Environmental Innovations and Profitability: How does it pay to be green?

An empirical analysis on the German innovation survey

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Seminar at UniFE

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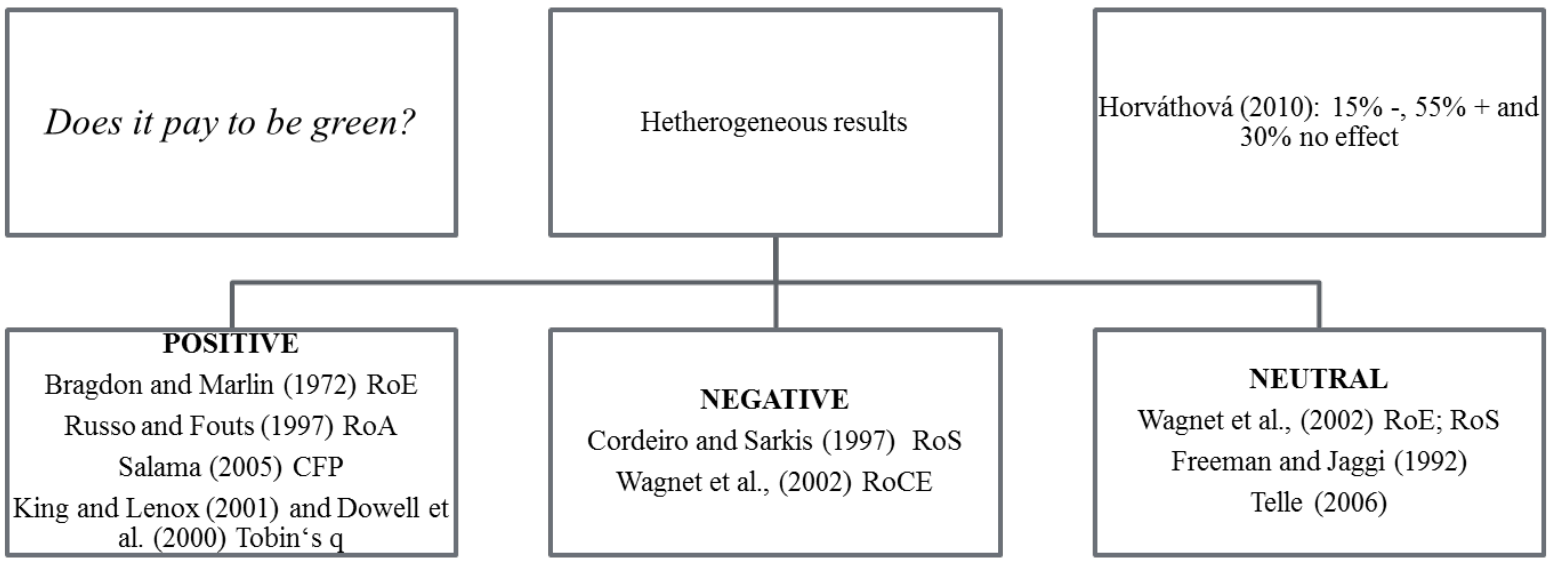

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It pays to be green

- Bragdon and Marlin (1972) Returns on Equity (ROE) in the pulp and paper industry
- Russo and Fouts (1997) Returns on Assets (ROA)
- Salama (2005) Corporate Financial Performance
- King and Lenox (2001) and Dowell et al. (2000) Tobins q index.
  - King and Lenox (2002) positive correlation between financial and environmental performance were driven by the waste prevention methods.
- Hart and Ahuja (1996) ROS and ROA: one year; ROE two years before financial performance was positively affected.
- Al Tuwaijri et al. (2004) Three Stages Least Squares
  - to overcome the simultaneity problem, i.e. that environmental and economic performance are jointly determined and jointly depending on the unobservable firms management strategy

