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Regional differences in the determinants for structural change in German agriculture

Norbert Röder[1] and Stefan Kilian[2]

1) Institute of Rural Studies
Von Thünen Institute
Bundesallee 50, D-38116 Braunschweig, Germany
Norbert.roeder@vti.bund.de

2) TUM (Technische Universität München)
Environmental Economics and Agricultural Policy Group
Alte Akademie 14, D-85350 Freising, Germany

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Abstract: In Germany agricultural land use is very heterogeneous with respect to management orientation and productivity even at local level. Also the rate of structural change shows a wide variation. While for a limited number of factors (e.g. farm size) a stable relation to structural change could be widely confirmed for different parts of Germany, the results for other indicators are contradictory. This holds especially for indicators describing to the marginality of a site. Many concerns related to structural change and development of land use intensity, e.g. abandonment of high nature value farmland, are only relevant in a very specific local context. Therefore, it is necessary to establish indicators for farm development on a disaggregated level.

This paper evaluates the stability of the relation between a set of explanatory variables and the rate of structural change at different spatial scales. Our results indicate that only for a few variables (farm size, gross margin per ha, stocking density and productive orientation of the local stock) a generally valid link between them and the rate of structural change can be established. For the majority of the explanatory variables, their respective impact on structural change depends on the regional context.

Keywords: Structural change, data mining, Regionalization

1. Introduction

Across the developed world farm number declined drastically within the last decades (e.g. BREUSTEDT & GLAUBEN, 2007). Especially the abandonment of agricultural activities in marginal areas causes various problems related to nature conservancy and rural development causes (e.g. CABALLERO et al., 2007). In Europe, areas of high nature value are concentrated in marginal areas and often associated with low input forms of agriculture, particularly low input grasslands (BIGNAL & MCCRACKEN, 1996).

Two different approaches for the empirical analyses of structural change are commonly used. Either data are analysed on an aggregate level, preferably on an administrative unit like the county level, or time series data for individual farms. The first approach has the advantages of longer time series and wider geographic coverage, whereas individual data allow the coverage of farm specific differences (e.g. age, education, farm history). Unfortunately, individual longitudinal data are only available in a few countries and are not necessarily sampled in statistically representative fashion (e.g. if based on Farm Accountancy Data Network data).

Relevant data in the context of agriculture generally show a high degree of spatial autocorrelation, correlation and at least partial dependencies. This can lead to global regression models, i.e. models incorporating all data in a sample, which are inappropriately specified. Effects, which express themselves only if certain thresholds limits for one or more variables are exceeded, are one cause of misspecification. This problem is widely recognized in landscape ecology, geography and agronomy and generally handled by a priori stratification of the data, and the calculation of stratum specific models. In agricultural economics, a different approach is frequently used. Here, the impact of different strata (regions) is depicted by the inclusion of dummy variables into the global models (e.g. most papers in the following literature review). However, WEISS (2008) shows for Austria that the direction and the magnitude of impact, a certain explanatory variable has on the structural change, are not only dependent on the value of the variable itself, but frequently depend on the level of other explanatory variables.

This paper analyses the rate of structural change in Germany from 1999 to 2007. This cross section analysis is based on data aggregated at the municipality level. We estimate OLS-

regression models in two different settings. In the first one, we estimate models incorporating all German municipalities. In the second setting we partition the municipalities into homogenous groups (clusters) which are based on the work of Roeder & Kilian (2008). For each group a separate model is estimated. Afterwards the stability of the coefficients is evaluated.

The paper is structured as follows. The following section gives a review of recent literature relating to structural change. Next, we describe the material and applied methods for data manipulation and regression analysis followed by the presentation of the empirical results. The discussion of the results and the methodological issues finish the paper.

2. Structural change in agriculture

Many studies across Europe and North America confirm that the rate of structural change, respectively the likelihood of farm exit, declines as farms get larger (e. g. Glauben et al., 2006; Hoope & Korb, 2006; Juvancic; 2006; Weiss, 2008; Pietola et al., 2003; Hofer, 2002; Baur, 1999; Kimhi & Bollman; 1999; Weiss, 1999). Good proxies for the assessment of farm exit rates are the farmer's age and the recent development (e. g. amount of recently rented land, recent investments) of the farm. The likelihood of farm exit is positively related to the farmer's age, as farms frequently close when the owner retires (e. g. Glauben et al., 2006; Hoope & Korb, 2006; Hofer, 2002; Baur, 1999; Weiss, 1999). Regarding the history of the farm, farms which were successful in the past have lower farm exit rates. In Central Europe, farms mainly grow by renting additional land, therefore the negative correlation between farm exit rates and the ratio of rented land is comprehensible (Glauben et al., 2006; Baur, 1999; Hofer, 2002; Weiss, 2008).

