The convergence in cost efficiency of dairy farms in the UK

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Information about the cluster

- CLEANER COWS: Consequential Life Cycle Assessment of Environmental and Economic Effects of Dairy and Beef Consolidation and Intensification Pathways

- Collaboration between Cardiff University, Bangor University and Aberystwyth University.

- Cardiff University: Economic modelling

- Bangor University: Consequential Life Cycle Assessment

- Aberystwyth University: Animal husbandry and nutrition

Estimating Efficiency

- Parametric approach
  - Define the production functions
  - Stochastic Frontier Analysis
    - Cobb-Douglas functional form
    - Translog functional form

- Non-parametric approach
  - No functional form of production function needed
  - Data Envelopment Analysis

Cost Efficiency
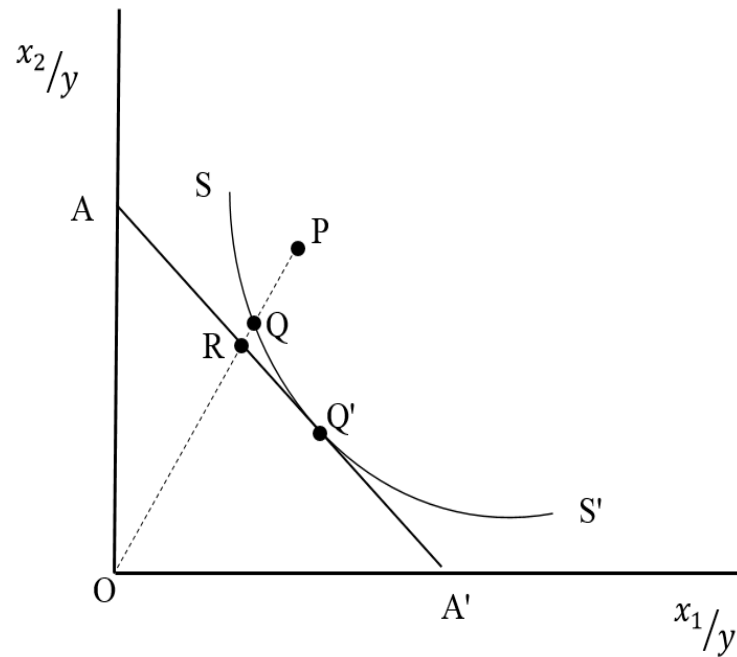
- Two input and one output model
- SS': frontier
- AA': slope of isocost line

$$TE = \frac{OQ}{OP}$$

$$CE = \frac{OR}{OP}$$

Farm Business Survey

- Annual Survey
- 1,750 farms in England and 550 farms in Wales
- Around 20% of these farms are specialized dairy farms
- Dairy cows age 2+ years and have borne at least a calf.
- Herd size ≥ 20 dairy cows

	2006	2008	2010	2012	2014	10 yr avg
UAA (ha)	140	142	140	140	138	140
COWS (qty)	121	133	135	139	147	135
LABOUR HOURS (hrs)	7,041	7,337	7,319	7,419	7,565	7,335
FEED (tonnes)	346	266	481	422	489	400
MILK PRODUCED (hl)	8,156	8,930	9,478	9,833	10,574	9,386
PRODUCTION COST PER MILK UNIT (£/hl)	30.2	32.7	39.4	36.9	36.5	35.2
INCOME PER MILK UNIT (£/hl)	23.7	29.6	27.6	29.6	31.6	28.4
GHG EMSISSONS (kg CO_2 eq/hl)	79	78	81	78	77	79
No of obs	885	921	939	900	860	4505

Data

- Inputs:
  - Number of cows
  - Labour Hours
 - Feed
- Output
  - Milk production

Results

- Less than 1% of dairy farms were cost efficient
- The efficiency score implied that the farms could potentially reduce their costs by 28% to 41% over the 10-year period

	Number of technically efficient farms	Average cost efficiency Score
2006	7	0.61
2008	9	0.59
2010	7	0.69
2012	8	0.61
2014	7	0.72

