An Analysis of the Cost Efficiency of Farms in Scotland 1989-2008

Cesar Revoredo-Giha, Philip Leat and Catherine Milne

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Outline of the presentation

1. Background
2. Significance for Scotland
3. Research questions
4. Empirical work
    a. Data used
    b. Methods
    c. Results
5. Conclusions

Background

- This paper derives from work for the Scottish Government - Rural and Environment Research and Analysis Directorate and for the UK Department of Environment Food and Rural Affairs.
- It is a follow up from a previous work analysing the impact of the reform of the Common Agricultural Policy for Scotland (Revoredo-Giha et al, 2009).
- Previous work was based on an panel dataset for 1997 to 2003 from Scotland's Farm Accounts Scheme Survey and analysed cost efficiency of farms using a fixed effects estimator and two stages approach.

Background

- Results showed dispersion in efficiency amongst farms and scope for improvement.
- We could not identify the same variable ‘explaining’ cost efficiency for all the farm types. Their sign and significance changed across farm types. Difficult to identify a strategy for all the farms.
- Also the analysis showed a negative relationship between cost efficiency and farm size for dairy, cattle and sheep and specialist sheep farms.

Significance for Scotland

- Interest from the Scottish Government side on keeping track on the evolution of farmers’ efficiency in Scotland.
- This is associated to two aspects that figure prominently in Scotland’s National Food Policy framework (‘Recipe for Success’): (1) ensure growth in the supply of food towards food security and (2) increase the competitiveness of the food supply chain.
- In addition, there is interest in how farmers are reacting to the introduction of decoupled payments under the reform of the Common Agricultural Policy (CAP).

Research questions

- This paper reflects research in progress using a larger sample from the Farm Accounts Scheme survey.

Questions:

- What is the evolution of the average cost efficiency by farm type? Is it possible to identify any trend or structural change?
- What is the dispersion of the cost efficiency by farm type.
- How variable is the relative position of the farms over time? and by farm type (i.e., are there farms that are always the most efficient and others that are the least efficient?)

Empirical work - data

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- The data used to estimate the cost functions were from the Farm Accounts Scheme (FAS) survey, which annually records a wide range of financial and non-financial data for a selection of full-time farms across Scotland.
- The data used cover the 19 year period from 1989 to 2008.
- After cleaning the dataset for incomplete data, this resulted in an unbalanced panel dataset for 1,089 individual farms and 10,245 observations.
- The survey presents information for the following farm types: cereal specialist, general cropping, dairy, LFA specialist sheep, LFA cattle, LFA cattle and sheep, lowland cattle and sheep and mixed farms.

Empirical work - data

- Costs and outputs by farm type were computed directly from the FAS data.
- Costs were allocated to one of five groups:
  - **materials** (e.g., seed, fertiliser, feed);
  - **energy** (e.g., fuel use, electricity);
  - **labour** (e.g., all labour used including that of the farmer, farm family, business partners and hired workers);
  - **land** ;
  - **capital** (e.g., machinery).
- Two aggregated outputs: output from **crops** and outputs from **livestock**, both were deflated using Defra's output price indices.

Empirical work - data

- The FAS survey does not report input prices only their expenditure.
- The advantage of working with a panel dataset is that it is possible to introduce prices by assuming that those in the sample change over time but not across farms.
- We used Defra's input price data for the UK for materials, energy and capital.
- The land and labour input prices were estimated from FAS data.

Empirical work -methods

- The cost efficiency indicators were estimated assuming that the inefficiency term followed a half normal distribution.
- The cost function used was the generalised multiproduct translog cost function (Caves, Christensen and Tretheway, 1980) using directly the outputs instead of transforming the output using a Box-Cox transformation (a hybrid between a translog and a quadratic cost function).
- Also the cost functions considered trend terms (linear and quadratic) to account for gains in productivity.

Empirical work - methods

- Having estimated the model by MLE, cost efficiency indicators and confidence intervals were constructed.
- We also constructed coefficients of variation per year in order to observe the dispersion of efficiency over time.
- To study how fluctuating is the relative performance of farms in terms of their cost efficiency, presents the problem that we cannot observe all the farms in all of the years.
- Then, comparisons were made for farms observed in consecutive years.
- Each farm was classified according to their relative position during the year (tertiles) and then the dynamics were studied by constructing ‘transition’ matrices.

