$

Where p_n = area of individual cultures, p = total monitored area, k_{pn} = coefficient of ecological significance: field: 0.14, meadows: 0.62, pastures: 0.68, gardens: 0.5, fruit orchards: 0.3, forests and water: 1, other 0.1 (more in: Miklós, 1986).

$$CES\ (Löw) \frac{1.5A + B + 0.5C}{0.2D + 0.8E} \quad (7)$$

Where A = 5th grade area (best landscape: forest area, water area, wetlands, bare mountain), B = 4th grade area (scrub/bush), C = 3rd grade area (permanent grasslands), D = 2nd grade area (arable land), E = 1st grade area (worst land use: built up areas, anthropogenic areas). Units: % (more in: Löw, 1987).

The results will then be evaluated by means of comparison. I will identify the trends in agricultural land exploitation in EU countries as well as the detailed comparison countries. The comparison will indicate the economic valuation of agricultural land and how anthropogenic interventions affect AL exploitation. These conclusions will form the input information for the follow-up research in the area of efficiency of agricultural land exploitation.

Results and discussion

The initial comparison of EU countries based on quantitative and qualitative economic indicators that are explicitly related to AL exploitation. The Czech Republic's position within the EU-27 is derived from the data shown in Table 2 (WB, FAO, 2014). The CR has an above-average share of AL in the national territory (+11.27 p.p.) as well as the tilled area (+11.86 p.p.) in relation to the EU average. In terms of agricultural land per capita, the CR has an average value within the European Union. The macroeconomic indicators describe the CR as a country with a lower economic importance of agricultural production. Agriculture value addend (% of GDP) in the CR is 1.04 p.p. higher than the EU average, and Employment in agriculture is 1.95 p.p. lower than in the EU. The importance of agriculture in the Czech Republic is decreasing, its share in the GDP and employment are also decreasing (WB, 1993-2014). The technical equipment is better than in the other Central and Eastern European countries; however, the agricultural efficiency does not achieve EU-15 results (Pělucha, 2006).

The smaller EU countries of Northern and Western Europe, where the share of added value of agriculture in the GDP is below 2%, are oriented to exportation of agricultural products with a high added value (Denmark, Ireland, the Netherlands). Other countries in this area do not have significant export activities (Belgium, United Kingdom, Finland, Sweden) . In Finland and Sweden, the tilled land percentage is normally higher than 85%. In large EU countries (France and Spain), agriculture plays a significant role and is relatively efficient (share of agriculture in GDP is 1.73% and 2.50%, respectively, and the share of economically active is 2.82% and 4.24%). These countries too belong among major exporters of agricultural commodities (FAO, 2014). South European countries (Portugal, Italy and Greece) belong among areas where agriculture is important but not efficient. Agriculture is clearly important in economically important countries of Central Europe (Germany and Austria). It is based on small-scale farms. Austria belongs among countries with a high share of ecologically farmed soil. However, both countries are importers of agricultural products (FAO, 2014).

The Baltic states have a higher share of agriculture in GDP (approx. 4%), they have a problem with high employment in the sector (4-9%) and they struggle with obsolete technical equipment in agriculture (ČTK, 2003). Among Central and South-Eastern European countries, agriculture is of great importance particularly in Poland, Romania and Bulgaria with a share in GDP of 3-5%, while both Poland and Romania have a high employment in agriculture (11.47% and 28.35% of economically active). The share of the agricultural sector in GDP of newly acceded EU countries decreased over the study years, although it is still above the 1.7% average for the EU-28 (WB, 2000-2014). More in Table 2.

Analysis of structure of agricultural land and associated macroeconomic indicators

Using the procedure of Bičík (1982) (equation 1), the analysis of structure of agricultural land found out that the agricultural land exploitation in the Czech Republic shows the greatest similarity with Poland (*CGA* = 4.03), Slovakia (5.83) and Germany (*CGA* = 8.32), as well as Bulgaria (*CGA* = 9.01) and Lithuania (*CGA* = 10.11). The countries least similar in terms of AL structure (reflection of natural conditions) are Ireland, Slovenia, Portugal, Greece and the UK. This is generally due to the higher share of permanent grassland in agricultural land (from 76.28% in Ireland to 49.04% in Portugal). In addition, Greece and Portugal have a higher share of permanent cultivation in AL (11.96 and 18.40%) than the CR.

