The role of environmental goods and services firms in the uptake of environmental technology: Evidence from the London Taxi Emissions program

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Environmental goods and services (EGS) firms

Firms that make, improve, market and/or sell a product or service to another, typically non-compliant polluting firm for the purpose of achieving compliance with legally binding environmental regulations

EGS firms are definitely not

- Firms doing corporate environmental responsibility
- Resource efficient firms

Policies: WTO, OECD countries, UK, numerous regions.

Environmental protection domains (CEPA)

1. Air and climate
2. Wastewater
3. Waste
4. Soil, groundwater, surface water
5. Noise and biodiversity
6. Biodiversity and landscape
7. Radiation
8. Environmental R&D
9. Other

European Commission 2006

EGS sector firms in UK and Europe

	UK	EU
Total turnover	€31-53 billion	€227 billion
Total firms	17,000	144,500
Total employment	400,000	3.4 million
EGS as a % of GDP	1.25%	2.3%

DTI (2005) and European Commission DG Environment (2006)

Today

Looking today at the effects of supplier firms on the uptake of environmental technology by polluting firms

EGS firms:

a) reduce technical and regulatory uncertainty for polluters

b) compress costs through learning and specialisation

c) adapt technologies to new regulatory contexts which leads to incremental innovations

Theoretical context (1)
‘who adopts’ studies

- Ordinary innovation diffusion studies: early adopting firms larger, more educated workforces, spatially concentrated, homogenous, technologically savvy (Rogers 1995)

- Uptake depends on information: personal or impersonal information source; advancement of soft (instructions) knowledge alongside hard (technical) knowledge (Geroski 2000)

Theoretical context (2) environmental technology (ET) diffusion

Little explicit treatment of supplier effects

- Equipment to control NOx and SO2 (Popp 2005)
- Equipment for radioactive waste disposal (Lanjouw and Mody 1996)
- Phase down of lead in gasoline (Jaffe, Newell and Stavins 2002)

Some speculation on responses to policy instruments but no empirics

- Impact of environmental policy instruments on likelihood of polluters to invest in R&D internally (Magat 1978)
- and to other firms (Milliman and Prince 1998)

Theoretical context (3)
effects of supplier firms

- Suppliers' continuous learning causes costs and prices for durables to fall continuously (linearly) over adoption period, while uptake is initially weak, then strong, then weak (a sigmoid curve) (Bass 1980)

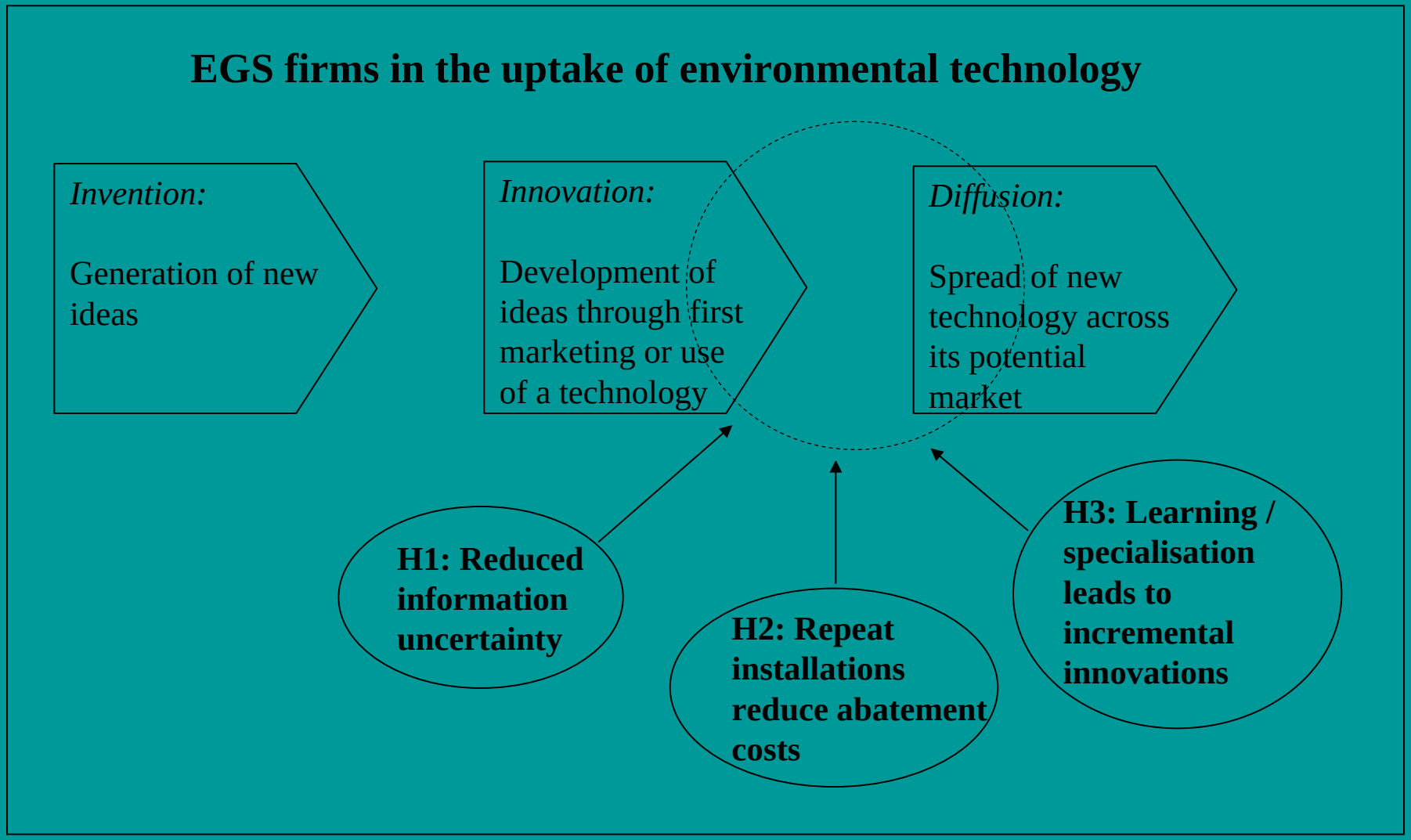
- Competitive effects *between* supplier firms affect uptake (Gatignon and Robertson 1989)

