Dairy farming on permanent grassland: can it keep up?

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Contents

1. Motivation and Literature
2. Data
3. Method
4. Results
5. Concluding Remarks

1. Motivation

- Why dairy farming on permanent grassland?
  - Bioeconomy / Resource efficiency
    - Increasing competition between food / feed / other uses
    - **Grassland ideally used for dairy production**
  - Provides **extra benefits** (compared to arable land)
    - Carbon sink
    - Habitat function (Biodiversity)
    - Ground and surface water quality
    - Landscape (recreational activities, tourism)
    - Recognized by greening strategy of CAP

1. Motivation

- What's the **problem** of permanent grassland (PGL) farms in Middle Europe, ….
  - elevated, mountainous areas
  - **energy yield per ha approximately half** of fodder crops
- competing with fodder crop (FC) farms
  - produce relatively homogenous good
  - serve the same market

1. Motivation

- Consequences if PGL farms are not competitive
  - give up farming
  - We do no longer use this land for food production
  - Farms need additional subsidies to survive
    - Less favored area payments

1. Motivation

- Research Questions:
  - Can dairy farms operating solely on permanent grassland keep up with fodder crop farms?
  - We compare **efficiency, productivity and the development of productivity** over time

2. Data

- Unbalanced panel of Bavarian dairy farms
  - Dairy: at least 2/3 of revenues from dairy production
  - No. of farms = 1142
  - T = 9 (Years: 2000 – 2008)
  - 9482 observations

2. Data

- We spilt sample into
  - Permanent Grassland farms:
    0% arable land
    85% of PGL farms above 600 m
  - Fodder Crop farms:
    at least 10%, ϕ = 45% arable land
    83% between 300 and 600 m

3. Method: Translog stochastic distance function

- multioutput stochastic production function
  - 2 outputs:
    - **milk** revenues deflated
    - **other** revenues deflated
  - 4 Inputs:
    - **Land**: cultivated
    - **Labor**: family and hired
    - **Capital**: building, machinery, livestock
    - **Intermediates**: seed, fertilizer, pesticides, veterinary, concentrates, water, energy, fuel
  - accounting for **inefficient** resource use

$$-\ln y_{Mit} = \alpha_0 + \sum_{m=1}^{M-1} \alpha_m \ln y^*_{mit} + \sum_{k=1}^{K} \beta_k \ln x_{kit} + \frac{1}{2}\sum_{m=1}^{M-1}\sum_{n=1}^{M-1} \alpha_{mn} \ln y^*_{mit} \ln y^*_{nit}$$
$$+\frac{1}{2}\sum_{k=1}^{K}\sum_{j=1}^{K} \beta_{kj} \ln x_{kit} \ln x_{jit} + \sum_{k=1}^{K}\sum_{m=1}^{M-1} \delta_{km} \ln x_{kit} \ln y^*_{mit} + \tau_1 t + \frac{1}{2}\tau_2 t^2$$
$$+\sum_{m=1}^{M-1} \varsigma_{mt}\, t \ln y^*_{mit} + \sum_{k=1}^{K} \nu_{kt}\, t \ln x_{kit} + e_{it}$$

$\boldsymbol{y}$ … outputs
$\boldsymbol{x}$ … inputs
t … time trend to model technical change

3. Method: Heterogeneity within groups

- **Location dummies** (agricultural production areas)
- **Latent class** stochastic frontier model (e.g. Orea & Kumbhakar 2004, Greene 2005) separates dairy production systems based on
  - Inputs and outputs
  - Additional concomitant variables
    - Stocking rate: cattle livestock unit / ha forage area
    - Milk yield / cow & year

3. Method: What we measure

- **Technical Efficiency** (TE): distance of the farm from potential output, given used inputs
- **Total Factor Productivity** (TFP): Index of all outputs divided by an index of all inputs
- Decompose the change in TFP
  - Technical change
  - Technical efficiency change
  - Scale efficiency change