Empirical work - methods

- Transition matrix

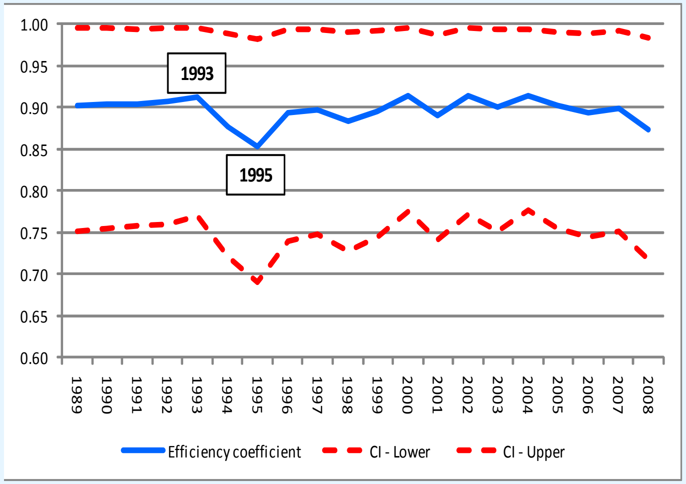
		1990		
		1	2	3
1989	1	7	4	0
	2	2	5	3
	3	1	1	8

Green = improvement in the relative position, yellow = remains in the same relative position and orange = decrease in the relative position.

