



Trends in land ownership fragmentation during the last 230 years in Czechia, and a projection of future developments



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ABSTRACT

A high level of fragmentation of farmland ownership is an important underlying cause of land degradation and, at the same time, an obstacle to sustainable land management. This study makes the first-ever analysis of long-term trends in the rate of fragmentation. Our study covers the period from the earliest stages of the current form of ownership patterns at the end of the 18th century until the present day. On the basis of significant predictors that have been identified (initial fragmentation, population growth, historical development of inheritance laws and of the land market, natural soil fertility and landscape type), we go on to project probable developments for the period from 2016 to 2045. A total of 102,984 land parcels in 56 cadastral units in the territory of Czechia have been analysed on the basis of data from four years (1785, 1840, 1950, 2015). Our study considers the development of two basic indicators of fragmentation – Mean Parcel Size and Number of Owners per 100 ha. The Mean Parcel Size has decreased over a period of 230 years from 1.08 ha to 0.64 ha, at a mean rate of -0.26% year⁻¹. During the same period, the Number of Owners per 100 ha has risen from 17.50 to 79.66, at a mean rate of 0.61% year⁻¹. A detailed analysis of the development trends confirms significant spatial variability and also time variability of the rates of the two indicators. The analysis also shows their mutual complementarity: growth in the rate of one of the indicators is usually accompanied by a drop in the other. The general trend that we project for the territory of Czechia in the upcoming 30 years is that there will be further diminution of the physical size of land parcels (continuing fragmentation of land parcels) accompanied by a reduction in the Number of Owners (defragmentation of land ownership).

1. Introduction

Little is known about the causes and the consequences of farmland ownership fragmentation, and almost nothing is known about its development or about the speed at which it becomes an important determinant of sustainable land use in a number of regions of the world. Fragmentation very often limits access to land (Pašakarnis and Maliene, 2010) or reduces the productivity of agricultural labour (Ženka et al., 2016). Land prices respond to these limitations, and the price for excessively small and dispersed land parcels drops significantly (Medonos et al., 2011; Sklenicka et al., 2013). A high level of farmland ownership fragmentation has even been classified as an underlying cause of insecurity that leads indirectly to various types of land degradation (Sklenicka, 2016). In a number of countries in Asia and in Central and Eastern Europe, fragmentation has reached extreme levels, where individual cultivation of excessively small parcels is no longer economically viable. The land can then be cultivated only on the basis of tenure, and by integration by users of small land parcels into

economically viable production blocks (Sadoulet et al., 2001; Vranken and Swinnen, 2006).

While land ownership fragmentation is an issue in many countries in the world, including the most populated countries, such as China (Tan et al., 2006) and India (Pani, 2016), it is mentioned most often in the literature in connection with Central and Eastern Europe. Examples of European countries with extremely fragmented land ownership are Macedonia, with its Mean Parcel Size of 0.3 ha (Noev, 2008), Slovenia with 0.38 ha (Ministry of Agriculture, Forestry and Food, 2007), Romania with 0.43 ha (Sabates-Wheeler, 2005), Slovakia with 0.45 ha (Ciaian and Swinnen, 2006), and Bulgaria with 0.6 ha (Kopeva and Noev, 2001). Other Central and Eastern Europe countries with a high rate of ownership fragmentation are Hungary, Albania, Croatia, Serbia, Bosnia-Herzegovina, Montenegro, Kosovo, Moldova, Georgia, Azerbaijan, Poland and Ukraine (Hartvigsen, 2014). A high level of fragmentation can also be observed in a number of regions of countries in Southern Europe, specifically in Portugal (Coelho et al., 2001), Cyprus (Demetriou et al., 2012) and Spain (Crecente et al., 2002). Last but not

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least, Czechia (Sklenicka et al., 2014), which is presented here as a case study, has a high rate of land ownership fragmentation. In these areas of Europe, the minimum economically viable farmland parcel size is around 1 ha. This threshold has been derived using various methods by Gonzalez et al. (2004) and by Sklenicka et al. (2014a). Thus the fragmentation rate far exceeds the limit for sustainable use of individual land parcels in large areas of the countries mentioned above.

The speed and the course of ownership fragmentation is affected by several main factors. An important but little explored determinant is the circumstances in which ownership fragmentation was initiated. In individual countries or regions, this can be considered as the starting point for the development of the current structure of land ownership rights. Long-term validity of partible inheritance, whereby land is divided among all heirs, is also a strong accelerator of the fragmentation process (Sklenicka, 2016). Other important determinants are natural soil fertility, the proportion of certain types of farmland or landscape, population growth, land markets, and also various historical events that have caused sudden jumps in the fragmentation rate, mostly via various types of land reforms or land consolidation policies (Niroula and Thapa, 2005; Sklenicka et al., 2009a,b). A very important cause of fragmentation is the physical division of land parcels when they are sold or when their use is changed, most frequently as a result of land conversion induced by development pressure (Irwin and Bockstael, 2007; van Dijk and van der Vlist, 2015).

