

ENVIRONMENTAL INNOVATIONS DIFFUSION AND ECONOMIC PERFORMANCES
IN REGIONAL CONTEXTS



UNIVERSITY
OF FERRARA

- EX LABORE FRUCTUS -



- Ecological Economics
- Regional studies
- Innovation economics



EMILIA ROMAGNA

kilometres



5 millions inhabitants, GDP per capita 33,000€, 18% italian industry GDP

Outline

- Assessment of the topic and objectives
- Literature review and research hypotheses
- Methods and Data
- Results
- Conclusions

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Agglomeration economies, Eco-innovation and Economic Performance

The main aims of this work are the following:

- (i) to assess whether agglomeration economies in regional systems represent a pre-condition for eco-innovations (EIs) diffusion
- (ii) to investigate whether EIs are integrated with other techno-organisational strategies
- (iii) to analyse whether EIs – in integration with other innovations – impact on firm's productivity and profitability performances.

Background works in the agenda

- Cainelli et al. (2012) – **Industry and Innovation**
 - On the networking and foreign ownership relationship with Eco innovations
- Costantini et al. (2013) – **Ecological Economics** –
 - On the sector regional environmental and innovation performances
- Antonioli et al. (2013) – **Research Policy**
 - On complementarity between eco innovations and organizational change
- Hall, Lotti and Mairesse 2012 EINT (also NBER), paper on Italian innovation drivers and performances

The sustainability and competitiveness of the Italian Economy

- Low Productivity growth since 2000
- Mixed environmental results
- Mixed innovation results
- Still industrial and innovative
 - Especially in some regions