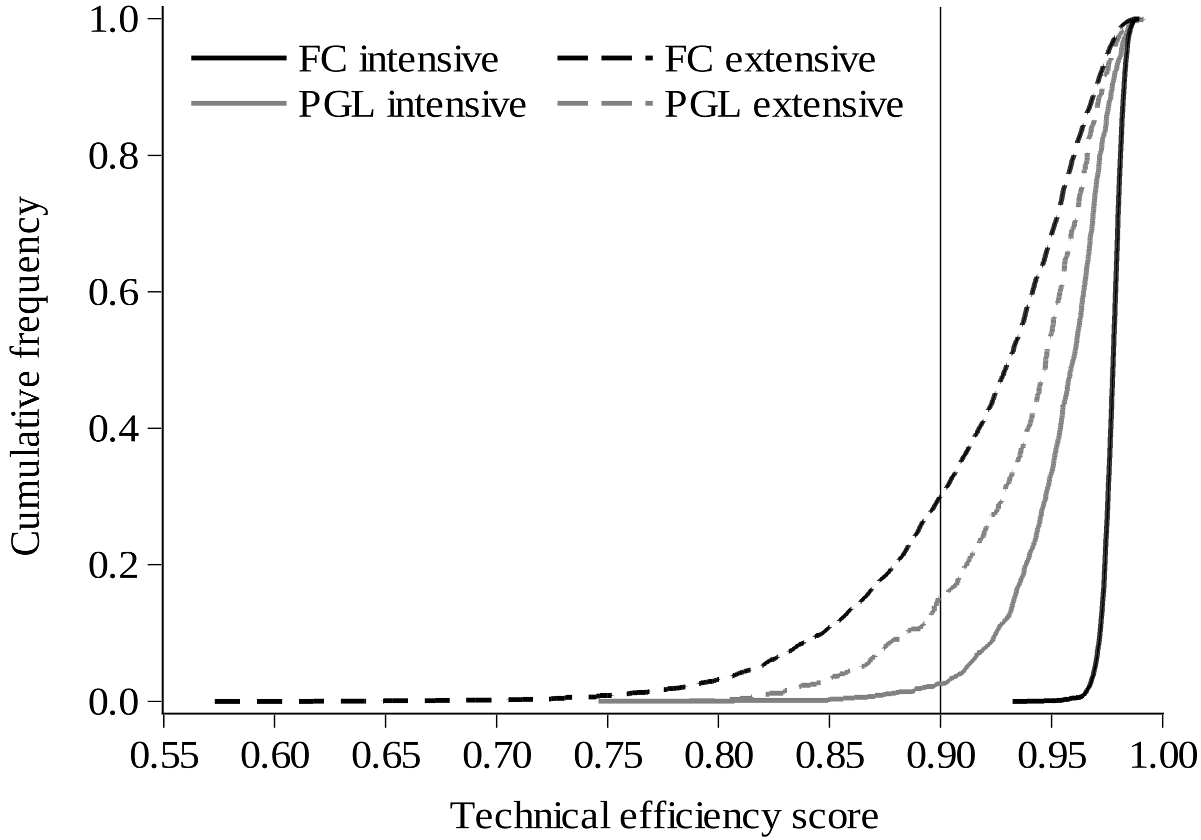
4. Results: Latent class model

- Best way to describe the date with **2 subgroups** in each group
  - “intensive” grassland farms
  - “extensive” grassland farms
  - “intensive” fodder crop farms
  - “extensive” fodder crop farms