As needed for the research, equation 1 has been modified to equations 2 and 3, in which the attention is not focused only on structure of agricultural land but on wider context derived from agricultural land exploitation.

The calculation of the *Coefficient of Basic Association (CBA)* (equation 2) indicates: the relative extent of agricultural land

Country	Agricultural land (% of land area)	Tilled land (% of agricultural land area)	Agricultural land per capita	Agriculture, value added (% of GDP)	Employment in agriculture
	%	%	hectare	%	%
Austria	32.36	49.80	0.32	1.40	4.80
Belgium	43.61	61.37	0.12	0.72	1.22
Bulgaria	44.84	70.04	0.69	5.26	7.01
Croatia	26.66	53.90	0.36	4.14	9.50
Cyprus	11.69	73.82	0.09	2.08	4.43
Czechia	53.46	74.55	0.40	2.74	2.75
Denmark	61.25	92.51	0.47	1.58	2.48
Estonia	21.54	66.52	0.74	3.58	3.85
Finland	6.70	98.40	0.42	2.79	4.24
France	52.39	63.73	0.43	1.73	2.82
Germany	46.80	70.98	0.21	0.78	1.43
Greece	61.95	31.80	0.75	3.72	13.57
Hungary	57.47	82.38	0.54	4.70	4.66
Ireland	63.55	23.69	0.97	1.46	5.69
Italy	43.68	51.12	0.22	2.16	3.64
Latvia	29.03	64.58	0.94	3.48	7.50
Lithuania	45.22	79.60	1.01	3.79	9.17
Luxembourg	50.58	47.80	0.24	0.29	1.40
Malta	31.97	87.68	0.02	1.29	1.34
Netherlands	44.27	56.82	0.11	1.84	2.11
Poland	46.13	75.76	0.38	2.95	11.47
Portugal	40.14	30.72	0.36	2.32	8.65
Romania	58.01	63.47	0.69	5.34	28.35
Slovakia	39.25	72.45	0.36	4.37	3.50
Slovenia	30.34	29.95	0.30	2.42	9.57
Spain	52.53	46.20	0.57	2.50	4.24
Sweden	6.78	85.34	0.31	1.34	1.96
United Kingdom	70.74	36.17	0.27	0.68	1.24
EU average	42.19	62.69	0.46	1.70	4.70

Sources: Own calculations based on FAOSTAT (2014) and WORLDBANK (2014)

Table 2: Selected economic indicators (EU, 2014).

Coefficient of Geographic Association CGA (Bičík, 1982)			Coefficient of the Basic Association CBA (2 indicators)			Coefficient of the Extended Association CEA (5 indicators)		
Differences of EU countries to the value of the Czech Republic: 4.03-105.28			Differences of EU countries to the value of the Czech Republic: 8.53-70.60			Differences of EU countries to the value of the Czech Republic: 12.99-74.95		
	Country			Country			Country	
1	Poland	4.03	1	Poland	8.54	1	France	12.99
2	Slovakia	5.83	2	Germany	10.23	2	Germany	13.70
3	Germany	8.32	3	Hungary	11.84	3	Hungary	15.85
4	Bulgaria	9.01	4	France	11.88	4	Poland	17.49
5	Lithuania	10.11	5	Bulgaria	13.12	5	Slovakia	18.73
23	United Kingdom	79.84	23	Portugal	57.15	23	Greece	63.39
24	Greece	85.49	24	Sweden	57.46	24	Portugal	63.51
25	Portugal	87.67	25	Ireland	60.95	25	Ireland	65.74
26	Slovenia	89.20	26	Slovenia	67.71	26	Finland	72.16
27	Ireland	105.28	27	Finland	70.60	27	Slovenia	74.95

Note: Malta - not evaluated (incomplete information in the FAOSTAT).
Source: Own calculations based on relation (2), (3) and FAOSTAT (2014)

Table 3: Values of Coefficient of Association (2014).

in the Czech Republic (with respect to share of AL in the country's soil and conversion to AL per capita) is similar to that in Poland, Germany, Hungary, France and Bulgaria. The greatest similarity was found with Poland (difference between the two selected indicators = 8.54).

