Does foreign environmental policy influence domestic innovation? Evidence from the wind industry

Antoine Dechezleprêtre, LSE

Matthieu Glachant, Mines ParisTech

Motivation

- The empirical literature has extensively shown that environmental regulation fosters innovation in environmentally-friendly technologies
  - Jaffe & Palmer, 1997; Brunnermeier & Cohen, 2003 ; Newell et al, 1999; Popp, 2002
- But most papers assess the impact of domestic regulation on domestic innovation
- Innovators are likely to be influenced not only by domestic but also by foreign policies
  - The market for technologies is global: 49% of wind power patents are filed by non-residents

Research question

- Does foreign wind policies encourage domestic innovation?
  - If so, the empirical literature under-estimates the overall effect of environmental policies
- We distinguish between:
  - Demand-pull policies encouraging the deployment of new turbines
    - Feed-in tariffs, renewable portfolio standards…
  - Technology-push policies encouraging innovation
    - Public support to R&D

Policy relevance

- Environmental policies are also sold by politicians as a tool to achieve technological leadership of domestic firms
- But domestic policies might also help foreign competitors
  - Ex: Spain's solar policy has strongly benefited Chinese producers

Data

- A panel of 28 OECD countries, 1995-2005
- Innovation
  - Patent data from the EPO World Patent Statistical database (PATSTAT)
  - 16,168 patent applications
- Demand-pull policies
  - Annual installations of new wind power capacities (IEA)
- Technology-push policies
  - Public R&D expenditures (IEA)

Econometric framework

- Fixed effects Poisson regression
- The equation:

$$N_{i,t} = \exp(\alpha_1 \ln cap_{i,t} + \alpha_2 \ln cap_{-i,t} + \beta_1 \ln rd_{i,t-1} + \beta_2 \ln rd_{-i,t-1} + \gamma_1 \ln K_{i,t-1} + \gamma_2 \ln K_{-i,t-1} + \eta_i + \rho t + \varepsilon_{i,t})$$

- N_{it} is the number of patents filed by private inventors from country *i* in year *t*
- $cap_{i,t}$ is the wind power capacity which is added in country *i* in year *t*
- $cap_{-i,t}$ is the capacity installed in the rest of the world
- rd_i and rd_{-i} are public R&D expenditures at home and abroad

Control variables

- Knowledge stocks: discounted stock of previous citation-weighted patents
  - At home
  - Abroad
- Time trend or time dummies
- Country fixed-effects

Foreign variables

Two specifications:

- Total foreign capacity or total foreign public R&D

$$cap_{-i,t} = \sum_{j \neq i} cap_{j,t} \qquad rd_{-i,t} = \sum_{j \neq i} rd_{j,t}$$

  - Coefficients measure the average country effect

- Weighted:

$$cap^{w}_{-i,t} = \sum_{j \neq i} w_{ij} cap_{j,t} \qquad rd^{w}_{-i,t} = \sum_{j \neq i} s_{ij} rd_{j,t}$$

  - wij, share of patents from country i in country j
  - Sij, flows of patent citations from i to j.
  - More variation in the cross section, but coefficients are difficult to interpret

Results

	Non weighted + time trend	Weighted + time dummies
$\ln cap_{i,t}$	0.0705**	0.0712*
	(0.0278)	(0.0385)
$\ln cap_{-i,t}$	0.2862**	
	(0.1332)	
$\ln cap^{w}_{-i,t}$		0.4604*
		(0.2734)
$\ln rd_{i,t-1}$	0.1978*	0.1959**
	(0.1068)	(0.0829)
$\ln rd_{-i,t-1}$	-0.0730	
	(0.3885)	
$\ln rd^{w}_{-i,t-1}$		0.3627
		(0.5716)
$\ln K_{i,t-1}$	0.2251*	0.2140*
	(0.1249)	(0.1213)
$\ln K_{-i,t-1}$	-0.1647	
	(0.3755)	
$\ln K^{w}_{-i,t-1}$		1.2137
		(0.8190)
Country FE	yes	yes
Time trend	yes	no
Year dummies	no	yes
Observations	280	280
Countries	28	28

- Foreign installations influence innovation
- Foreign public R&D does not

Marginal effects of installations

- +1 MW at home = + 0.022 - 0.033 invention
- +1 MW abroad = + 0.0004 - 0.0009 invention
- A factor between 36 and 55

- There exist barriers to technology diffusion which discourage innovation
  - Policies to increase technology transfer also increase innovation

The total effect of 1 MW

- Our data set includes 28 countries
- Hence 1MW induces 0.00065 * 27 ≈ 0.017 foreign invention worldwide

➢ Demand-pull policies have a comparable aggregate impact on domestic and foreign innovation

Tech-push vs demand-pull

- The innovation impact of 1 million USD:

Effect of 1 million USD spent on:	Public R&D expenditures	New capacities
Home	0.67 – 0.86 invention	0.04 - 0.05 invention
Abroad	0	0.02 – 0.04 invention
Global	0.67 – 0.86 invention	0.06 – 0.09 invention

Assumptions: Installing 1 MW costs 0.65 million USD relative to conventional electricity

- Innovation has to be seen as an ancillary benefit of demand-pull policies

Conclusion

- Foreign demand policies influence innovation
- The marginal effect is 36-55 times less than the effect of domestic installations
  - Removing barriers to international diffusion is key
- But the total effect of foreign installations and domestic installations is comparable
  - Existing studies strongly underestimate the overall impact of environmental policies on innovation
- Foreign public R&D has no significant impacts

Thank you

Research question (2)

- If the impact of foreign regulation is less than that of domestic regulation, why is it so?
  - What drives the international diffusion of wind innovation?

Understanding cross-border technology diffusion

- A diffusion equation which explains patent flows between country i and country j

$$n_{i,j,t} = \exp(a_1 \ln cap_{j,t} + a_2 \ln trade_{i,j,t} + a_3 fdi_{j,t} + a_4 ipr_{j,t} + a_5 \ln K_{j,t-1} + a_6 \ln gdp_{j,t} + a_8 \ln N_{i,t-1} + \eta_{i,j} + \beta T_t + \nu_{i,j,t})$$

- Explanatory variables
  - installations of new capacities, IP strictness, barriers to trade, barriers to foreign direct investments, technological absorptive capacities