Labor productivity, 1997-2008, EU27 = 100

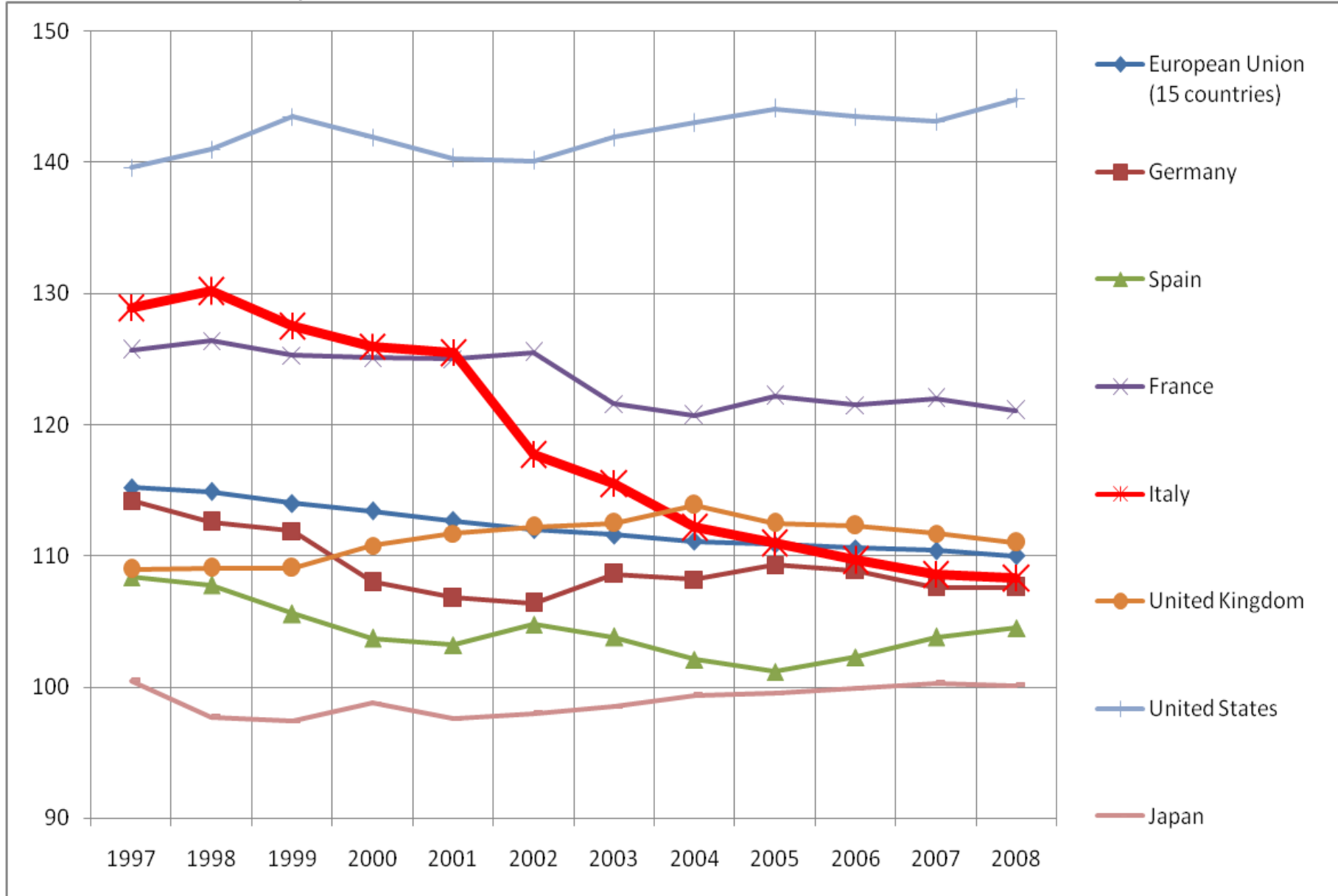
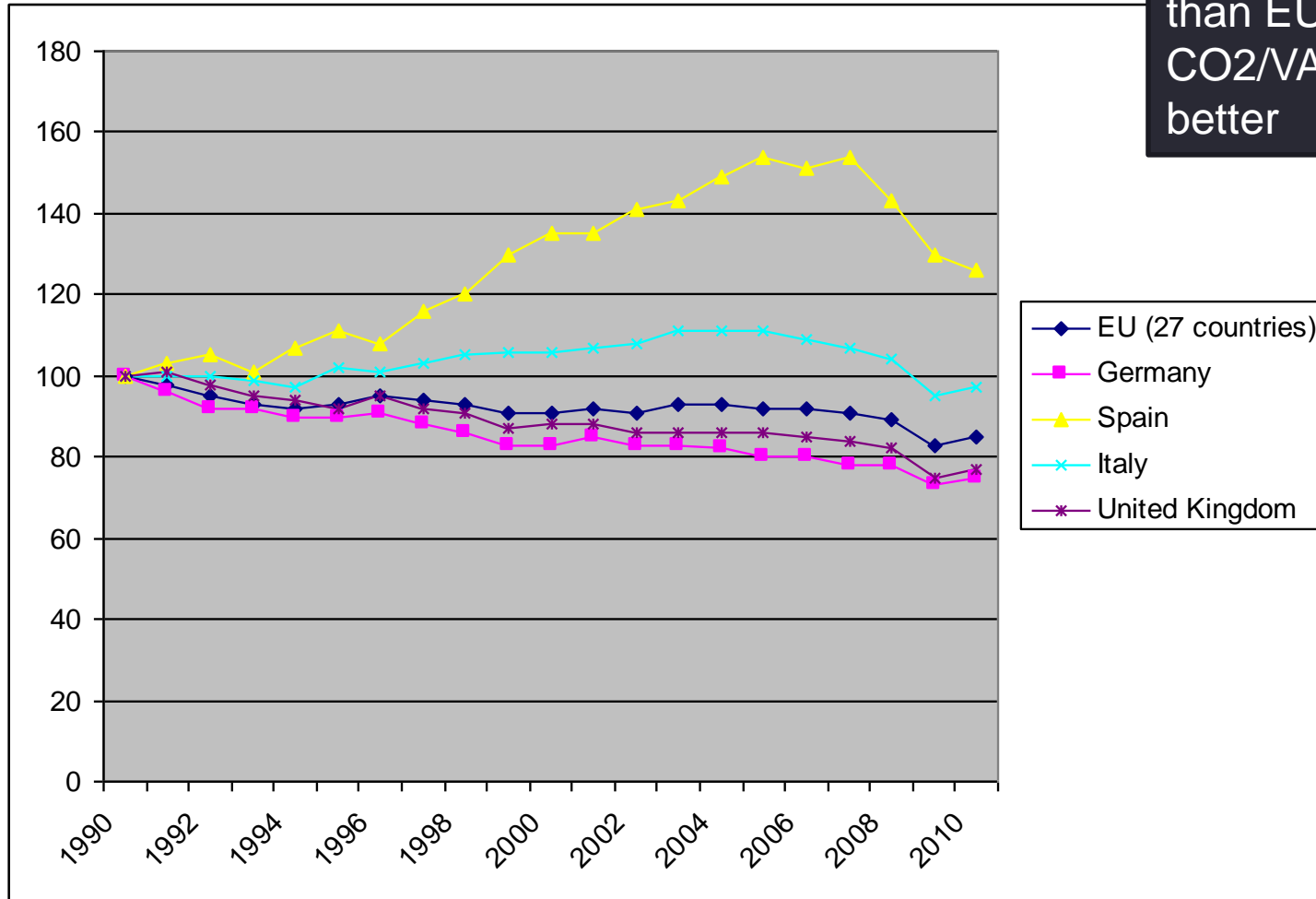
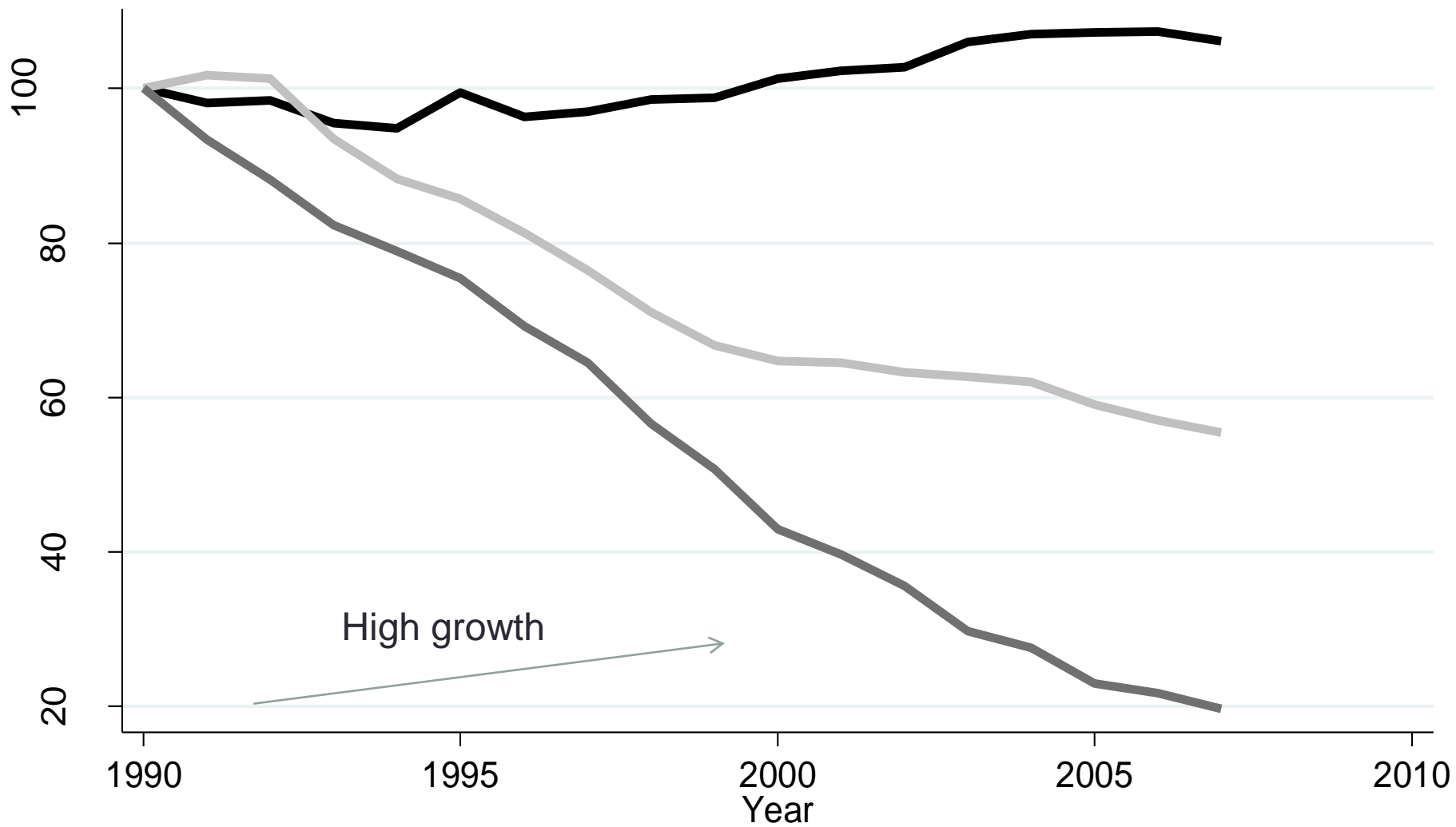


