DO ENVIRONMENTAL POLICIES MATTER FOR PRODUCTIVITY GROWTH?

Joint project
OECD Economics Department
and Environmental Directorate

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OCDE
DES POLITIQUES MEILLEURES
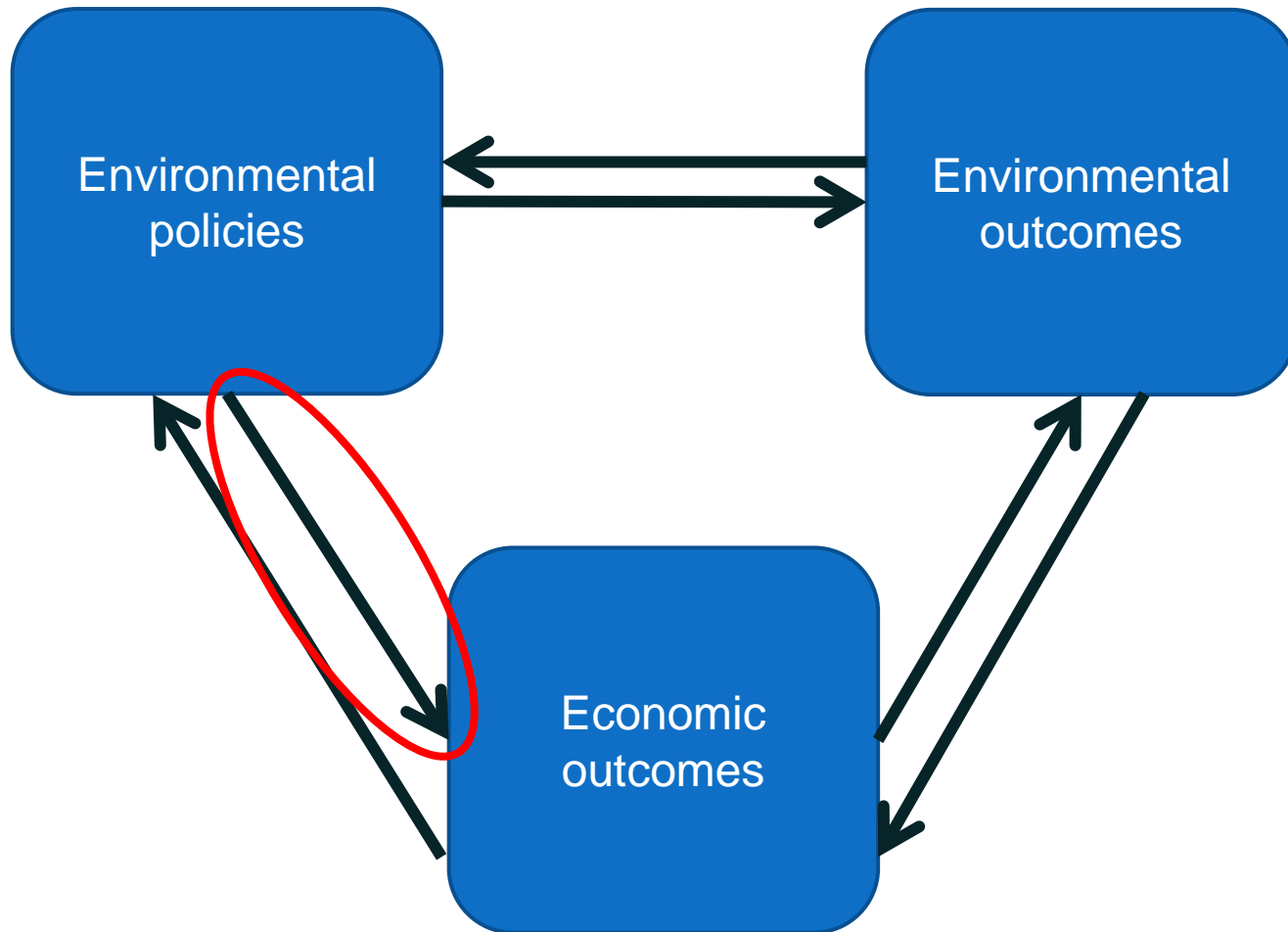POUR UNE VIE MEILLEURE

Outline

- Motivation

- Scope and approach

- Indicator of Environmental Policy Stringency (EPS)