The macroeconomic characteristics of agriculture, involved in the calculation of the *Coefficient of Extended Association (CEA)* (equation 3) confirmed the relationship between the CR and Germany, France, Hungary and Poland. The list of "similar" countries was extended by Slovakia (to the detriment of Bulgaria).

The highest *CEA* values were against identified for Slovenia, Portugal, Ireland, Greece and Finland. These are countries with natural conditions different from those in the CR. Moreover, Portugal has a 13.32 p.p. lower share of AL in the national territory. Except Finland and Ireland, they are countries with a higher share of people employed in agriculture (more than 8% of economically active). Finland has a very low share of AL in its national territory (6.7%) and thus the high tilled land percentage (98.4%) makes sense. Both the employment and share of the sector in GDP in Finland are low, attesting to its high economic level.

The next comparison focused on countries with which the CR has similar economic-geographical indicators, i.e., a similar base for development of agricultural primary production as indicated by the calculations of the *CEA* (Table 4, equation 3).

The share of agricultural land in the total national territory of selected countries in 1993 was from 48.05% (Germany) to 65.89% (Hungary). In 2014, the lower bound of the range (Germany) decreased to 46.80%, and a significant reduction occurred in Hungary (to 57.47%). The upper and lower bounds thus converged to a range of 10.67 percentage points (p.p.).

The tilled land percentage has been traditionally high in the new EU member states (Table 2): CR = 74.55%, Hungary = 82.38%, Poland = 75.76%, Slovakia = 72.45%.

The assessment of the time series (1993-2014) indicates the following. While the tilled land percentage decreased in the Czech Republic (-3.27 p.p.), it increased in France, Germany, Hungary and Slovakia. This is caused by the increasing arable land area (France, Germany) or a decrease in the arable land area lower than in the agricultural land (Hungary, Slovakia). In Slovakia the 10.63 p.p. decrease in the share of AL in its national territory (1993-2014) has been offset by the increased share of tilled land (+8.60 p.p.). It can be said that the countries in the detailed comparison show a tendency towards reduction in the tilled land percentage to around 70% (except Hungary, which has 82.3% in 2014).

Employment in agriculture (1993-2014) has been decreasing significantly in all the studied countries. The greatest decrease has been in the CR (-65% of agricultural employees) and Slovakia (-66%). Significant decreases are

	Agricultural land (% of land area)	Tilled land (% of agricultural land area)	Agricultural land per capita	Agricultural land area	Employment in agriculture
Czechia	0.98	0.96	0.96	0.98	0.35
France	0.94	1.07	0.82	0.94	0.51
Germany	0.97	1.04	0.98	0.97	0.40
Hungary	0.87	1.06	0.91	0.87	0.51
Poland	0.77	0.99	0.78	0.77	0.47
Slovakia	0.78	1.13	0.77	0.79	0.34

Source: Own calculations based on FAOSTAT (1993, 2014)

Table 4: Baseline indicies of selected economic indicators (1993 – 2014).

also registered in Germany (-60%) and Poland (53%). The reasons are reductions to agricultural production, decreasing farmed areas of AL (see below), and increasing automation of agricultural production.

The Czech Republic shows an average annual decrease in AL (-0.07% over the study period of 1993-2014). The stably low rates of decrease can easily be compared to the situation in Germany and France. Other countries included in the comparison show worse results (annual decrease in extent of AL from -0.68% to -1.28%). The information on average annual shrinkage of agricultural land is complemented with the baseline index (2014/1993). The 19-year time series indicates that the extent of AL in Poland and Slovakia has shrunk by a significant 23% and 21%, respectively (baseline index, Table 5).

Indicator	Average annual rate of loss (1993-2014) in %	Baseline index of loss (2014/1993)
Czechia	-0.07	0.98
France	-0.25	0.95
Germany	-0.12	0.97
Hungary	-0.68	0.87
Poland	-1.28	0.77
Slovakia	-1.21	0.79

Source: Own calculations based on FAOSTAT (1993, 2014)

Table 5: Loss of Agricultural Land (1993-2014).