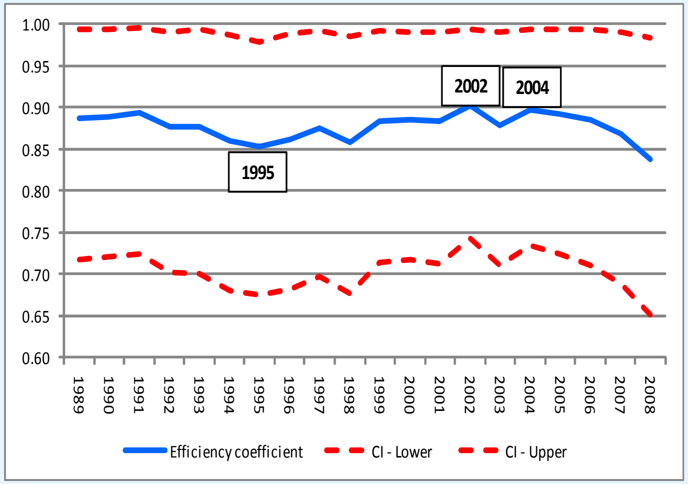
Empirical work - results

Evolution of cost efficiency 1989-2008

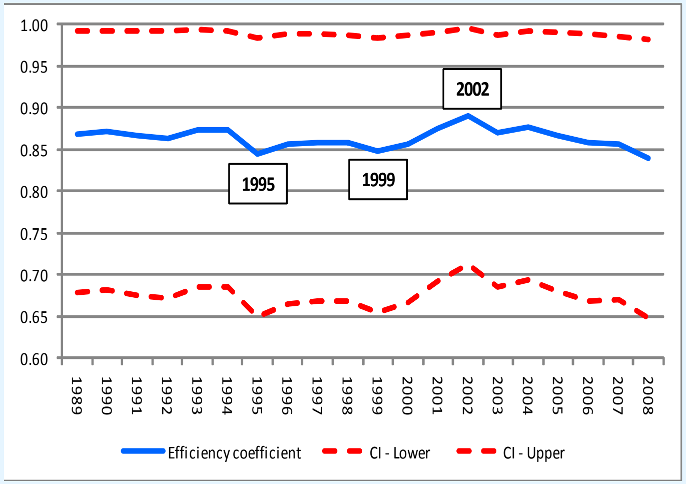
Cereals



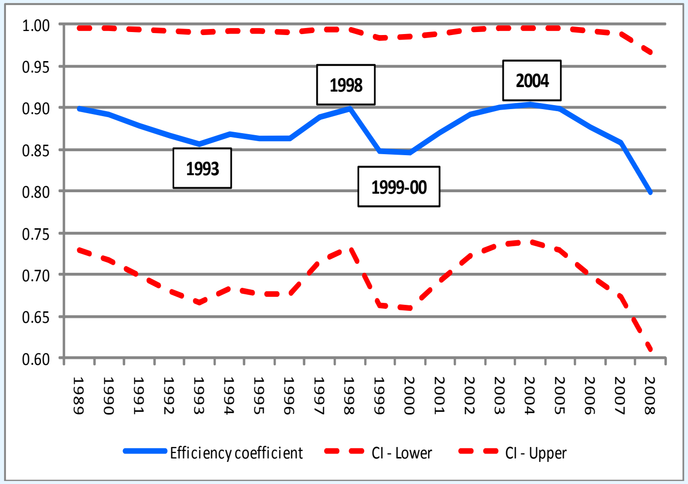
General cropping



Dairy



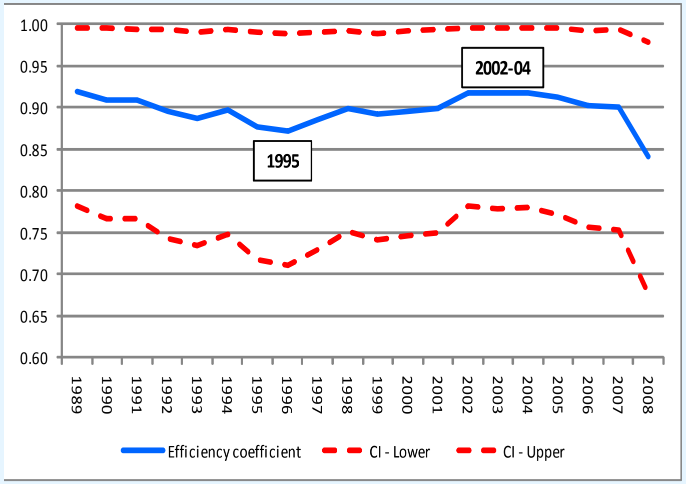
LFA Specialist Sheep



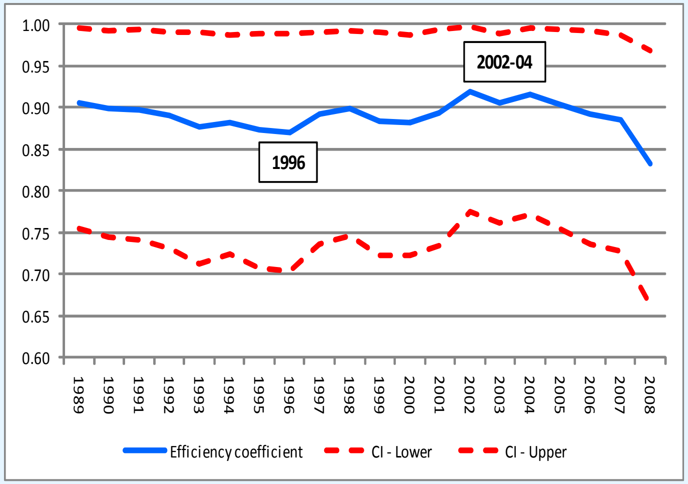
The series show trends that are not that different. 1995-06 and 2002-04 look like break points. Acceleration of decline after 2004 in livestock sectors.

