Environmental Policy Stringency, Innovation and Productivity in the EU Countries

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Motivation (i)

- The EC has established at the end of 2014 the toughest climate change target of any region in the world: greenhouse gas emission has to be cut by 40% and 27% of total energy production has to be from renewable sources before 2030.

- The EU is well on track towards meeting its targets for cutting greenhouse gas emissions both under its own internal target in the Europe 2020 Strategy and under the Kyoto Protocol's second commitment period (2013-2020).

- By reducing emissions since 1990 while expanding its economy, the EU has successfully shown that economic growth and emission cuts are not contradictory.

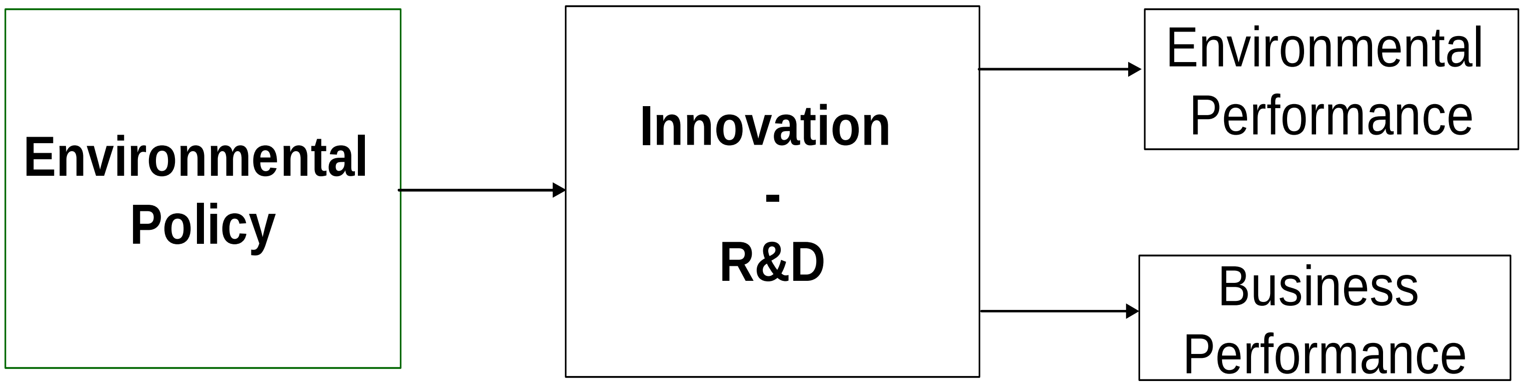
Motivation (ii)

- The conventional perception about environmental protection is that it imposes additional costs on firms, which may reduce their global competitiveness with negative effects on growth and employment.

- But Porter and Van der Linde (1995) found that more stringent environmental policies can stimulate innovations that may over-compensate for the costs of complying with these policies.

- The Porter hypothesis suggests that "*clean air*" and competition are not incompatible since properly designed environmental regulation can stimulate innovation which in turn will increase competitiveness.

The «Porter Hypothesis»



Three variants of the PH (Jaffe et al, 2005):

- "*weak*": environmental regulation will stimulate certain kinds of environmental innovations, although there is no claim that the direction or rate of this increased innovation is socially beneficial.
- "*narrow*": flexible environmental policy regimes give firms greater incentive to innovate than prescriptive regulations, such as technology-based standards.
- "*strong*": more stringent environmental policy may induce innovation that may compensate (or more than compensate) for the cost of complying with it.

Motivation (iii)

- Pollution is a negative environmental externality, while innovation is a positive externality.

- Therefore, without a public intervention to manage these two market failures, firms pollute too much and innovate too little compared with the social optimum.

- As such, investments and thus, innovation to develop “green” technology are likely to be below the social optimum because, for them, the two market failures are mutually reinforcing. (Jaffe et al 2014)

Motivation (iv)

- Thus the big challenge for the policymakers is to stimulate environmental innovation to enhance productivity growth.

- Innovation is the core element to guarantee the coexistence of economic growth and environmental improvements.

- Technological policies should be seen as a complement to environmental policies.