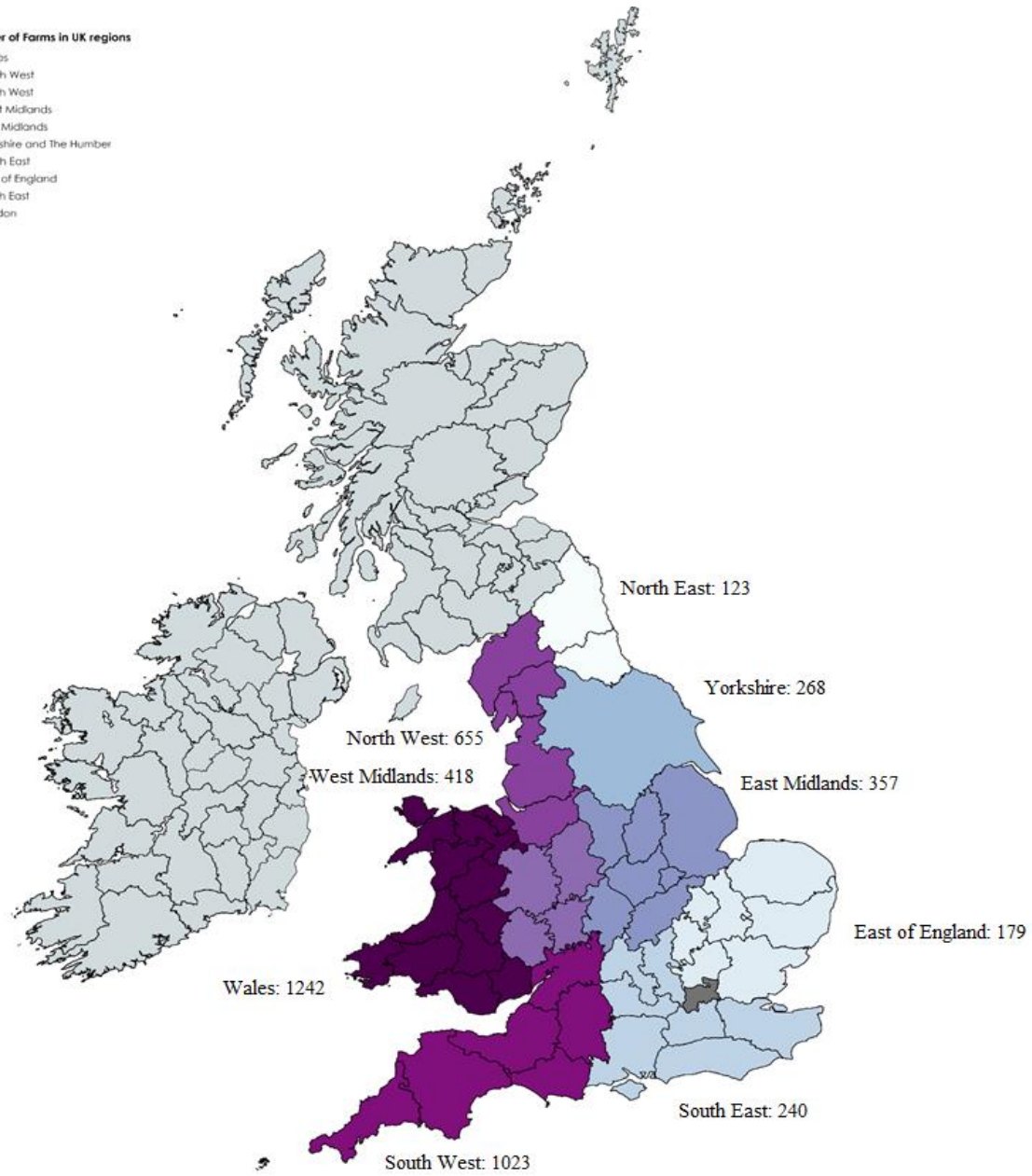|	CE <1		CE = 1			
	Mean	**SD**	**Mean**	**SD**	**P-value**	**Sig.**
UAA (ha/farm)	140	117	148	132	0.406	
Cows (cows/farm)	134	86	252	270	0.751	
Labour Hours (lh/farm)	7,316	3,860	9,550	8,248	0.970	
Feed (t/farm)	398	334	664	743	0.715	
Milk Produced (hl/farm)	9,292	6,572	20,487	18,492	0.007	***
Total production cost (£/farm)	293,562	190,002	489,528	454,445	0.242	
Total income (£/farm)	269,195	204,712	576,269	536,860	0.013	**
Milk yield (hl/cow)	67	16	98	56	0.000	***
Stocking Intensity (cows/ha)	1.19	0.63	1.51	0.67	0.001	***
Labour hours per cow (lh/cow)	64	34	69	64	0.145	
Feed per cow (t/cow)	2.93	1.42	2.77	2.54	0.058	*
Production cost per cow(£/cow)	2,243	610	2,599	1,991	0.129	
Total income per cow (£/cow)	1,918	558	2,707	1,628	0.000	***
Output input ratio (£)	0.88	0.25	1.1	0.25	0.000	***
GHG per hectolitre of milk (kgCO$_2$ eq/hl)	79	43	65	29	0.000	***