Evolution of cost efficiency 1989-2008

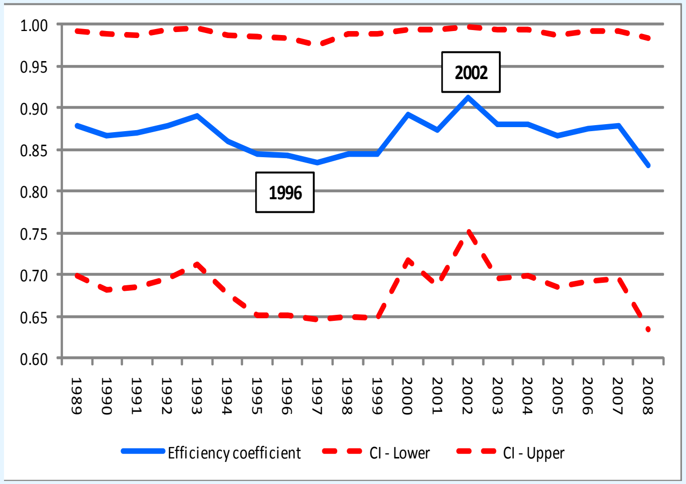
LFA Cattle



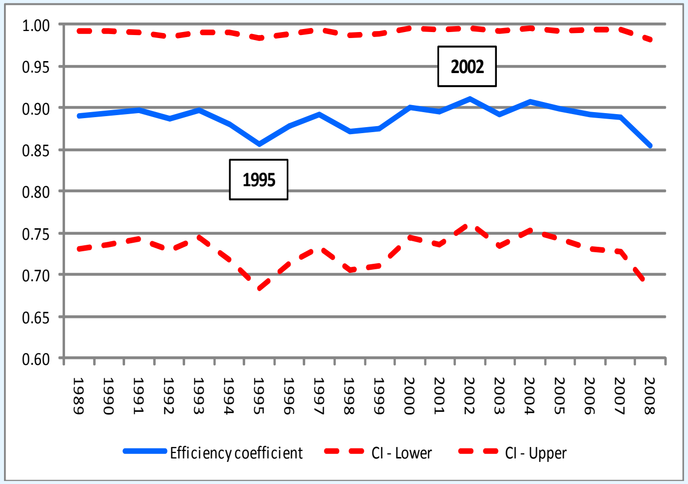
LFA Cattle and Sheep



Lowland Cattle and Sheep



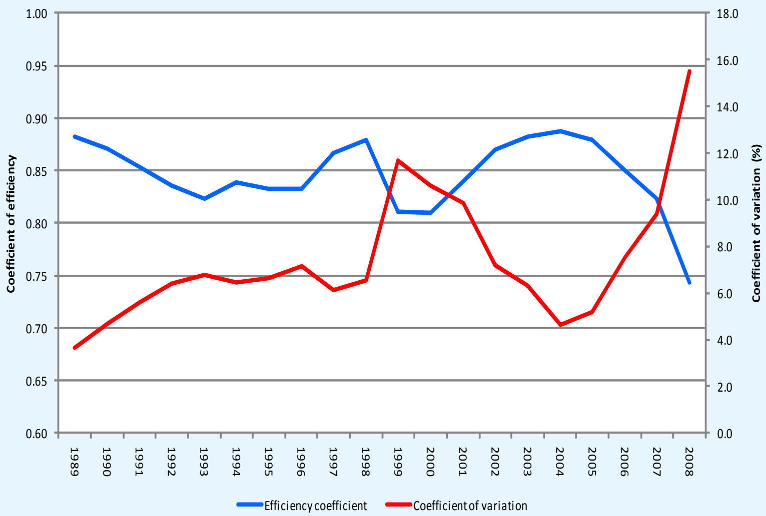
Mixed farms



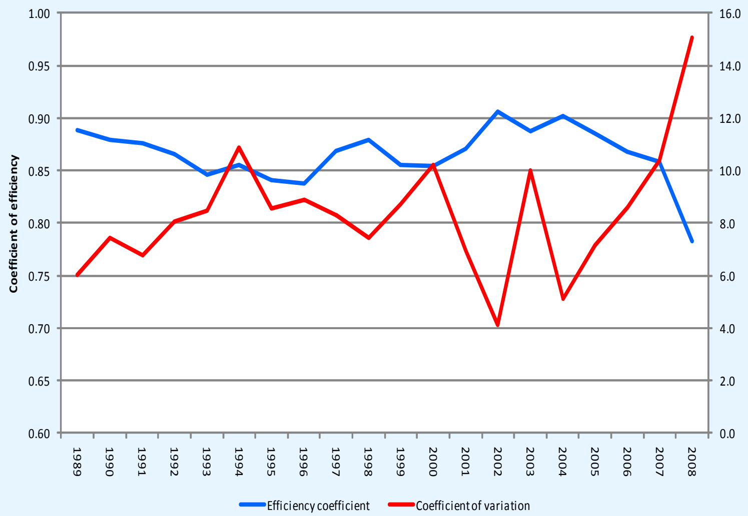
The decline in efficiency in livestock sectors is consistent with the contraction in the number of animals.