- Empirical analysis: effects of EPS on productivity growth

- Indicator of the Burdens on the Economy of Environmental Policies (BEEP)
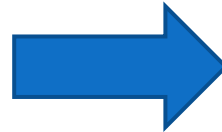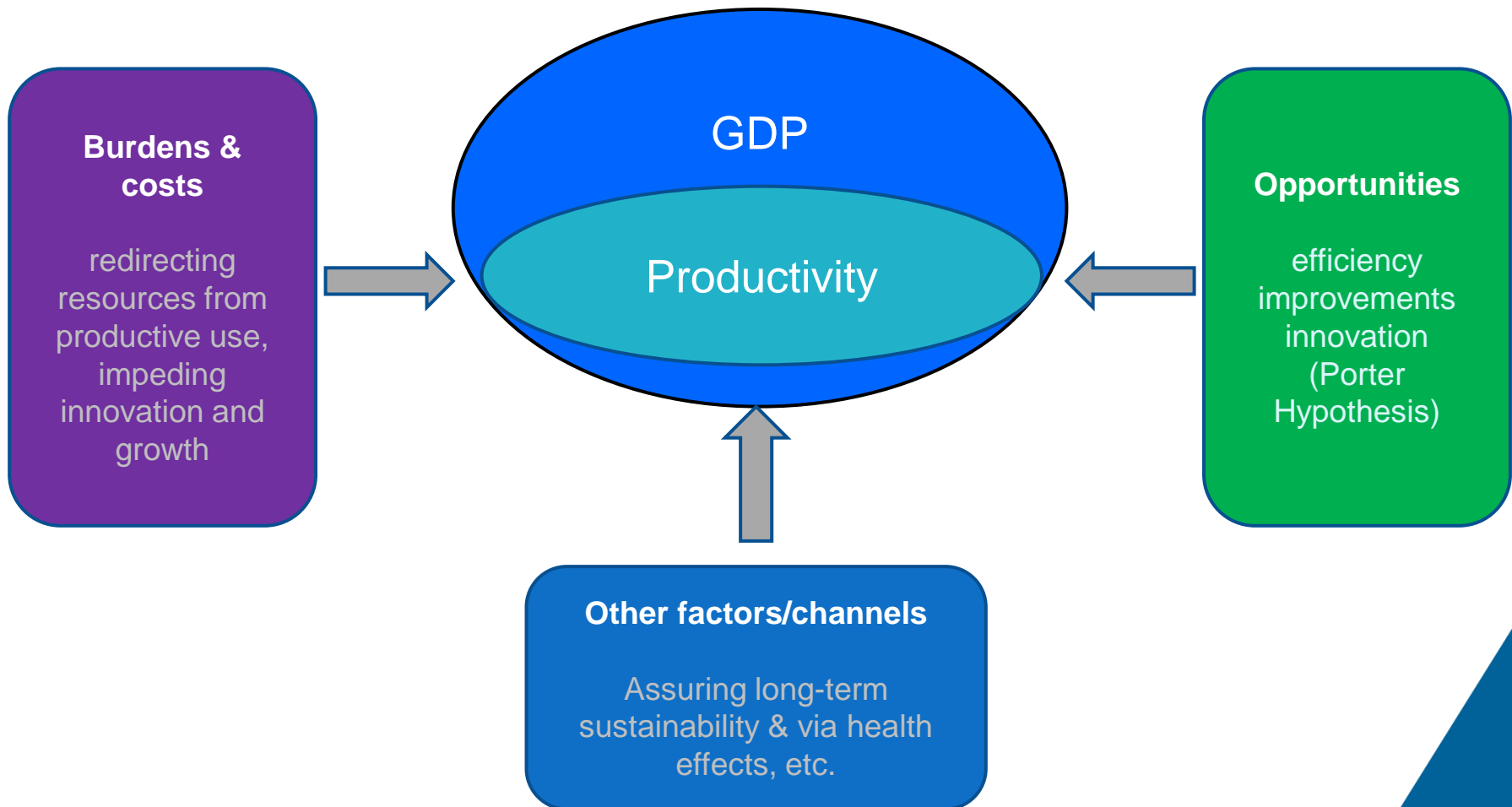
- Conclusions

What are we looking at?

Motivation

Increasing recent attention to environmental issues and implementation of environmental policy (EP)

What are the effects on economic outcomes?
Even more relevant in times of sluggish recovery and productivity slowdown.

How can environmental policies affect productivity (and GDP)?

Burdens & costs

redirecting resources from productive use, impeding innovation and growth

GDP

Productivity

Opportunities

efficiency improvements innovation (Porter Hypothesis)

Other factors/channels

Assuring long-term sustainability & via health effects, etc.