Note: *** denotes significance level <0.01 ,   ** denotes significance level <0.05   and   * denotes significance level <0.1

Distribution of cost efficiency scores
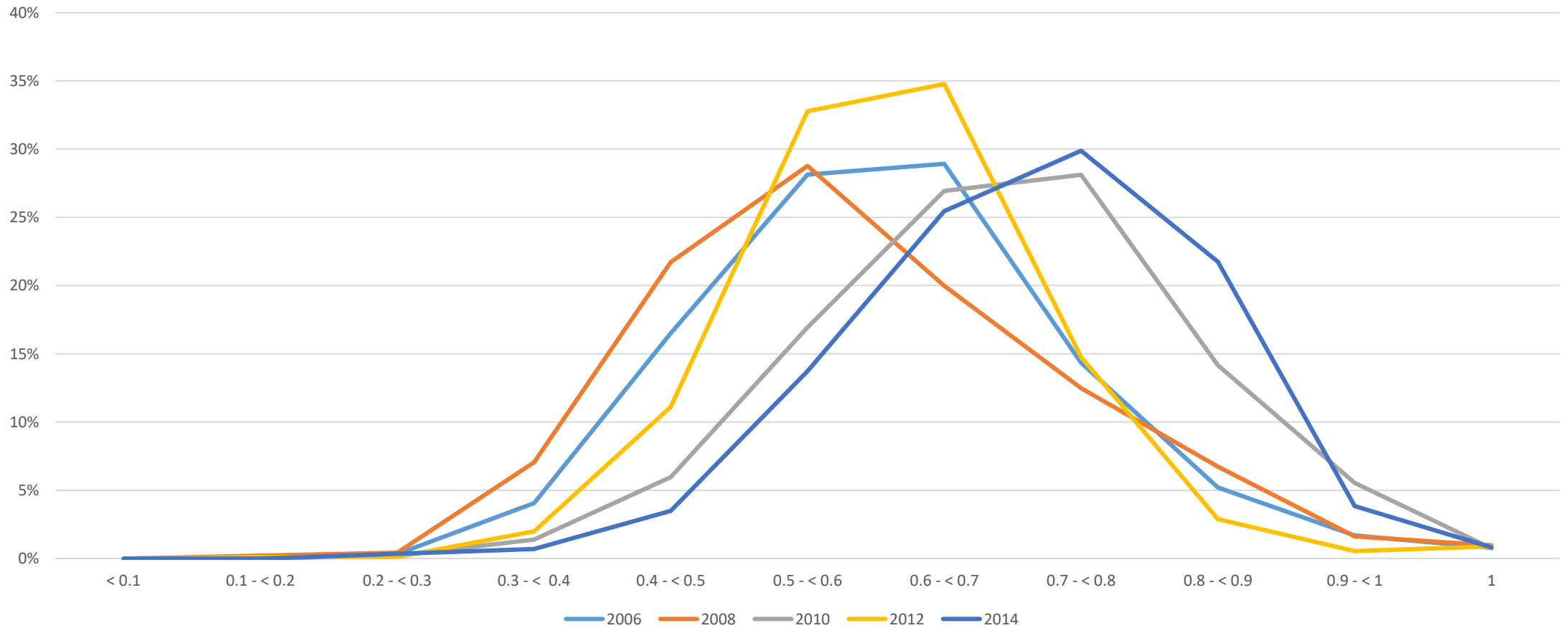
Number of Farms in UK regions

- Wales
- South West
- North West
- West Midlands
- East Midlands
- Yorkshire and The Humber
- South East
- East of England
- North East
- London

North East: 123

Yorkshire: 268

North West: 655

West Midlands: 418

East Midlands: 357

East of England: 179

Wales: 1242

South East: 240

South West: 1023

Convergence

- The β- convergence
  - used to test for the hypothesis that the regions with lower cost efficiency would have faster growth rates than the regions with higher cost efficiency.
  - Evaluates the catch-up effect

- The σ- convergence
  - used to determine whether the cost efficiency dispersion decreases over time