- Before making statements about collective uptake patterns (diffusion) it makes sense to look empirically at factors affecting uptake of ET by individual firms.

Role of EGS firms: hypotheses

- H_o: Polluting firms face the same adoption costs regardless of the influence of EGS firms; binding regulations are the real cause of uptake, not EGS firms.
- H_1: EGS firms reduce technical and regulatory uncertainty for polluters
- H_2: Learning and specialisation from repeat installations lowers abatement costs
- H_3: Technology adaptation to regulatory conditions leads to incremental innovations

H_1 – H_3 in Schumpeter's innovation process



Case study design

- Study successful when . . . .
- 18 public notices published by Public Carriage Office (PCO), 2004-2008
- 3 expert interviews
  - Supplier and distributor of vehicle emissions control equipment
  - Civil servant working on EGS policy for 5 years in DTI/BERR
  - Technology accreditation manager, Energy Saving Trust

London Taxi Emissions program (1)

- Vehicular traffic responsible for 67.9% of PM10 and NOx in the capital; old, heavy, diesel vehicles especially
- About 21,000 taxis providing 85 million trips per year, primarily in central London and around Heathrow. Fleet exhaust emissions account for ~23% of all PM10 emissions and ~7% of all NOx emissions in central London in 2002.
- European Vehicle Emissions Standards (‘Euro Standards’)

London Taxi Emissions Program (2)

- Revenue neutral for vehicle owners

- Policy options
  - Vehicle replacement (£30,000)
  - Engine conversion to LPG (£5,000)
  - Fit abatement equipment (diesel particulate filters, exhaust gas recirculation equipment or diesel oxidation catalysts) (£2,500)

H_1: EGS firms reduce technical and regulatory uncertainty for polluters

- Little late contact with vehicle owners (polluters) in marketing/sales/distribution stage but extensive collaboration with vehicle owners in early equipment design stage

- Supplier/distributor played ‘technical advisor’ to then-Mayor of London for ‘at least 5 years’ in run up to compliance date (from 2003). Uncertainty reduced for *policymakers*.

H_2: Learning and specialisation from repeat installations lowers abatement costs

- Iterative learning seemed to occur in government durability testing of candidate abatement equipment, not by the EGS firm's introduction of successive models

- Some evidence of influencing the policy requirement to suit the technological capability, not vice versa: EIC lobbies for definitions and 'technology champion' in EA.

H_3: Technology adaptations lead to incremental innovations

- Specifically for TEP market, distributor/supplier of exhaust treatment equipment combined two technologies – diesel particulate filter (DPF) and an exhaust gas recirculation (EGR) system. 'Better NOx control than anything on the UK'.

- Adaptations seem to have occurred in early consultation with vehicle owners, and in pre-market durability testing by government laboratories. No evidence they occurred in market-based cycles of adapt → sell → feedback → adapt.

Conclusions (substantive, theoretical)

- Limited evidence, small scale, short time frame, but:
  - H_1 (uncertainty): supported, but reduced in different ways and for different audiences than expected
  - H_2 (learning and specialisation): evidence to support (owner consultation, laboratory testing) and reject (EIC).
  - H_3 (incremental innovations): strongly supported

- EGS firms impact on uptake and diffusion
  - Supplier technical expertise an ‘active ingredient’
  - Government approval mediates technological innovations
  - Costs lowered through collaborative effects (2 types) more than competitive effects

Conclusions (case study design)

- Interviewee ‘steers’ are dangerous
- Evidence supported multiple hypotheses; from ‘identify effects’ stage to ‘quantify effects’ stage
- Mandatory regulations cloud the effects of EGS firms
  - Multiple case studies to ‘control’ for regulatory effects
  - Either across urban centres (US, UK, Sweden)
  - Or across environmental domains (air, water, soil) in UK

Thanks for your time

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