- There is a trade-off between the marginal cost of pollution control and its marginal benefit. Technological progress reduces the marginal cost of pollution control offering a more complete response to environmental problems.

Literature

- Empirical investigation of the consequences of environmental regulation at the macroeconomic level is rather scant, heterogeneous and mostly developed in the context of international trade .

- Evidence about the positive impact of tighter environmental regulation on environmental innovation is inconclusive and at sectorial level (Lanjouw and Mody, 1996; Popp, 2006; De Vries and Withagen, 2005).

- In a very recent paper, Albrizio et al (2014) look at the effects of environmental stringency policy changes on productivity growth in the OECD countries.

What is new?

- We investigate both direct and indirect impacts of various environmental stringency proxies on productivity and innovation adopting a cross-country perspective.

- Country level studies are more suitable for international policy-making compared to industry or firm level studies that suffer from lack of generality, as they usually provide very context-specific conclusions

- We test the PH looking at the impact of both command and control and market based environmental policy instruments on productivity and innovation (ICT and R&D).

Environmental Policy Instruments (i)

- **“Command—and—control** instruments refer to environmental policies that rely on regulation (permission, prohibition, standard setting and enforcement) as opposed to financial incentives, that is, economic instruments of cost internalization” (OECD 2001).

- There are generally two types of command-and-control regulatory instruments, **technology-based** and **performance-based**.
  - Technology-based regulations typically prescribe the use of specific equipment, processes or procedures;
  - Performance-based standards enforce environmental standards (i.e. limit to CO2).

Environmental Policy Instruments (ii)

- “**Market based** instruments use markets, prices and other economic variables to provide incentives for polluters to reduce or eliminate negative environmental externalities.

- Market based instruments increase the opportunity cost of pollution and environmental damage.

    - i.e. environmentally related taxes, charges and subsidies, emissions trading and other tradable permit systems, deposit-refund systems, environmental labeling laws, licenses, and economic property rights.

Environmental Policy Instruments (iii)

- The environmental economics literature has broadly discussed the incentives for the adoption and development of environment-friendly technologies provided by different policy instruments.

- The debate was in fact dominated by the opposition between command-and-control versus economic and market driven approach, the first being considered inferior compared to the second. i.e. Malueg (1989) and Fisher et al. (2003)

The Data

- Our analysis covers 11 EU countries (Austria, Belgium, Germany, Denmark, Spain, Finland, France, Italy, The Netherlands, Sweden, UK, plus USA as a control country) over the period 1995-2008.

- Annual data are from OECD and EUKLEMS.

Environmental Policy Stringency Indicator (EPS)