The causes of the annual shrinkage of agricultural land (Poland, Slovakia, Hungary) are the following:

- Poland belongs to those EU countries with a high share of economically active people employed in agriculture (1994: 24%, 2011: 11.47%; WB 2014). The basis of Poland's agriculture is family farms, which are relatively "overstaffed" and, particularly during the economic crisis in 2009, rural inhabitants were willing to dissolve their farms, leave home and travel to work even to other EU countries.
- Slovakia does not have the conditions for intensive agricultural production. The country is characterised by mountainous areas with a higher share of pastures. People are leaving agriculture for other sectors of the national economy for economic reasons. Farming prefers agricultural land of better qualitative properties while other, less valuable soil is permanently afforested (VÚPOP, 2015).
- At the onset of the economic crisis, Hungary was forced by economic reasons to reduce both the rent per hectare and the extent of farmed agricultural land (1993: 65.89%, 2009: 62.16%, 2014: 57.47% , WB 2014, MoA 2015).
- Besides, a common factor of shrinkage of agricultural land is the preference to extensive infrastructure construction, primarily the construction of vast logistics centres in Central and Eastern European countries (EUROSTAT, 2009, 2015).

Agricultural land in the CR is losing both its quality and utility value (effects of water and wind erosion, floods, intensive droughts and farming methods). The reduced quality of soil is reflected in the reduced official price of soil in the CR's cadastral areas (MoA, 2015). The average market price of agricultural land grew by approx. 7% year-on-year in 2009-2014 (IQ Fund Management In: Daniel, 2015).

In comparison with the old EU-15 countries, the Central and Eastern European countries have lower agricultural land prices (MoA, 2015; Daniel, 2015). The international comparison is made based on marked prices of land in the national currency adjusted for the exchange rate (Sklenička et al., 2013; MoA, 2015). Table 6 shows the comparison of AL prices with respect to domestic population income (net income of selected economic category of population in EUR/year).

	Agricultural land price	Net income of selected group of inhabitants[1)]	Agricultural land price ratio between the selected EU countries and the Czech Republic	Annual income ratio of selected EU countries to the Czech Republic	Agricultural land price ratio of the selected country to the Czech Republic (by purchasing power)	Affordable agricultural land area according to the net income of residents
	EUR/ha	EUR/year				hectares
Czechia	5 070	8 675				1.71
Germany	18 099	27 662	3.57	3.19	1.12	1.53
France[2)]	5 910	26 578	1.17	3.06	0.38	4.50
Poland	5 706	7 994	1.13	0.92	1.22	1.40
Slovakia[3)]	4 100	8 034	0.81	0.93	0.87	1.96
Niederland	53 000	33 237	10.45	3.83	2.73	0.63

Note: [1)] Net income after taxes in EUR (Single person at 100% of average earnings, no child). Exchange rate for 2014: 1 EUR = 27.533 CZK. Source: OECD, Pepersonal income tax rate (2014). [2)] Source: MoA, 2015. [3)] The selected districts of the Slovakia, Source: Budaj, Š. et al. (2015).
Source: IQ fund management (2015), Kursy. CZ (2014), unless otherwise defined herein.

Table 6: Comparison of market prices of agricultural land in the Czech Republic and selected EU countries (2014).

The prices of agricultural land are 3.57 times higher in Germany than in the CR, 1.17 times in France, and 1.13 times in Poland (Table 6). The prices are 1.24 times lower in Slovakia than in the CR. For information, the AL price in the Netherlands is shown, which is 10.45 times higher than in the CR (2014). In terms of purchase parity of domestic population (selected category), the situation is as follows: With the exception of France and Slovakia, purchase of agricultural land is more financially demanding for the other domestic inhabitants in Germany, Poland and the Netherlands. For example, Land in Germany is more than 3 times as expensive as in the CR, but purchasing AL in Germany is only 1.12 more expensive for German citizens than it is for Czechs in the CR. In the CR (limited to selected population category), 1.73 ha can be purchased for the net annual income; it is 1.53 ha in Germany (Table 6). It cannot be supposed that it is necessary to equalise the prices of AL in the CR to, e.g. the German level without the countries' income levels equalising as well.

The proportion of the rent price to the market price of agricultural land (%) is from 2% (Germany) to -4% (Lithuania). The proportion of the rent price and the market price of AL in the CR was 2.39% (EUROSTAT, 2009).