Several studies indicate a stabilizing effect of direct payments (Glauben et al., 2006; Hoope & Korb, 2006, Weiss, 2008; Hofer, 2002; Barkley, 1990). Nevertheless in some studies the effect is fairly small (Glauben et al., 2006; Hoope & Korb, 2006, Barkley, 1990).

Comparing different farm types and sectors of agricultural production, Hoope & Korb (2006) derive lower exit rates for beef farmers than for those involved in cash cropping or hog fattening. Weiss (2008) states that farms specialized in permanent cultures, hogs or poultry fattening or mixed forage cropping are more likely to give up farming than other types.

Furthermore, data indicate a negative correlation between stocking density and exit rates. GLAUBEN et al. (2006) report a negative correlation for permanent cultures and for the relative ratio of farms keeping cattle for Western Germany.

Other reported influential factors have a less clear connection to structural change. Studies from Austria (WEISS; 1997, 1999), Switzerland (BAUR, 1999; HOFER, 2002) and the US (ROE, 1985) report a positive correlation regarding the connection between off-farm employment and structural change. However, regarding this relation the results of GOETZ & DEBERTIN (2001) and HOOPE & KORB (2006) for the US are ambivalent and several studies indicate even a negative correlation for parts of Canada (KIMHI & BOLLMAN, 1999), Israel (KIMHI, 2000), Western Germany (GLAUBEN et al., 2006) and Slovenia (JUVANCIC, 2006).

For indicators describing the marginality of certain areas in demographic terms, the picture is generally ambivalent. While JUVANCIC (2006), HOOPE & KORB (2006) and GOETZ & DEBERTIN (2001) report a positive correlation of the exit rates and the population density, the results of GLAUBEN et al. (2006) indicate a negative one. For the US, HOOPE & KORB (2006) and GOETZ & DEBERTIN (2001) report a negative correlation of the exit rates and the distance of the next metropolitan area, while in Austria outside less favoured areas the distance to larger cities is negatively correlated to the exit rates (WEISS, 2008). In contrast, WEISS (2008), BAUR (1999) and JUVANCIC (2006) report lower exit rates in more marginal areas. In HOFER (2002), exit rates and distance are positively correlated. Regarding the connection between regional unemployment rates and farm exit rates, JUVANCIC (2006) and GLAUBEN et al. (2006) report a positive correlation.

3. Material

The analysis is conducted on the level of German municipalities. In the federal state of Lower Saxony we used the data of the "Samtgemeinden" and in Rhineland Palantine of the "Verbandsgemeinden" which are comparable to municipalities. Excluding municipalities without any farms and taking into account municipal reform in the investigated time frame, this results in a sample size of 9270 municipalities. For 16 variables identified in previous studies as being relevant for determining structural change, we could obtain reliable data on the local level (Tab. 1).

Seven variables depict the site conditions. With increasing *altitude,* the conditions for agricultural production become increasingly adverse as vegetation period gets shorter and the precipitation increases. With increasing *relief* (steeper slopes), the conditions for agriculture become problematic due to increases in labour demands and erosion risk.

Generally speaking, the natural conditions in Germany are favourable for the cultivation of cereals. Specific climatic and edaphic conditions are often the reason other cultures may reach above average shares. We use four variables to differentiate these conditions. Permanent cultures like wine and fruit trees are in Germany concentrated in areas with above-average temperatures (*PermCult_UAA*). Root crops, like potatoes and sugar beet, as well vegetable cultivation and horticulture are linked to light, deep and fertile soils (*Root_UAA*). While high shares of the first two variables indicate more favourable condition than on average the remaining two are linked to relatively unfavourable conditions. Permanent grassland (*GrassUAA*) can mainly be found in areas where at least one of the following conditions is met: high summer precipitation, short vegetation period, high risk of late or early frosts or a high groundwater table. Remnants of the potential natural vegetation like forests, moor- and heathland only cover significant shares of the land where the climatic and edaphic conditions for agriculture are unfavourable. Only in these areas do these marginal land uses become economically superior (*MarginalLand*). The last indicator of this domain differentiates the natural potential of the site for the nutrition of ruminants. Grassland is either a marginal form of land use, just before abandonment, or is highly competitive in case of high summer rain fall and long vegetation periods. While the first case is associated with low stocking densities, the densities in the latter case are exceptionally high (*RCLU_MFA*).

