



Farm Efficiency and Structural Change

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Outline

- Review the concept of structural change
- Describe the measurement of efficiency
- Discuss modelling issues
- Present empirical application using data of Spanish dairy farms

Structural Change



Concept of Structural Change

- SC has to do with changes in the 'structure'

- Typical questions
 - What changes?
 - What drives the changes?

Research on Structural Change (I)



- Study the evolution of observed variables
 - Number of farms
 - Farm Size
 - Size distribution of farms

 - Other:
 - Output mix
 - Specialisation
 - Property

Comment



- How to interpret trends in the number of farms?
 - The decline in the number of dairy farms is of limited relevance by itself since we don't know if they quit farming or switched to a different activity (meat)
 - Number of farms is different from number of farmers
 - In order to be able to 'fully' interpret trends in key variables (equilibrium), we need to know something about the stability of 'structural parameters'



Research on Structural Change (II)

- What drives structural change?
 - External to the farm
 - Farm Policy
 - Technology
 - Market conditions (prices)

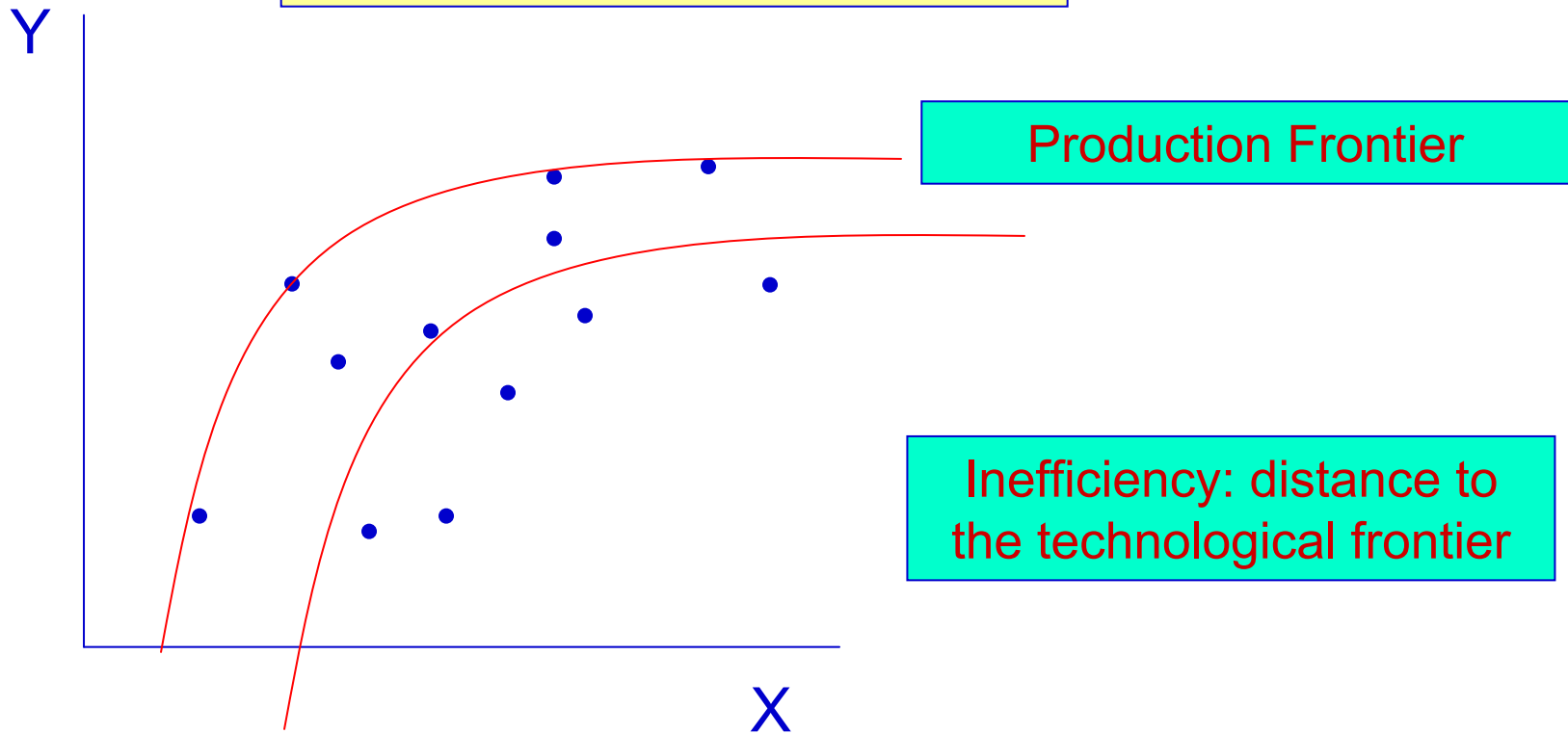
 - Internal to the farm
 - Farmer characteristics: Age, Education
 - Farm Efficiency
 - What is the direction of causation?
 - What happens if both directions are possible?