Previous literature and data

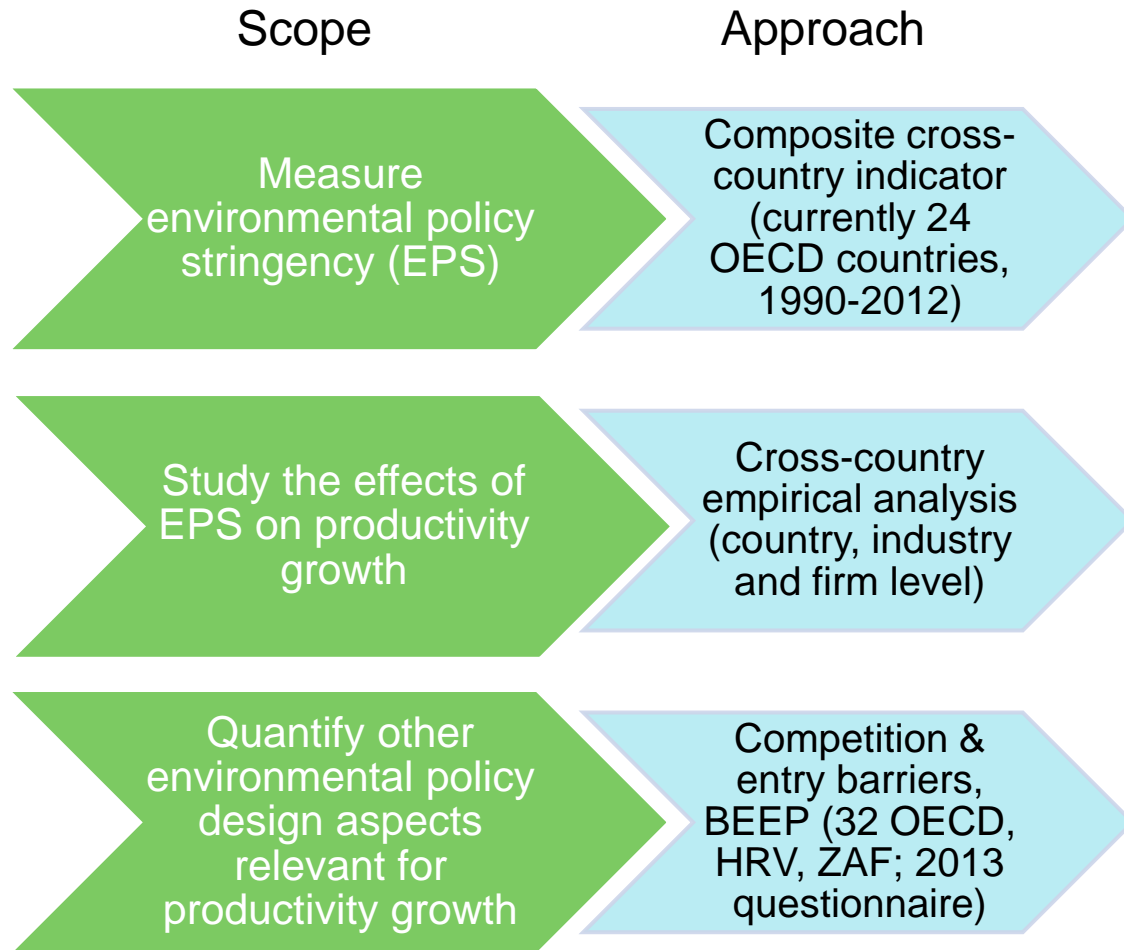Studies on the effect of EP on economic outcomes:

- GDP, productivity, competitiveness

- Investment, employment

- Location, entry/exit, etc

However, inconclusive findings due to:

- Lack of cross-country time-series measures of EP

- (Partially) unavailability of firm level data

- Case studies with little scope for generalization of the results

Scope and approach

Scope	Approach

Measure environmental policy stringency (EPS) → Composite cross-country indicator (currently 24 OECD countries, 1990-2012)

Study the effects of EPS on productivity growth → Cross-country empirical analysis (country, industry and firm level)

Quantify other environmental policy design aspects relevant for productivity growth → Competition & entry barriers, BEEP (32 OECD, HRV, ZAF; 2013 questionnaire)

Indicator of "Environmental Policy Stringency"(EPS)

EPS Definition

Stringency of environmental policy :

the policy-induced cost of polluting faced by firms, which can be explicit or implicit.