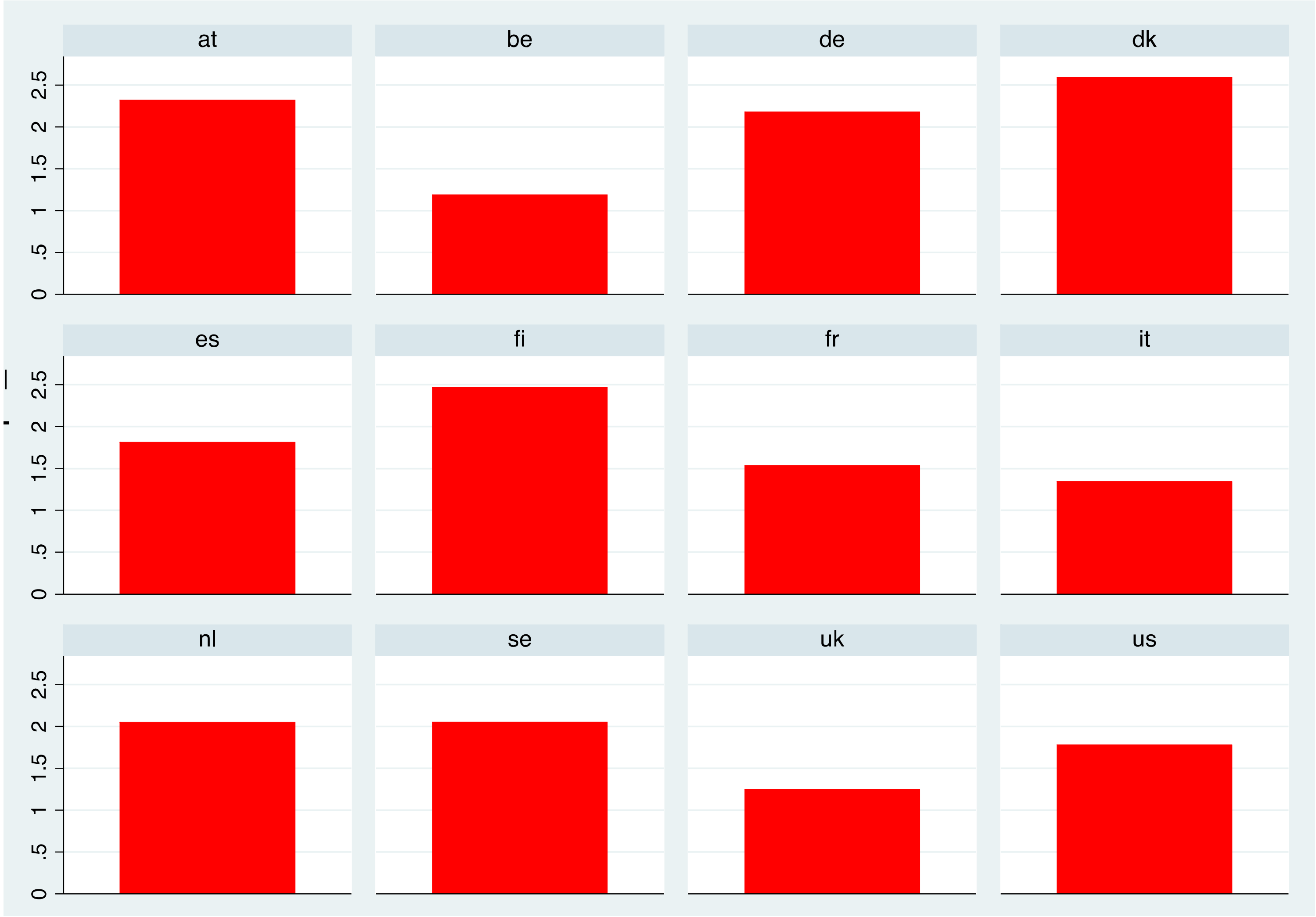
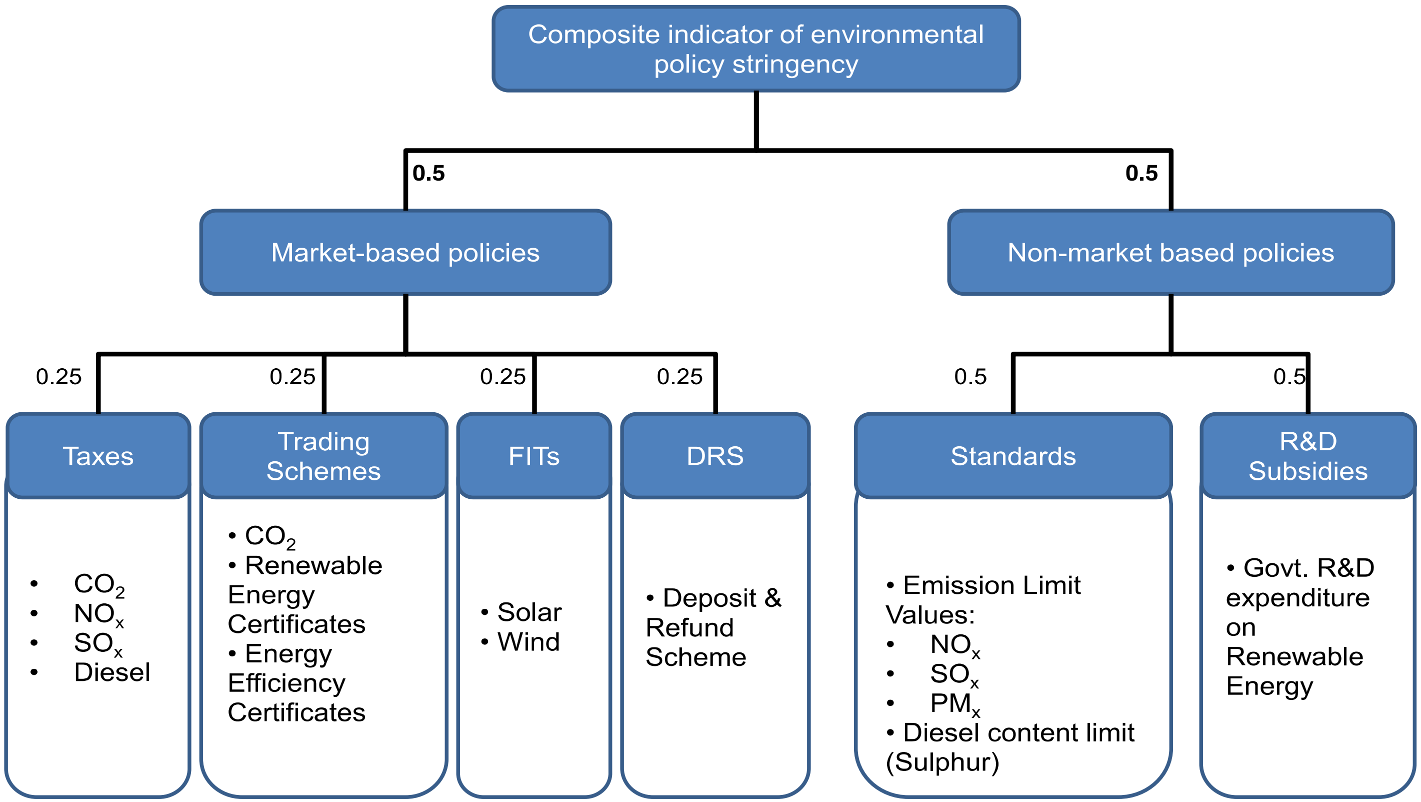