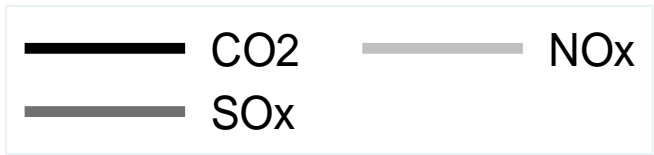
Figure 1 - GHG trends (1990 =100), source EUROSTAT



Some industrial sectors are higher than EU average, CO2/VA figures are better



ITALY



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EIs and agglomeration economies in regional settings

Despite very recent works, (Horbach, 2013) the analysis of EIs in regional settings is overlooked

Recently, in line with the increasing EU emphasis on climate change and resource efficiency (following the EU roadmap launched in 2011), great relevance has been assigned to the role of EIs and their diffusion at sector and spatial levels

In the sustainability transitions literature the role of national level has been overemphasised at the expenses of other geographical levels (Truffer and Coenen 2012)

Bernhard Truffer & Lars Coenen (2012): Environmental Innovation and Sustainability Transitions in Regional Studies, *Regional Studies*,

- *‘Much of the sustainability transitions literature can be criticized for being spatially blind and for (implicitly) overemphasizing the national level at the expense of other geographical levels. More specifically, the role of regions in sustainability transitions has received little attention in this literature’.*

The economics of agglomeration

- **endogenous growth theories** (Romer, 1986, 1990; Lucas, 1998): the role of **knowledge spillovers** for enhancing technological change and long-run economic growth;
- **technological spillovers** not only generate **externalities** and thus economic growth, but also tend to be **spatially bounded**;

The economics of agglomeration

- **spatial proximity**, stimulates face-to-face interactions between economic agents;
- the spread of **ideas, information** and of different **types of knowledge** within a local system;
- a positive impact on firm level employment and productivity but also on local growth;

The economics of agglomeration

«the cramming of individuals, occupations, and industries into close quarters provides an environment in which ideas flow quickly from person to person» (Glaeser et al. 1992)

Agglomeration economies: theoretical insights

two main types of agglomeration economies:

- localisation externalities;
- Jacobs' externalities.

Agglomeration economies: localisation externalities

- **localisation externalities** arise from the spatial concentration of firms in **the same industry**;
- the idea that firms **belonging to the same industry** can benefit from **spatial proximity** refers to the **industrial district argument** proposed by Marshall (1920) and formalised by Glaeser *et al.* (1992), extended by the contributions of Arrow (1962) and Romer (1986), the **so-called Marshall-Arrow-Romer (MAR) model**;

Agglomeration economies: localisation externalities

- The **MAR model** shows that the concentration of an industry in a spatially defined area facilitates **the (tacit) transmission of information among economic agents**, promoting both **knowledge spillovers** among firms and **incremental and process innovations**;

Agglomeration economies: localisation externalities

- firms can be expected to learn more from other firms in the same industry due to **intra-industry knowledge spillovers** (van der Panne and van Beers, 2006);
- localisation externalities are **external to the firm**, but **internal to the industry**;

Agglomeration economies: Jacobs' externalities

- **Jacobs' externalities** (Jacobs, 1969) are **external to both firm and industry** and arise from the **diversity and variety** of the regional economic structure;
- **Jacobs' externalities** result from the spatial agglomeration of firms **belonging to different industries**, in the form of intra-industry knowledge spillovers (Frenken *et al.*, 2007; Baltzopoulos, 2009).

Agglomeration economies: empirical evidence

- several papers have investigated **the empirical relationship** between **spatial agglomeration** and **employment and productivity growth** at the **local** and **firm** levels;
- these findings are **conflicting** and **generally inconclusive**;

Eco Innovations

MEI (Measuring Eco-Innovation) research project eco-innovation is defined as

- *“the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organisation (developing or adopting it) and which results, throughout its life-cycle, in a reduction of environmental risks, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives”.*

- Stern 2006 review on the Economics of Climate change
 - Mitigation of CO₂ / policy design
 - **Technological development**
 - Behavioral change