Productive Efficiency

Technical Efficiency (I)



Concept of Efficiency





Technical Efficiency (II)

Frontier Models

Deterministic Frontiers

$$Y = f(x) - u ; u \geq 0$$

Stochastic Frontiers

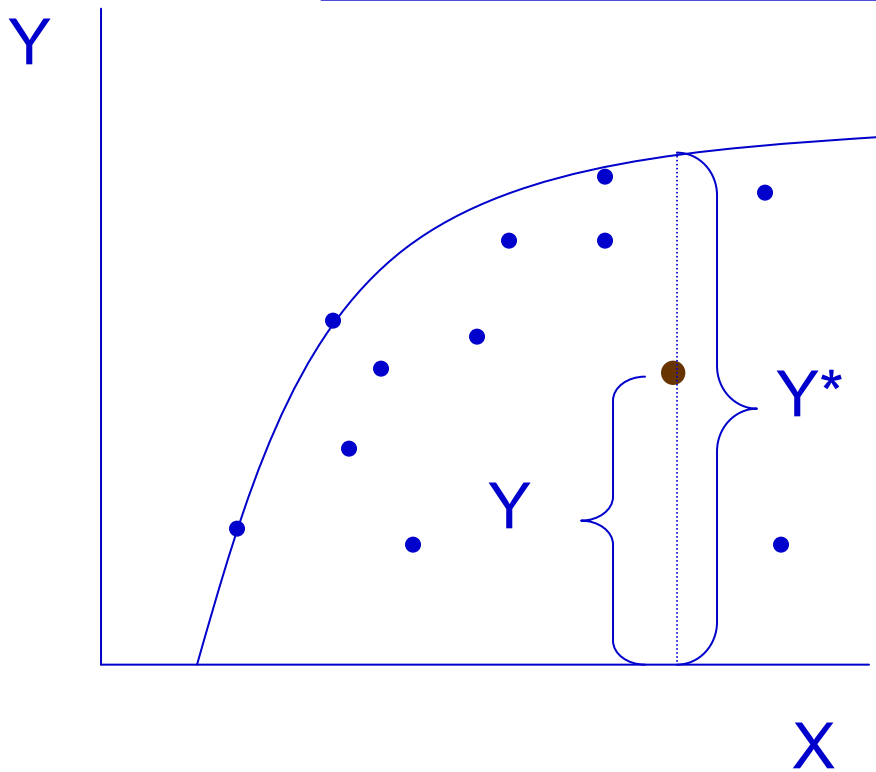
$$Y = f(x) + v - u ; u \geq 0$$

- U is inefficiency
- V is statistical noise



Technical Efficiency (III)

Efficiency Measurement



$$TE = \frac{Y}{Y^*}$$



Modelling Inefficiency

- Stochastic Frontier Model

$$y_{it} = \alpha + \beta x_{it} + v_{it} - u_{it}$$

- U_{it} is (time-varying) technical inefficiency

Modelling Issues

Structural Change in Demand (I)



- Well established field of analysis

- Preferences are not stable over time
 - Health concerns, demographic changes...

- Modelling
 - Theory: Change in the utility function
 - Empirics: Demand function with time-varying coefficients

Structural Change in Demand (II)



- In demand analysis, SC is not associated with changes in the number of consumers or in 'per capita' consumption
- 'Structure' is associated with 'structural parameters' in a model
 - Therefore, Structural Change is identified through changes in the parameters