Results: 4 groups

	Fodder-crop		Grassland	
	intensive	extensive	intensive	extensive
Farms	491	467	116	68
Observations	4,100	3,899	951	532
Labor (fte)[1]	1.6	1.54	1.49	1.48
Land (ha)	46.9	45.5	31.4	30.9
Intermediate inputs (€)	58,602	49,510	31,116	24,833
Cows	41	32	30	22
Milk production (1000 kg/yr)[2]	265.1	185.3	180.9	125.7
Milk yield (kg/cow yr)	6,432	5,708	6,087	5,693
Cattle LU/ha forage land[3]	2.54	2.18	1.64	1.37
av. growth rate milk yield (%/yr)	1.8	1.87	1.61	1.41
av. growth rate milk prod. (%/yr)	2.9	2.39	2.61	1.17
Concentrate/Cow (€)	312.3	277.2	259.7	274.1
Vet. cost/Cow (€)	90.3	99.6	76	96.8
No agricult. education (%)	6.7	8.8	9.8	14.1
Basic agricult. education (%)	61.3	68	69.5	69.4
Higher agricult. education (%)	32	23.2	20.7	16.5
Farmers age (yr)	46.7	48.2	46.9	47.3

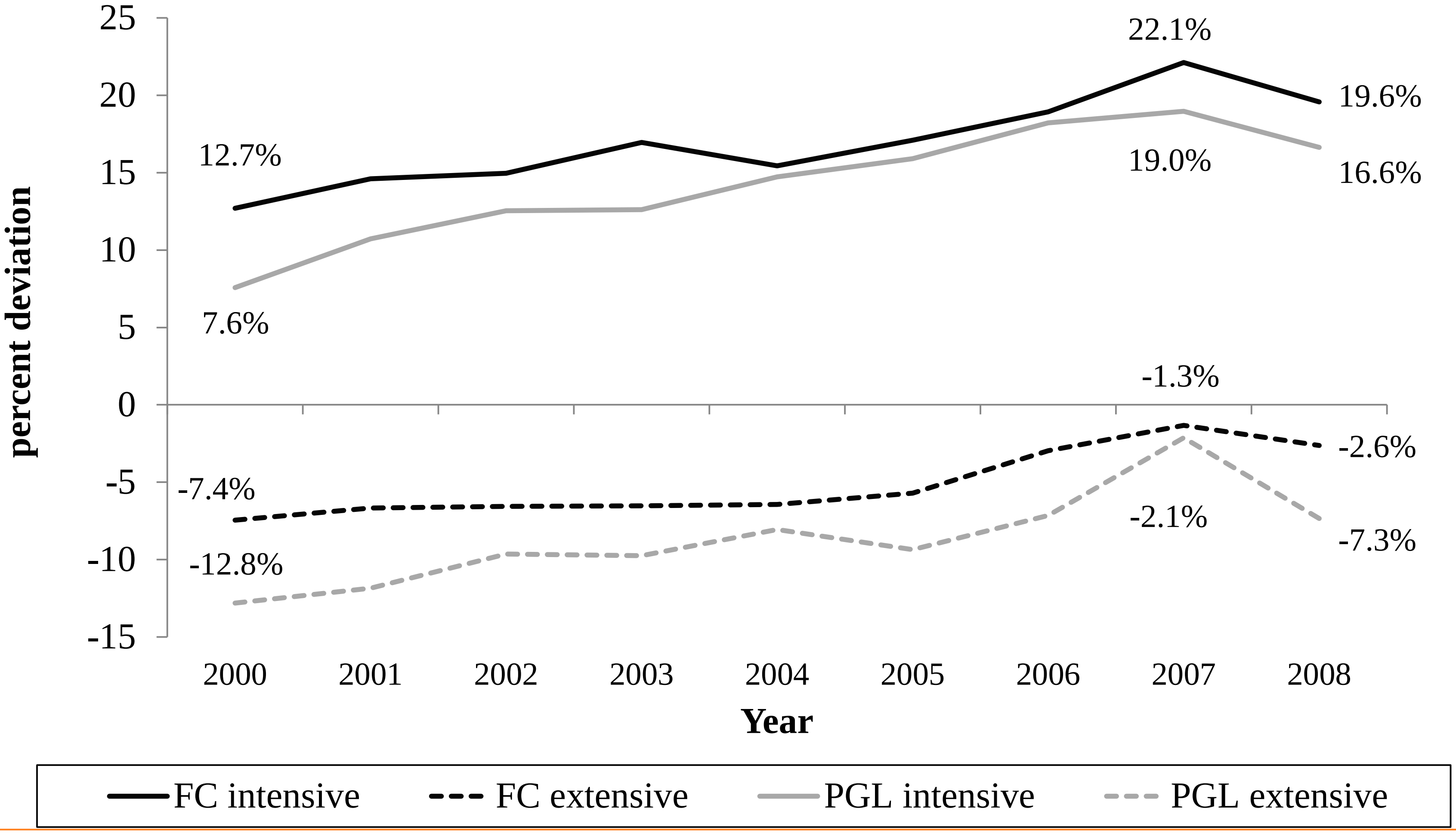
Results: Technical efficiency



	Fodder crop		Grassland	
	intensive	extensive	intensive	extensive
Mean	0.977	0.917	0.954	0.937
Max	0.989	0.988	0.991	0.989
Min	0.933	0.573	0.746	0.787

Results: Productivity

Percentage deviation of the groups total factor productivity (TFP) from the overall average TFP in the base year 2000.



Results: TFP change

Table 5. Malmquist index of total factor productivity (TFP) change for the 4 identified classes

	Fodder crop				Grassland			
	Intensive		Extensive		Intensive		Extensive	
Item[1]	ΔTFP[2]	Cumul.[3]	ΔTFP	Cumul.	ΔTFP	Cumul.	ΔTFP	Cumul.
Year		0.00		0.00		0.00		0.00
2000/2001	1.06	1.06	0.62	0.62	2.60	2.60	0.78	0.78
2001/2002	0.90	1.97	0.34	0.97	1.81	4.40	1.21	1.99
2002/2003	1.16	3.13	0.46	1.42	1.21	5.61	0.45	2.44
2003/2004	0.99	4.12	0.67	2.10	1.59	7.20	0.98	3.42
2004/2005	1.42	5.54	1.33	3.43	1.09	8.29	−0.24	3.19
2005/2006	1.41	6.95	1.73	5.16	1.05	9.34	0.83	4.01
