A Markov chains analysis for the growth of wine farms in Rheinland-Pfalz

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***Abstract* - This study is conducted within the project "Szenarien weinbaulicher Flächenausweitung". It aims at predicting the effects of planting rights liberalization in terms of changes in the total acreage, number, size and location distribution of wine farms in the region of Rheinland-Pfalz (Germany). It is expected that under the new circumstances brought by the CAP reform of 2008, the wine sector of this region will experience structural changes: enlargement and reallocation of farms.**

Application of Markov chains analysis to the data on wine farms distribution yields a projection of an increase of the total acreage of vineyards by the 2020s. Reduction in the number of small farms is offset by growth of larger units in areas of flatter slope. The results are compared to the projection of land suitability for vine cultivation according to climate change scenarios.

Introduction

Production and marketing of wine in the EU are governed via the Common Market Organization (CMO), which is a part of the EU Common Agricultural Policy (CAP). Since 1976, a crucial point of this CMO has been a prohibition on planting of new vineyards. The aim of such a measure was to prevent overproduction, stabilize the prices, and secure a quality oriented production.

Therefore, total acreage of vineyards in Germany has been strictly regulated. With the CAP reform of 2008, a new approach in regulating the wine sector has been introduced. Following the goal of elimination of political intervention into the market, the planting rights are to be liberalized from 2018 the latest. Among other changes of the CMO for wine, this one has been debated the most.

Many wine producers, experts, policy makers and other interested parties doubt about the efficiency of planting rights liberalization and argue its negative effects on the profitability and structure of the sector. For Rheinland-Pfalz the effect of the reform is a question of sensitivity. Being the largest wine producing region in Germany (Statistisches Bundesamt, 2010), it comprises farms of different efficiency levels. Typically, vineyards which are bigger in acreage and situated in flatter areas are more cost-effective than vineyards of smaller size and on steep slopes. The liberalization is likely to lead to an enlargement of already cost-effective units. Consequently, one might expect many large wine farms on flat lands and a few wine farms in mountainous areas.

A shortcoming of the process described is that beautiful vineyard landscapes as well as small-scale wine farming, which entails production of special quality wine, might disappear. The full responsibility for restructuring, however, should not be attributed solely to the reform, since it has already started. According to statistical data of the years 1999, 2007 and 2010, total acreage of large farms on flat lands has been increasing and of farms situated in areas of more than 30% slope decreasing. Therefore, the aim of this study is to project the effects of planting rights liberalization in terms of changes in the total acreage, number and distribution of wine farms within categories of size and location. In order to do so, Markov process is applied to data on wine farms distribution. This is, to our knowledge, an innovative approach for the wine sector.

Materials and methods

Projection of farm growth by Markov chains models was first conducted in 1961. Up to 1964, however, only the so called micro-data had been used. By dealing with total number of farms per class per period, Krenz (1964) introduced an estimation of transition probabilities from aggregated datasets. Krenz (1964) followed by Keane (1976 and 1991) applied a maximum likelihood estimation (MLE) to determine a transition probabilities matrix, and developed restrictive assumptions on farm growth. The latter are necessary, since MLE is a technique to be applied to micro-data and, thus, produces a large amount of allowed combinations of individual routes when applied to aggregated samples. This approach serves the purpose relatively well in circumstances of poor data availability. In particular, assumptions on the movement within the categories compensate for the absence of clear empirical evidence.

For the current analysis, a model of first-order stationary discrete time absorbing Markov chain with exit possibilities is used. Stationarity implies an important assumption on the process under projection: observed trends of enlargement and reallocation of farms remain constant. It means, for example, that the current situation of growth of larger farms and disappearance of smaller ones is assumed to continue.

Following Keane (1991), we estimate the transition probabilities by the method of maximum likelihood suggested by Anderson and Goodman (1957).

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Since only macro data are at hand, farm growth is restricted by assumptions. In particular, (1) increase in the number of farms in one size comes from the next smallest state, (2) the farms in the largest category remain in that category, (3) decrease in farm size can result only in exit from the business, and (4) there will be no new farms established and, thus, the total amount of farms in the previous period equals the amount of farms in the next period, plus units which exit.

Data used come from Rheinland-Pfalz Statistisches Landesamt (RPSL). They comprise the total acreage of vineyards per size category and production region, of the share of areas planted with vines on slopes of more than 30%, and of average farm sizes per size category for the years 1999 and 2010. Size classes refer to the total area of cultivated vineyards per farm: 0-5 ha, 5-10 ha, 10-20 ha, 20-50 ha and >50 ha. Following the estimation procedure, the data form transition probability matrices for the projection of farms distribution within the period of 2010-2032.

Results

Two remarks must be made before presenting the results. First, farm growth is expected to accelerate with planting rights liberalization due to the availability of the new land. Therefore, the restructuring is expected to happen earlier than 2032. Respectively, the modeling date is further referred as 2020s. Second, in order to estimate the future acreage of vineyards, projected numbers of farms are multiplied by the average farm sizes. The latter values are assumed to be 3 ha, 7 ha, 15 ha, 30 ha and 60 ha for each of the size categories (in the ascending order). They differ from the observed average farm sizes of 2010. By using assumed instead of the observed values, we try to reduce the effect of drastic growth of number of farms in the largest size class and reflect the situation that the smallest farms tend to exit first.

Table 1. Projection of distribution of vineyards acreage and number of farms within the classes of size and area.

Size (ha) and area categories	Projection (2020s)		2010	
	Area (ha)	Farms number	Area (ha)	Farms number
Slope > 30% 0-5	598	199	2055	1008
5-10	926	132	1398	192
10-20	1132	75	910	66
20-50	682	23	435	15
>50	86	1	119	1
Slope > 30% 0-5	2876	959	8888	4361
5-10	5129	733	12149	1673
10-20	20562	1371	21465	1553
20-50	28978	966	12973	477
>50	10092	168	2958	36
Total	71061	4627	63350	9380

[a]All numbers are rounded to zero decimal places. Source: own calculations based on the data from RPSL.

Projection of farms distribution is presented in Table 1. Total area of vineyards will increase by almost 8000 ha. It will result from the farms growth in the larger size categories of areas with less than 30% slope. Total number of farms as well as acreage of active vineyards in mountainous areas will decrease.

Apart from political and market circumstances, farm growth can also be hindered by climate. Since enlargement of the farming units is expected to take place in areas around already existing vineyards due to the limited transportation expenses, the availability of suitable land is particularly relevant. With this concern, the modelling results are compared with projections on land suitability for vine growing with respect to climate change scenarios (developed by RLP AgroScience GmbH). Taking into account the difference in the modelling periods, i.e. 2020s and 2050, it is concluded that land suitability will not trigger the growth of wine farms due to the increased area for vine cultivation.

Discussion

Our results provide a plausible scenario of the future farms distribution. However, further improvements can be made regarding the assumptions of growth and stationarity of transition probabilities. Improvements on the former relate to Markov chains models, within which transition probabilities are not estimated by MLE, e.g. Lee and Judge (1996). In addition, application of non-stationary Markov chains models is more suitable when modelling the processes under policy changes.

Acknowledgement

We would like to thank the Ministerium Umwelt, Landwirtschaft, Ernährung, Weinbau und Forsten in Rheinland-Pfalz for financial support of the project, the RPSL for providing the data, and our project partners from RPDLR, Marc Deßler and Jurgen Oberhofer, for providing expert opinions on the wine sector of the region. We thank Michael Keane and George G. Judge for providing the references.

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