The agricultural production is covered by five variables. The farm size is depicted in monetary terms (*GM_farm*). The amount of 1st pillar payment is depicted by the average value of a single farm payment (*SFP*) in the municipality. Average gross margin per ha is an indicator for the value added per ha of agricultural land (*GM_UAA*). The composition of a municipality's livestock production is depicted by the share of ruminants on the total livestock kept (*RCLU_LU*). *LU_UAA* is the stocking density and serves as indicator for the overall importance of livestock production.

The last domain reflects the general economic conditions on the local level. The gradient between rural and urban areas is covered by the population density (*Pop_dens*). We use the

driving time by car to the next larger city (Oberzentrum) as an indicator for the remoteness of a given municipality (*Dis_city*). *UAA_change* reflects mainly the conversion of agricultural land to housing and construction and can be viewed as proxy for the urban pressure on agricultural land. In Germany the differences in the rate of population changes are strongly linked to the flux of population in and out of a community (*Pop_Change*). These levels themselves are strongly related to the general economic prosperity of a given region.

Tab. 1: Variables used in the regression models

Variable	Description	Unit	Source	Regression
Altitude	Avg. altitude of a municipality	m.a.s.l.	USGTOPO30	I
Relief	s.d. of a municipality's altitude			
MarginalLand[c]	Share of total land covered by forests, moor- and heathland in 2000	%	DeStatis (2006)	
Pop_Change[c]	Change in the population between 1996 and 2004			
UAA_Change[c]	Change in agricultural land between 1996 and 2004			
Pop_Dens[d]	Population density in 2000	Inh. / km²		
LU_UAA[c]	LU per ha of UAA in 1999	LU / ha	DeStatis (2008)	
RCLU_MFA[c]	Ruminant LU per ha of main forage area in 1999			
Grass_UAA[c]	Share of UAA covered by permanent grassland in 1999	%		
Root_UAA[a]	Share of UAA covered by root crops, horticulture, ... in 1999			
RCLU_LU	Ratio of ruminant LU to total LU in 1999			
PermCult_UAA[a,c]	Share of UAA covered by permanent cultures (wine, fruits) in 1999			
SFP[c]	Single farm payments per ha in 2005	€ / ha	ZID	
GM_UAA[c]	SGM per ha (based on 1999 land use and average German SGM for the period 2000-2008)	€ / ha	DeStatis (2008); KTBL (2008)	
GM_farm[b,c]	SGM per farm	€		
Dis_City	Driving distance to the next larger city (Oberzentrum)	minutes	BBR (2008)	
Stru_Change[c]	Rate of structural change between 1999 and 2007		DeStatis (2008)	D

Source: Own presentation based on various data sources
a: data are log-transformed (ln(%+0.01)
b: data are log transformed (ln())
c: stabilized by a moving window approach
d: data are root transformed
LU: livestock units; UAA: utilized agricultural area; SGM: Standard Gross margin; Inh.: Inhabitants
I: Independent variable; D: dependent variable

The average annual rate of structural change (*Stru_Change*) with respect to the number of agricultural holdings between 1999 and 2007 is the derived variable for the regression analysis (1).

(1) $$c_m := \frac{\ln(x_{m,1999}) - \ln(x_{m,2007})}{8}$$

c_m: annual rate of structural change

x_m: number of farms in municipality m

m: municipality

In order to analyse the relevance of regional peculiarities we use the typology of ROEDER & KILIAN (2008) who divide the German municipalities into 30 homogenous groups. This classification is based on various structural features of the respective municipalities.

4. Method

We calculate five different OLS regression models in order to analyze the impact of the explanatory variables on structural change (Tab. 2). In three of these models (A-C) the coefficients are derived for the entire data set (global models) while in the remaining two (D, E), for each cluster an individual OLS is calculated (nested models). In model A the OLS calculation is performed without using regional dummies while model B takes into account only the impact of the regional dummies. Model C combines the previous two models. In model D for each cluster an independent OLS regression is calculated. Model E is based on this model. However, in each sub-model all variables are successively removed by backward elimination whose p-value exceeds 0.05.

