DEMOGRAPHIC MODELLING OF FARMERS' POPULATION

Ondřej Šimpach – Marie Pechrová

Abstract

The agricultural sector not only in the Czech Republic faces a demographic challenge – a shortage of young farmers – that undermines its sustainability. Long-term policy planning requires appropriate knowledge of the data about development of the situation. Hence, there is a need to know the age-and-sex specific structure of the population of agricultural workers in the future. Therefore, the aim of the paper is to evaluate and find suitable methods for demographic modelling of young farmers' population. Generally used methods as same as new method of projection of age-and-sex structure of the population are introduced and compared. The article states their advantages and disadvantages and searches for the most suitable method in terms of the applicability on agricultural workers' population, data availability, demand for data, duration and finances. The main (and so-far the only one) publicly available source of the data about age-and-sex specific structure of Czech agricultural workers' population is Census of the Czech Republic held in 2011. This lack of actual data is a key problem for demographic modelling of the development of agricultural workers' population structure. Only modified component method is suitable in this case, when data are available in required structure for only one year.

Key words: demographic modelling, young farmers, component method, Lee-Carter method

JEL Code: J11, J43, Q18

Introduction

The agricultural sector not only in the Czech Republic faces a demographic challenge – a shortage of young farmers – that undermines its sustainability. It is mainly due to the fact that "Younger farmers have a longer planning horizon and tend to invest more heavily in business growth than comparable older age groups," (Davis et al., 2013). Besides, generation renewal is essential not only to keep the tradition, but also to maintain the landscape. According to Burton (2014) "the majority of studies examining the relationship between age and environmental behaviour suggest that younger farmers are more likely to undertake programs or environmental

enhancements than older farmers. Besides, "young farm households with organic production are most likely to diversify activities particularly on-farm, ..." (Weltin et al., 2017). However, many factors, such as reduced access to land and credit, and lack of rural infrastructure, drive young people away from a career in agriculture.

The EU therefore provides various forms of support and incentives to facilitate young people's entry in the farming business, most notably in the framework of the reformed Common Agricultural Policy (CAP) 2014–2020, which introduced new or strengthened measures to encourage them to set up in farming. As a young farmer is considered a person that is younger than 40 years. Under the so-called first pillar of the CAP, where direct payments are provided, young farmers receive a 25% supplement to the direct aid allocated to their farm, for a period of five years, as part of the "Young Farmer Scheme" which Member States are obliged to implement. Under the second pillar, they have access to support co-financed under the European Agricultural Fund for Rural Development (EAFRD): a start-up grant and various economic, environmental, development and innovation measures which Member States can choose to include in their national Rural Development Programmes.

Long-term policy planning requires appropriate knowledge of the data about development of the situation. Hence, there is a need to know the age-and-sex specific structure of the population of agricultural workers in the future. Therefore, the aim of the paper is to evaluate and find suitable methods for demographic modelling of young farmers' population. The structure is as follows. First section introduces data sources that can be possibly used for the demographic projections of farmers' population. Next section present the possible methods and discusses their advantages and disadvantages.

1 Data and Methods

There are certain issues concerning the availability of the data about the labour structure of the workers in the agriculture. Regarding the data about young farmers, Eurostat provides data of Farm Structure Survey (FSS), but still only up to 2013. Despite that the structure does not change much and FSS is available also for year 2005, 2007 and 2010, there is still a need for new data. However, results of FSS for year 2016 will be published only in the second part of 2017. It is an issue as this data source is heavily used. For example, European farm survey data of 2 154 farms from eleven European regions was used by Weltin et al. (2017) in order "to identify distinct farm types in order to investigate differences regarding the willingness to diversify in the future."

The main (and so-far the only one) publicly available source of the data about age-and-sex specific structure of agricultural workers' population is Population Census of the Czech Republic held in 2011. It presents detailed structure of the labour force in agriculture in table "Population economically active by age by economic activity, sex and by economic activity and main job classes". The results are from 25th March 2011 and according to usual residence of the respondent. The division is per gender and 5-year age categories from 15 to 70 and over. There are CZ-NACE categories of economic activity – for us is particularly interesting: agriculture, forestry, fishery. For three groups of inhabitants: 1. Population economically active total, 2. Employed, and 3. Unemployed are observed following job classification classes: 1. Main classes of employment total, 2. Legislators and managers (we can assume that here are included young farmers – managers of the farms or agricultural holdings. There are not special data about young managers explicitly surveyed), 3. Specialists, 4. Engineers and professionals, 5. Officials, 6. Service and sales staff, 7. Qualified workers in agriculture, forestry and fishing, 8. Craftsmen and repairers, 9. Machine and equipment maintenance, assemblers, 10. Auxiliary and unskilled workers, 11. Employees in the armed forces, and 12. Unidentified employment.