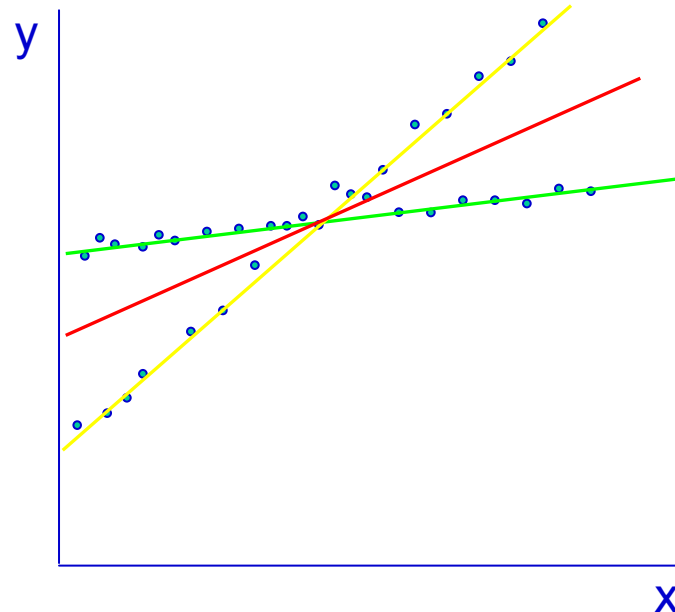
SC in Production Parameters

- An alternative topic of interest for the analysis of SC in production is the switch of technology
- This is different from Technical Change
- By switch of technology I mean switching between alternative ways of production which already exist
 - Extensive vs intensive production systems



Different technologies

- If some firms use different technologies, the estimation of a single production function may generate biased estimates





Different Technologies

- Empirical work in this area aims to identify different technologies and also a mechanism to move between them

- Methods to estimate different technologies
 - Split the sample using a priori information and estimate different functions for each group
 - Examples: Location, Breed, ...
 - Econometric procedures
 - Random Coefficient Models
 - Local Maximum Likelihood
 - Latent Class Models



Latent Class Models

$$y_{it} = \alpha_j + \beta_j x_{it} + v_{it|j}$$

- LCM assume that there are a number of finite structures underlying the data

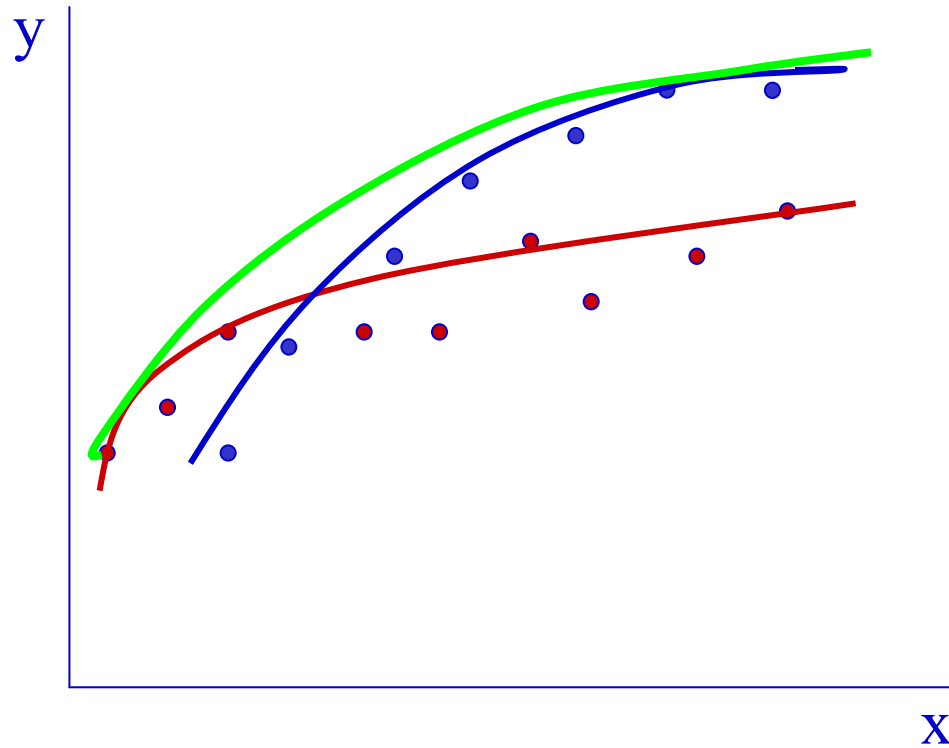


Interesting Questions (I)