Tab. 2: Overview over the regression models

Model	Type	One model	One model per cluster	Structural variables	Regional dummies	Significant variables only
A	global	**X**		**X**		
B	global	**X**			**X**	
C	global	**X**		**X**	**X**	
D	regional		**X**	**X**		
E	regional		**X**	**X**		**X**

Source: Own presentation

Between 1999 and 2007 the number of farms in Germany dropped by nearly 97 500 or on average 2.6 % per year (DeStatis, 2008). Taking into account the roughly 10 000 municipalities, this means that in an average municipality about 10 farms closed down in the observed period. However, in 1999, in half of the German municipalities less than 25 farms existed. As a consequence, the closure of a single farm has a large impact on the observed rate of structural change on the municipality level. We apply an approach based on the "moving

window" technique in order to stabilize the variables related to the agricultural sector on the municipality level. Actually, the value of each variable assigned to a municipality is a weighted sum of the respective value originally observed this municipality and the values observed in its neighbours (2). If the variable is a relative value, the value is derived after the nominator and the denominator are separately calculated using formula (2):

(2) $$i_{new,m} := 0.5 * i_{old,m} + \sum_{n} 0.5 / l_n * i_{old,n}$$

i: variable

$i_{new,m}$: derived value of variable i in municipality m

$i_{org,m}$: originally observed value of variable i in municipality m

n: municipality neighbouring m; n neighbours m if n and m share a common border; $n \neq m$

l: number of neighbours of a municipality

For the analysis we take further steps in order to stabilize the data. We transformed some variables having an extremely skewed distribution (*Pop_Dens*, *UAA_farm*, *GM_farm*, *Root_UAA*, *PermCult_UAA*) to spread their data well over their respective range. Furthermore, all extreme values of all variables are truncated to the 0.5% or 99.5% quantils of the respective variable.

We use two indicators analogous to the analysis of association rules to determine the general validity and applicability of the statistically determined correlation (Witten & Frank, 2005). These are the support and the confidence. The support measures the relative number of sub-models in which a certain variable has a significant impact on structural change (3):

(3) $$S_i := \frac{Q_i}{T}$$

S_i: Support for variable i

Q_i: number of models in which the variable i is significant at the 5% level

T: number of models

The confidence analyzes how stable the result is for the various sub-models if and only if the respective variable has a significant impact. For the analysis we concentrate on the predominant sign of the respective correlations (4):

(4) $$C_i := \frac{|P_i - N_i|}{Q_i}$$

C_i: Confidence of the sign for variable i

P_i: number of models in which the impact is significantly positive at the 5% level

N_i: number of models in which the impact is significantly negative at the 5% level

We calculate each variable's impact to assess the relevance of a given explanatory variable for structural change in the different models (5). This is necessary since the mean and the variance of a given variable differs between each of the sub-models. As a result, the coefficient themselves are barely comparable. Since we are only concerned with the magnitude of the observed impact and not its sign the absolute value is used for calculation.

(5) $$I_{t,i} := |\sigma_{t,i} * \alpha_{t,i}|$$

$\sigma_{t,i}$: s. d. of the variable i in model t

$\alpha_{t,i}$: coefficient of variable i in model t

The average impact of a variable is its weighted impact in the different sub-models (6). For this analysis all coefficients in all sub-models irrespective of their respective level of confidence are considered.

(6) $$\bar{I}_i := \frac{\sum I_{t,i} * a_t}{A}$$

$\bar{I}_i$: avg. impact of variable i

a_t: number of observations in model t

A: total number of observations; $A := \sum_t a_t$

We use the following software for the analysis: ESRI ArcMap 9.2 for processing of the geographic data; SAS 9.1 for regression analysis; MS Access 2002 for storing and manipulating the data.

5. Results

The different models explain between 34% and 55% of the observed structural change (Tab. 3). The model with regional dummies performs worst (B) while model D performs best. However, even the simple regional model (B) is capable to explain a third of the variance in the data. Looking at the AIC and the BIC the models A, C and E perform equally well. The comparatively low BIC for model D indicates an overspecification.