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It does not pay to be green

- Cordeiro and Sarkis (1997), ROS short-term negative effects, which were stronger for pollution prevention strategies than for end-of-pipe measures.
- Wagner et al., 2002 Return on Capital Employed (RoCE) Eu paper industry, simultaneous structural model: - effect
  - but when adopting ROE or ROS, the effect was no longer significant
- Elsayed and Paton (2005) misspecification issues: unobserved firms fixed effects.
  - static and a dynamic panel analysis on UK data: only a weak impact on the financial performance
- Telle (2006) the conclusion that it pays to be green is premature.
  - random effect panel model vs a pooled OLS one
- the question is no longer *if* it does pay to be green, rather *when* or *for whom* it pays (Telle, 2006; King and Lenox, 2001).

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Environmental Innovations

Consensus has emerged on the notion of EI
(e.g. Kemp and Pearson 2007; Kemp, 2010; Rennings, 2000),
:
the production, assimilation or exploitation of a product, production process, service or management or business methods
that is novel to the firm [or organization]
and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use)
compared to relevant alternatives .

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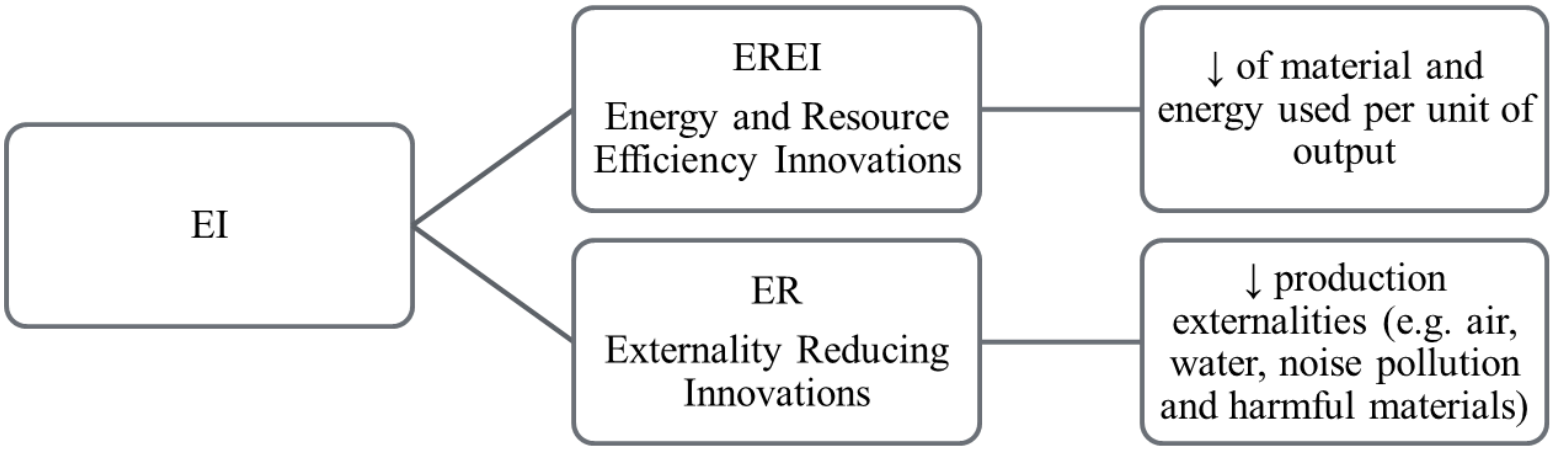
Types of Environmental Innovations



- EREI differ from ER either in the drivers (e.g. EREI benefit more from the use of external information sources) or in the productivity (sales over employees) or in the role of barriers to innovation, which are perceived as more intense for EREI than for other EI (Rennings and Rammer, 2011).