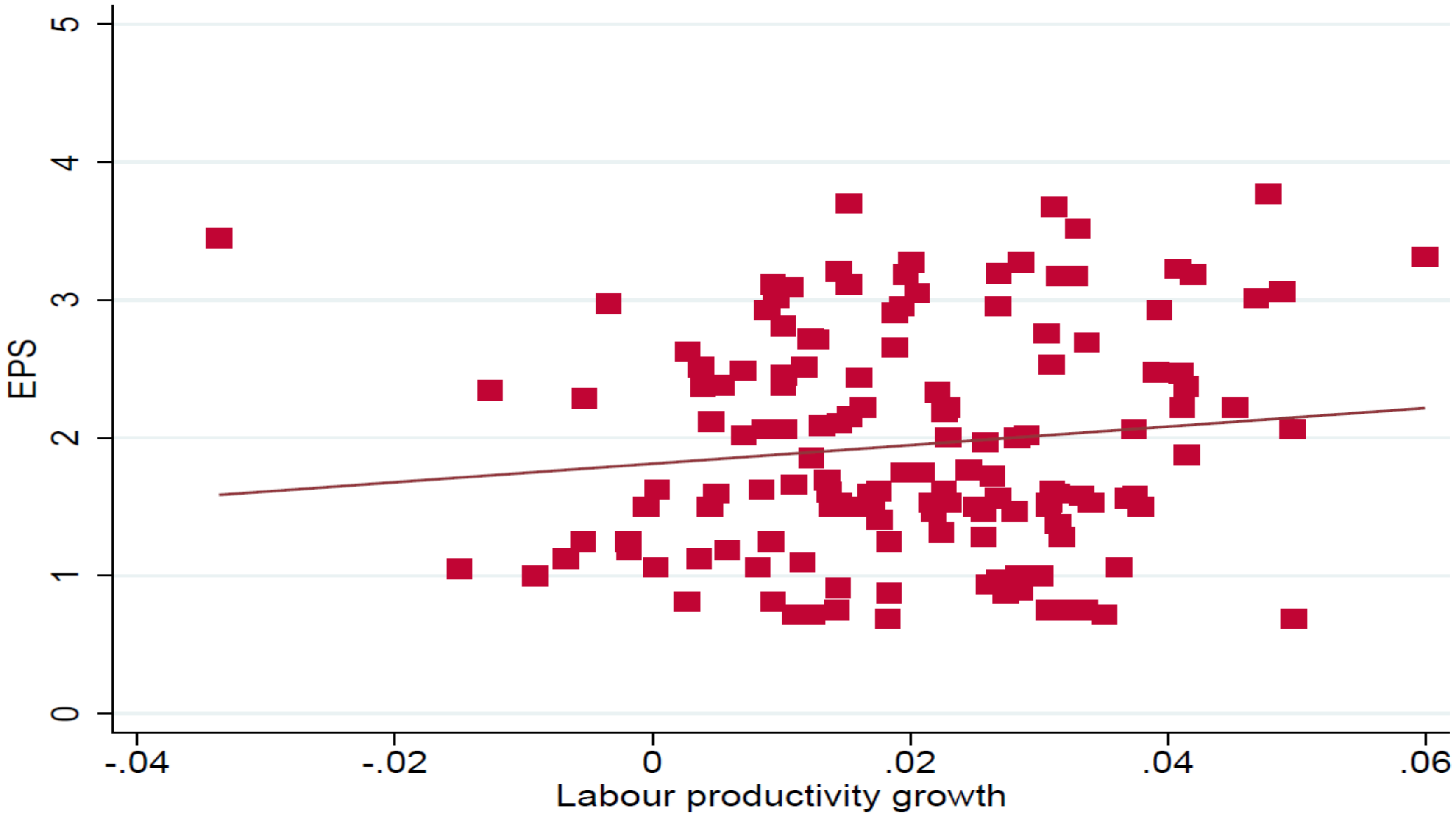