Tab. 3: Summary of the results of the regression models

Model	Variables		R^2	Adj. R^2	AIC	BIC
	total excl. intercepts	thereof $p < 0.05$				
A	15	11	43.4%	43.3%	-1.24	-1.23
B	29	28	34.2%	34.0%	-1.09	-1.07
C	44	23	45.3%	45.0%	-1.27	-1.24
D	450	163	54.5%	52.1%	-1.37	-1.01
E	182	182	53.1%	51.9%	-1.39	-1.22

Source: Own calculation
AIC: Akaike Information Criterion
BIC: Bayes Information Criterion (=Schwarz Information Criterion)

Fig. 1 depicts the level of support and confidence for the different variables in the reduced reginalized model (E). The level of support reaches up to 97% for the farm_size (*GM_farm*) and is always negatively correlated with structural change. On the other hand, the impact of the share of root crops (*Root_UAA*) is highly ambivalent. In each 7 of the 14 regions where it has a significant influence, the correlation is positive respectively negative. Stocking density (*LU_UAA*), share of marginal land (*MarginalLand*) and share of ruminants (*RCLU_LU*) are in many regions negatively correlated with the rate of structural change while the correlation is positive for gross margin per ha (*GM_UAA*) and remoteness (*Dis_City*). Only in a restricted number of regions *Pop_change*, *SFP*, *PermCult_UAA* and *Pop_dens* are of some importance for structural change. The impact of *Root_UAA*, *Grass_UAA*, *Relief* and *RCLU_MFA* is highly ambivalent and depends on the given region.

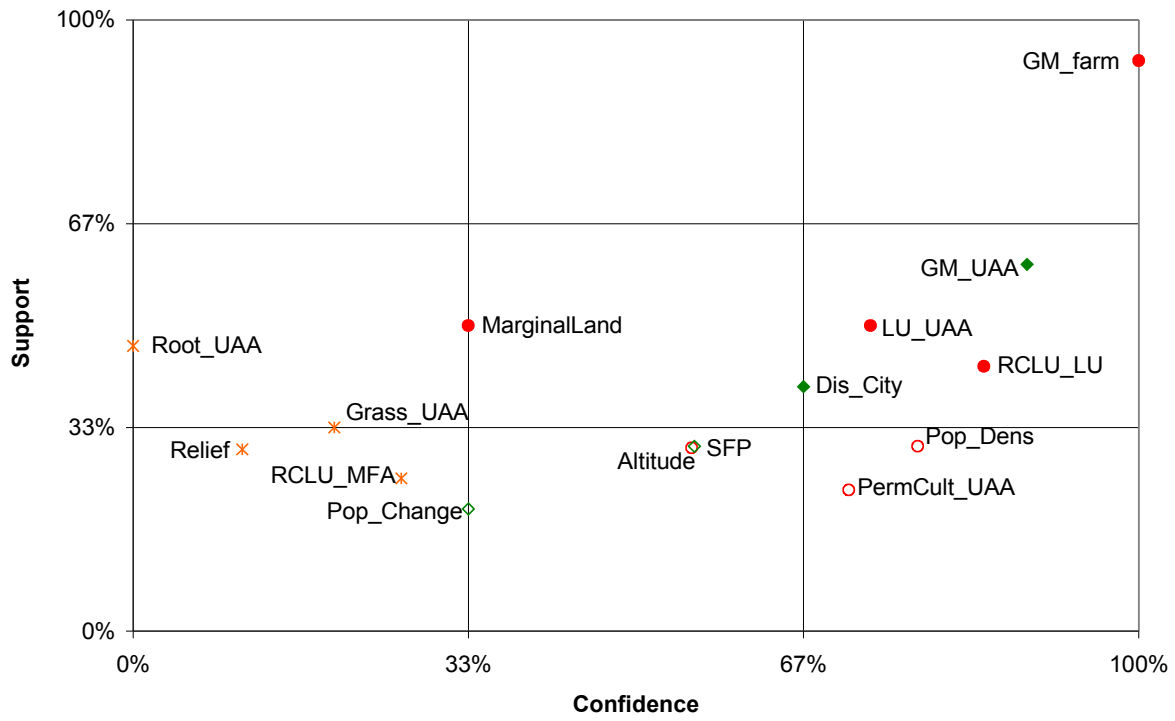

Fig. 1: Support and confidence of the independent variables in the nested model (E)
Source: Own presentation based on the analysis of the regression models
Cubicles: positive correlation between the variable and the rate of structural change predominant
Circles: negative correlation between the variable and the rate of structural change predominant
Filled Cubicles / filled circles: variables having a support exceeding $^{1}/_{3}$

Fig. 2 compares the impact of the different variables in the global and nested models. Farm size (*GM_farm*) is the most important factor in all models. The relationship between farm size and structural change shows that the impact declines and the relationship gets flatter the more regionalized the models become (A→C→D). In contrast the impact gets larger for a group of variables related to livestock husbandry (*RCLU_MFA_UAA*, *Grass_UAA*, *LU_UAA*) as the models become more regionally differentiated. *RCLU_LU* is the only parameter that is of overall relevance and whose is impact is fairly independent of the model specification. For most of the remaining variables their respective impact is fairly low and constant irrespectively of the chosen model specification.