Problem: multi-dimensionality related to the diversity of activities and pollutants - particularly difficult at the level of the whole economy.
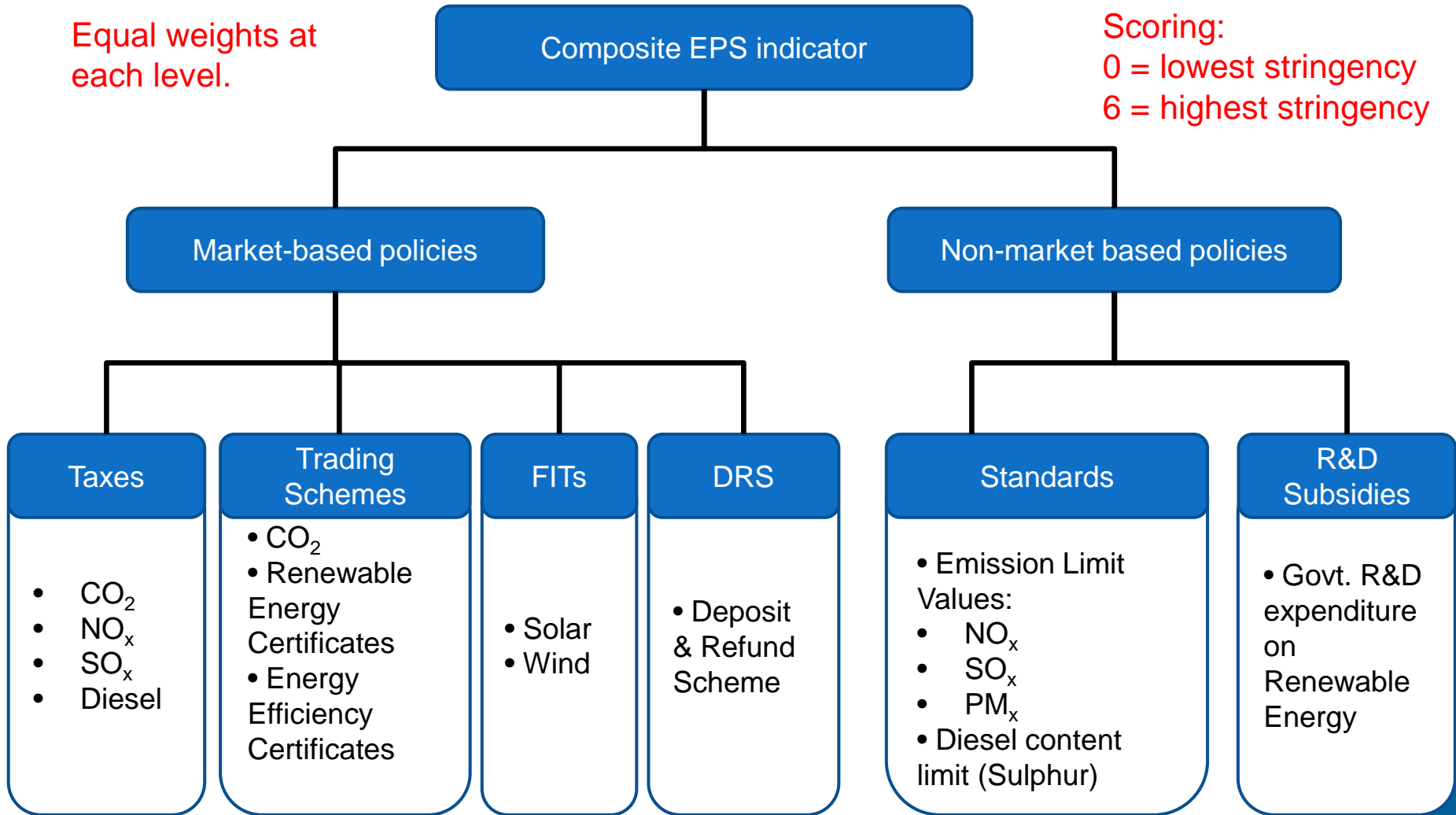
EPS composite indicator:

- Regulation in upstream sector (e.g. energy, transport):
    - Cross-country comparability
    - Proxy for degree of policy control for the same externalities in other sectors
- Focus on 15 key instruments (air pollution and climate).
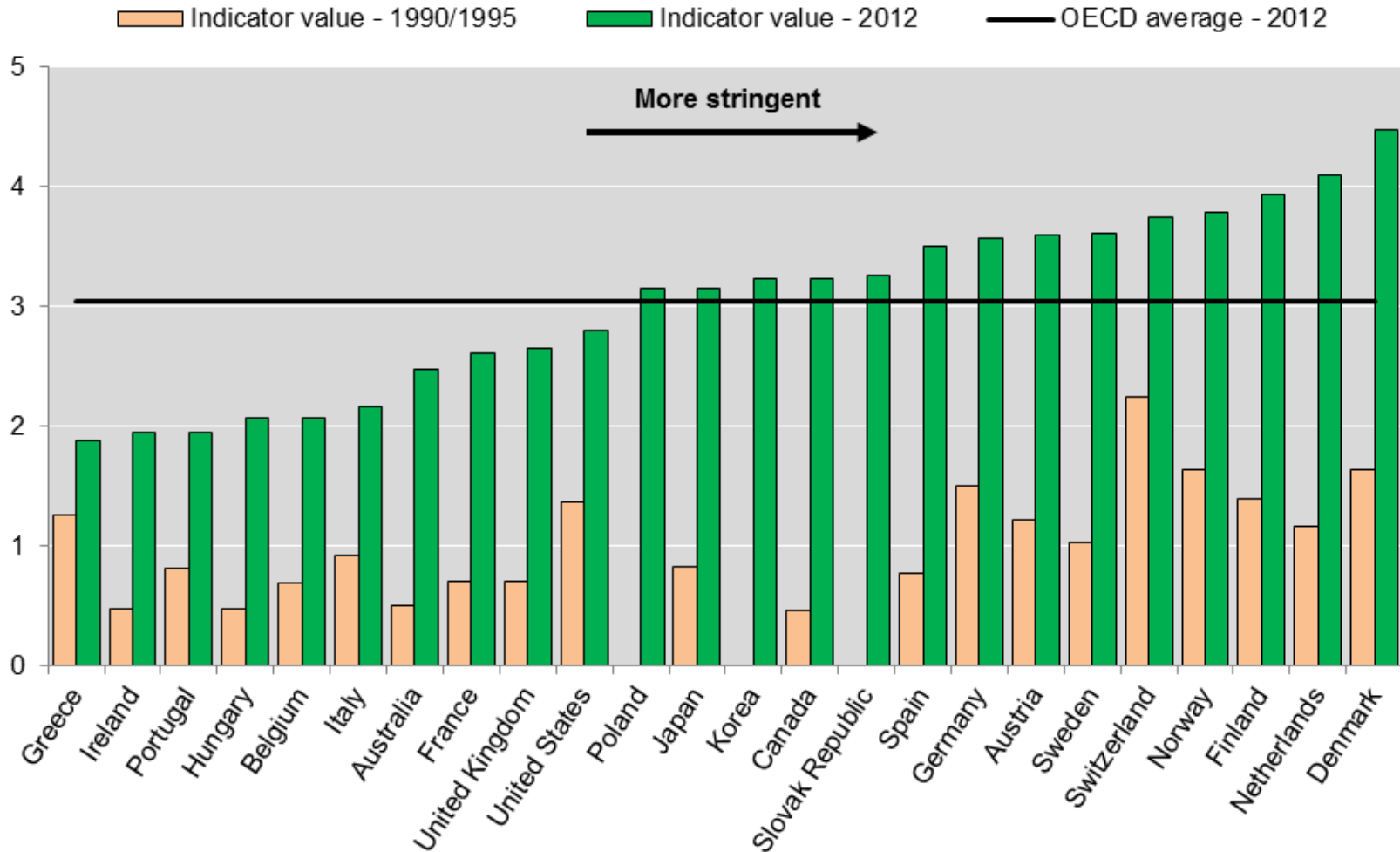
EPS indicator structure

Equal weights at each level.

Scoring:
0 = lowest stringency
6 = highest stringency

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                          Composite EPS indicator
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              Market-based policies          Non-market based policies
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Taxes	Trading Schemes	FITs	DRS	Standards	R&D Subsidies
• CO_2 • NO_x • SO_x • Diesel	• CO_2 • Renewable Energy Certificates • Energy Efficiency Certificates	• Solar • Wind	• Deposit & Refund Scheme	• Emission Limit Values: • NO_x • SO_x • PM_x • Diesel content limit (Sulphur)	• Govt. R&D expenditure on Renewable Energy

Botta, E. and T. Koźluk (2014), *OECD Economics Department Working Papers*, forthcoming.

Environmental policy stringency has been increasing in OECD countries

Botta, E. and Koźluk, T. (2014), *OECD Economics Department Working Papers*, forthcoming.

Good proxy for overall country's EPS

High correlations with other measures of stringency:

	2004	2005	2006	2007	2008	2009	2010	2011	Over the period
Perceived stringency (WEF)	.60 (.00)	.50 (.01)	.48 (.01)	.49 (.01)	.45 (.02)	.53 (.00)	.44 (.03)	.45 (.03)	.44 (.00)
CLIMI							.56 (.01)		

Notes: numbers in brackets are significance levels.
WEF – World Economic Forum Executive Opinion Survey question on managers' perceptions of EPS.
Climate Laws, Institutions and Measures Index (CLIMI) – EBRD (2012).

Botta, E. and Koźluk, T. (2014), *OECD Economics Department Working Papers*, forthcoming.

Empirical analysis: Research Question

**Do environmental policies
matter for productivity growth?**

Literature on EPS and productivity: inconclusive results

Macro level

- Adjusted MFP for selected pollutants:
  - Scenario analysis: <u>negative</u> (Jeon and Sickles, 2004) and <u>positive</u> effects (Wu Wang, 2008)
  - Ratification of the UNFCCC as proxy for EPS: <u>positive</u> (Wu Wang, 2008) and <u>negative</u> effects (Yuruk and Zaim, 2005)

Industry level

- Early contributions:
  - slowdowns of US productivity in the 1970s, <u>negative</u> effect, identification issues
- Recent contributions: longer time series or case studies:
  - Hamamoto (2006), Yang et al. (2012): positive effect
  - Lanoie et al. (2008): short term <u>negative</u> effect outweighed by a <u>positive</u> effect
  - Alpay et al. (2002): international dimension, <u>null</u> effect for US, <u>positive</u> for Mexico