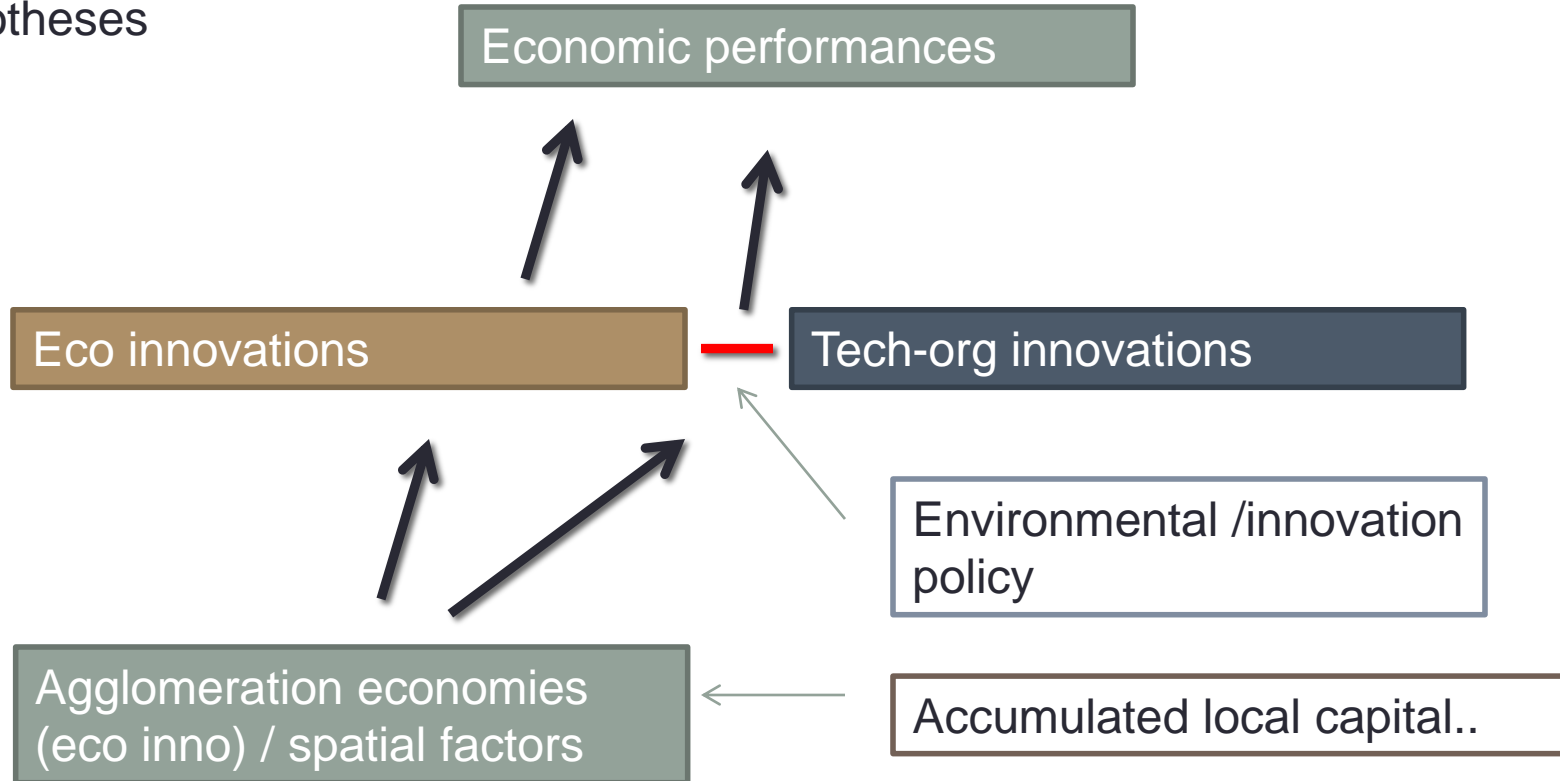
EIs and firms' economic performance

- The literature on EIs effect on economic performance is recent and heterogeneous
- On the heels of the work by Porter (Ambec et al., 2010; Ambec and Barla, 2006; Ambec and Lanoie, 2008), researchers have traditionally looked at the competitiveness effects of EI adoption in the heavier manufacturing sectors
- Part of the works focus on regulation-induced EIs, finding mixed results (Lanoie et al, 2011; Rexhauser and Rammer 2011).
- Other works measure EIs through the use of green-patents (Lotti and Marin 2013) finding an EIs lower impact on productivity with respect to other innovations

Setting the hypotheses

- **[H1]** *The degree of closeness of firm j to other firms that adopt EIs might influence the adoption of EI in firm j (knowledge transfer and the presence of homogeneous institutional conditions in a given territory)*
- **[H2]** *The adoption of product and process EIs by firms might enhance the competitiveness of productive organisations through value creation and efficiency achievements.*
- **[H3]** *The more EIs are correlated to other techno-organisational strategies of the firm, the higher the probability that economic performances are positively influenced*

Sketching the papers'
(and other's)
hypotheses



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Data

Survey

- Manufacturing firms with at least 20 employees located in the Emilia-Romagna region
- Questionnaires was administered in 2009
- The respondents were firms' managers
- The number of respondents is 555
- Sample stratified by sector, size and geographical location