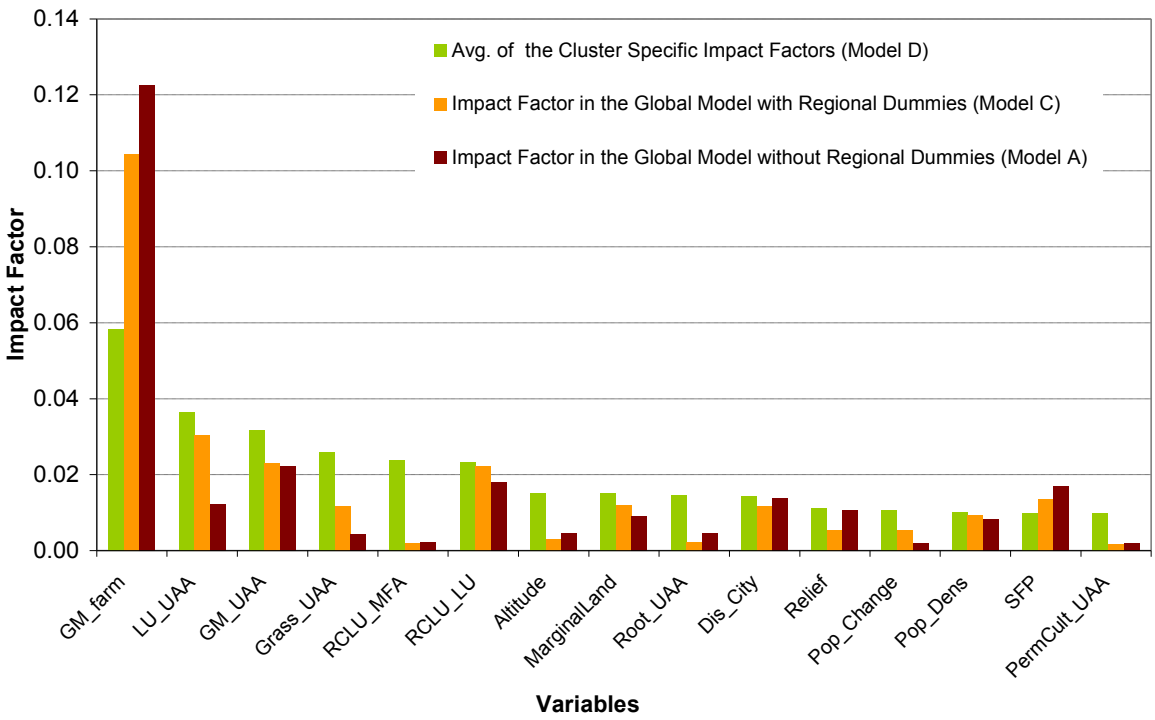

Fig. 2: Comparison of the magnitude of the impact of the independent variables in the regionalized (D) and global models (A, C)
Source: Own presentation based on the analysis of the regression models

6. Summary and conclusions

Throughout Germany the rate of structural change observed at the municipality level can generally be well explained by the farm size (*GM_farm*) and the intensity of land use (*GM_UAA*). The larger the farms are and the less intensive the land use is the lower is the observed decline in farm numbers. In contrast, some variables effect structural change only in some regions (e.g. *Pop_dens*, *PermCult_UAA*) or the direction of their relation to structural change depends on the region (*Root_UAA*). Therefore, one can not transfer results from one region to another one to one.

If one defines a marginal area as one:

- where farms are small (1),
- where the share of marginal land is high (2),
- where the gross margin per ha (3), and the share of permanent cultures are low (4),

- where livestock consists mainly of ruminants (5),
- and which is sparsely populated (6) and located in remote (7) mountain area (8),

the question whether farms in marginal areas are more likely to quit can not definitely be answered. While the coefficients of (2), (3), (4), (7), and (8) indicate lower rates in more marginal areas, (1), (5), and (6) do the opposite.

