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Public policies for a sustainable energy sector: regulation, diversity and fostering of innovation

Valeria Costantini, Francesco Crespi

Department of Economics, University Roma Tre

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Outline

- Introduction
- Aim of the paper
- Theoretical background
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- Conclusions

Introduction: the international context

- A dramatic increase in oil prices volatility
- A growing concern about the consequences of carbon emissions from fossil fuels

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• Policy measures in order to reduce the environmental impact of economic activities

•Interest in producing biofuels from agricultural crops

Introduction: regulation vs/pro international competitiveness

VS: stringent environmental regulations is harmful to productivity and competitiveness due to higher costs faced by firms

(Antweiler *et al*., 2001; Bommer, 1999; Brock and Taylor, 2004; Copeland and Taylor, 2003, 2004; Levinson and Taylor, 2004)

PRO: severe environmental regulations can stimulate green innovations and increase the export competitiveness of environmental technologies

(Porter and van der Linde, 1995; Hascic *et al*., 2008; Markard and Wirth, 2008; Walz *et al*., 2008)

Starting points

- No consensus on the relevance of the Porter hypothesis;
- No univocal evidence on the effect of stringency of environmental policy on technological innovation;
- Increasing consensus on the idea that technology responses are not a mere reaction to regulatory pressure;
- New environmental regulation may represent a stimulus for new research but innovation systems should be equipped with adequate scientific and technological knowledge;
- Relevance of the mix of technology policies and environmental policies.

Aim of the paper

- Assess the impact on the export dynamics of energy technologies generated by broad environmental regulation policy and specific innovation policies;
- Evaluating the conflicting effects on export competitiveness of energy technologies of different policies due to the distortive potential of the enforced policy mix.

Analytical Background

- The standard normative economic theory of environmental policy has been increasingly challenged (Rammel and van der Bergh, 2003);
- Growing interest on the potential of evolutionary economics to explain sustainable development and environmental policies (Nill and Kemp, 2009);
- The notion of *transition policy* has emerged as a valuable framework of analysis.

Analytical Background

Transition Policy

- **Definition**: stimulation and management of learning processes, preserving the variety of policy and technological options and motivated by a long-term policy objective (Rotmans et al, 2001);
- **Characteristics**: a credible *transition policy* seeks the integration of three main specific aspects: environmental **regulation**, unlocking policy preserving **diversity** and **fostering of innovations** (van der Berg et al. 2007);
- **Relevance**: the notion of transition policy is of particular relevance in the energy sector.

Analytical Background

Transition Policy and the energy sector

Why is it relevant?

1) Strong need in the energy system for regulatory strategies to force technological regime shifts. (Rennings, 2000)
2) In energy and transport systems, a carbon lock-in has emerged. Progress in environmentally-friendly technologies should be supplemented by changes in consumer behaviour and institutional framework (Unruh, 2000, 2002)
3) Since every successful adaptation is only a temporary solution to changing selective conditions, maintained diversity allows for a repertoire of alternative options and increases the possibility that altered conditions can be successfully met through pre-adaptations and further evolution.

Analytical Background

The policy mix: the problem of contrasting policies

- Several contemporaneous public policies aim at escaping the carbon lock-in in the energy sector.
- In the absence of strong coordination between all public policies in the energy sector, the final outcome could be a non-optimal policy mix with contrasting forces and impacts.
- Policies can affect the direction of technological change by acting in favour of a specific technological path in new energy technologies, limiting the emergence of alternative technologies.

Analytical Background

Contrasting policies: The case of biofuels

- Interest in public support for biofuels that can be justified within the ***niche management approach*** (Kemp *et al*., 1998; Hoogma *et al*. 2002; Nill and Kemp, 2009)
  - They are an inexhaustible energy source and they could have a positive impact on reducing CO2 emissions;
  - Biofuels allow to use the existing network thus minimising the financial and psychological costs of a transition to completely different transport systems;
  - scale effects can help to discover new (second and third-generation) technologies for producing biofuels.

Analytical Background

Contrasting policies: The case of biofuels

- The creation of a protected niche like the biofuel market can divert resources from other new energy technologies.
  - Agricultural lobbies are strong enough in advanced economies to determine another lock-in situation.
  - It represents a sector where subsidies are pervasive.
- A strong orientation of the policy framework towards the diffusion of biofuels can negatively impact on the variety of alternative technologies.
- Possible lock-in effect in inferior technologies such those related to first generation biofuels.

Our Research Hypotheses

1) Environmental regulation can produce positive effects on competitiveness via inducement effects on innovation;

2) A strongly oriented policy framework (as in the case of energy policies dominated by the public support for biofuels) has the potential to direct technological change, with implications for policy design.

