Structural Change of European Dairy Farms – A Cross-Regional Analysis

Andrea Zimmermann*, Thomas Heckelei**

* LEI-Wageningen UR, Alexanderveld 5, 2585 DB The Hague, The Netherlands
andrea.zimmermann@wur.nl

** Institute for Food and Resource Economics, University of Bonn, Nussallee 21, 53115 Bonn

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Introduction

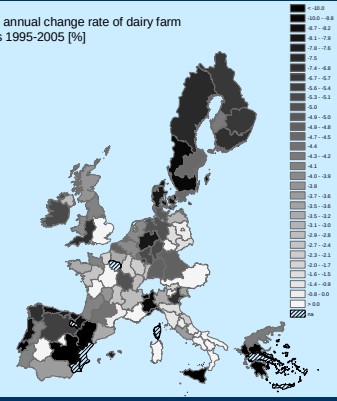
With the EU milk quota abolition approaching in 2015 and the recent milk price volatility, structural changes in the European dairy sector are a major topic of discussion among policy makers, media, and science.

Previous analyses of dairy farm structural change focused on the variation over time in one or a small number of regions. We present an EU15-wide analysis of the change of the number of farms in different size classes. The purpose is to (1) identify the differences in regional development patterns and (2) to measure the explanatory relevance and effect of key factors suggested in the literature.

The approach analyses data on regional farm numbers in 5 different size classes (macro data) combined with observed transitions (micro data) from the Farm Accountancy Data Network (FADN). Time series are available from 1995 to 2005 for 94 regions of the EU15.

Differences across regions

Average annual change rate of dairy farm numbers 1995-2005 [%]



Size class	Definition	Average annual change of farm numbers (%)	Standard deviation across the regions
SIZE1	< 20 cows	-10.5	9.5
SIZE2	20-39 cows	-3.9	7.1
SIZE3	40-79 cows	1.6	9.3
SIZE4	80-119 cows	4.4	8.3
SIZE5	≥ 120 cows	9.2	12.0

- Structural change: Change of the number of farms in different size classes
- There exist considerable regional differences in the farm structural development regarding
  - Total farm numbers and
  - Farm numbers in different size classes

Methodology

1. step: Calculation of time-varying transition probabilities for each region

$$\min\left[\sum_i\sum_j\sum_t p_{ijt}\ln\left(p_{ijt}/q_{ijt}\right)+\sum_m\sum_j\sum_t w_{mjt}\ln\left(w_{mjt}/u_{mjt}\right)\right]$$ } Objective function

$$\text{s.t.}\quad y_{jt}=\sum_i y_{it-1}+\sum_m v_m w_{mjt}\qquad \forall j,t$$ } Markov constraint

$$\sum_j p_{ijt}=1,\ \sum_m w_{mjt}=1\ \text{ and }\ p_{ijt}, w_{mjt}\geq 0$$ } Probability constraints

- Generalized cross-entropy approach (Stokes 2006)
- Minimizes the difference between estimated probabilities and prior information
- Farm numbers (in shares): macro data
- Prior information on transition probabilities based on observed transitions: micro data

2. step: Cross-regional regression analysis

$$\ln\left(\frac{p_{ijrt}}{p_{ikrt}}\right)=\mathbf{z}_{irt}\boldsymbol{\beta}_{ij}\qquad \text{for } i=1,2,\ldots,s \text{ and } j=1,2,\ldots,s-1 \text{ and } k=s$$

- Regression of log-odds ratios against explanatory variables
- In order to measure the direct effect of the explanatory variables on the transition probabilities, probability elasticities are calculated (Zepeda 1995)

p_{ijt}: transition probability for time period t to move from farm type i to farm type j
q_{ijt}: prior information on transition probability p_{ijt}
w_{mjt}: weight of the error term
u_{mjt}: prior information on w_{mjt}
y_{jt}: share of farms in farm type j at time t
v_m: m-dimensional supports for the error term
r: region
$\mathbf{z}_{irt}$: explanatory variables
$\boldsymbol{\beta}_{ij}$: coefficients

Determinants and results

Determinants

Technology	Trend
	Milk yield (kg/cow)
Farm structure	Initial farm size (cows)
	Gini coefficient of dairy farms (index)
	Gini coefficient of the other farms (index)
	Stocking density (LU/forage ha)
Market conditions	Milk price over time (€/kg)
	Milk price across regions (€/kg)
	Milk price coefficient of variation (€/kg)
	Land rent (€/ha)
Natural resources	Share of grassland (%)
	Slope (%)
	Temperature sum (ºC)
Social and demographical factors	Population density (population/km²)
	Population growth (%)
	Unemployment (%)
	Share of farmers > 55 years (%)

Transition probability matrix (from step 1)

	SIZE1	SIZE2	…	EXIT
SIZE1	0.863	0.079	…	0.056
SD region	0.094	0.084		0.056
SD time	0.012	0.004		0.011
…	…	…	…	
ENTRY	0.001	0.001	0.001	0.996
SD region	0.004	0.003	0.002	0.008
SD time	0.001	0.001	0.001	0.005

SD: Standard deviation

Estimated coefficients (from step 2)

- Most coefficients are highly significant for many of the log-odds ratios
- Time-dependent variables (trend and milk price over time) are mostly not significant
- R^2 for entry very low (0.058 on average), for the other transition probabilities on average 0.194

Exemplary probability elasticities

- Hypotheses are made concerning each variable's influence on the transition probabilities classified according to farm size growth, farm size decline, entry, and exit
- For space limitations, here, two examples are evaluated

		Dairy farm size heterogeneity	Share of farmers > 55 years
Farm size growth	Expected sign	+	-
	p12	3.60	-0.04
	p13	0.61	0.27
	p14	-0.67	-0.17
	p15	-1.02	-0.43
	p23	2.17	-0.92
	p24	-0.91	0.74
	p25	-0.47	0.03
	p34	4.71	-1.12
	p35	-2.98	-0.05
	P45	5.36	-0.65
Exit	Expected sign	+	+
	p1e	0.33	1.22
	p2e	-0.11	0.77
	p3e	-1.10	0.51
	p4e	3.43	-0.73
	p5e	5.10	-0.06

- *Farm size heterogeneity* at the beginning of the observation period is expected to enhance resource reallocation between farms and thereby to generally increase farm structural change
  - Farm size growth: only 50% of the probability elasticities confirm the hypothesis
  - Exit: three out of five probability elasticities confirm the hypothesis
- We assume that the higher the *share of farmers being older than 55 years* was at the beginning of the observation period, the less likely is farm size growth and the more likely are sector exits
  - Farm size growth: 70% of the probability elasticities confirm the hypothesis
  - Exit: Three out of five probability elasticities confirm the hypothesis. The hypothesis is not confirmed for exits from the large size classes indicating that larger farms are more likely to continue farming even if the initial farm holder retires

Conclusions

- EU15-wide cross-sectional analysis of dairy farm structural change
- Considerable cross-regional variance
- Overall, relevance of assumed key factors of structural change confirmed
- Results reveal complexity of structural change process and interaction between different determinants not sufficiently identified

References

Stokes JR (2006) Entry, Exit, and Structural Change in Pennsylvania's Dairy Sector. Agr Resource Econ Rev 35 (2):357-373

Zepeda L (1995) Technical Change and the Structure of Production: A non-stationary Markov Analysis. Europ Rev Agr Econ 22:41-60

Andrea Zimmermann andrea.zimmermann@wur.nl +31-(0)70-33 58 28 6, Thomas Heckelei thomas.heckelei@ilr.uni.bonn.de +49-(0)228-73 23 32