In order to improve the confidence in the obtained results, the introduction of variables depicting the distribution of a given variable on a local scale might yield additional insights (e.g. based on the coefficient of variation, the Gini coefficient or the Shannon-Weaver Index).

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8. References

Barkley, A. P. (1990): The Determinants of the Migration of Labour out of Agriculture in the United States, 1940-85. American Journal of Agricultural Economics 72: 567-573.

Baur, P. T (1999): Agrarstrukturwandel in der Schweiz. Dissertation ETH. Nr. 13240. Zürich.

BBR (Federal Office for building and regional planning) (2008): Erreichbarkeitsindikatoren. personal communication.

Bignal, E. M. & McCracken, D. I. (1996): Low-intensity farming systems in the conservation of the countryside. Journal of Applied Ecology 33: 413-424.

Breustedt, G. & Glauben, T. (2007): Driving Forces behind Exiting from Farming in Western Europe, Journal of Agricultural Economics, 58 (1): 115-127.

Caballero, R., Riseth, J. A., Labba, N., Tyran, E., Musial, W., Molik, E., Boltshauser, A., Hofstetter, P., Gueydon, A., Röder, N., Hoffmann, H., Moreira, M., Seita Coelho, I., Brito, O., & Gil, A. (2007): Comparative Typology in six European Low-intensity Systems of Grassland management. Advances in Agronomy 96: 351-420.

DeStatis (Federal Statistical Office) (2006): Statistik lokal. Wiesbaden.

DeStatis (Federal Statistical Office) (2008): agricultural structural surveys. various years.

Goetz, S. J. & Debertin, D. L. (2001): Why Farmers Quit: A County-Level Analysis. American Journal of Agricultural Economics 83: 1010-1023.

Hofer, F. (2002): Strukturwirkungen von Direktzahlungen. Dissertation ETH. Nr. 14464. Zürich.

Juvancic, L. (2006): Determinants of Farm Survival and Growth in Slowenia (1991-2000). Paper presented at the 96th EAAE seminar (10-11.01.2006). Tänikon: 17.

Kimhi, A. & Bollman R. (1999): Family Farm Dynamics in Canada and Israel: The Case of Farm Exits. Journal of Agricultural Economics 21: 69-79.

Kimhi, A. (2000): Is Part-time Farming Really a Step in the Way Out of Agriculture? American Journal of Agricultural Economics 82: 38-48.

KTBL (Kuratorium für Tecknik und Bauwesen in der Landwirtschaft) (2008): Database for Standard Gross margin; scientific access, URL: http://daten.ktbl.de/sdb.

Pietola, K., Vare, M. & Lansink, A. O. (2003): Timing and Type of Exit from Farming: Farmers' Early Retirement Programmes in Finland. European Review of Agricultural Economics 30: 99-116.

Roe, B. (1995): A Study of US Farm Exits with Evidence from the Panel Study of Income Dynamics. Paper presented at the 1995 Annual meeting of the American Agricultural Economics Association.

USGSGTOPO30 (U.S. Geological Survey Center for Earth Resources Observation and Science (EROS)) (2006): Digital elevation model, Sioux Falls.

Weiss, C. R. (1997): Do They Ever Come Back Again? The Symmetry and Reversibility of Off-Farm Employment. European Review of Agricultural Economics 24: 65-84.

Weiss, C. R. (1999): Zum Ausscheiden landwirtschaftlicher Betriebe: Eine Empirische Analyse, Agrarwirtschaft, 48 (5): 202-209.

Weiss, F. (2008): Bestimmungsgründe für die Aufgabe / Weiterführung landwirtschaftlicher Betriebe in Österreich. Berichte über Landwirtschaft 86 (2):322-345.

Witten, I. H. & Frank E. (2005): Data Mining: Practical Machine Learning Tools and Techniques.

Glauben, T., Tietje, H. & Weiss, C. R. (2006). Agriculture on the move: Exploring regional differences in farm exit rates in Western Germany. Jahrbuch für Regionalwissenschaft 26: 103-118.

Hoppe, R. A. & P. Korb (2006). Understanding U.S. Farm Exits. USDA Economic Research Report No. (ERR-21). Washington: 42.

Röder, N & Kilian, S. (2008): Which parameters determine farm development in Germany? Paper presented at the 109th EAAE Seminar (20-21.11.2008). Viterbo. URL: purl.umn.edu/44788.