3) Environmental policies and technology policies should be integrated in order to produce a significant impact on technological competitiveness in the energy sector.

Methodology: the gravity equation

The exact formulation of the gravity equation analyzed in a panel context is as follows:

$$\ln EXP_{ijt} = \alpha + \beta_1 \ln \mathbf{M}_{it} + \beta_2 \ln \mathbf{M}_{jt} + \beta_3 \mathbf{G}_{ijt} + \beta_4 \mathbf{X}_{it} + \beta_5 \mathbf{X}_{jt} + \varepsilon_{ij}$$

M = Mass, explaining the role of income (GDP) and population size (POP) both for exporting (*i-th*) and importing countries (*j-th*)

G = Geography, explaining the role of geographic distances between trading partners, land area etc.

X = Other control variables for countries *i* and *j*

Methodology: the gravity equation

The exact formulation of the gravity equation analyzed in a panel context is as follows:

$$\ln \mathbf{ENEXP}_{ijt} = \alpha + \beta_1 \ln \mathbf{GRAV}_{ijt} + \beta_2 \ln \mathbf{REG}_{it} + \beta_3 \ln \mathbf{BIOF}_{it} + \beta_4 \ln \mathbf{RDENE}_{it} + \beta_5 \mathbf{DUMMIES}_{ijt} + \varepsilon_{ij}$$

ENEXP = bilateral export flows from countries *i* to countries *j* at time *t* of technologies for renewable energies and energy saving

GRAV = Basic variables within a gravity model

REG = Environmental and energy regulation variables

BIOF = Biofuels policies applied by exporting countries

RDENE = Public RD efforts in energy sector in exporting countries

Methodology: dataset description

- **Exporting countries** (*i*): Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States .

- **The (j) countries** include 148 countries (including OECD countries).

- **Time period**: 1996 - 2006.

- **Number of Observations**: The full sample covers a total of 32,560 observations (=20 x148 x 11) of which 28,160 (=20x128x11) are bilateral cross-border observations and 4,400 (=20x20x11) are intra-country trade observations (all equal to zero).

Methodology: the dependent variable

Code	Description
	Renewable energies
7321.13	Cooking appliances and plate warmers for solid fuel, iron or steel
7321.83	Non electrical domestic appliances for liquid fuel
8410.11	Of a power not exceeding 1,000kW
8410.12	Of a power exceeding 1,000 kW but not exceeding 10,000 kW
8410.13	Of a power exceeding 10,000 kW. 8410.90 – Parts including regulators
8410.90	Hydraulic turbines and water wheels; parts including regulators
8413.81	Pumps for liquids, whether fitted with a measuring device or not; [Wind turbine pump]
8419.11	Instantaneous gas water heaters
8419.19	Instantaneous or storage water heaters, non-electric — other [solar water heaters]
8502.31	Electric generating sets and rotary converters — Wind powered
8502.40	Electric generating sets and rotary converters [a generating set combining an electric generator and either a hydraulic turbine or a Sterling engine]
8541.40	Photosensitive semiconductor devices, including photovoltaic cells whether assembled in modules or made up into panels; light-emitting diodes

Methodology: the dependent variable

Code	Description
	Energy savings and management
3815.00	Catalysts
7008.00	Multiple-walled insulating units of glass
7019.90	Other glass fibre products
8404.20	Condensers for steam or other vapour power units
8409.99	Parts suitable for use solely or principally with the engines of HS 8407 or 8408; other
8418.69	Heat pumps
8419.50	Heat exchange units
8419.90	Parts for heat exchange equipment
8539.31	Fluorescent lamps, hot cathode
8543.19	Fuel cells
9028.10	Gas supply, production and calibrating metres
9028.20	Liquid supply, production and calibrating metres
9032.10	Thermostats

Methodology: the final dataset

	Dependent variables	
$ENEXP_{ijt}$	Total bilateral export flows in renewable energies and energy-saving technologies (constant 2000$ PPP) from countries *i* to countries *j*	UNCTAD-COMTRADE
$RENWEXP_{ijt}$	Bilateral export flows in renewable energies technologies (constant 2000$ PPP) from countries *i* to countries *j*	
$ENEFFEXP_{ijt}$	Bilateral export flows in energy-saving technologies (at constant 2000$ PPP) from countries *i* to countries *j*	
	Standard gravity (GRAV)	
$GDP_{i,j,t}$	Natural logarithm of GDP (constant 2000$ PPP) of country *i* and *j*	World Bank WDI
$POP_{i,j,t}$	Natural logarithm of total population of country *i* and *j*	
$LAND_{j}$	Natural logarithm of land area of country *j* (sq. km)	
$DIST_{ij}$	Bilateral geographic distances	CEPII
COL_{ij}	Existence of colonial relationships between country *i* and *j* (dummy variable)	
$CONT_{ij}$	Geographic contiguity between country *i* and *j* (dummy variable)	