- Are there different technologies in the sample?
- What implications follow from the existence of different technologies?
- What technology is used more efficiently?
- Model: Latent Class Stochastic Frontier

$$y_{it} = \alpha_j + \beta_j x_{it} + v_{it|j} - u_{it|j}$$

Efficiency of Different Groups





Latent Class Stochastic Frontiers

■ Model

$$\ln y_{it} = f(x_{it})|_j + v_{it}|_j - u_{it}|_j$$

■ Likelihood function

$$\log LF = \sum_{i=1}^N \log \left(\sum_{j=1}^J P_{ij} \prod_{t=1}^T LF_{ijt} \right)$$

■ Probabilities

$$P_{ij} = \frac{\exp(\delta_j q_i)}{\sum_{j=1}^J \exp(\delta_j q_i)}$$

■ Number of classes is unknown



Interesting Questions (II)

- Doable, but ...
 - Do many farms switch technology over time?
 - How does a change in some exogenous variable (policy) affect technology choice?
 - Both questions imply a model where the probabilities of class membership vary over time
 - Cannot be answered in the framework of a panel SF LCM
 - Split the sample
 - Pooled LCM



Interesting Questions (III)

- Not doable
 - Does efficiency alter the choice of technology?
 - Can we detect 'misplaced' farmers?
 - Farmers who would perform better (more efficiently) under the other technology
 - Hint: Least efficient farmers in each technology are good candidates to switch



Identification problem

- Sometimes we can ask complicated questions that require estimation of (too) flexible models
 - But even if estimation is possible one must wonder about identification problems

- We are interested in several effects
 - Technical change
 - Structural Change (shift between technologies)
 - Efficiency change

- It may be difficult to disentangle the effects
 - To identify EC we need to determine the frontiers. But the firms that determine each frontier depend on the probability of belonging to each group

Structural Change in the Dairy Sector



Objective

- Analyse the main stylized fact of Structural Change in the dairy sector: FARM GROWTH

- Dairy Farming in Europe
 - Large reduction in the number of farms
 - 50% reduction during 2000-2008

 - Quota system since 1984
 - To be abolished in 2015

 - Farms have grown
 - Average quota almost doubled in last seven years



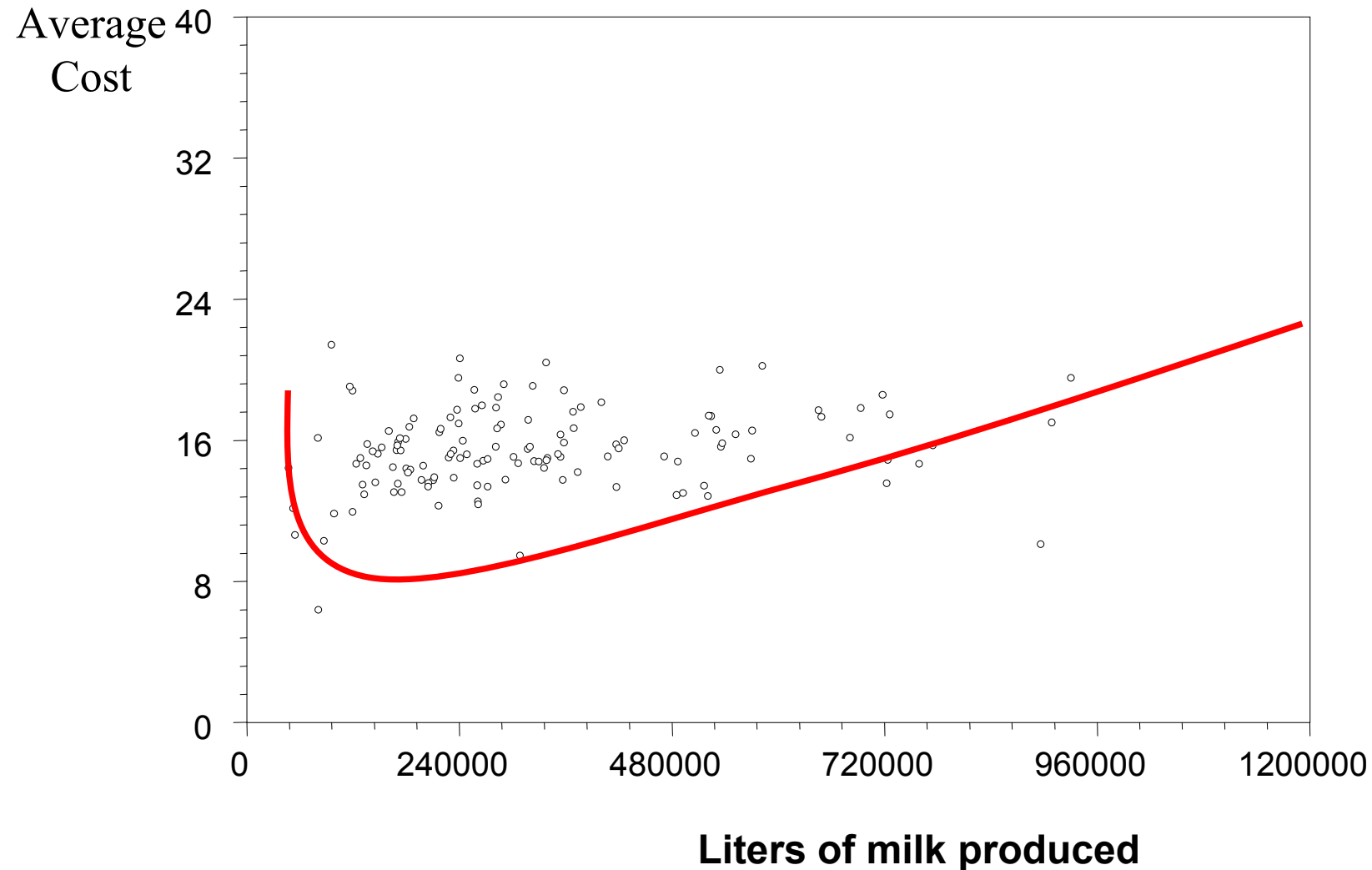
Why do farms grow?