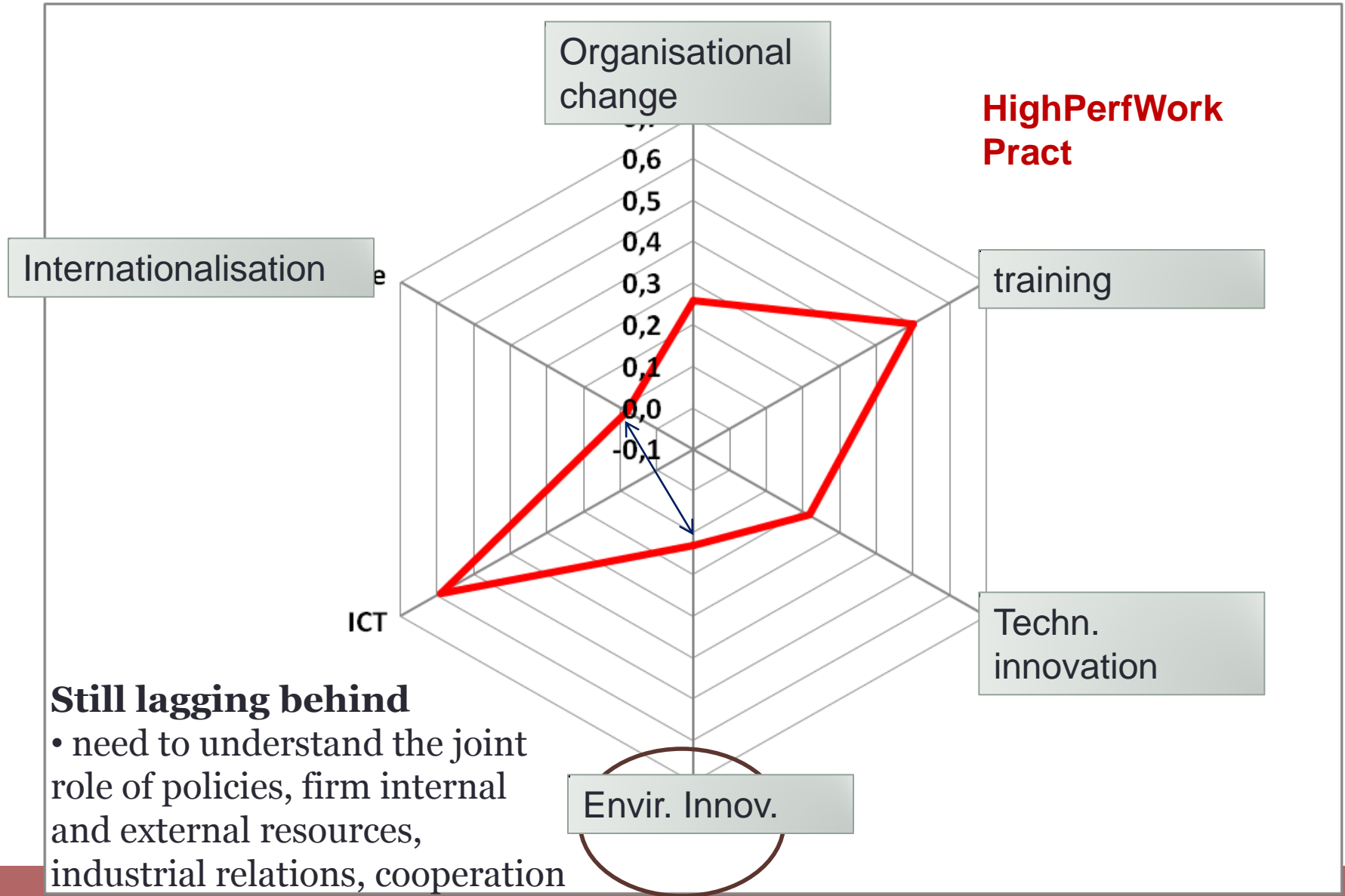
Population and sample

Firms with more than 20 employees	Firm population		Interviewed sample	
		%		%
Food	382	9,39	49	8,83
Textile and clothing	355	8,73	35	6,31
Wood, pulp and paper, publishing and printing	434	10,67	47	8,47
Rubber and plastic products	342	8,41	56	10,09
Non-metallic mineral products	285	7,01	42	7,57
Basic metals and metal products	883	21,71	94	16,94
Machinery	1387	34,10	232	41,80
Total	4068	100,00	555	100,00

Population source: Aster ER Region (2009), on Istat data (2008)

We need to understand the weight of eco innovations

Environmental innovations adoption in industrial firms



Internationalisation

HighPerfWork
Pract

training

Techn.
innovation

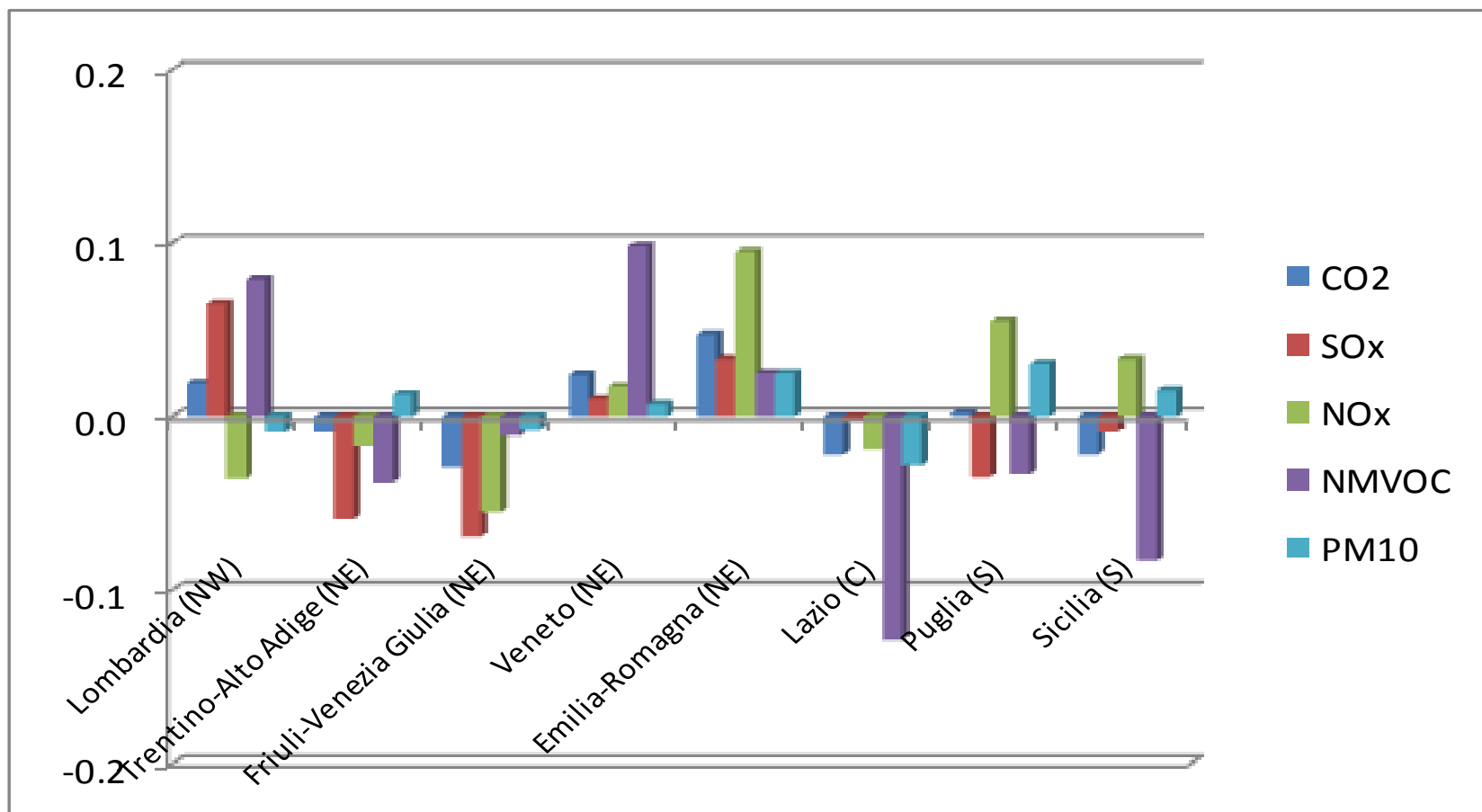
Envir. Innov.