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Research Hypothesis

- **RQ1:** Do different typologies of EI engender heterogeneous competitiveness effects?
  - *EREI positive* effect on profitability, as lead to a reduction in the use of physical resources and can be a source of competitive advantage (NRBV Hart, 1995)
  - *ER* neutral or negative effect on profitability, add-on measures that do not fundamentally modify production processes
- **RQ2:** Do the motivations driving firms' adoption of EI moderate EI profitability gains?
  - Current or forseen regulation *REG* might be beneficial and stimulate competitiveness (Porter Hypothesis)
  - Availability of financial incentives *GR* might be provided for innovations that are not profitable on their own
  - Voluntary codes or agreements for environmental good practices *VOL* might be leading to cost savings innovation rather than cost-burden ones

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Dataset

- Mannheim Innovation Panel German Community Innovation Suvey
- PATSTAT
- Waves merge 2009 and 2011
- The focus of the survey is on firms with 5 or more employees in manufacturing and service sectors
- EI variables are not however panel: only 2009 wave (for 2006 2008 time frame) contains questions on the adoption of EI **cross sectional analysis**

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Econometric Strategy

To Test HP1

1. $OM_i = \alpha + \beta_1 EI_i + \beta_2 MS_i + \beta_3 HHI_i + \beta_4 SIZE_i + \gamma\ SECT_i + \epsilon_i$
2. $OM_i = \alpha + \beta_1 EREI_i + \beta_2 ER_i + \beta_3 MS_i + \beta_4 HHI_i + \beta_5 SIZE_i + \gamma\ SECT_i + \epsilon_i$
3. $OM_i = \alpha + \beta_1 EREI + \beta_2 ER_i + \beta_3 MS_i + \beta_4 HHI_i + \beta_5 SIZE_i + \beta_6 RD_i + \beta_7 LPAT_i + \beta_8 PC_i + \gamma\ SECT_i + \epsilon_i$
4. $OM_i = \alpha + \beta_1 EREI + \beta_2 ER_i + \beta_3 MS_i + \beta_4 HHI_i + \beta_5 SIZE_i + \beta_6 RD_i + \beta_7 LPAT_i + \beta_8 PC_i + \beta_9 EAST_i + \gamma\ SECT_i + \epsilon_i$

To Test HP2

1. $OM_i = \alpha + \beta_1 EREI\_REG_i + \beta_2 ER\_REG_i + \beta_3 EREI\_NOREG_i + \beta_4 ER\_NO\ REG_i + \beta_5 MIXED\_REG_i + \gamma\ CONTROLS_i + \epsilon_i$
2. $OM_i = \alpha + \beta_1 EREI\_VOL_i + \beta_2 ER\_VOL_i + \beta_2 EREI\_NOVOL_i + \beta_3 ER\_NOVOL_i + \beta_5 MIXED\_VOL_i + \gamma\ CONTROLS_i + \epsilon_i$
3. $OM_i = \alpha + \beta_1 EREI\_GR_i + \beta_2 ER\_GR_i + \beta_3 EREI\_NOGR_i + \beta_4 ER\_NOGR_i + \beta_5 MIXED\_GR_i + \gamma\ CONTROLS_i + \epsilon_i$

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Dependent Variable

- Firm profitability measured as the estimated operating margin OM pre tax profits over sales.
  - To reduce non-responses answers are given on an interval scale
- As OM is categorial with known thresholds:
  - interval regression model: Maximum Likelihood that allows to model fixed cut points (Wooldridge, 2002)

OM	Freq.	Percent
< -5%	60	5.64
-5% to 2%	38	3.57
-2% to 0%	59	5.55
0% to 2%	156	14.68
2% to 4%	161	15.15
4% to 7%	216	20.32
7% to 10%	150	14.11
10% to 15%	127	11.95
>15%	96	9.03
Total	1063	100

Key Environmental Variable

Environmental Process Innovations	Share of EI with low, medium or high environmental benefits	Share of EI with high env. benefits	Type of EI
Reduced Material per unit of output	37%	5%	EREI
Reduced energy per unit of output	44%	6%	EREI
Reduced CO_2 footprint	34%	6%	EREI (*)
Reduced air pollution	24%	4%	ER
Reduced water pollution	24%	4%	ER
Reduced soil pollution	15%	2%	ER
Reduced noise pollution	24%	2%	ER
Replaced dangerous materials	24%	4%	ER
Recycled waste, water or materials	39%	5%	None (**)