Firm level

- Negative but not robust effect, case studies
  - Comparison regulated and unregulated firms: <u>negative</u> effect (Gollop and Roberts (1983), etc) , <u>positive</u> (Berman and Bui (2001)), lack of firms' specific characteristics
  - Becker (2011) and others: <u>negative</u> effect considering firms' specific characteristics
  - Greenstone (2012): effect depends on the pollutant considered (particulates vs. sulphur emissions)

Our approach:

- 3 levels of analysis: **country, industry, firm**

- **Neo-Schumpeterian model** of productivity growth, where:
  - Multi-factor productivity (MFP) growth depends on technological catch-up (convergence) and technology pass-through (spillovers from technological frontier)
  - EPS may affect MFP growth heterogeneously depending on the technological advancement of the country/industry/firm and the industry environmental dependence (pollution intensity)

- Robustness checks: country, industry and firm controls; different specifications, lag structures and time/country sub-samples; two definitions of exposure (environmental and energy dependence).

- Additional hypotheses: flexibility vs. command and control instruments, announcement/anticipation, level of EPS.
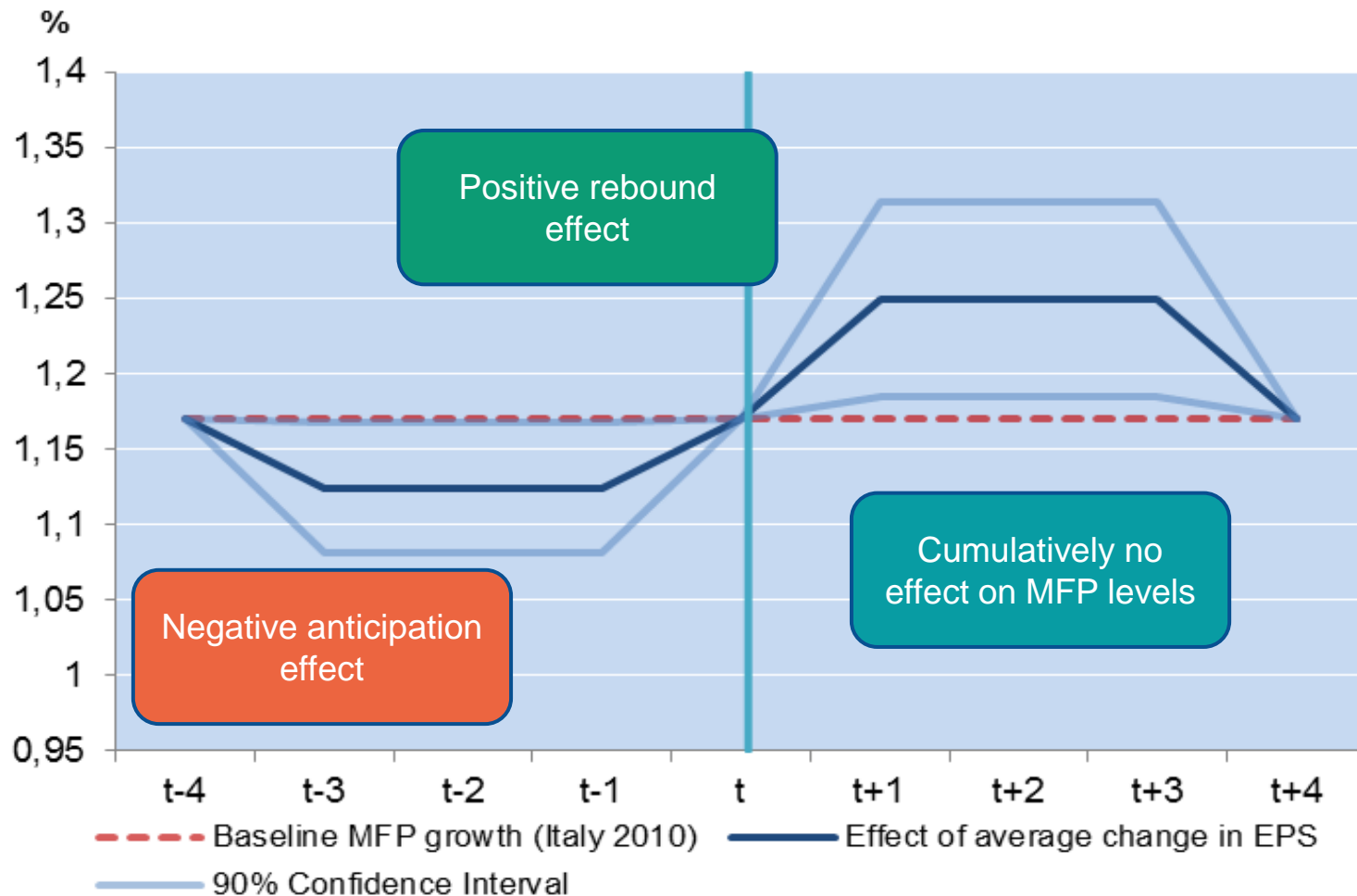
Econometric setup – Macro level

