Taxation, tax incentives or public financing.How to successfully incentivize firms' green behavior?

J. Garcia-Quevedo
University of Barcelona
E. Martinez-Ros
Carlos III University of Madrid
K.B. Tchorzewska
University of Barcelona

MOTIVATION

Importance of Eco-Innovation

Introduction of any novel product, process, organizational change or marketing solution that either reduces the use of natural resources or decreases the release of harmful substances across the whole-life cycle. (Eco-Innovation Observatory, 2012)

Drivers of Eco-innovation:

- Institutional factors: role of government, public financing, normative pressures, cooperation, expanding market (Kesidou & Demirel, 2012; Chen et al., 2012)
- Management factors: adoption of certification, environmental culture, performance, efficiency (De Marchi, 2012; Horbach et al, 2012)

Novelty of our paper:

- unique database
- more detailed policy instrument, with a special focus on investment tax credits
- comparison of effectiveness of the policies between adoption of
- technology and private environmental R&D
- interaction of three policies (policy-mix)

EMPIRICAL MODEL

$$EcoInnov_{it} = \beta_0 + \beta_1 Ecoinnov_{it-1} + \beta_2 lnRD_{it-1} + \beta_3\, Taxes_{it-1} + \beta_4\, Subsidies_{it-1} + \beta_5 Tax\ Credit_{it-1} + \beta_6 Env\ Culture_{it-1} + \beta_7 Env\ Certif_{it-1} + \beta_8 Size_{it-1} + f_s + f_t + \epsilon_{it}$$

- unique data set from National Institute of Statistics of Spain (INE): "The Survey on Industry Expenditure on Environmental Protection"

balanced panel

- 1009 Spanish firms over 7 years (2008-2014)
- 30 manufacturing sectors
- 26 different expenditure variables related to environmental protection
- at least 10 remunerated employees

THEORETICAL MODEL

- Emission tax already in place and firms have an option to apply for a subsidy:
  - $\Pi 1 = y - c - t$
  - $\Pi 2 = y - \hat{c} - \text{ŧ} - I$
  - $\Pi 3 = y - \hat{c} - \text{ŧ} - I + sI - e$
- Assumptions:
  - $c > \hat{c}$ for CP, $c = \hat{c}$ for EP \\
  - $t > \text{ŧ}$ for both CP and EP
  - s belongs to [0,1]
  - $e \geq 0$
- t=[1,2] where, in t=1 firm decides to invest in green technology or not, in t=2 firm produces with a resulting technology

- $\Pi 31 + \beta \Pi 32 > \Pi 21 + \beta \Pi 22$
- $I > \frac{e}{s}$
- $I < \frac{c - \hat{c} + t - \text{ŧ} + \beta(c - \hat{c} + t - \text{ŧ}) - e}{1-s}$

RESULTS I

Results: End of Pipe Technologies

	(1) FE	(2) FE	(3) Logit	(4) Logit
ln(taxes)	-0.02	-0.02	-0.00	-0.00
	(0.02)	(0.02)	(0.00)	(0.00)
dsubsidies	1.16**	1.19**	0.37*	0.38*
	(0.56)	(0.56)	(0.19)	(0.19)
dtcredits	1.30**	1.40**	0.40*	0.39*
	(0.69)	(0.69)	(0.20)	(0.20)
dECult	1.79**	1.88**	0.81**	0.81**
	(0.76)	(0.76)	(0.34)	(0.34)
dECert	0.00	0.02	-0.04	-0.05
	(0.48)	(0.48)	(0.16)	(0.16)
size	0.00**	0.00**	0.00**	0.00**
	(0.00)	(0.00)	(0.00)	(0.00)
N	6,995	6,995	4,341	4,342
year FE	x	x	x	x
firm FE	x		x	
sector FE		x		x
R squared	0.02	0.01		
Log Likelihood			-1531	-1552

Note: Standard errors shown in parentheses. All standard errors are robust to sector heteroskedasticity. *** denotes significance at the 99% level, ** denotes significance at the 95% level and * denotes significant at the 90% level.