Dispersion and cost efficiency 1989-2008

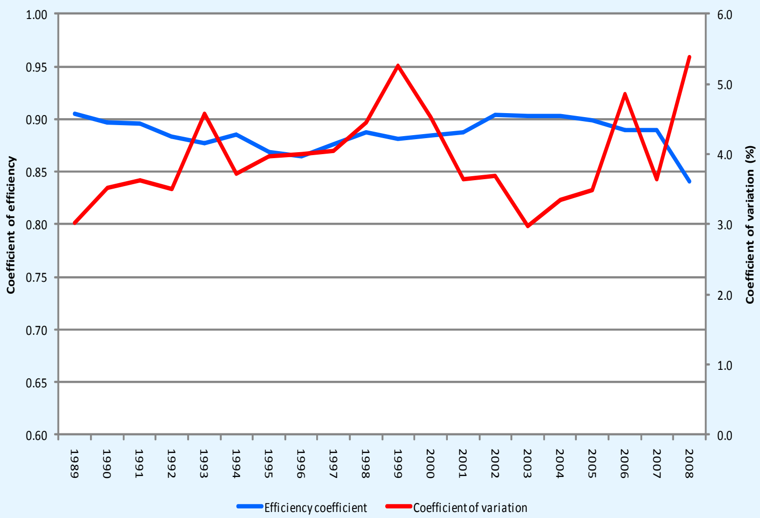
LFA specialist sheep



LFA cattle and sheep

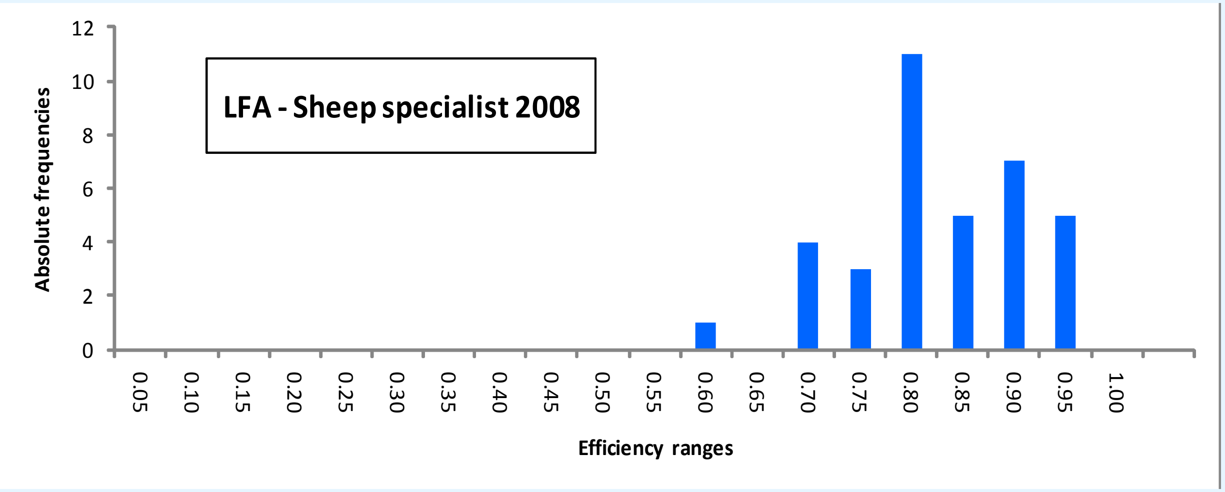


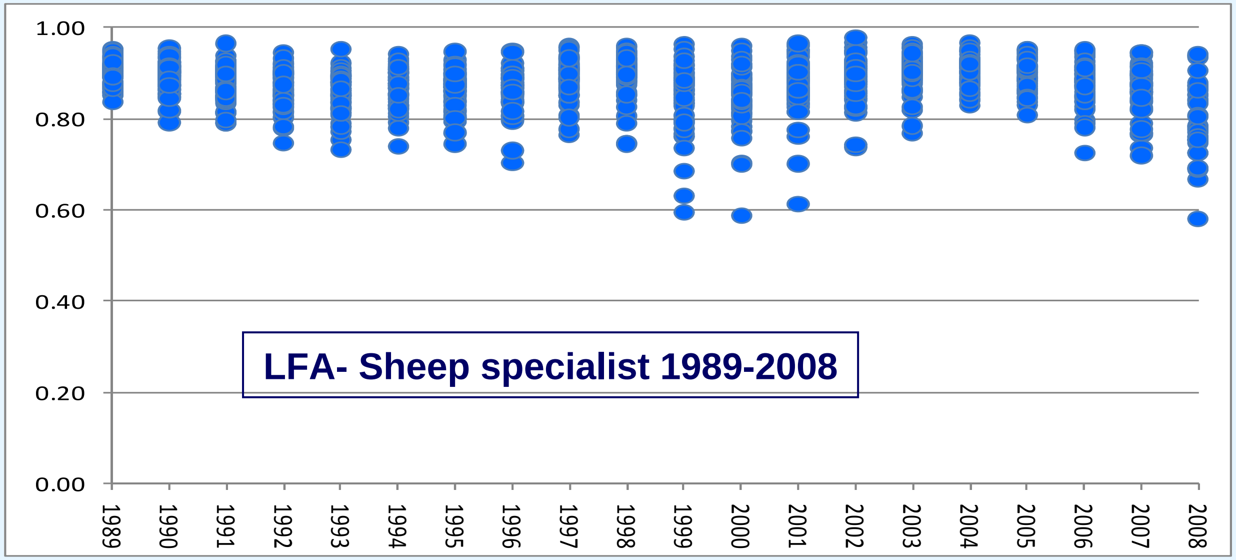
LFA cattle



- **Efficiency trend and dispersion go in opposite directions.**
- **No real explanation – maybe reform periods are accompanied with increases in the dispersion associated to the adjustment.**