$$\Delta \ln MFP_{ct} = \alpha_1 + \sum_{j=-k}^{n} \alpha_{2j}(\Delta EPS_{ct-j}) + \alpha_3 gap_{ct-1} + \alpha_4 \Delta \ln \widehat{MFP}_{ct} + \boldsymbol{x_{cit}\gamma} + \eta_t + \delta_c + \epsilon_{ct}$$

Where subscripts *c* denotes country and t denotes year, and:

- $\Delta \ln MFP_{ct}$ is the growth rate of multi-factor productivity
- ΔESP_{ct} denotes the change in the indicator of environmental policy stringency
- gap_{ct} is the distance to frontier
- $\Delta \ln \widehat{MFP}_{ct}$ denotes MFP growth of the technological leader
- $\boldsymbol{x_{cit}}$ vector of control variables, such as output gap, openness and crisis dummy
- η_t common time trend
- δ_c represents country FE

Results: Simulated effects of EPS tightening on macro-level productivity growth (over time)

Albrizio et al. (2014), *OECD Economics Department Working Papers*, forthcoming.

Econometric setup – Industry (& firm level)

$$\Delta \ln MFP_{cit} = \propto_1 + \sum_{j=1}^{n} \propto_{2j} \left(ED_{i\ 1987} \Delta EPS_{ct-j} \right) + \sum_{j=1}^{n} \propto_{3j_{it-j}} gap_{cit-1} \left(ED_{i\ 1987} \Delta EPS_{ct-j} \right)$$

$$+ \propto_4 gap_{cit-1} + \propto_5 \Delta \ln \widehat{MFP}_{it} + \boldsymbol{x_{cit}\gamma} + \eta_t + \delta_{ci} + \epsilon_{cit}$$

Where subscripts *c* and *i* denote country and industry, t denotes year, and:

- ED is pre-sample US industry environmental dependence - exposure to EP

- additional non-linear effect of change in EPS, by inter-acting EPS and gap

- δ_{ci} corresponds to country and/or industry FE

Industry Results

Dependent variable: MFP growth	1	2	3	4	5	6	7	8
	Baseline	Baseline	Baseline + Regulation	Baseline + Regulation	Baseline + Country/ind controls	Baseline + Country/ind controls	Full set of controls	Full set of controls
Leader MFP growth	0.151***	0.129***	0.149***	0.128***	0.129***	0.107***	0.126***	0.105***
	(0.0276)	(0.0283)	(0.0273)	(0.0283)	(0.0289)	(0.0294)	(0.0286)	(0.0295)
Distance to frontier (lagged)	0.172***	0.0921***	0.168***	0.0898***	0.170***	0.0915***	0.166***	0.0892***
	(0.026)	(0.013)	(0.025)	(0.013)	(0.026)	(0.013)	(0.025)	(0.012)
EPS tightening (MA)	0.147***	0.130***	0.150***	0.134***	0.151***	0.140***	0.151***	0.143***
	(0.0371)	(0.0278)	(0.0375)	(0.0283)	(0.0327)	(0.0240)	(0.0334)	(0.0250)
Effect of gap on EPS tightening (MA)	-0.212**	-0.165**	-0.216**	-0.170**	-0.201**	-0.166***	-0.203**	-0.170***
	(0.1010)	(0.0775)	(0.1010)	(0.0773)	(0.0797)	(0.0553)	(0.0793)	(0.0555)
Fixed effects								
Country*Industry	Yes	No	Yes	No	Yes	No	Yes	No
Country	No	Yes	No	Yes	No	Yes	No	Yes
Industry	No	Yes	No	Yes	No	Yes	No	Yes
N	2084	2084	2084	2084	1944	1944	1944	1944
Adjusted R2	0.12	0.169	0.123	0.174	0.123	0.188	0.125	0.191

Note: Robust standard errors in parentheses and they are clustered at country-industry level; *** denotes statistical significance at the 1% level, ** significance at 5% level, * significance at 10% level.

(MA): denotes the moving average of the EPS change over three-years-lags.