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Methodology: the final dataset

	Environmental and energy regulation (REG)	
$ENVREG_{it}$	Sum of public and private costs for environmental protection expressed as % of GDP	OECD, EUROSTAT
$RENWPOL_{it}$	Number of policy actions promoting renewable energy sources (solar, solar PV, wind, geothermal, etc.)	IEA/JRC Global Renewable Energy Policies and Measures Database
$ENEFFPOL_{it}$	Number of policy actions promoting energy efficiency (R&D, incentives, subsidies, education, etc.)	
	Public support for biofuels (BIOF)	
$AHSBF_{it}$	Applied MFN tariff ad valorem for biofuels, weighted with import flows (%)	UNCTAD-TRAINS
$MANDBF_{it}$	Fuel mandate, targets of blending shares of total consumption (%)	GSI
$EXCBF_{it}$	Value of excise tax reductions for bioethanol and biodiesel (US$ per litre of biofuels)	
$POLICYBF_{it}$	Arithmetic mean of AHSBF, MANDBF, and EXCBF (%)	

Methodology: the final dataset

	Public support to RD in the energy Sector (RDENE)	
$RDENE_{it}$	Ratio of public R&D expenditure in the energy sector on total R&D (%)	OECD-IEA
$RDENEFF_{it}$	Ratio of public R&D expenditure in energy efficiency on public R&D expenditure in the energy sector (%)	
$RDRENW_{it}$	Ratio of public R&D expenditure in renewable energies (excluding biomass) on public R&D expenditure in the energy sector (%)	

ijt represents the bilateral interaction between exporting and importing countries with a temporal dimension.

ij represents the bilateral interaction between exporting and importing countries without a temporal dimension.

i,j,t represents the value of the variable for country *i* and *j* respectively, with a temporal dimension.

it represents the value of the variable for country *i* with a temporal dimension.

Results: environmental regulation

Dependent variable	Export of renewable energies and energy-saving technologies (RENWSAVEXP)	Export of renewable energies technologies (RENWEXP)	Export of energy-saving technologies (SAVEXP)
GDPj	0.042	0.151***	-0.002
	(1.03)	(2.68)	(-0.04)
GDPi	2.710***	4.124***	5.103***
	(9.20)	(10.94)	(14.65)
POPj	-0.012	-0.154**	0.100
	(-0.21)	(-2.00)	(1.47)
POPi	-1.148***	-2.061***	-3.123***
	(-4.01)	(-5.63)	(-9.01)
DIST	-1.117***	-1.497***	-1.305***
	(-12.08)	(-12.34)	(-11.85)
ENVREGi	2.193***	1.013**	3.347***
	(8.80)	(2.26)	(11.52)
RDENEi	0.231**		
	(2.31)		
RDRENWi		0.503**	
		(2.27)	
RDENEFFi			0.606***
Adj. R-sq	0.63	0.64	0.61
Obs	23,936	21,808	19,813

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Results: biofuels policies

Dependent variable	Export of renewable energies and energy-saving technologies (RENWSAVEXP)			
	1	2	3	4
GDPj	0.043	0.043	0.043	0.043
GDPi	2.676***	2.223***	2.257***	2.550***
POPj	-0.012	-0.012	-0.012	-0.012
POPi	-1.107***	-0.683*	-0.700*	-0.987***
DIST	-1.108***	-1.139***	-1.149***	-1.103***
ENVREGi	2.100***	2.164***	2.156***	2.147***
RDENERTOTi	0.235**	0.453*	0.515**	0.194*
POLICYBFi$_{(t-1)}$	-0.051***			
AHSTOTi$_{(t-1)}$		0.015		
EXCBFi$_{(t-1)}$			-0.056***	
MANDi$_{(t-1)}$				0.0128
Adj. R-sq	0.63	0.63	0.63	0.63
Obs	23936	23936	23936	23936

Conclusions

- Environmental regulation positively affects international competitiveness in the export of energy technologies, in a Porter-like effect.

- Environmental policies should be supported by technology policies aiming at equipping innovation systems with adequate scientific and technological knowledge in order to respond creatively to changes in external constraints.

- Existence of potential negative effects related to the adoption of pervasive niche strategies with respect to the objective of preserving diversity.

- The design of a balanced policy mix emerges as a crucial element for directing economic systems towards sustainable paths of economic growth.

Thank you for your attention!