Dispersion of cost efficiency

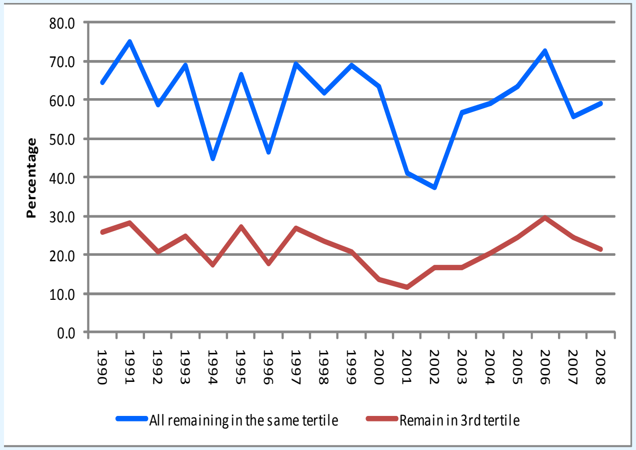




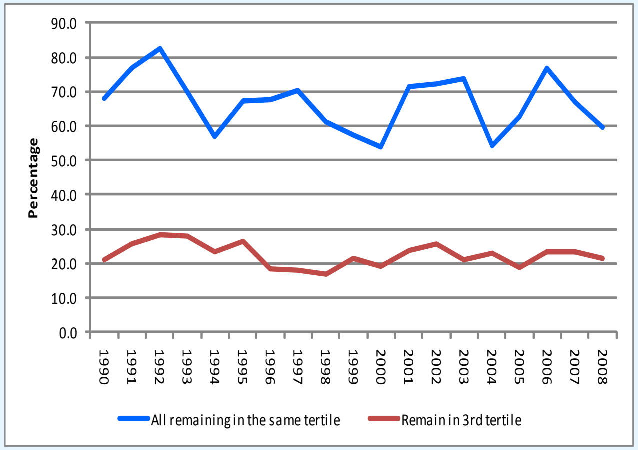
Dispersion in efficiency indicates that average efficiency could be improved by increasing that of lagging farmers, but are they always the same people?

How fluctuating is the relative position of farmers?

