Can innovation and markets supply low carbon technologies?

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Two “Bali”statements

Uncontentious

- Technological change can contribute to reducing carbon emissions compared to a plausible counter(bau)factual

More contentious

- Optimal levels of technological change are matters for markets and not governments

Philosophical to practical

Four ways to low carbon technologies

- Greater take up of Best Available Technologies
- Translation of backstop technologies to commercial viability
- Incentives to firm innovation in low carbon technologies
- Technology transfer; within countries and across borders

Focus on middle two

Issues

- Cost reduction (across many dimensions)
- Industry structure and competition
- Wait and see
- Technology lock in
- Compatibility between two performance frontiers. (profit maximising and minimal carbon)

Talk Structure

- backstop technologies and LBD
- Barriers to low carbon Innovation:
    - Structure and firm conduct
    - “wait and see”
    - technology “lock in”
- Knowledge gaps
- concluding observations

Definitions

- Low carbon: that which achieves significant lower carbon intensity in world production and consumption
- Carbon intensive sectors; EUETS phase 2,plus road and air transport, households.

General approach

- Observations on current analysis
- Nothing on BAT, forests and policy, technology transfer, hardly anything on modelling,
- Ideas for further work

Backstop technologies (1)

- Sources of known technology but not fully commercial
- Needs to keep world emissions at 2005 levels by 2055

Backstop technologies (2)

- Wind. 300k 5MW turbines (Portugal)
- Solar. 700 times current capacity, growing 60 times faster and covering 10 million ha.
- Biofuels.250m ha. One sixth crop productn
- CCS. At 700 1GW coal power plants
- Hydrogen fuels.1bn cars powered by carbon free hydrogen
- Advanced vehicles. 2bn cars at 60mpg

Approximate generation costs(p/kwh)

- Tidal 13
- Wind turbine (off/onshore) 8.5/6
- Biomass 7
- Clean coal 4
- CCGT 3.8
- Nuclear 3.8
- Coal 3.5

Source BERR

Challenges

- Costs
- Technology integration
    - CCS
    - battery
    - fuel cells
- Security of supply/baseload

Modelling approaches

- Coverage
- Partial versus general equilibrium
- Modelling versus empirical work
- Engineers bottom up versus Economists top down

Learning rates for energy technologies(%)

Technology	Europe	US	R of W
Photovoltaics	35	18	
Wind	18	32	
Biomass	15		
Ethanol			20
Coal	4		

Old to new

- Backstop adopted;
  - technology known
  - change in relative price
- Technological innovation; economically beneficial change in nature of productive activity
- Low carbon technologies: an increase in the number of plausible substitute technologies

Analytical starting point

Economics of Innovation

- Innovation systems
- Usual market failures. Externalities, free riders, wedge between private and social costs and returns.
- “S” curve. Technical superiority, Early adoption, diffusion and take off, maturity and decline.
- Significant variability across sectors. Inputs and outputs.
- outcomes diverse in quantity, kind and quality.
- Explained by incentives, industry structure, intensity of product market competition.
- Precise source of spillovers often illusive

R and D spend by sector(2005)

£million UK

• Pharma	3,308
• ICT	2,770
• Aerospace	2,197
• Auto	741
• Iron and steel	34
• Electric, gas and water	15

Barriers to low carbon innovation

- Industry Structure and firm conduct
- Wait and see
- Technology lock in

Industry Structure and firm conduct

Varied across sectors but concentration on

- Process industries
- High fixed costs
- Few firms
- Vertical integration
- Mature technologies