- Focus on those with high effects.
- Check for those with high and medium effects

Variables Descriptive Statistics

	Description	Year	N	Mean	δ	Min	Max
OM	Estimated Operating Margin, i.e. profit before taxes on income as a percentage of turnover	2010	1063	5.614	2.123	1	9
EREI	Energy, Material and CO2 reduction process innovations with high environmental benefits	2006-2008	1063	0.106	0.308	0	1
ER	Externality reducing process innovations with high environmental benefits	2006-2008	1063	0.104	0.306	0	1
EAST	Eastern Germany Location	2008	1063	0.332	0.471	0	1
SIZE	Natural Logarithm of employees corrected for the part time workers	2008	1063	4.028	1.577	0.41	10.27
RD	Engagement in internal or external R&D activities	2006-2008	1063	0.485	0.500	0	1
PC	Process Innovators	2006-2008	1063	0.394	0.489	0	1
HHI	Herfindahl concentration index at 3 Digit (German Monopoly Commission GMC)	2007	1063	46.941	78.59	0.21	644.05
LPAT	Natural Logarithm of Patent Stock, perpetual inventory method 15% δ PATSTAT	1978-2008	1063	-7.489	3.719	-9.21	6.11
MS	Firm´s market share within the top-selling line of products	2006-2008	1063	0.275	0.302	0	1

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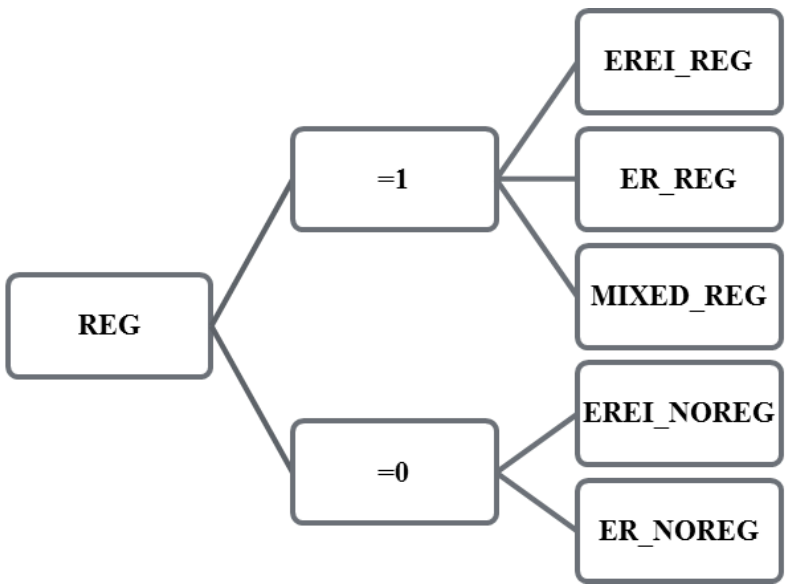
EREI and ER motivations variables

- EREI or ER introduced in response to a current or foreseen regulation (REG), as a reaction to the availability of financial incentives, grants or subsidies (GR), thanks to the existence of voluntary codes or agreements for good environmental practices (VOL).



- for each of the 3 motivations (REG, GR and VOL) joint inclusion of five variables as above (bench: NON Eco-Innovator)

Econometric Results HP1

	(I)	(II)	(III)	(IV)
EI	0.3976			
	(0.4984)			
EREI		1.8502***	1.7776***	1.7403***
		(0.6578)	(0.6591)	(0.6579)
ER		-1.1512*	-1.1915*	-1.2831*
		(0.6753)	(0.6821)	(0.6795)
SIZE	-0.0408	-0.0504	-0.1114	-0.1457
	(0.1305)	(0.1306)	(0.1383)	(0.1397)
MS	0.6053	0.6266	0.6088	0.6964
	(0.7713)	(0.7633)	(0.7627)	(0.7662)
HHI	-0.0041	-0.0040	-0.0041	-0.0044
	(0.0029)	(0.0029)	(0.0029)	(0.0030)
RD			0.4938	0.2890
			(0.4558)	(0.4832)
LPAT			0.0470	0.0469
			(0.0630)	(0.0629)
EAST				-0.0468
				(0.4208)
PC				0.5902
				(0.4520)
N	1063	1063	1063	1063
MLCox-Snell R^2	0.055	0.061	0.063	0.065