This paper is not unique with its contents. Similarity of natural and agricultural conditions between different countries can be found, e.g. in Ciutacu et al. (2015). They emphasise differences and similarities between the European model of agricultural and rural development and Romania's agricultural sector. Studying the extent of AL is also still an up-to-date issue. In the long term, shrinkage of agricultural land in the CR has been identically pointed out, e.g. by Bičík et al. (2000), Němec (2004), Ministry of the Environment (CENIA, 2013) and Ministry of Agriculture (MoA, 2015). The extent and exploitation of AL in Europe has been studied with similar results, e.g., by the European Environment Agency (EEA, 2013) and others (Lorencová et al., 2013; Bucała-Hrabia, 2017; Schwaab et al., 2017; Steinhäußer et al., 2015).

Assessment of agricultural land in EU countries by coefficient of ecological stability

For landscape to be able to withstand major and minor change (stress, loading, etc.), it has to achieve a certain level of ecological stability. According to available data from the FAOSTAT for 2009 and 2015, The Czech Republic has $CES_{EU,\ Czechia}$ = 1.64 and 1.73 (methodology, equation 5) and is thus within the medium interval of *CES* classification ($1 < CES_{EU} < 3$; Table 1). The Czech Republic's position is below average in this land assessment (22nd place, 2015).

The lowest CES_{EU} (2015) values in the EU were given to three countries (Malta, Denmark and Hungary). Malta and Denmark were in the third (negative) zone (Table 7), which shows a tendency for ecologically and naturally unstable exploitation of land. Hungary only exceeded the threshold for unstable areas ($CES_{EU} = 1$) only very slightly ($CES_{EU,\ Hungary} = 1.09$). The above countries have high tilled land percentages (ranging from 92.51 to 82.38%; Table 2). In addition, Denmark and Hungary have a significant share of agricultural land in the national territories (61.25% and 57.47%, respectively). The majority of the countries

(15 of the EU-27) are in the medium zone (places 12 - 26). The ecological stability values for the EU-27 (Table 7) are ranked from the best at 16.23 (Sweden) for the worst at 0.74 (Hungary). The CES_{EU} (2015) value equals 2.78.

The detailed comparison again focuses on the following countries: Hungary, Poland, Slovakia, Germany and France. Among these countries, the CES_{EU} indicates that least ecologically stable is Hungary (Cropland = 43.7% of the territory). Germany among the other countries is rated better than Hungary (CES_{EU}, Germany = 1.52, Cropland = 32% of the territory). The position of the CR (22nd place) is very similar to that of Poland (21st place). France is 18th; Slovakia is in the 13th place. France has extensive permanent grassland areas (approx. 27% of its territory), while Slovakia has extensive forest areas (45% of its territory) (EUROSTAT, 2015).

Between 2009 and 2015, a positive change is shown in the CR (0.9 increase in *CES*), Hungary (+0.11) and Poland (+0.13). The primary reason for the *CES* increase was the reduced share of cropland in the national territory: CR (-1.6 p.p.), Hungary (-1.97 p.p.) and Poland (-2.1 p.p.) (EUROSTAT, 2009, 2015). The share of unstable areas (built-up areas) increased the most in Germany (+0.6 p.p.) and France (+0.3 p.p.), which led to a slight decrease in the *CES* (Table 7) with a stable share of cropland.

It has to be noted that the *CES* assessment is based on statistical classification of exploitation of surfaces of different countries. Ecological stability should reflect how land cover is exploited qualitatively (land use). Modification of the *CES* has been studied, e.g., by Miklós (1986) or Löw (1986). Instead of distinguishing among relatively stable and unstable areas, Miklós differentiates among their ecological importance by implementing numerical coefficients for different AL crops (equation 6). Another variation of the *CES* can be found in Löw (Agroprojekt, 1986), which classifies elements into categories based on the degree of element quality (equation 7). The use of weighted coefficients in *CES* calculations has mostly not brought better quality results. I in fact believe that the negative impacts of the share of some areas (arable land, built-up areas) on ecological stability (e.g. in the Netherlands, Ireland and Luxembourg) were overestimated.