Fig. 1: Example of the table of Czech Population Census 2011

Tab. 609 Population economically active by age by economic activity, sex and by economic activity and main job classes
1. Population economically active total 2. Legislators and managers **Area:** Czech Republic

Economic activity type, gender	Population economically active total	in that according to the age							
		15 - 19	20 - 24	25 - 29	30 - 34	35 - 39	...	70 and more	not found
Population economically active total	**282 941**	**134**	**5 222**	**21 395**	**40 708**	**47 234**	**...**	**1 254**	**144**
men	186 504	71	2 949	12 259	27 115	32 437	...	1 049	93
women	96 437	63	2 273	9 136	13 593	14 797	...	205	51
agriculture, forestry, fishery	5 992	4	72	254	520	695	...	75	1
men	5 048	3	52	194	440	571	...	72	-
women	944	1	20	60	80	124	...	3	1

Source: Czech Statistical Office (Population Census 2011).

There is a selective survey of labour force held by Czech Statistical Office every quarter year, but the categorization of employees is only according to CZ-NACE, where A - Agriculture, forestry, fisheries contains different types of work and is not divided according to the age of the worker. Czech Statistical Office also surveys the farm structure following international standards. Last large Agrocensus designed according to Food and Agriculture

Organization of the United Nations recommendations took place in 2010, last was in 2000 and the next will take place in 2020.

This lack of actual data is the main problem for demographic modelling of the development of the situation in agriculture. Also, Zagata and Sutherland (2015) find difficult to survey the data about young farmers. „We find a major inconsistency between European policy documents, which conflate young farm holders with new entrants; Eurostat numbers, which focus on young sole holders; and the academic literature, which consistently demonstrates the importance of farming successors to farm business development." From this data limitation ensue the problems with possible modelling and prediction of age structure of the farmers that are discussed in the next chapter.

2 Results and Discussion

There are two ways to determine the future development of demographic indicators – demographic forecasts and projections. Demographic projection is used to estimate the future development of the population. The outcome is information on future population developments in the current population situation when it is assumed constant or small progress in the processes of mortality and fertility. Population prognosis means prospective estimates of future population (households, workforce) by age-and-sex structure. Population forecast seeks to provide the most reliable forecast for future demographic development based on scientific calculations.

In the first step of demographic forecasts it is necessary to obtain the available statistical data, based on which the forecasts of the future development of the population are formed. The second step is to decide what method to use when calculating the demographic forecast. Data availability was widely discussed in previous section. Regarding the methods, demographic projections are usually done by component method (see Keyfitz, 1964). The method can consider that the migration balance is equal to zero (see e.g. study by Šimpach and Langhamrová, 2014 about the projection of graduates with consideration of zero migration increment), or can assume some migration scenarios (see e.g. study by Šimpach and Dotlačilová, 2013 about the migration scenarios in the Czech regions). Data on migration are included in the forecast calculation especially in the case when the projection concerns smaller territorial units, such as regions. Projections that result from a sample of living people are reliable unless they are too long.