Discussion Econometric Results HP1

- *EI* overall have a neutral effect on profitability
- *EREI* are innovations that in reducing the use of materials and energy reduce production costs. Different combinations in the use of these idiosyncratic resources can engender a competitive advantage that a firm can exploit in the market
- *ER* are conversely neither associated to a cost reduction in the production nor to possible competitive advantages deriving from the exploitation of strategic resources. ER costs actually overcome the benefits in a way that the profitability return of such an adoption becomes negative
- A minimum threshold of (green) innovativeness is required before profitability gains arise: profitability effects arise only for firms introducing highly innovative innovations

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Econometric Results HP2

	(REG)	(VOL)	(GR)
EREI_REG(VOL/GR)	1.7726*	1.1825	0.2980
	(1.0424)	(1.3684)	(1.0669)
ER_REG(VOL/GR)	-1.8817**	-1.8301	-6.7765***
	(0.9110)	(1.4693)	(1.7819)
EREI_NOREG(VOL/GR)	1.3738	2.0289**	2.0365***
	(1.0072)	(0.8007)	(0.7451)
ER_NOREG(VOL/GR)	-0.7887	-1.1232	-1.0242
	(1.4041)	(0.8536)	(0.7398)
MIXED_REG(VOL/GR)	0.9503	0.2572	-0.4049
	(0.9100)	(1.1979)	(1.6742)
N	1013	1013	1013
MLCox-Snell R^2	0.065	0.065	0.067

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- *REG* may help firms in seeking new production solutions that allow them to more than offset the costs of compliance and to take advantage of competitive gains that derive from that, but still the typology of EI matters (Porter HP confirmed)
- *GR* effects on competitiveness are confirmed to be negative for ER, and no longer significant for EREI. A financial incentive is usually paid for innovations that are not profitable on their own (ER).
  - *EREI* engender positive profitability effects only when they are not introduced as a response to a financial incentive (EREI GR positive and significant)
- *VOL* No effects when the driver of the adoption is the presence of voluntary codes or agreements. It is intertwined with organizational costs, which are not necessarily making the adoption itself profitable.

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1. Self selection in providing financial data: bias?
   - we constructed a variable equal to one when information on OM are provided and modeled the probability through a probit model regressed on all the explanatory variables, rejecting the null Hypothesis that the non-response to OM is random
   - As the variable that is driving the non-randomness of the non-responses is EAST, significant in the probit model, it has been selected to construct the exclusion restriction in a two step Heckman selection model.
     - The coefficient of the mills ratio in the Heckman model is not statistically significant.
2. The non-response to all the variables in the sample restricted our operative sample to only 1063 observations
   - Results are robust as OM, EREI, ER and EI do not present significant differences in the means between the sample used in the regression and the full sample (t Test)

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   - we constructed a variable equal to one when information on OM are provided and modeled the probability through a probit model regressed on all the explanatory variables, rejecting the null Hypothesis that the non-response to OM is random
   - As the variable that is driving the non-randomness of the non-responses is EAST, significant in the probit model, it has been selected to construct the exclusion restriction in a two step Heckman selection model.
     - The coefficient of the mills ratio in the Heckman model is not statistically significant.
2. The non-response to all the variables in the sample restricted our operative sample to only 1063 observations
   - Results are robust as OM, EREI, ER and EI do not present significant differences in the means between the sample used in the regression and the full sample (t Test)

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THANKS FOR YOUR ATTENTION

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