Innovating for an uncertain market: The role of patents for environmental innovation

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July 13, 2009
Geneva

Acknowledgements

- Thanks to WIPO for the invitation, to the US National Peace Foundation and US National Chamber of Commerce for their support of this project, and to Kristina Lybecker and David Popp for their generous and insightful comments.

- The literature review resulting from this work covers over 200 academic papers on the topic, and has been compiled into a set of three working papers, available shortly at http://faculty1.coloradocollege.edu/~djohnson/papers.html. The three papers target the challenges of IPRs, diffusion and financing of environmental innovation respectively.

Outline

- The big story
- What economists already know
- What economists (and you) want to know

Uncertainty is the story

- *"Innovation involves attempts to deal with an extended and rapidly advancing scientific frontier, fragmenting markets flung right across the globe, political uncertainties, regulatory instabilities, and a set of competitors who are increasingly coming from unexpected directions."* (Tidd 2006)

- Already great reviews of the really extensive literature on the economics of innovation: Freeman 1994; Stoneman 1995; Fagerberg et al. 2005; Shavinina 2006

Uncertainty is greater for eco-innovation

- research problems are enormous, complex and frequently systemic or inter-related
- uncertainty surrounds the pricing of competing as well as complementary goods.
- appropriability of returns is open to question, as innovators wonder whether their research will be subject to ‘public interest’ exclusions to patent law
- ***valuation by the marketplace is uncertain***
    1. consumers do not have the knowledge / tools to evaluate
    2. consumers and producers rarely ‘value’ any given environmental impact, as they involve externalities (costs or benefits incurred by someone other than the direct producer or consumer)
    3. value depends upon government intervention, which varies over time and often between adjacent jurisdictions

Uncertainty reduces investment

- Hundreds of examples of empirical evidence, ranging from St. Petersburg Paradox to studies of R&D managers to game show contestants to insurance markets to financial markets
- Conclusion: Risk reduction has high value. There's a role for patents here, as property rights reduce risk.

Are patents inefficient by being anti-competitive?

- Might we achieve more adoption if we discouraged monopoly practices and encouraged quicker competition (e.g. by weaker or no patent rights)?
- Economists call this a static solution that is dynamically inefficient

Could LDCs wait for others to innovate?

- Can any of us wait?
- Will innovations be relevant?
- Will the market be large enough without emerging economies and LDCs?
- Could the LDCs be leaders instead of followers?

Can LDCs adopt?

- Copenhagen (2009) finds that IPRs do not constitute as significant a barrier to LDC adoption of emission-reduction technologies. Evidence: IPR-protected technologies are not regularly more costly than unprotected alternatives.
- Moreover, there has been a rapid rise in LDC patenting in the area, increasing 500% between 1994-98 and 2004-08.

Should IPRs be tailored to fit eco-innovation?

- Numerous studies have suggested that the uniform treatment of all patented products and processes is economically inefficient.
- Evidence and models in Klemperer 1990; Gilbert and Shapiro 1990; Gallini 1992; Green and Scotchmer 1995; Scotchmer 1996; Scotchmer 1999; Gallini and Scotchmer 2001; Yiannaka and Fulton 2001; Yiannaka and Fulton 2003

We already treat some sectors differently

- The real question is how we should be simultaneously encouraging innovation (via incentives and/or direct funding) and diffusion (via competition and/or public provision)
- Specifically, how for eco-innovation?
  - Seven reasons that I propose here

Reason #1 to treat eco-innovation differently

1. Externalities

- Effects on others mean that the market doesn't reflect the true value of innovation. Insufficient market incentives result in too little research.
- *"A vision without resources is a hallucination."*
- Friedman (2006) calculates that US energy sector (including oil, coal and gas) receives about $3 billion in US federal funding for R&D, with another $5 billion in private sector and venture funds. That amounts to 0.8% of revenues, compared to manufacturing sectors that may average 6-8%.
- Prizes/rewards (e.g. Mandel 2005)
- Formalize markets via tradable permits and derivatives markets for them (Laffont and Tirole 1996)
- Other market-creating policies

#1: The financing challenge

- Could we just subsidize research?
- Hall and van Reenen 1996; Popp 2006; Morgan 2007; Copenhagen 2009
- Popp (2002) finds that US federal energy R&D served as a substitute for private energy R&D during the 1970s, but as a complement to private energy R&D afterwards.
- No studies on impact of tax credits or joint ventures/cost sharing or countervailing taxes/subsidies

Reason #2 to treat eco-innovation differently

2. Basic / fundamental research

- Scotchmer 1991; Green and Scotchmer 1995; Scotchmer 1996; Cohen 2005; Cahoy and Glenna 2009
- Help for thickets where ownership is not highly concentrated, e.g. private ordering in biofuels
- Potential for local adaptation
- Networks are important, distance is less so (Johnson et al. 2004; Johnson 2008, 2009; Sneed and Johnson 2009; Roy and Johnson in progress)

Reason #3 to treat eco-innovation differently

3. Local adaptations are usually required

- Pray 1981; Farrell and Saloner 1985; Besen and Farrell 1994; Katz and Shapiro 1994; Liebowitz and Margolis 1994; Lanjouw and Mody 1996; Johnson and Evenson 2000; Kanwar and Evenson 2001, 2009; Popp 2006; Kanwar 2007

- Is eco-innovation globally transferrable? Will diffusion occur?