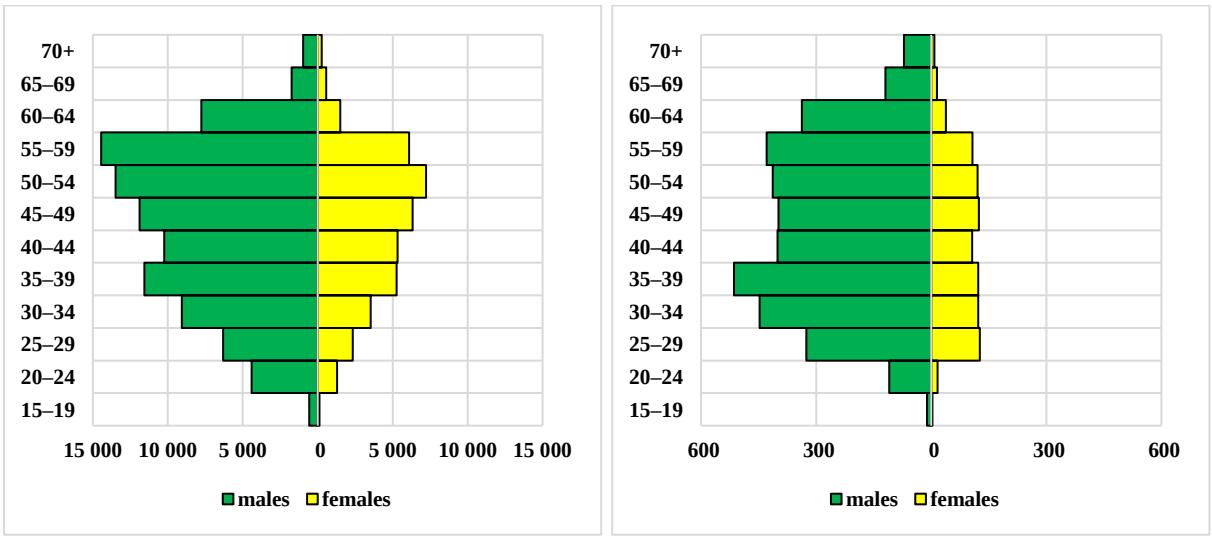
Demographic forecast can be obtained by extrapolation method, which is usually used for simpler cases. More complicated population prognoses are based on the prognosis of demographic structure of inhabitants. Here we can include Lee-Carter method (lee, Carter, 1992). The logarithms of age-and-sex specific demographic rates (rates of the relevant demographic process, such as mortality, fertility or migration) are decomposed on

$$\ln\left(rate_{x,t}^{M/F}\right) = a_x^{M/F} + b_x^{M/F} \cdot k_t^{M/F} + \varepsilon_{x,t}^{M/F}, \tag{1}$$

where age x is age, time t = 1, 2, ... T, parameters $a_x^{M/F}$ are the age-specific profiles of demographic process independent of time, $b_x^{M/F}$ are the additional age-specific component that determines the change in the level of demographic process in each age group when the indicator $k_t^{M/F}$ changes, and finally $k_t^{M/F}$ are time-varying parameters – the total indices of demographic process. $\varepsilon_x^{M/F}$ is a residual element with characteristics of white noise process, where $E(\varepsilon_x) = 0$, $D(\varepsilon_x) = \sigma^2$, $cov(\varepsilon_x ; \varepsilon_x') = 0$ and $\varepsilon_x \approx$ N distribution, letters M and F denote gender. Estimation of parameters $b_x^{M/F}$ and $k_t^{M/F}$ is based on principle of singular value decomposition (SVD) of matrix of age-specific demographic rates, as presented e.g. on the case of mortality by Bell and Monsell (1991), Lee and Carter (1992) and Hyndman and Ullah (2010).

Demographic forecasting is supplemented by expert judgments about future demographic developments that estimate the size and structure of the population. A qualitative estimate is based on historical and current state of population size and structure.