β- convergence

- Unconditional β- convergence

$$\Delta CES_{i,t} = \alpha + \beta CES_{i,t-1} + \lambda TREND_t + u_{i,t}$$

		β		λ		α		Adj. R²
2006-2014	Coefficient	-1.643	***	0.028	***	0.956	***	0.752
	Std. error	(0.163)		(0.006)		(0.100)		
2006-2008	Coefficient	-0.625				0.379		-0.108
	Std. error	(1.337)				(0.813)		
2008-2010	Coefficient	-1.282	***			0.851	***	0.894
	Std. error	(0.155)				(0.094)		
2010-2012	Coefficient	-0.327	*			0.147		0.266
	Std. error	(0.166)				(0.114)		
2012-2014	Coefficient	-0.138				0.186		-0.125
	Std. error	(0.419)				(0.255)		

Note: *** denotes significance level <0.01 , ** denotes significance level <0.05 and * denotes significance level <0.1

- Conditional β- convergence
- Included dummy for countries
- β : -1.600

Cost efficiency scores

	2006	2008	2010	2012	2014
North East	0.602	0.636	0.703	0.618	0.700
North West	0.611	0.648	0.686	0.609	0.724
Yorkshire	0.637	0.638	0.690	0.629	0.745
East Midlands	0.599	0.603	0.677	0.600	0.698
West Midlands	0.603	0.604	0.681	0.608	0.674
East of England	0.599	0.605	0.659	0.590	0.718
South East	0.609	0.614	0.666	0.579	0.690
South West	0.597	0.613	0.670	0.606	0.698
England (all)	0.605	0.620	0.677	0.606	0.705
Wales	0.612	0.500	0.730	0.632	0.745
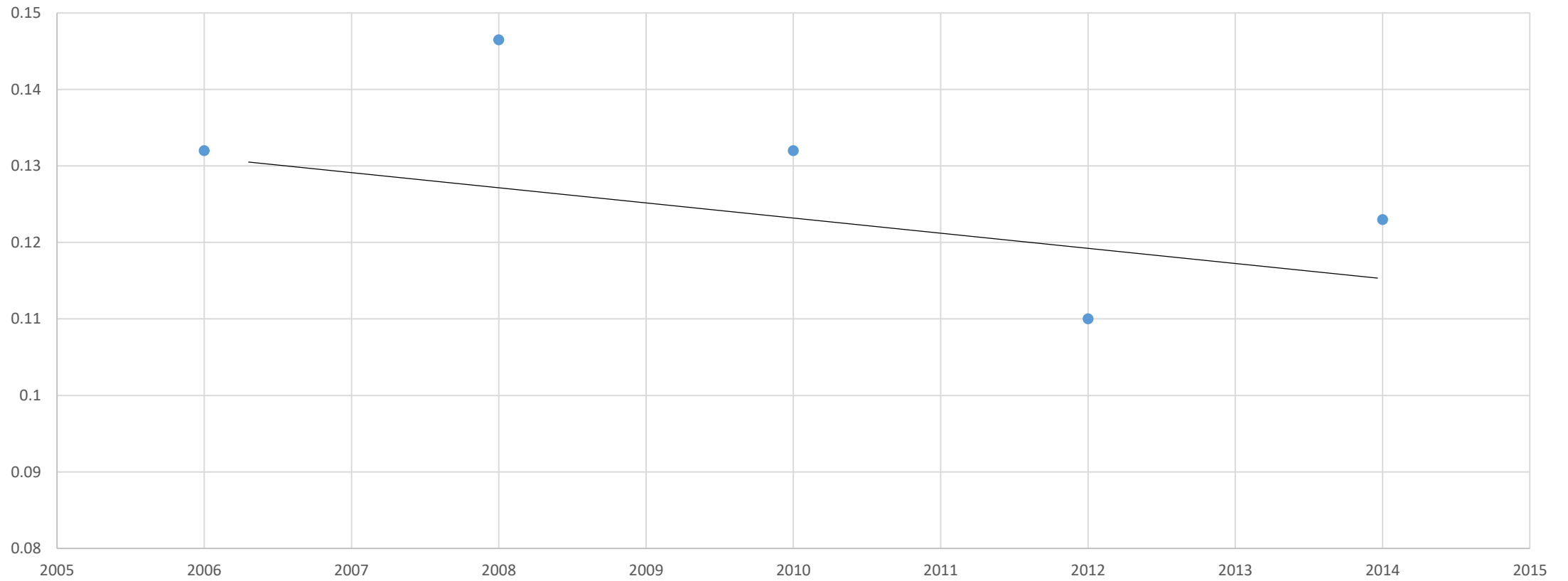
σ-Convergence

Conclusion

- Less than 1% of dairy farms are cost efficient

- Farms can potentially reduce their cost of production by 28-41%

- Dairy animals in cost efficient farms produce significantly more milk

- Presence of β- convergence and σ-Convergence