Taxation, tax incentives or public financing.How to successfully incentivize firms' green behavior?

J. Garcia-Quevedo
University of Barcelona
E. Martinez-Ros
Carlos III University of Madrid
K.B. Tchorzewska
University of Barcelona

RESULTS II

Results: Cleaner Production Technologies

	(1) FE	(2) FE	(3) Logit	(4) Logit
ln(taxes)	0.03	0.03	0.01	0.01*
	(0.02)	(0.02)	(0.01)	(0.01)
dsubsidies	1.30**	1.25**	0.36**	0.35*
	(0.59)	(0.60)	(0.18)	(0.18)
dtcredits	3.37***	3.32***	0.95***	0.94***
	(0.72)	(0.72)	(0.16)	(0.22)
dECult	0.56	0.57	0.08	0.09
	(0.66)	(0.66)	(0.28)	(0.28)
dECert	1.26**	1.28**	0.49***	0.49***
	(0.51)	(0.51)	(0.16)	(0.16)
size	0.00**	0.00**	0.00**	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
N	6,995	6,995	4,535	4,535
year FE	x	x	x	x
firm FE	x		x	
sector FE		x		x
R squared	0.01	0.01		
Log Likelihood			-1692	-1678

Note: Standard errors shown in parentheses. All standard errors are robust to sector heteroskedasticity. *** denotes significance at the 99% level, ** denotes significance at the 95% level and * denotes significant at the 90% level.

RESULTS III

Results: Policy Interaction Terms

	ICP	ICP	IEP	IEP
dtax	0.51	0.55	-0.54	-0.54
	(0.42)	(0.43)	(0.41)	(0.41)
dsub	1.03	0.97	0.89	0.92
	(0.75)	(0.75)	(0.70)	(0.69)
dtcred	4.41***	4.30***	-0.05	-0.01
	(0.99)	(0.99)	(0.92)	(0.93)
dtax*dsub	2.25	2.26	-1.08	-1.14
	(1.40)	(1.40)	(1.39)	(1.40)
dtax*dtcred	-1.71	-1.61	2.39*	2.35*
	(1.39)	(1.40)	(1.32)	(1.33)
dsub*dtcred	-1.35	-1.29	2.75	2.65
	(1.69)	(1.70)	(1.75)	(1.76)
dtax*dsub*dtcred	-2.95	-2.98	1.13	1.25
	(2.60)	(2.60)	(2.90)	(2.91)
other controls	x	x	x	x
N	6,997	6,997	6,997	6,997
time fixed effects	x	x	x	x
firm fixed effects	x		x	
sector fixed effects		x		x

Note: Standard errors shown in parentheses. All standard errors are robust to sector heteroskedasticity. *** denotes significance at the 99% level, ** denotes significance at the 95% level and * denotes significant at the 90% level.

Cleaner Production
positively correlated only with tax credits.

End-of-pipe technologies
positively correlated with an interaction term of pollution taxation and tax-credit.

DISCUSSION

Robustness Analysis

- using an internal measure of eco-innovation: private R&D
- controlling for mutual endogeneity
- using only technologies and policies relevant for air-pollution
- using an unbalanced dataset
- using a different time frame to avoid imputed variables (2010-2014)
- using dynamic models

CONCLUSIONS

Contribution:

how do taxation, public financing, tax incentives and their mix affect adoption of different types of environmentally friendly technologies

Main results so far:

- investment tax credit important and much more strongly correlated for cleaner production technologies than for end-of-pipe technologies
- public financing is also relevant
- ambiguous results of pollution taxation - correlated with eco-innovation only when controlling for mutual endogeneity and for 2010-2014 time period (scope for further research)
- policy interaction terms: tax incentive relevant for CP, while for EP – a combination of tax credit with taxation
- public financing and taxation ineffective at encouraging private environmental R&D