Cereals

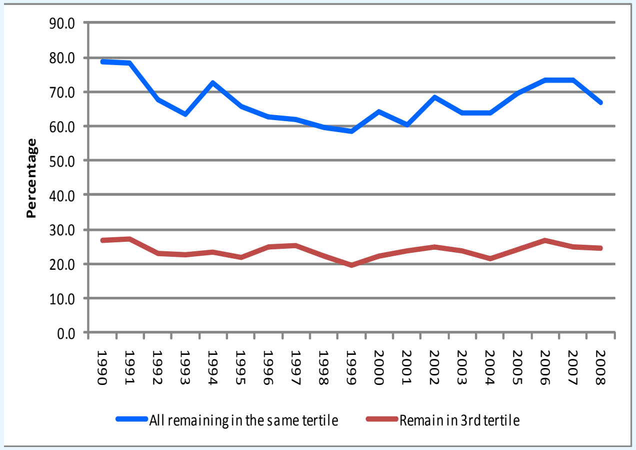


General cropping

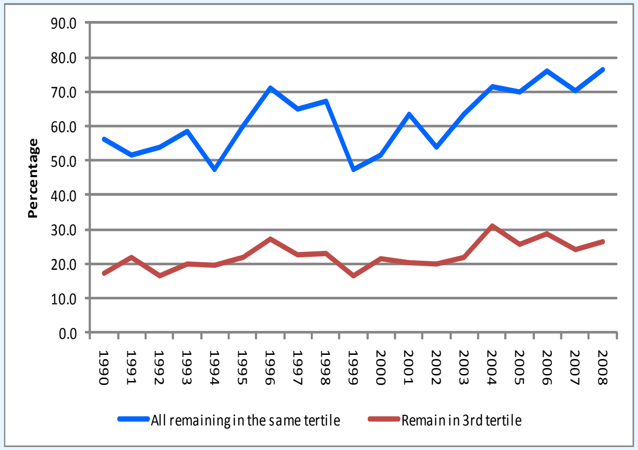


Figures show only the percentage of those that remain in the same position

Dairy



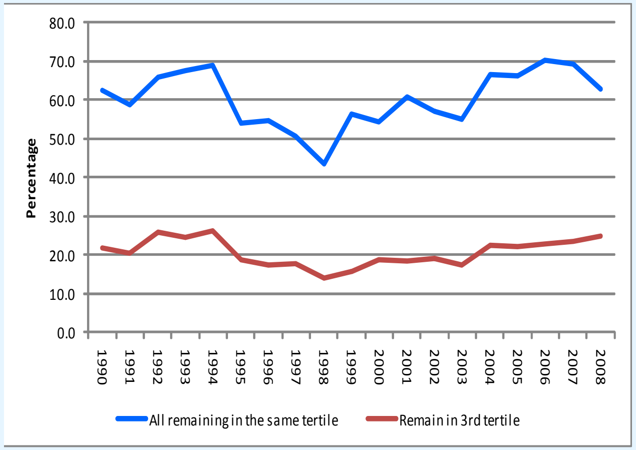
LFA Specialist Sheep



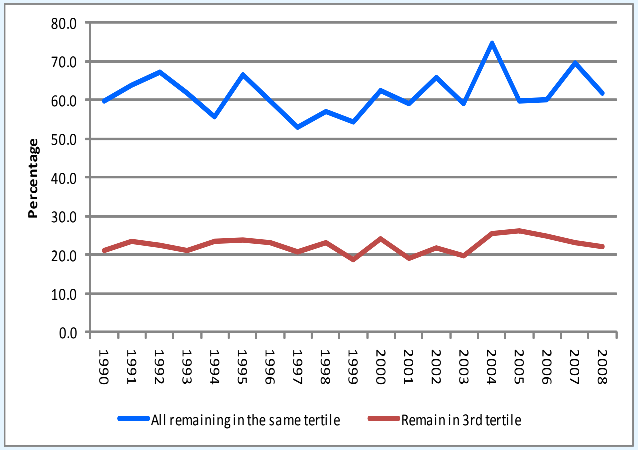
In general more than 50% of the cases considered remain in the same relative position.

How fluctuating is the relative position of farmers?