- Some possible answers
- The most commonly used
 - Economies of scale

However...



There are diseconomies of size!!!



Then...



- Why farms grow despite the fact that
 - Real price of milk is going down
 - Prices of main inputs are going up
 - There are no economies of scale

- What's left that can explain farm growth?
 - Technical change
 - Increase in efficiency (Jovanovic)
 - Switch between existing technologies



Objectives

- Has efficiency increased during the sample period?
- Are there different technologies in the sample?
- What are the differences in technical characteristics between groups?
- Which technology is being used more efficiently?

Data



■ Panel data set

- 178 dairy farms
- 9 years (1999-2007)

■ Output

- Milk (litres)

■ Inputs

- Cows, Feed (kg.), labour, crop expenses (€), animal expenses (€)



Empirical Model (I)

- Translog stochastic production frontier

- Control variables
 - Time dummies
 - Location dummies

- Separating variables
 - Cows per hectare of land
 - Feed per cow



Empirical Model (II)

- Two specifications
 - Stochastic Frontier with inefficiency effects
 - Latent Class Stochastic Frontier Model

Inefficiency Model



$$u_{it} = g(z_{it}, \delta) \cdot u_i = \exp(\delta' z_{it}) \cdot u_i \quad , \quad u_i \geq 0$$

- Explanatory variables of inefficiency
 - Size
 - Time
 - Farm characteristics



Estimation – SF (inefficiency effects)

Explanatory Variables of Inefficiency	Coef.
Constant	-3.656***
Cows	0.023***
Time	0.069*
Free Stall	- 0.965***
Grazing	- 0.975**
Plot size	-0.056***

*, **, *** indicate significance at the 10%, 5% and 1% levels



Estimation results - LCM

Elasticities at the sample mean

	Intensive Group	Extensive Group
Cows	0.632***	0.364***
Feed	0.328***	0.405***
Labour	0.047***	0.074***
Crop Expenses	0.060***	0.120***
Animal Expenses	0.028***	0.086***

*, **, *** indicate significance at the 10%, 5% and 1% levels

Characteristics of the Systems



	Extensive	Intensive
Milk (litres)	270,130	340,395
Cows	39	40
Land (ha.)	18	18
Milk per hectare	15,588	18,013
Cows per hectare	2.10	2.45
Milk per cow	6,522	7,930
Feed per cow	3,239	3,747

Scale Elasticity in the LCM



Extensive	Intensive
0.945	1.052

- Intensive farms have higher scale elasticity
- This result helps to explain why farms grow despite the decline in the price of milk

Technical Efficiency



	Extensive	Intensive
LCM	0.946	0.967

- Intensive farms have higher technical efficiency than extensive farms
 - This means that they are located closer to their frontier than the extensive ones are to theirs
- This can imply that intensive technologies are easier to manage



Conclusions

- Studying Structural Change as a shift between technologies is an interesting aspect of Structural Change
- Some new techniques provide an interesting framework to control for technological heterogeneity
 - Latent Class Models



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