- Cournot rather than Bertrand

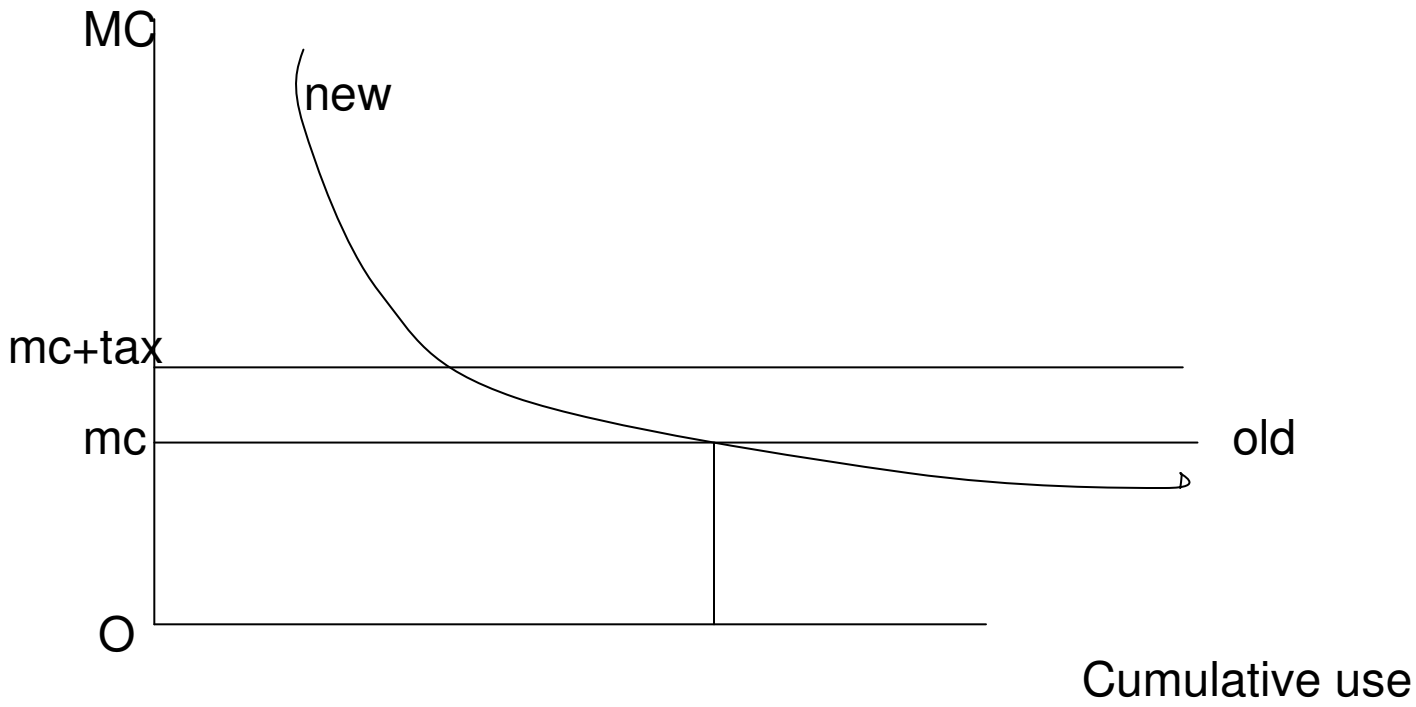
Wait and see

- Benefits of waiting exceed costs of acting
- First mover required if others are to see
- Importance of being second
- when does being first pay off?

Technological lock in (1)

- Established technology significantly lower cost than new.
- New could be lower cost than established at high levels of output. But how increase output and lower unit costs.

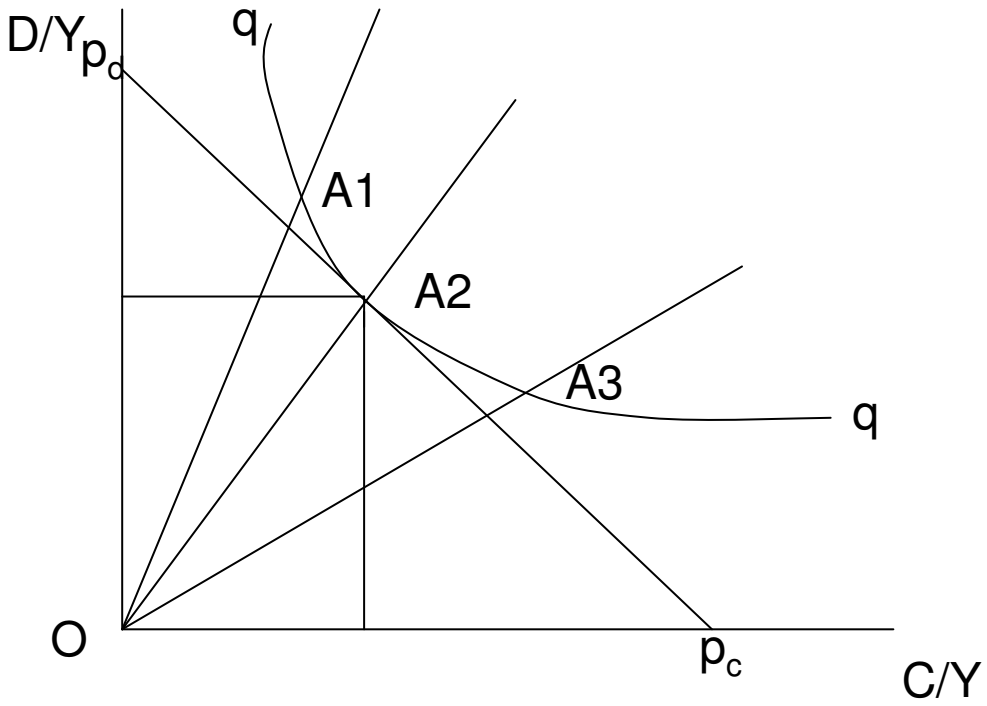
Marginal costs of production (new and old technologies)