#3: Johnson and Evenson (2000)

- examined where US/Europe/Japan agricultural-use patents are protected in LDCs
- Obvious factors matter: climatic similarities, soil similarities, crop/livestock similarities, education levels
- Most important, by several orders of magnitude: market size

Reason #4 to treat eco-innovation differently

4. Economies of scale

- Clear evidence that there are lower costs for eco-innovation as more units are produced
- Joskow and Rozanski 1979; Zimmerman 1982; Sharp and Price 1990; Lester and McCabe 1993; Nakicenovic 1996; Neij 1997; Grübler and Messner 1999; Grübler et al. 1999
- Classic example of First Solar

#4: Scale at work

- Friedman (2006) points out the very deep pockets of research funds in corporations, not in government agencies or in third party sources like venture capital.
- Microsoft alone had a research budget of $6 billion in 2007, more than all of the venture capital going to clean energy tech that year, and roughly triple the US federal government's investments in energy efficiency and renewable energy R&D.

Reason #5 to treat eco-innovation differently

5. Induced innovation responses

- All evidence shows strong effect of prices on innovation, controlling for policy effects
- Ohta and Griliches, 1976; Goodman, 1983; Atkinson and Halvorsen, 1984; Wilcox, 1984; Greene, 1990; Pakes 1993; Berry et al., 1996; Goldberg, 1999; Newell et al. 1999; Popp 2002, 2006; Arrow et al. 2004; Crabb and Johnson, 2010

#5: Crabb and Johnson (2010)

- Study of impact of oil prices on fuel-efficiency innovations in automotives
- CAFE standards act as a ratchet.
- In the US, every $5 per barrel increase in the price of crude oil (roughly 5% increase in retail price of gasoline) translates into a 4% increase in granted patents dealing with energy-efficiency in automobiles (36 per year in the US alone).
- Naturally, that effect mounts with time, as future knowledge builds upon the new base.
- Challenge is that prices are indirect, affected strongly by policy

Reason #6 to treat eco-innovation differently

6. Sensitivity to policy

- Porter and van der Linde (1995) and subsequent studies
- Press (2007) review of literature
- Requate (1998) shows that comparing taxes and permits depends critically on the parameters
- Details matter more than overall direction of policy: Kemp 1997; Parry 1998; Cleff and Rennings 1999; Hemmelskamp 1999; Klemmer et al. 1999; Montero 2000; Jaenicke et al. 2000; Frondel et al. 2004; Jaffe et al. 2004; Jacob et al. 2005; Johnstone et al. 2005, 2007, 2008; Bernauer et al. 2006; Rehfeld et al. 2006
- Arimura et al. (2007) find that perception of policy stringency matters more than policy details

Reason #7 to treat eco-innovation differently

7. System complexity

- Goolsbee (1998) and Jaffe et al. (2001) raise the question of the elasticity of supply of R&D inputs
- Tough to mathematically model implications, but we continually try
- Nordhaus (1994), arguably the first and simplest of the models, includes 74 variables and 32 equations
- Extensions run to 36 pages of equations.
- Nordhaus and Boyer 2000; Buonanno et al. 2003; Gerlagh and van der Zwaan 2003; Bosetti et al. 2006a and 2006b

Conclusion #1 of 2

- Non-economists might suggest that a separate reason to treat eco-innovation separately is our common interest in a global goal
- Markets should rank its importance appropriately, if we take care of the ‘smaller’ problems
- Coase Theorem could work well here, if we solve some other problems first

Conclusion #2 of 2

- Economists should focus on solving the problems we can identify:
  - How to identify basic research from applications, and to stimulate them differentially
  - How to value externality-reducing innovations in a non-market sense (think about stock market values, for example)
  - How to access economies of scale without cutting down our portfolio of research
  - How to empower induced innovation channels
  - How to advise policy intelligently on a case by case basis (useful models, clear direction)
  - How to deal with, and communicate, system complexity without losing the key message
- We need your help to focus our efforts via RFPs and funding in the right direction

Thank you

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- Contact me with questions or thoughts or projects: djohnson@ColoradoCollege.edu