



## **Environmental regulation and eco-innovation: the Porter hypothesis refined**

**Who?** Abdel. BITAT

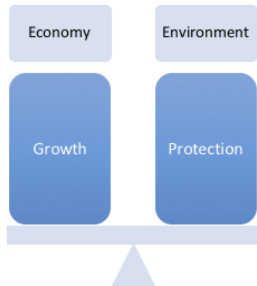
**From?** University Saint-Louis Brussels – Belgium

**When?** 25 Novembre 2016  
Open Evaluation Conference, Vienna

## Central question

# Motives

Does environmental regulation improve business competitiveness while reducing environmental harm?



## Sub-questions:

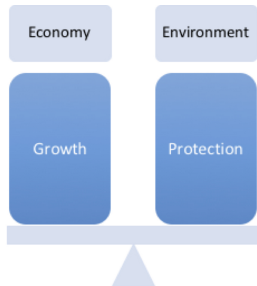
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Does eco-innovation improve firm competitiveness outweighing the cost of regulatory compliance?

## Central question

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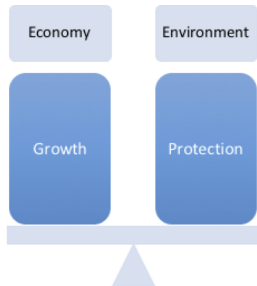
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# The Porter Hypothesis

Environmental regulation and competitiveness  
through innovation

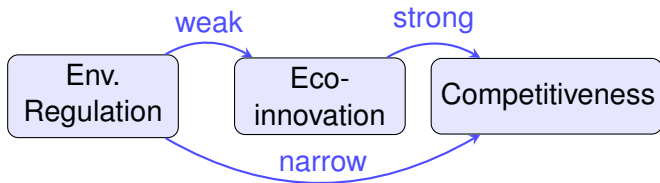
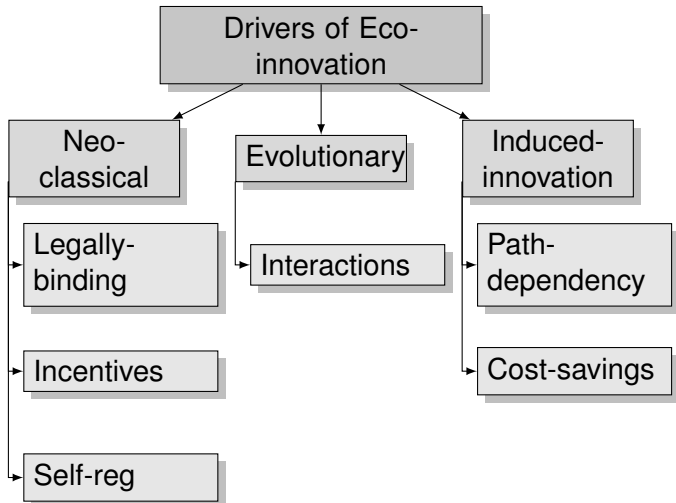


Figure: The Porter Hypothesis

# Theoretical approaches



## Time-Series Cross-Section Panel: Mannheim Innovation Panel (MIP)

- German part of Community Innovation Survey. (EC)
- Representative sample of around 25 000 (10%).
- Stratified by sector (23), size (3) and region (2).
- Net panel data sample (2006-2012) close to 2000.
- Short panel: 3 time periods (small T, large N).