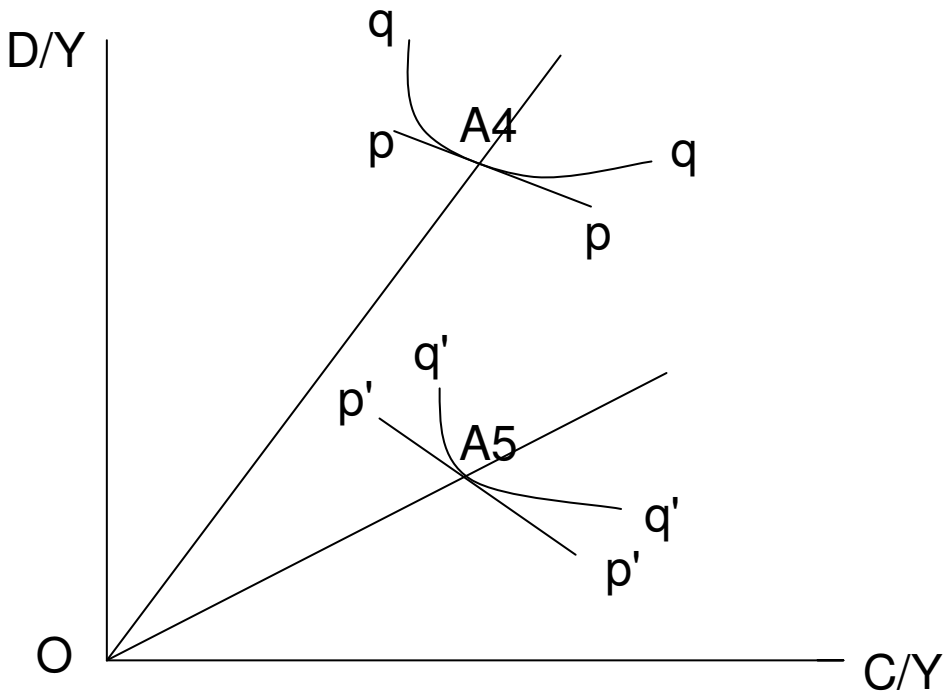
Technology lock in (2)

- Process industries; high levels of fixed costs in asset specific technology.
- High sunk costs source of competitiveness.
- High exit costs or transaction costs between old dirty/clean new

No Innovation



Radical Innovation



Three technology margins

Abatement through substitution within

- Machine
- Process
- Between processes across plants (full substitution one technology for another)

Margin determination

- Autonomous technical progress in energy efficiency improvements
- Indivisibility/ divisibility of process or cost of disintegration
- Sunk costs and exit costs
- Cross elasticity of substitution between dirty and clean
- Relative prices

Switching costs and responses

- High for entirely new plants
- Irreversible
- Lower for switching within process
- Flexibility in feedstock fuel inputs
- Variable transaction costs between process
- Production shift: domestic/import
- Price pass through

AEEI (industry sector estimates)

Total emissions*	60.7	aeei(%)
• Iron and Steel	19.8	2
• Chemicals	10.6	4
• Cement	10.0	5
• Aluminum	2.7	5
• Glass	2.0	3-7
• Pulp and paper	4.0	3

*2003 $mtco_2$

Knowledge gaps

- Costs of disintegration
- Transaction and integration costs within and between processes
- Firm investment decision ;physical and knowledge capital
- Incentives to invest or innovate

Some observations

- Know more about low carbon options in electricity generation than other sectors
- Incentives are key but what is optimal
- Structure and market distortions lessen firm incentives to innovate
- Cannot divorce firm investment decision from actions of governments
- Not clear when innovation generally and in low carbon are complements or substitutes

sources

Slide

- Backstop technologies (2). Pacala and Socolow (2004). Stern page 235
- Generation costs. BERR
- Learning rates and model. Loschel A. technological change in economic models of Environmental policy: a survey. Centre for European Economic Research (ZEW). Mannheim.
- R and D spend. ONS.