

Intra Firm Diffusion of Wind Turbines

Liz Hooper

Centre for Competition Policy, UEA

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Outline

1 Motivation

- Transition to a low carbon economy demands technological change
- We don't know much about how complex process technologies diffuse within firms

2 Patterns of diffusion of wind turbines

- The big picture
- Inter firm adoption path
- Comparison with other technologies
- Intra firm diffusion of wind turbines

3 Econometric analysis of intra firm diffusion

- Data
- The model
- Results

Utilities plan to make large investments in generation capacity (PwC 2009)

- Risk of supply gap in EU
 - ▶ Low investment in generation capacity
 - ▶ Rising demand
 - ▶ Scheduled retirement (DE Nuclear Phase Out, LPD)

- Which technologies will utilities invest in?

Objectives of the research

- Map the characteristics of leading generating companies onto a particular intensity of use of wind turbines - explore characteristics likely to be associated with intensive use
- Generate a detailed picture of the diffusion of wind turbines by firm rather than by country - firms make the investments

Defining diffusion

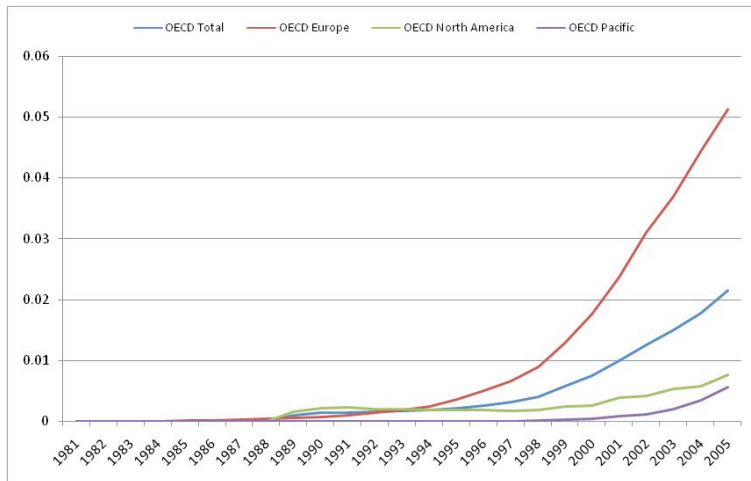
- **Overall** diffusion is the product of inter firm diffusion and intra firm diffusion
- A firm becomes an **adopter** the year they first report producing power from wind
- **Inter** firm diffusion is the proportion of firms that have adopted the technology
- **Intra** firm diffusion is the proportion of wind in a firm's total capacity

The speed of inter firm diffusion varies widely, but what of intra firm diffusion?

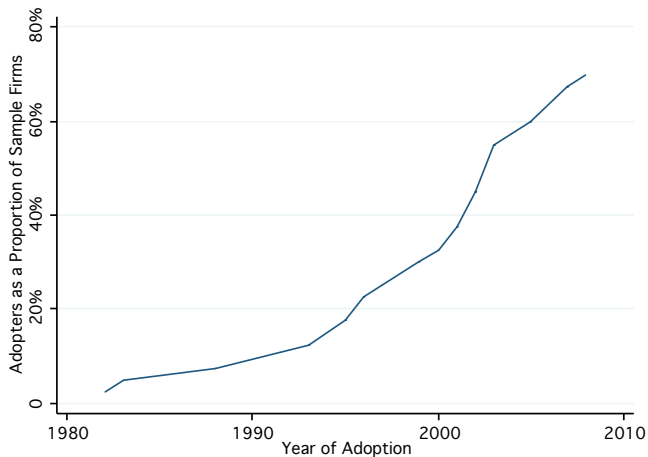
- Some firms adopt the new technology early, while others wait a considerable number of years
 - ▶ Spread of knowledge - epidemic analogy (Mansfield 1963)
 - ▶ Expected profitability (Davies 1979) - cost reductions, firm heterogeneity
- Is technology transfer *within* firms influenced by the same factors?
 - ▶ Stylised facts of intra firm diffusion (Battisti & Stoneman 2003)
 - ★ Time path of adoption within firms similar to between firms
 - ★ Firms follow different intensification paths
 - ★ Different technologies exhibit different paths
- The literature is ambiguous

Overall diffusion of wind turbines in 2005 is very low.

Source: OECD



Around 50% of firms had adopted after 20 years; 70% by 26 years



How does 50% in 20 years compare with other technologies?