# Panel structure

id: **300043, 300076, ..., 1412185**

n = **12408**

y: **1, 2, ..., 3**

T = **3**

Delta(y) = **1 unit**

Span(y) = **3 periods**

(id\*y uniquely identifies each observation)

Distribution of T\_i:    min            5%            25%            50%            75%            95%            max

                              1            1            1            1            2            3            3

Freq.	Percent	Cum.	Pattern
3080	24.82	24.82	1..
2827	22.78	47.61	..1
2014	16.23	63.84	.1.
1446	11.65	75.49	111
1163	9.37	84.86	.11
1128	9.09	93.96	11.
750	6.04	100.00	1.1
12408	100.00		XXX



# Empirical model

## Count Data Model

### Random Effect Negative Binomial (RENB) Model

- Dependent variable: Non-negative integer values.
- Poisson: Over-dispersed.
- Sample: Zero-inflated.
- Panel: Unobserved heterogeneity across  $i$  and  $t$ .
- Truncated:  $Y \leq 200$

# Empirical model

## Static Negative Binomial Model Maximum Likelihood

$$y_{it} = x'_{it}\beta + w'_i\gamma + \nu_{it} \quad (1)$$

$$\nu_{it} = \alpha_j + \epsilon_{it} \quad (2)$$

Where:

$y_{it-1}$	Lagged values of the dependent
$x_{it}$	Time-varying variables
$w_i$	Time-invariant variables
$\alpha_j$	Individual-specific effect
$\epsilon_{it}$	Time-varying error term

## Empirical model (Continued)

### Dynamic Negative Binomial Model w/ Correlated Random Effect and Initial Condition

$$y_{it} = \rho y_{it-1} + \theta y_{it_0} + x'_{it}\beta_1 + \bar{x}'_i\beta_2 + w'_i\gamma + \nu_{it} \quad (3)$$

Where:

$y_{it-1}$	Lagged values of the dependent variable
$y_{it_0}$	Initial values of the dependent variable
$x_{it}$	Time-varying variables
$\bar{x}_i$	Mean of time-varying variables
$w_i$	Time-invariant variables
$\nu_{it}$	Error term

# Neo-classical approach

[Huber, 2008]

"Stringent environmental regulation paves the way of environmental innovation."

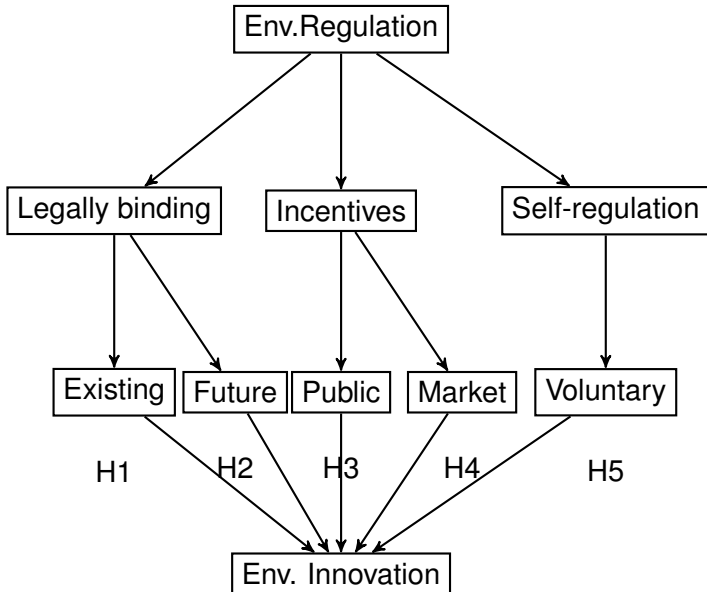
[Murphy and Gouldson, 2000]

"Innovative policy instruments need to replace traditional regulation."