Figure 1. Structure of the Environmental Policy Stringency (EPS) indicator



Source: Botta and Koźluk (2014)

EPS vs labor productivity growth: 1995-2008



Econometric strategy (i)

We start from a standard production function augmented with environmental policy variables to check for the direct impact of environmental regulation on productivity growth:

$$DlnY = a_1 + a_2 DlnX + a_3 Z_1 + a_4 Z_2\ e \qquad (1)$$

Where:

Y is an indicator of labor productivity (*LP, TFP)*,
X is a set of controls including measures of innovation and capital stock and Z_1 is a measure of environmental regulation.
Z_2 is a vector of control variables including output gap, real oil price, trade openness, government balance, FDI inflows and a time trend.

If a_3 is positive then PH holds

Econometric strategy (ii)

- Then we test whether environmental regulation has a positive direct impact on the accumulation of technological and innovation capital.

- More stringent environmental regulation is assumed to foster ICT and R&D investments since they are key elements to reduce the environmental footprint of economic activities.

- Thus we investigate the correlation between a set of environmental stringency proxies and two measures of technological and innovation capital stock K^i (i.e. ICT, R&D) in equation 2 below.

$$DlnK^i = a_1 + a_2 lnZ_1 + a_3 Z_2 \; e \qquad (2)$$

- if a_2 is positive and significant we can take the results as an “indirect” test of PH.

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Econometric strategy (iii)

Finally, we tested an equation including interaction terms to evaluate the differential impacts of the various environmental stringency measures on productivity growth:

$$DlnY = a_1 + a_2 DlnK_i + a_3 lnK_i{*}Z_1 + a_4 lnZ_1 + u \qquad (3)$$

If a_3 is positive then countries with tighter environmental regulation and higher innovation intensity experience faster productivity growth compared to less innovative countries.

Econometric strategy (iv): environmental policy indicators

- The EPS index, developed for the OECD countries by Botta and Koźluk (2014).

- 4 different measures of "EU specific" environmental regulation:

    i. CO^2 emissions in metric tons per capita as a difference with respect to the 2020 target,

    ii. the adoption of the Kyoto agreement (1997),

    iii. the revenues from environmental taxes in percentage of GDP and

    iv. a dummy "2005" in order to catch the impact of the introduction of the European Emission Trading System (ETS).