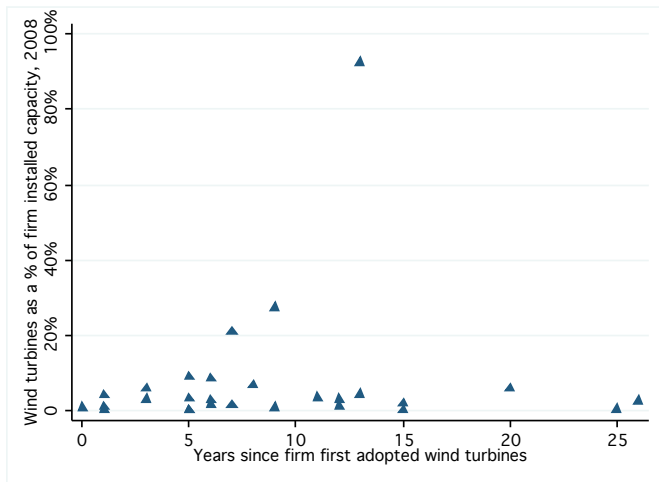
Time to reach 50% (Mansfield 1989)

- 12 years Industrial robots
- 9 years Diesel locomotives
- 15 years By-product coke oven

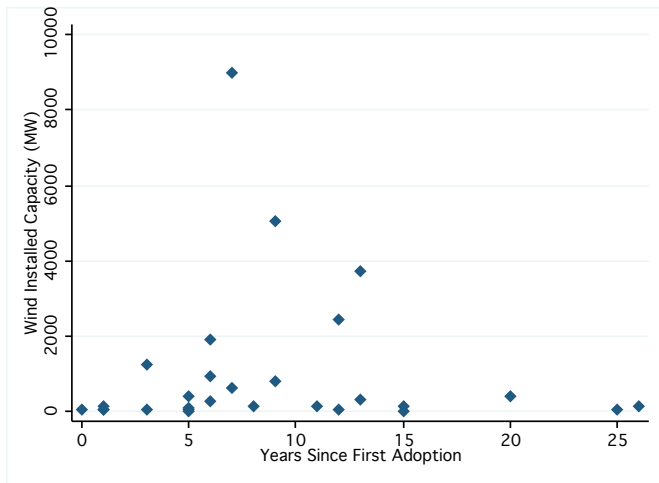
22 years for Computer Numerically Controlled Tools to get to 83% (Battisti & Stoneman 2003)

Inter firm adoption of wind turbines is slow relative to comparators

On average wind accounts for 5% of firm's capacity mix 26 years after first firm adopted...



Focussing on technology transfer within the firm. No clear relationship between the size of firm's wind capacity & years experience



A small number of firms dominate the industry at the EU level

- The sample
 - ▶ Leading firms - among 5 largest gencos in home member state
 - ▶ N = 40
- An adopter is a sample firm that has reported producing power from wind since first firm in sample did so(2002)
- Cross section for 2008, collected from firm annual reports, websites and correspondence

Econometric specification

- Dependent variable *INTENSITY* - proportion wind as % firm total capacity (low, basic, intense)
- Estimating equation

$$INTENSITY = f(SIZE, CR2, MNAT, M\&A, R\&D, WAITYEARS)$$

- Econometric approach
 - ▶ Ordered probit (ordinal dependent variable)
 - ▶ General to specific variable selection based on literature, goodness of fit and AIC

	(1)	(2)	(3)
SIZE (GW)	-0.516 (0.445)	-0.432 (0.489)	-0.346 (0.496)
CR2	-3.186 (0.015)*	-3.090 (0.014)*	-3.069 (0.015)*
MNAT	1.748 (0.037)*	1.815 (0.025)*	1.840 (0.023)*
WAITYEARS	-0.0417 (0.330)	-0.0398 (0.347)	-0.0379 (0.358)
R&D	0.107 (0.873)	0.155 (0.812)	
M&A	0.110 (0.739)		
pseudo R^2	0.321	0.319	0.318
AIC	50.22	48.33	46.39

Size doesn't matter... but multinationality and competition do

Higher levels intra firm diffusion positively associated with

- Firm multinationality
 - ▶ An effective means of technology transfer to countries that may not adopt
 - ▶ Overcomes technical barriers to cross border trade
 - ▶ Multinationality affords access to superior wind resource
- The absence of monopoly in home member state
 - ▶ Second (and third) entrant has most significant competitive impact on competition (Bresnahan & Reiss 1991)
 - ▶ Dynamic outcome of competition

Summary

- **Dynamic competition** can be fostered by even low levels of competitive pressure. Firms that are not monopolists in their home country are likely to be intensive users.
- **Multinational firms** may be important in realising the wider benefits of the innovation process. Clean technologies typically do not flow across borders.
- Measures of overall diffusion can be misleading. We need to **develop the modeling of intra firm diffusion** if we are to understand more about how firms make those decisions and tailor energy and merger policy accordingly.