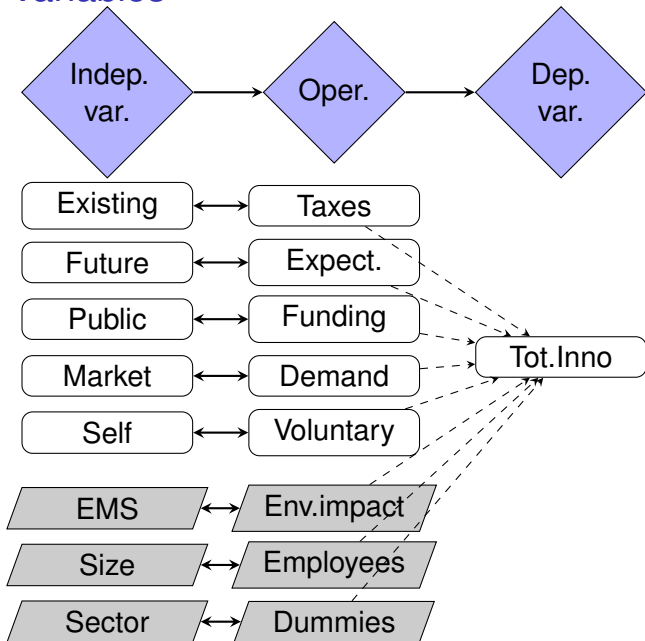
[Johnstone, 2005]

"Performance-based regulation rather than standard-based regulation."

# Hypotheses of the neo-classical model



# Variables



## Results

Variable	Coefficient	(Std. Err.)
LB	0.084	(0.060)
FR	0.366**	(0.063)
PF	-0.004	(0.084)
MI	0.383**	(0.057)
SR	0.204**	(0.058)
EMS	-0.298**	(0.059)
RD	11.569**	(0.428)
size	0.335**	(0.014)
region	-0.024	(0.044)

# Evolutionary approach

[Andersen, 2010]

"Drivers of eco-innovation are not isolated from each other but are rather in interaction with one another."

[Howlett and del Rio, 2015]

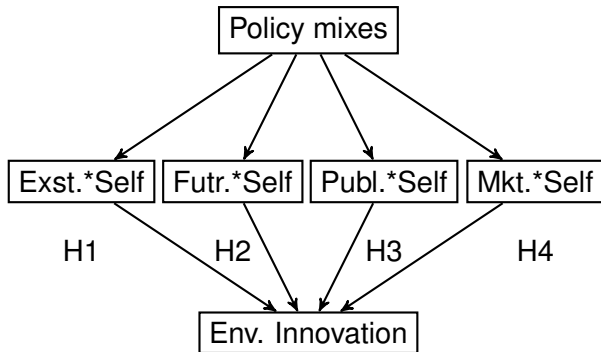
"Policy mixes could generate synergies but also create redundancies."

[Del Río et al., 2010]

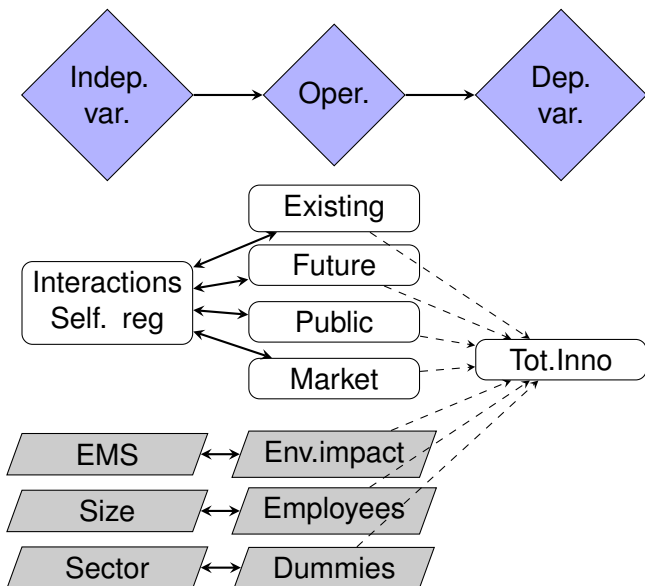
"Self-regulation needs to be coupled with the threat of future regulation (Combining the stick and the carrot)."