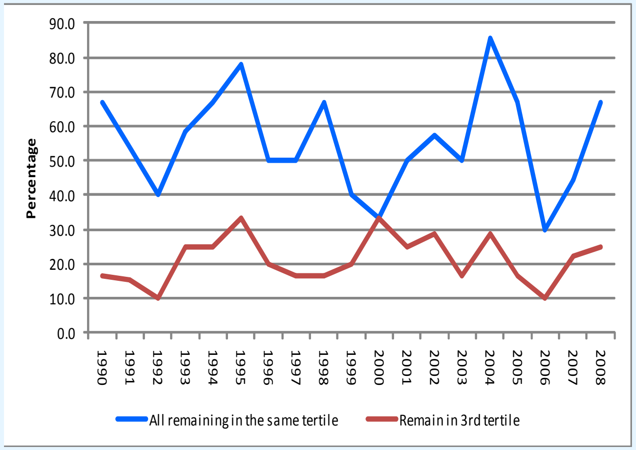
LFA Cattle



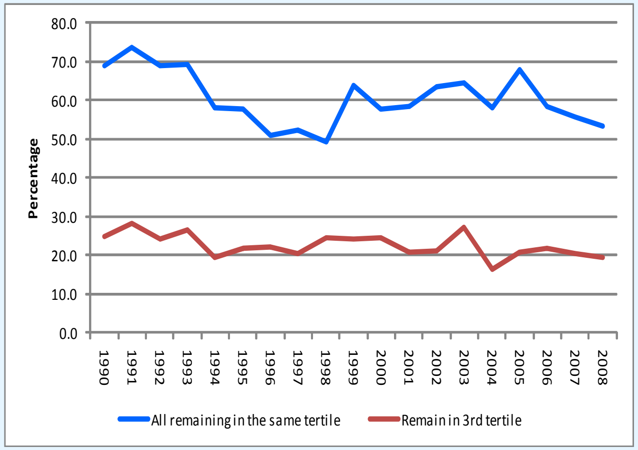
LFA Cattle and Sheep



Lowland Cattle and Sheep



Mixed farms



Though with fluctuations over time the percentage that remains in the lowest tertile moves between 20% to 30% of the cases.

Conclusions

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- Although with their own particular characteristics, the trends in cost efficiency seem similar amongst the farm types.
- The series seem to have a trough around 1993-96, a peak by 2002-04 and then decrease.
- This may indicate that the introduction of the SFP is not bringing, so far, greater efficiency.
- Also, there seems to be greater dispersion in efficiency during the aforementioned periods. A hypothesis to explore is whether this is due to adjustment to policies.
- As regards the mobility in terms of efficiency relative efficiency groups, more than 50% of the farms remain in the same group in two consecutive years.

Conclusions

- More important in terms of policy is that between 20% to 30% remain in the lowest tertile. This is probably the case for farms with resource constraints or a low level of commercial orientation, which is something found in Leat and Revoredo-Giha (2008) for cattle producers.
- To enquire about the differences between the top and bottom groups is the next stage of the research.

Additional material

Sample

Farm types	Number of observations
Cereals	866
General cropping	1,066
Dairy	1,494
LFA specialist sheep	1,176
LFA cattle	2,067
LFA cattle and sheep	1,890
Lowland cattle and sheep	244
Mixed farms	1,442
Total	10,245

Source: Scottish Government

Estimation of cost functions

- The cost function used to represent the cost part of the farm models was the generalised multiproduct translog cost function (Caves, Christensen and Tretheway, 1980).

$$\ln C(Q_{it}, W_{it}, \tau_t; \Omega) = \alpha_0 + \varphi_0 \tau_t + \varphi_0 {\tau_t}^2 + \sum_{j=1}^{n} \alpha_j \ln W_{jt} + \frac{1}{2} \sum_{j=1}^{n} \sum_{k=1}^{n} \beta_{jk} \ln W_{jt} \ln W_{kt}$$

$$+ \frac{1}{2} \sum_{j=1}^{m} \sum_{k=1}^{n} \delta_{jk} Q_{jit} \ln W_{kt} + \sum_{j=1}^{m} \gamma_j Q_{jit} + \frac{1}{2} \sum_{j=1}^{m} \sum_{k=1}^{m} \rho_{jk} Q_{jit} \cdot Q_{jit}$$

- The cost functions considered trend terms to account for gains in productivity.

Log-likelihood, efficiency estimator and confidence intervals

$$\ln L(y \mid \beta, \sigma, \lambda) = -\frac{N}{2}\ln\left(\frac{\pi\sigma^2}{2}\right) + \sum_{i=1}^{N} \ln \Phi\left(\frac{-\varepsilon_i \lambda}{\sigma}\right) - \frac{1}{2\sigma^2}\sum_{i=1}^{N} \varepsilon_i{}^2$$

$$CEI_i = \left[\Phi\left(\frac{u_i{}^*}{\sigma_*} - \sigma_*\right) \Big/ \Phi\left(\frac{u_i{}^*}{\sigma_*}\right)\right] \exp\left\{\frac{\sigma_*{}^2}{2} - u_i{}^*\right\} \qquad i = 1,\ldots,N$$

$$\exp\left(-u_i{}^* - \sigma_* \Phi^{-1}\left(\left(\frac{\alpha}{2}\right)\Phi\left(\frac{u_i{}^*}{\sigma_*}\right)\right)\right) < CEI_i < \exp\left(-u_i{}^* - \sigma_* \Phi^{-1}\left(\left(1 - \frac{\alpha}{2}\right)\Phi\left(\frac{u_i{}^*}{\sigma_*}\right)\right)\right) \qquad i = 1,\ldots,N$$

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Success through Knowledge