2006/2007	1.58	8.53	1.74	6.90	0.55	9.89	1.26	5.28
2007/2008	1.37	9.90	0.83	7.73	−0.48	9.41	−1.06	4.22
	Average annual change rate (%)							
TFPC	1.24		0.97		1.18		0.53	
TC	1.27		1.10		1.18		0.66	
TEC	−0.01		−0.02		−0.03		−0.13	
SC	−0.03		−0.12		0.03		−0.01	

[1]TFPC = total factor productivity change; TC = technical change; TEC = technical efficiency; SC = scale change.
[2]ΔTFP = class average percentage TFP change between the indicated years.
[3]Cumul. = cumulative percentage TFP change.

Conclusions / Main results

- Intensive systems are more efficient and productive than their extensive counterparts
- Intensive grassland farms can keep up with fodder crop farms
- Extensive farms, (especially on grassland) fall behind
- Productivity gap between extensive and intensive increased in observed period

Discussion

- Alvarez and del Corral (2010): intensive systems are easier to manage and less prone to mistakes
  - TE higher and less dispersed
- In our data:
  - intensive farmers are better educated
  - have less veterinary expenditures
- Efficiency and productivity as a **question of management** (intensive/extensive) rather than natural conditions (grassland/fodder crops)
  - Stresses the importance of education and extension
  - This may question additional subsidies for PGL farms to some extent

Concluding remarks

- Future research questions
  - What are the environmental effects of these different production technologies?
  - Maybe trade-off between intensity and environmental benefits
    - Müller-Lindenlauf et al. (2010)
      - Intensive farms better for global externalities: climate impact, land demand
      - Extensive better for local externalities: animal welfare, ammonia, milk quality (biodiversity)

Thank you for your attention!