Still lagging behind

- need to understand the joint role of policies, firm internal and external resources, industrial relations, cooperation

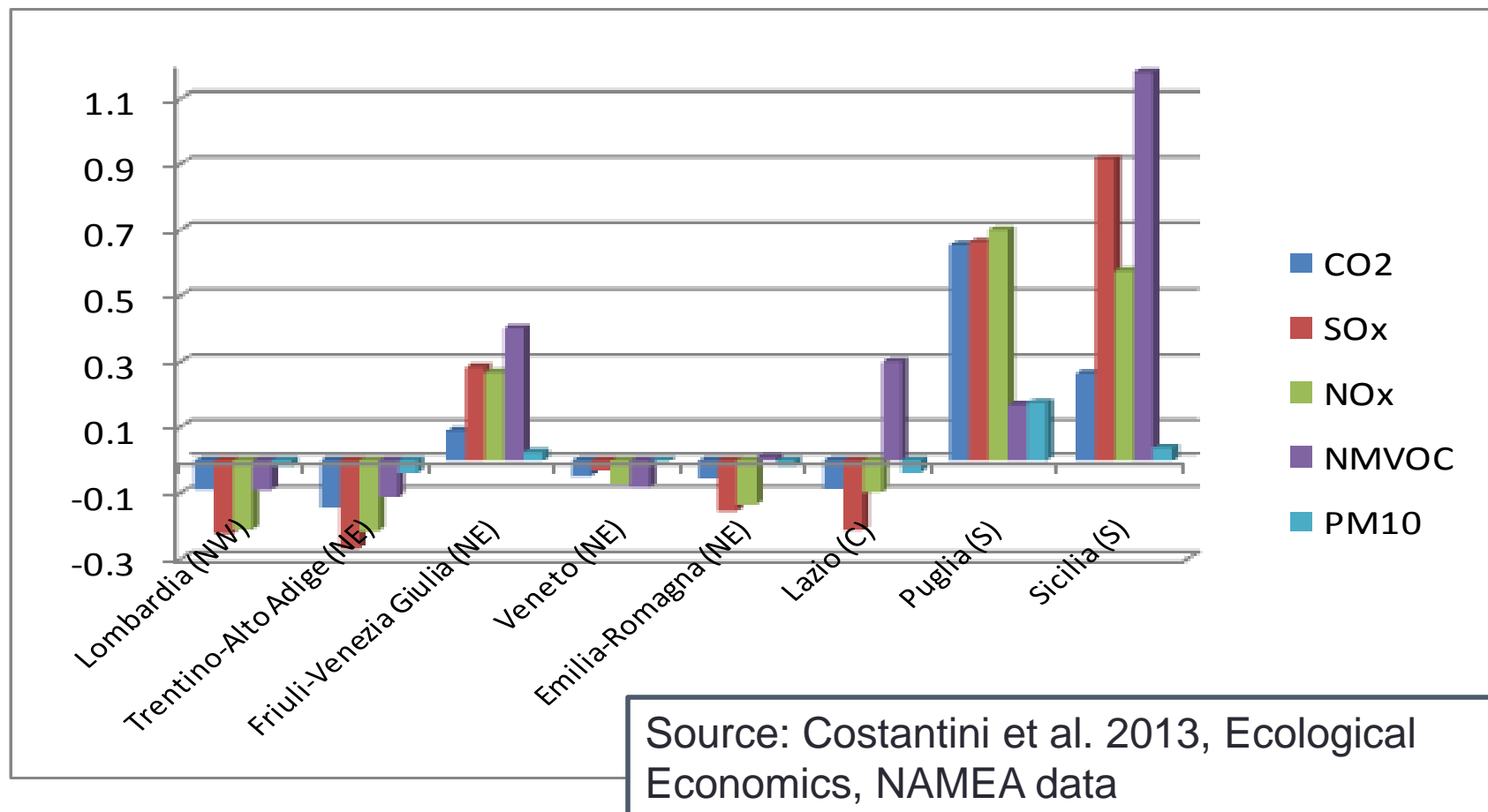
Data

- Why Emilia-Romagna?
- Shift share analysis - Regional gaps in terms of productive structure (**structural component**). Negative values represent performances better than the national average



Data

- Why Emilia-Romagna?
- Shift share analysis - Regional gaps in terms of efficiency of production (**efficiency component**). Negative values represent performances better than the national average



Data

Balance sheets

- Information retrieved by the AIDA-Bureau van Dijk
- Information on about 28,000 firms matched with the survey sample
- Economic performance indicators collected: output per employee; value added per employee and revenues per employee
- Missing values in accounting variables are treated using the STATA interpolation method --> 529 observations after cleaning procedure