# Hypotheses of the evolutionary model



# Variables



## Results

Variable	Coefficient	(Std. Err.)
LB	0.141*	(0.071)
FR	0.400**	(0.076)
PF	0.009	(0.105)
MI	0.533**	(0.069)
SR	0.550**	(0.082)
EMS	-0.305**	(0.059)
RD	11.490**	(0.428)
s1	-0.213 <sup>†</sup>	(0.129)
s2	-0.165	(0.133)
s3	-0.049	(0.170)
s4	-0.496**	(0.117)
size	0.337**	(0.014)
region	-0.021	(0.044)

# Induced-innovation approach

[Jaffe et al., 2003]

"The prospect of profit is sufficient for businesses to engage in eco-innovation."

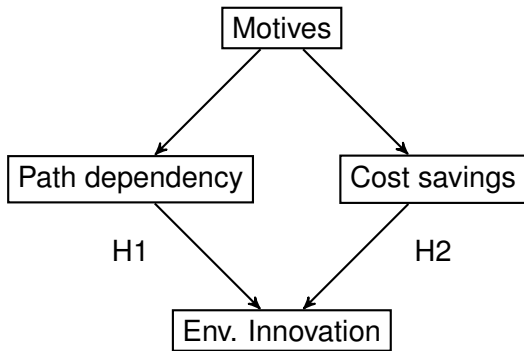
[Wagner and Llerena, 2011]

"Eco-innovation is a path dependent activity determined by historic processes."

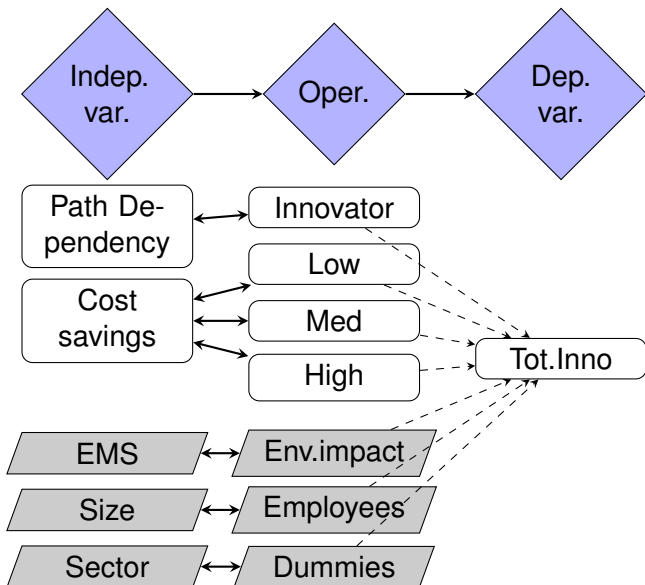
[Ghisetti and Rennings, 2014]

"Businesses would voluntarily adopt eco-innovation if they perceive an opportunity for cost savings."

# Hypotheses of the Induced-innovation model



# Variables



## Results

Variable	Coefficient	(Std. Err.)
L.inno	0.007*	(0.003)
L2.inno	0.009**	(0.004)
LB	0.149	(0.174)
FR	-0.025	(0.187)
PF	-0.517 <sup>†</sup>	(0.298)
MI	0.410*	(0.171)
SR	0.425 <sup>†</sup>	(0.244)
s1	-0.166	(0.333)
s2	0.478	(0.349)
s3	-0.537	(0.570)
s4	-0.778*	(0.310)
CS	0.398**	(0.056)
EMS	-0.051	(0.153)
RD	3.100	(2.541)
mRD	10.365**	(2.909)
size	1.110**	(0.350)
msize	-0.818*	(0.351)

## Conclusion: The Weak Porter Hypothesis

- Environmental regulation does foster innovation.
- Environmental regulation is a necessary yet not a sufficient condition.
- The design of policy instruments.
- Combining instruments with synergies.
- Clear, credible and consistent signal with enough uncertainty to stimulate eco-innovation.



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## Further Research

- Structural Equation Modeling
- Latent Class Analysis
- Classes based on firm characteristics
- Membership function (conditional probability)

Thank you for your attention !