The *CES* values (regional average) in the CR in 2006 ranged from 0.66 (areas with a high share of arable land) to 2.18 (high share of permanent grassland and forest land) (CSO, 2006). The *CES* values in the CR regions increased in 2015. They ranged from 1 to 2.6 (CVUT, 2015 In: MENDELU, 2016). The growing trend in the *CES* results is positive. In this paper, I apply the *CES* calculation procedure according to Míchal (ratio of stable and unstable areas). Another procedure is a difference between these variables, and the maximum result is the optimum (CSO, 2005). The *CES* calculation has become one of the methodological tools for implementation of principles of the European Landscape Convention (Strasbourg, 2004 In: COE, 2017) in principles of regional spatial development. Conditions

		CES (EU) 2015	CES (EU) 2009				CES (EU) 2015	CES (EU) 2009	
1	Sweden	16.23	15.89	The best CES results	15	Italy	2.12	2.06	Average CES interval
2	Finland	12.34	12.25		16	Lithuania	2.10	2.71	
3	Ireland	9.34	10.64		17	Luxembourg	2.02	-	
4	Slovenia	6.81	7.77		18	France	1.92	1.94	
5	Estonia	5.47	6.54		19	Romania	1.91	-	
6	Latvia	5.28	6.40		20	Netherlands	1.75	1.89	
7	Portugal	4.87	4.40		21	Poland	1.73	1.60	
8	Greece	4.33	3.97	Average CES results	22	Czechia	1.73	1.64	
9	Austria	4.12	4.15		23	Germany	1.52	1.56	
10	Spain	3.04	2.87		24	Belgium	1.50	1.73	
11	Cyprus	3.04	-		25	Hungary	1.09	0.98	Bad CES results
12	United Kingdom	2.80	2.82		26	Malta	1.00	0.68	
13	Slovakia	2.38	2.39		27	Denmark	0.74	0.82	
14	Bulgaria	2.22	-			Total	2.78	2.42	

Note: (-) absence of data in the EUROSTAT
Source: Author by Míchal (1985), EUROSTAT(2015, 2009) and classification by Míchal (1985) – Table 1.

Table 7: Results of CES_{EU} (2015, 2009).

for improvement of landscape protection can also be created based on the *CES* results (Maier, 2012). According to Pešout and Hošek (2013), studying the *CES* is important from the point of view of design of flood and erosion prevention measures, which may promote environmental biodiversity.

Conclusion

In terms of structure of agricultural land (Bičík, 1982), the Czech Republic compares well with Poland, Germany, Bulgaria, Lithuania and Hungary. I applied the calculation principle according to Bičík to a wider range of macroeconomic indicators. It follows from a modification of the calculation (equation 3) that the CR has agroeconomic results similar to Germany, France, Poland, Hungary and Slovakia. My calculations indicate that the average annual decrease in AL (1993-2014) does not exceed 0.1% (approx. 14 hectares a day; FAO, 2003-2014). The Czech Republic shows better results than France (-0.25% p.a.), Germany (- 0.12% p.a.), Hungary (-0.68 p.a.), Poland (-1.28% p.a.) and Slovakia (-1.21% p.a.) (Table 5). In addition, it can be concluded that the countries examined in the detailed comparison show a tendency towards a tilled land percentage to around 70% (except Hungary, which has 82.3% in 2014). The greatest decrease in employment in agriculture has been in the CR (-65% of agricultural employees) and Slovakia (-66%). The reason is the narrower agricultural production, great labour and time demand, decrease in farmed AL, and increasing use of machinery in farming. The comparison of market prices of agricultural land found out that land is cheaper for the nationals, e.g. in France. Purchasing a hectare of AL in France is 0.38 cheaper than in the CR. This means that the attainable size of agricultural land from the net annual income of a French national is 2.63 larger than in the CR. However, the price of soil in France is 1.17 time higher for a CR national (Table 6). The paper thus expands on the outcomes of MoA (2015) and IQ fund management (2015).

In addition, my calculations show that: The CR is in the lower half of the list of the EU-27 countries in 2015 based on the *CES* (Míchal, 1986) ($CES_{EU,\ Czechia}$ = 1.73, 22nd place). Between 2009 and 2015, a positive change is shown in the CR (0.9 increase in *CES*), Hungary (+0.11) and Poland (+0.13). The application of modified *CES* (equations 6, 7) yielded no major results. The ecological stability of land has decreased slightly in Germany and France (2009-2015).

The *CEA* results (equation 3) rate the CR among geographically similar and socioeconomically important countries of Western Europe (France, Germany). The price of the agricultural land is derived, and will be in future, from the price of production and, most importantly, from the added value generated by the land. This provides a potential room for future research – in the area of economic efficiency of the soil as a production factor.

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