Dependent variables

Variable	Construction
<u>Dep. First Stage</u>	
EI	Dummy: 1 if firms introduced an environmental innovation; 0 otherwise
OrgProd	Dummy: 1 if firms introduced a production-organisation innovation; 0 otherwise
Orglab	Dummy: 1 if firms introduced a labour- organisation innovation; 0 otherwise
Proc	Dummy: 1 if firms introduced a process innovation; 0 otherwise
Prod	Dummy: 1 if firms introduced a product innovation; 0 otherwise
<u>Dep. Second Stage</u>	
VAEMP09	<i>Value added per capita (in log) in 2009</i>
VAEMP10	<i>Value added per capita (in log) in 2010</i>
OUTPUTEMP09	<i>Output per capita (in log) in 2009</i>
OUTPUTEMP10	<i>Output per capita (in log) in 2010</i>
REVEMP09	<i>Revenues per capita (in log) in 2009</i>
REVEMP10	<i>Revenues per capita (in log) in 2010</i>

Covariates

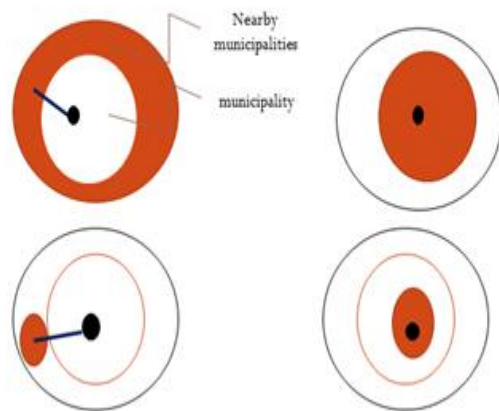
Variable	Construction
Covariates/ controls	
Size dummies	Size dummies by employee: size_1 20-49 empl.; size_2 50-99 empl.; size_3 100-249 empl.; size_4 > 249 empl.
Sector dummies	Sector dummies based on two digit NaceRev.1 classification (Food, Machinery, NonMetallicMineralProd, CokeChemical, WoodRubberPlasticOther, Textile, Shoes, PaperPrinting, Metallurgy). Sectors were grouped according to the RAMEA grouping.
Geographical dummies	Dummies of geographical location of the firm: NUTS 3 territorial units (9 provinces excluded extra region firms) were grouped into 3 clusters: CentralProv, EastProv, NearBordersProv
Export	Percentage of turnover made on international markets
FDI_BRIC	Dummy: 1 if firm invested in BRIC countries; 0 otherwise
VAEMP0305	Average value added per capita (in log) on the period 2003-2005
CO2_VA_PROV	CO2 emissions/Value Added by Province
R&D	Dummy: 1 if firm invested in R&D; 0 otherwise

First 'stage' specification: probit and multivariate probit

- (1) $EI_i = c + a1(CONT)_i + a2(Share_EI_Municipality)_i + e_i$

Different shares of EIs diffusion calculated in 4 ways:

- We calculated the share of eco innovating firms in 4 ways



1 contiguous municipality all sectors (left-up), 2 contiguous municipality all same sector (left-down), 3 same municipality all sectors (right-up), 4 same municipality same sector (right-down)

Second 'stage' specification

$$(2) \text{PERF}_{i,t} = c + b1(\text{CONT})_{i,t-1} + b2(\text{EI_FITTED})_{i,t-1} + b3(\text{INNO})_{i,t-1} + u_{i,t-1}$$

Where EI_FITTED refers to the fitted values of the probability to introduce an eco-innovation retrieved from the first step of analysis.

The use of a multivariate probit that jointly considers as dependent variables in the first step other binary innovation variables along with EI (OrgProd, OrgLab, Proc and Prod) allows us to fit the probability to jointly introduce EIs and all the other innovations

In our analysis EI_FITTED is the probability of introducing EI, jointly EI and OrgProd, jointly EI, OrgProd, OrgLab, Proc and Prod.

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Results from the first step: multivariate probit

	Multi-Probit [^]				
	EI	Proc	Prod	OrgProd	OrgLab
R&D	-0,0918	0.622*	0.853***	0,241	0,129
Train_Cov	1.028***	0.339*	0,227	0,282	1.410***
ICT	0,644	1.078***	0.607*	0.748*	1.485***
FDI_BRIC	0,164	-0,0232	0,367	0,163	0,16
Share_EI_Municipality	4.688***	-0,106	-0,0884	0,273	0,464
VA_EMP0305	1.536***	0,38	-0,021	0.584*	0,295
CO2_VA_PROV	-0,525	0,0134	-0,247	0,0148	0,029
Export	0,152	0,12	0.454*	0,213	-0,408
Size (d)	Yes	Yes	Yes	Yes	Yes
Sector (d)	Yes	Yes	Yes	Yes	Yes
Geo (d)	Yes	Yes	Yes	Yes	Yes

We have also run simple probit and a set of bi-probit in order to get information on the simultaneous adoption of EI with each other innovation variable selected: OrgProd; OrgLab; Proc and Prod;

*, **, *** significant at 10%, 5%, 1% respectively

Discussion of main results

- More and better trained workers are likely to be also more productive, which may spur the adoption of EIs by the firm, thus possibly generating a virtuous circle (no direction of causality detected because of cross-sectional data)
- The result of `Share_EI_Municipality` suggests the existence of a positive spillover effect of EIs within the municipalities in ER: being located in a municipality with a higher share of EIs enhances the probability of each firm's adoption of EIs

Results from the second step: OLS

	OLS [^]		
	VAEMP2010	OutputEMP2010	RevenuesEMP2010
EI_fitted (probit)	0.030 (0.072)	0.183** (0.074)	0.160* (0.088)
EI_fitted (bi_probit: Probability of jointly introduce EI and OrgProd)	0.039 (0.085)	0.222** (0.094)	0.189** (0.095)
EI_fitted (multi-probit: Probability of jointly introduce EI, OrgProd, OrgaLab Proc and Prod))	0.044 (0.125)	0.326** (0.128)	0.286* (0.154)
Inno*	Yes	Yes	Yes
Size (d)	Yes	Yes	Yes
Sector (d)	Yes	Yes	Yes
Geo (d)	Yes	Yes	Yes