EPS and Labor Productivity (i)

	(1)	(2)	(3)	(4)
VARIABLES	FE		IV	
DlnH_k_nonict_klems	0.426***	0.431***	0.528***	0.532***
	(0.0840)	(0.0838)	(0.106)	(0.100)
DlnH_k_ict_klems	0.111***	0.106***	0.0830**	0.0717**
	(0.0295)	(0.0296)	(0.0323)	(0.0320)
L.eps_fs	0.00754***		0.00805***	
	(0.00272)		(0.00237)	
Trend	0.00119*	0.00108	-9.27e-06	-0.000249
	(0.000716)	(0.000719)	(0.000609)	(0.000618)
L.outputgap	-0.00410***	-0.00388***	-0.00506***	-0.00466***
	(0.000792)	(0.000808)	(0.000699)	(0.000741)
L.eps_mb		0.00565***		0.00623***
		(0.00197)		(0.00166)
L.eps_nmb		0.00196		0.00199
		(0.00194)		(0.00166)
L.realoilp	-0.000145*	-0.000147*		
	(0.000716)	(0.000018)		
Constant	-0.0389*	-0.0342*	-0.00525	0.00327
	(0.0199)	(0.0202)	(0.0187)	(0.0191)
Observations	132	132	121	121
R-squared	0.423	0.431	0.640	0.647
Hausman test (□□)	1.89 (0.08)	12.7 (0.05)		
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

ICT, R&D and EPS

FE	(1)	(2)
	ICT	R&D
eps_mb	0.014**	0.006**
	(0.006)	(0.003)
eps_nmb	-0.006	-0.008***
	(0.006)	(0.003)
realoilp	-0.0004*	-0.0004***
	(0.0002)	(0.0001)
outputgap	0.013***	-0.001
	(0.002)	(0.001)
trend	-0.007***	0.003***
	(0.002)	(0.001)
Constant	0.334***	-0.032
	(0.053)	(0.028)
Observations	132	144
R-squared	0.433	0.223
Number of ctrycode	11	12
Hausman test (χ^2)	4.08 (0.54)	41.3 (0.00)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Labor productivity and "European" environmental provisions

FE	(1)	(2)	(3)	(4)	(5)
DlnnonICTK	0.495***	0.523***	0.427***	0.509***	0.456***
	(0.087)	(0.090)	(0.086)	(0.093)	(0.082)
DlnICTK	0.105***	0.085**	0.132***	0.102***	0.127***
	(0.032)	(0.036)	(0.032)	(0.036)	(0.032)
L.ets	0.008**	0.010**			
	(0.004)	(0.004)			
L.tgemiss	0.0002		0.001		
	(0.002)		(0.002)		
L.envtaxes	0.013**	0.014**			
	(0.006)	(0.007)			
L.kyoto	-0.002				-0.012*
	(0.004)				(0.007)
L.outputgap	-0.004***	-0.004***	-0.004***	-0.005***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
L.tradeopen	-0.001**	-0.001**	-0.0003	-0.0004	-0.0003
	(0.0002)	(0.0003)	(0.0002)	(0.0002)	(0.0002)
trend	0.002**	0.001**	0.002	0.001*	0.003**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
L.DICT_envtaxes		0.002			
		(0.011)			
ICT_tgemiss			-0.0002		
			(0.001)		
lnICTK			0.003		
			(0.009)		
ets				-0.001	
				(0.004)	
L.DICT_ets				0.095**	
				(0.046)	
L.lnICT					-0.005
					(0.009)
L.ICT_kyoto					0.004**
					(0.002)
Constant	-0.062**	-0.0398	-0.038*	-0.011	-0.056*
	(0.025)	(0.025)	(0.020)	(0.025)	(0.029)
Observations	132	121	132	121	132
R-squared	0.429	0.465	0.387	0.436	0.413
Number of ctrycode	11	11	11	11	11
Hausman test (χ^2)	10.52 (0.31)	13.4 (0.00)	3.02 (0.93)	6.78 (0.56)	3.88 (0.87)

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ICT, R&D. and “European” environmental provisions