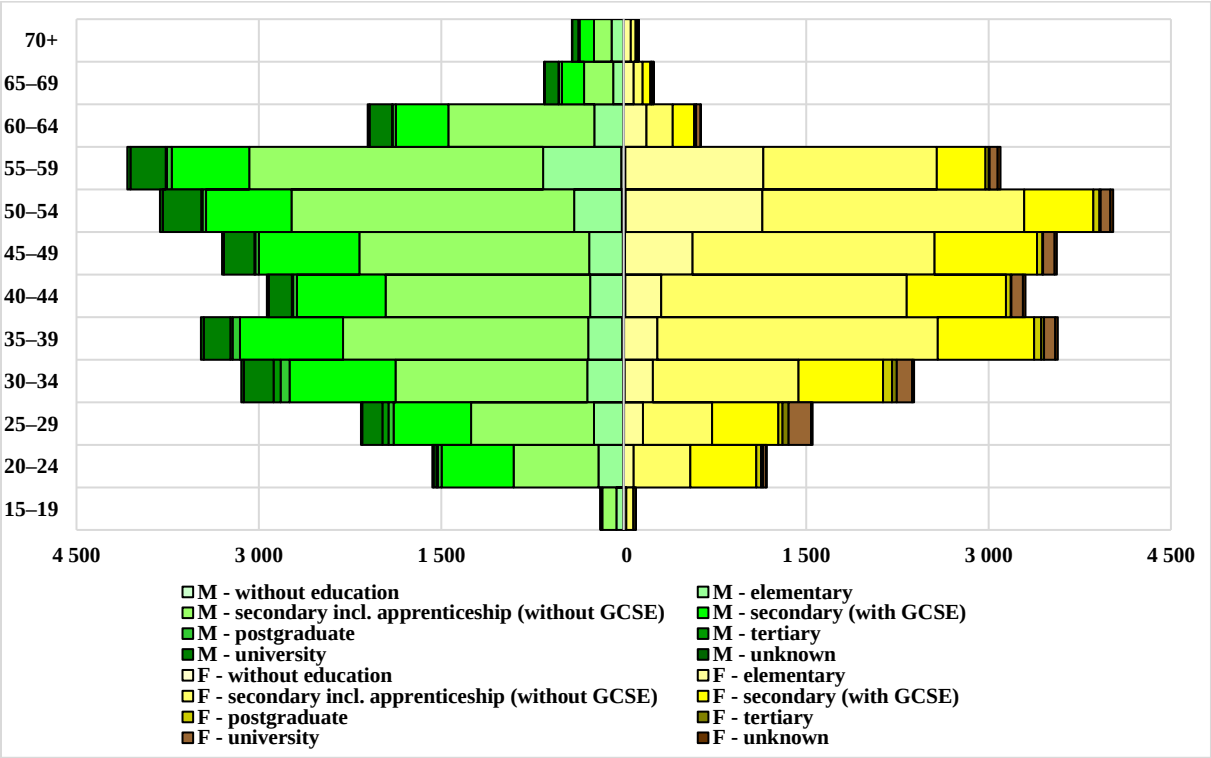
Fig. 2: Population economically active (total), 1. All main classes of employment – left chart, 3. Specialists only – right chart.



Source: Czech Statistical Office (Population Census 2011), authors' construction and illustration.

In Fig. 2 can be seen the age-and-sex-specific structure of economically active persons in sector of agriculture, forestry and fisheries. Left chart represents all classes of employment, right chart the specialists only. Authors who are trying to construct the future distribution of these structures need to consider a great amount of additional information from the field of economic statistics, education and economic policy, not only the expected population development. Educational structure of economically active qualified workers in agriculture can be seen in Fig. 3, from which it is clear that the most numerous group are persons with (different kinds of) secondary education. Changes in this structure must be considered in population projections.

Fig. 3: Population economically active (class 24: qualified workers in agriculture) by age, highest level of education attained and sex.



Source: Czech Statistical Office (Population Census 2011), authors' construction and illustration.

Extrapolation method is usually used for large population and long prediction horizon. The component method is applied on small populations (states, regions, districts) and short time period. This procedure is more correct than extrapolation as it uses more information. In addition to the above stated methods, there is also a multistate approach method applied firstly by Rogers (2015). It puts considerable demand on the amount of data. While the component method recognizes only one condition - alive - and examines the income to this state (birth) and

output from it (death), the multistage approach permits more states, e.g. married, unemployed, living in a region, etc. The principle is similar as in the case of a component method, only the possibilities of transition between individual states will increase significantly the amount of necessary data (e.g. estimation of the future structure of the population by marital status, economic activity, geographical deployment, etc.) will increase. It is used for example for labour market analysis (Miskolczi and Langhamrová, 2017).

Regarding the application of prediction method on a special population, as proclaimed by Fiala and Langhamrová (2011) "not only projections of the whole population, but often special projections of the development of the number and age structure of employees of various professions are computed. Fiala and Langhamrová (2011) projected ICT experts, Fiala and Langhamrová (2012) the graduates of informatics field, Šimpach and Pechrová (2015) forecasted the population structures in predominantly rural regions in the Czech Republic and Šimpach and Pechrová (2015) Czech farmers' age structure.

Conclusion

The aim of the paper was to outline suitable methods for demographic modelling of young farmers' population. It should be noted that population development is also affected by other circumstances that no general model cannot comprehend. For this reason, user correction is required - especially by incorporating expert expectation and adjustment. Therefore, the use of deterministic approaches and expert estimates is well founded. However, it is important that these projections are always associated with a comparison which are calculated by purely statistical models to include an element of randomness and to eliminate subjective influences. Finally, it is appropriate to find a suitable compromise between them. Because the main (and so-far the only one) publicly available source of the data about age-and-sex specific structure of Czech agricultural workers' population is Census of the Czech Republic held in 2011, the lack of actual data is a key problem for demographic modelling.

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