*The Inno set of covariates changes according to the fitted EI (e.g. fitted EI from biprobit represents the probability of jointly introduce EI and OrgProd, hence OrgProd is not included in Inno set of covariates);

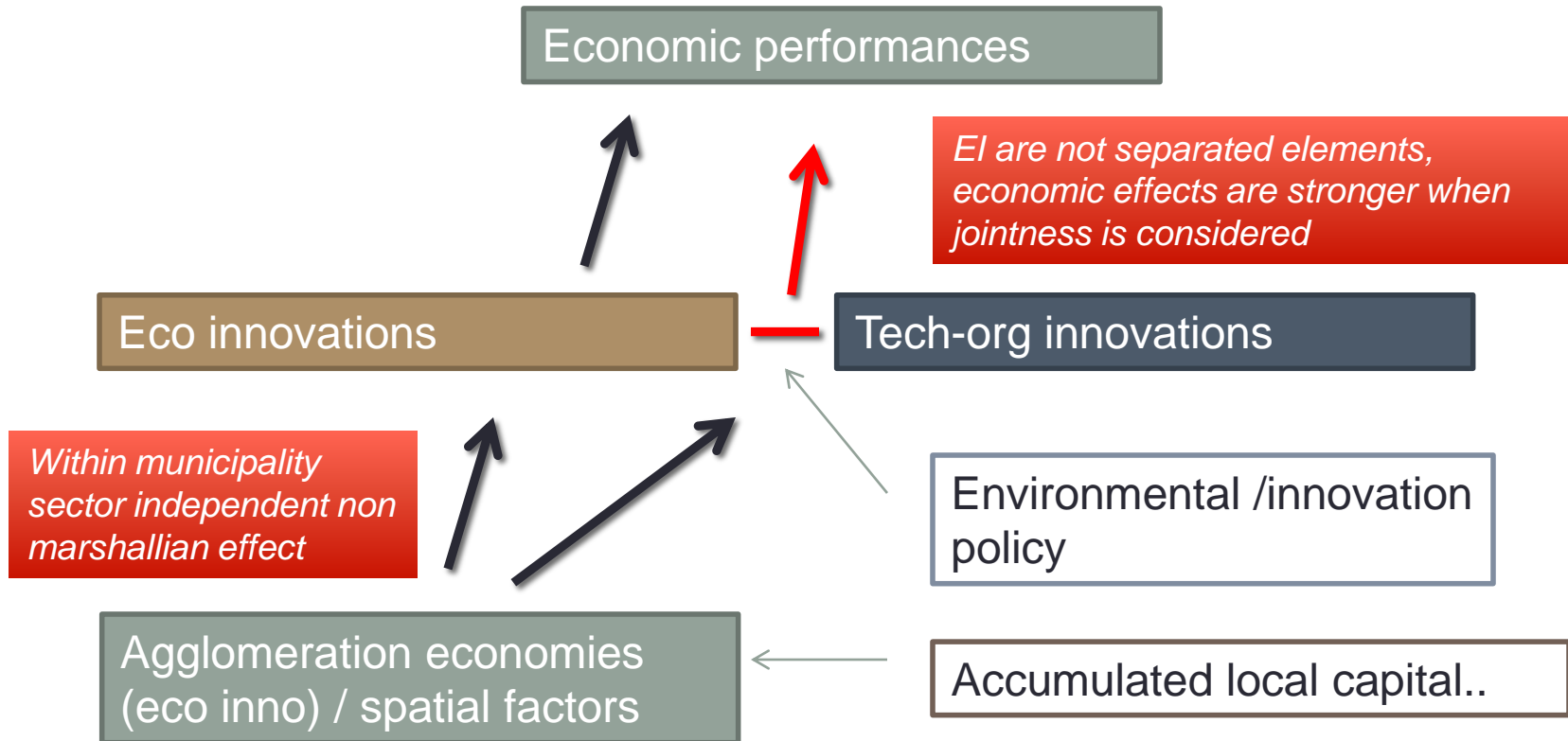
[^] *, **, *** significant at 10%, 5%, 1% respectively; Bootstrapped std in parenthesis

Discussion of main results

- EIs turn out to be positively and significantly correlated to two of the three economic performance variables (production volume per employee and revenues per employee).
- The EIs relations with economic performance is stronger when the EIs fitted values represent the probability of jointly introduce EIs with other innovations (OrgProd, OrgLab, Prod and Process)

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Concluding remarks

- Local conditions seem to play a substantial role: firms that are located in the same municipality of more eco innovative firms tend to adopt eco innovations with higher probability

--> H1 is supported

- EIs also tend to be adopted in correlation to some other firm's techno-organisational strategies (in particular with changes in production organisation)
- The productivity performances of firms tend to be higher for enterprises that jointly adopt EIs *and* other innovation, especially organisational innovations

-->H2 and H3 are supported

Further steps

- Constructing and using other measures of agglomeration:
 - geographical distance (we know the location differently from CIS)
 - Local labour systems (as sensitivity tests)
- Extending the period over which accounting variables are measured

Putnam and Municipalities

He comments on the 'roots of civic community' and civic legacies of medieval Italy. He stresses that 'although regional governments were established in 1970 [...] the regions themselves had far deeper historical roots. Italy had been since the fall of the Roman world and especially after the dark ages a 'geographical expression, a congeries of small city-states' (p. 121).

If on the one hand fragmentation leads to economic backwardness, Putnam argues that this has not always been the case: innovative political structures also emerged over those centuries.

In the towns of Northern Italy, unprecedented forms of self-government emerged over 1000-1500 a.c. The new form of political and social organisation of life even in economic terms was the 'commune', that is the municipality.

In the words of Putnam (1993, p.124), *'by the twelfth century communes has been established in Florence, Venice, Bologna, Genua, Milan and virtually all the other major towns of northern and central Italy, rooted historically in these primordial social contracts'. As communal life evolved, craftsmen and tradesmen were of key importance for the development of those areas. Mostly relevant 'to provide self-help and mutual assistance of social as well as for strictly occupational purposes'* (p.125).