FE	(1) ICT	(2) R&D
L.tgemiss	0.010*	0.003
	(0.005)	(0.003)
L.envtaxes	0.031**	0.004
	(0.015)	(0.009)
L.kyoto	-0.040***	-0.012**
	(0.011)	(0.006)
ets	0.023**	-0.014***
	(0.010)	(0.005)
L.tradeopen	0.001	-0.001*
	(0.001)	(0.0003)
trend	-0.004**	0.003***
	(0.002)	(0.001)
Constant	0.082	-0.018
	(0.063)	(0.034)
Observations	132	144
R-squared	0.418	0.161
Number of ctrycode	11	12
Hausman test (χ^2)	4.12 (0.66)	2.71 (0.85)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

MFP, EPS, and "European" environmental provisions

FE	(1)	(2)	(3)	(4)	(5)	(6)
eps_fs	0.383**					
	(0.179)					
outputgap	0.0974**		0.104**		0.143**	
	(0.0456)		(0.0476)		(0.0596)	
Trend	-0.112***	-0.0593*	-0.113***	-0.0630*	-0.135***	0.0278
	(0.0349)	(0.0317)	(0.0352)	(0.0320)	(0.0495)	(0.0459)
L.eps_fs		0.409**				
		(0.164)				
L.outputgap		-0.0971*		-0.0896*		-0.138**
		(0.0519)		(0.0528)		(0.0592)
eps_mb			0.241*			
			(0.132)			
eps_nmb			0.145			
			(0.127)			
L.eps_mb				0.284**		
				(0.126)		
L.eps_nmb				0.134		
				(0.119)		
Ets					0.129	
					(0.227)	
tgemiss					-0.0675	
					(0.111)	
envtaxes					0.283	
					(0.397)	
Kyoto					0.542*	
					(0.303)	
tradeopen					0.00160	
					(0.0151)	
L.ets						0.736***
						(0.218)
L.tgemiss						0.0976
						(0.113)
L.envtaxes						0.732**
						(0.317)
L.kyoto						-0.228
						(0.270)
L.tradeopen						-0.0235
						(0.0145)
Constant	2.878***	1.249	2.954***	1.393*	3.304*	-1.344
	(0.858)	(0.817)	(0.874)	(0.837)	(1.690)	(1.423)
Observations	123	123	123	123	123	123
R-squared	0.093	0.111	0.095	0.116	0.093	0.184
Number of ctrycode	12	12	12	12	12	12

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Estimation results (i)

- EPS has a positive and statistically significant impact on labor productivity growth mainly driven by market-based measures.

- Market based environmental stringency measures positively affect both ICT and R&D capital accumulation.

- The synergy between Kyoto, ETS and ICT is positive and statistically significant : those countries that are relatively more ICT intensive had higher productivity returns from the commitment to the Kyoto agreement and the introduction of the ETS.

- The positive effect of EU environmental measures is robust also when we look at ICT capital accumulation: the emission target had a positive and significant impact.

- As for R&D both Kyoto and ETS had a negative and significant impact: the effect of environmental policies on R&D is somehow difficult to catch at least at aggregate level.

Estimation results (ii)

- Eventually, we investigate the relationship between a measure of Total Factor Productivity growth and our environmental policy indicators.

- TFP is positively and significantly affected by EPS, probably because of the positive influence of market based policy measures on growth.

- The introduction of the ETS has a positive impact on productivity too.

- This result supports the idea that the introduction of a “cap and trade” provision is an effective incentive to the country to reduce pollution thus stimulating innovation.

Preliminary conclusions and ….

- Our findings support the assumption that environmental stringency measures on average did not erode competitiveness in EU members but stimulated innovations and productivity.

- Market based provisions positively affected productivity growth both directly and indirectly via capital stocks thus being effective in shaping the productivity and innovativeness within EU.

- Command and control measures produce mixed results.

- A deeper analysis of the mechanisms through which environmental policy influenced productivity and innovativeness has potentially relevant implication to develop further the European environmental policy agenda.

……next steps

- Project for the *International Laboratory for Comparative Economic and Social Research -* workshop Moscow 18-22 April 2016.

- We will empirically investigate how the quality of institutions and trust in financial institutions affect the effectiveness of public policies in enhancing productivity and innovation - with a specific focus on environmental policy - in a sample of 11 European economies in the years 1995-2011.

- Our main assumption is that trust and the quality of institutions might work as catalyst for strengthening the effect of environmental policy on firms' productivity and propensity for innovation.

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