A distinction can be drawn between two main manifestations of the fragmentation process. The first is physical division of land parcels causing a reduction in their area. The other manifestation is an increase in the number of co-owners of a parcel (Noev, 2008; Sklenicka et al., 2014b). Fragmentation can also result from a change in the shapes of parcels (Latruffe and Piet, 2014), a change in the spatial distribution, or reduced accessibility for agricultural machinery (Demetriou et al., 2013). As is usual in similar cases (Skaloš et al., 2012), we base our study of long-term trends on the methods of historical geography and historical cartography.

Until now, there has been no study that offers a comprehensive analysis of long-term trends in the farmland ownership fragmentation process as a basis for projecting or predicting the future development of the phenomenon. The lack of studies of the long-term development of fragmentation, which are necessary for an analysis of historical trends and for predicting future trends, may be due to the lack of a historical background that could serve as a data source. In many places, studies are obstructed by the use of old registration methods, or of a language that is no longer widely used locally. For example, in Czechia, old land records are mainly written in various historical forms of German language (Skaloš et al., 2011). Without studies of long-term trends, and without knowledge of the development trends, however, we will not be able to set adequate and efficient mechanisms for land use policy. Unfortunately, experts in many countries have tried to solve these issues without gaining sufficient knowledge of the essential factors.

In this sense, the present study is the first to fulfil the following objectives for a case study of Czechia: (1) Evaluate fragmentation values at the time which can be identified as the beginning of the period of modern ownership patterns (late 18th century); (2) Analyse the development of the rate of fragmentation from the 2nd half of the 18th century up to now; (3) Determine the factors that influenced the rate of fragmentation in the monitored period, and how they influenced it, and (4) Evaluate development trends and predict future developments.

2. Methods

2.1. Study areas

The basic spatial unit to which all variables are related is the cadastral unit, which has been used since 1785 in Czechia as a basic land unit in land registries. A total of 61 cadastral units were used in the study. They were selected with the use of stratified random selection

within the framework of the entire country of Czechia. The cadastral units situated in the territory of the Capital City (Prague), and other cadastral units without any farmland, were eliminated from the total number of 13,082 cadastral units of Czechia. The result was $N = 12,890$ cadastral units in which farmland is represented. The cadastral units ($n = 3215$) that were affected by land consolidation between 1991 and 2015 were also removed ($N = 9674$; database of the State Land Office of Czechia), because special consolidation measures were undertaken specifically to counteract the trend under study here (Sklenicka et al., 2009a,b). Further selection took place on the basis of natural soil fertility per cadastral unit (FERT), which is expressed here as the weighted mean of the ratio of the natural fertility of individual soils in the cadastral unit to the most fertile soil unit. The remaining cadastral units were divided, on the basis of FERT, into 15 groups according to the natural fertility of the farmlands. A total of 4 cadastral units within the framework of Czechia as a whole were selected in each group using stratified random selection. The minimum distance between two nearest selections was set at 50 km, in order to limit the influence of spatially correlated data. ArcMap 10.1 software was used for the selection.

2.2. Data collection

Basic data was collected in the 61 cadastral units in four land registers specified below. After the preliminary evaluation, 5 cadastral units were excluded because of abrupt historical changes, caused by local land reform measures in the past. The remaining 56 cadastral units, in which fragmentation developed gradually, were subjected to further statistical analysis.

The land register system is the most suitable source of information on changes in land ownership over a period of time. In the four years selected for our study, different land registration systems operated in the territory of present-day Czechia, namely the Joseph Cadastre (1785), the Stable Cadastre (1840), the Land Cadastre (1950) and the Real Estate Cadastre (2015). The name of the register system is followed by the year to which the data used in our study refers.

While the 2015 data for the present Real Estate Cadastre was available in digital form, the data in the written cadastral documentation from previous land register systems was available only in the original hard copy records. These are stored in the national archives (National Archive in Prague, Moravian Land Archive in Brno, Land Archive in Opava), and in 46 archives of the corresponding cadastral workplaces. Processing the original records involved an enormous volume of work, because almost none of the basic quantities were stated directly in the original register systems. It was necessary to search for, write down, combine and calculate hundreds of thousands of original records on parcels and owners. A total of 102,984 land parcels and 27,302 owners in four periods of study were identified and were further analysed in each of the four register systems.

The laborious task of identifying the land parcels in the historical register systems and collecting the data was carried out between 2014 and 2016. The data processing was further complicated by the fact that few of the original records had been written in Czech. Most of the texts were handwritten in German language, especially in the Joseph Cadastre and in the Stable Cadastre. They were written in neo-Gothic cursive script (Kurrentschrift), or were printed in Schwabacher style. Similarly, the Czech language texts used archaic forms and spellings that are unfamiliar to Czechs in the 21st century. The text was transliterated and transcribed to ensure that it could be read and understood. The numerical records for areas in the Joseph Cadastre and for the Stable Cadastre are recorded with the original Lower Austrian units. The unit for length is the fathom (Sáh or Klafter; approximately 1.896 m), and the unit for surface area is the Joch, i.e. 40×40 fathoms (Jitro or Yoke; approximately 5755 m^2). For the purposes of further processing, all numerical data was converted to metres (for lengths), and to square metres (for surface areas).

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