Baseline specification includes the following controls: output gap, dummy for crisis and year trend. Baseline + Regulation includes: employment protection legislation (OECD EPL), product market regulation (OECD PMR) and country's degree of capital account openness (Chinn-Ito Index). Baseline + Country/ind. includes industry-specific time-varying controls, such as trade openness, R&D expenditures, and real oil price.
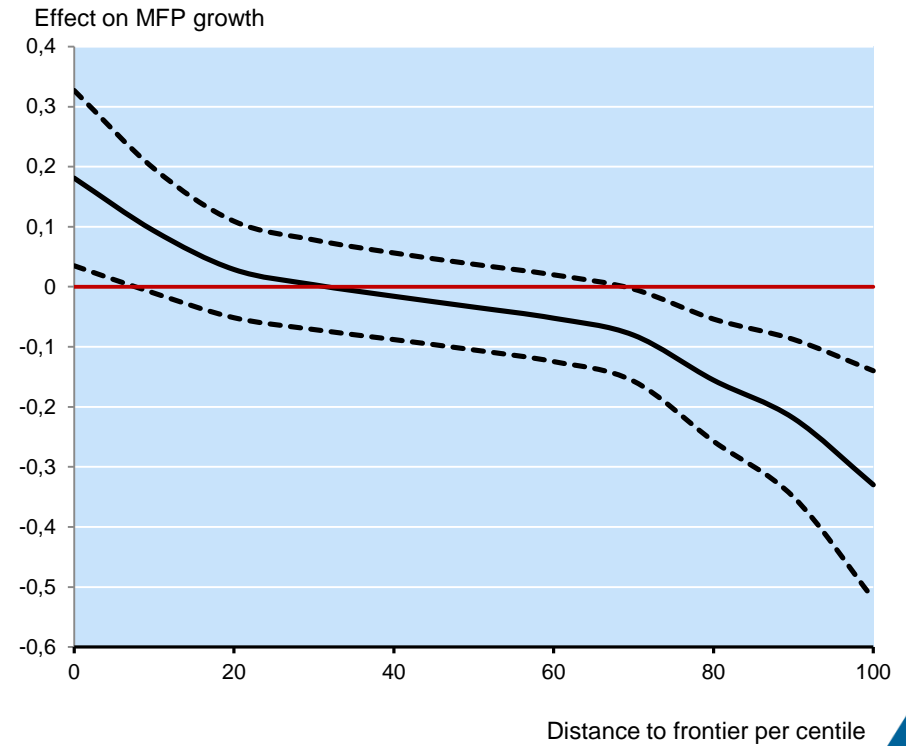
Industry and firms results

Industry level

— Estimated marginal effect
- - - 95% confidence interval
- - - 95% confidence interval

Effect on MFP growth

Distance to frontier per centile
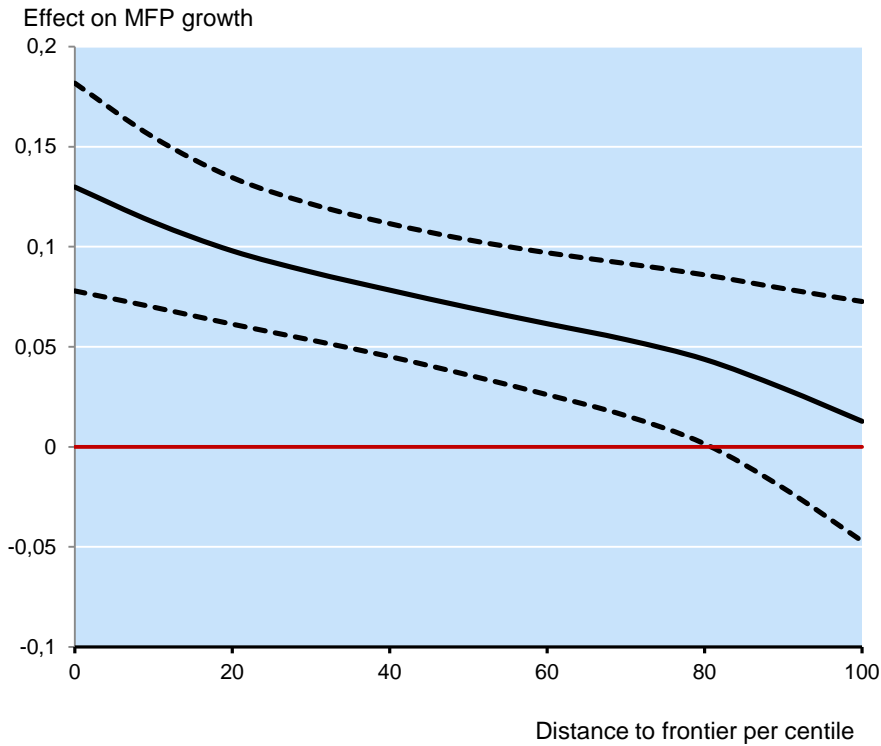
Firm level

— Estimated marginal effect
- - - 95% confidence interval
- - - 95% confidence interval

Effect on MFP growth

Distance to frontier per centile

Marginal effect of EPS tightening at firm level: market-based versus non-market indicator

Market based

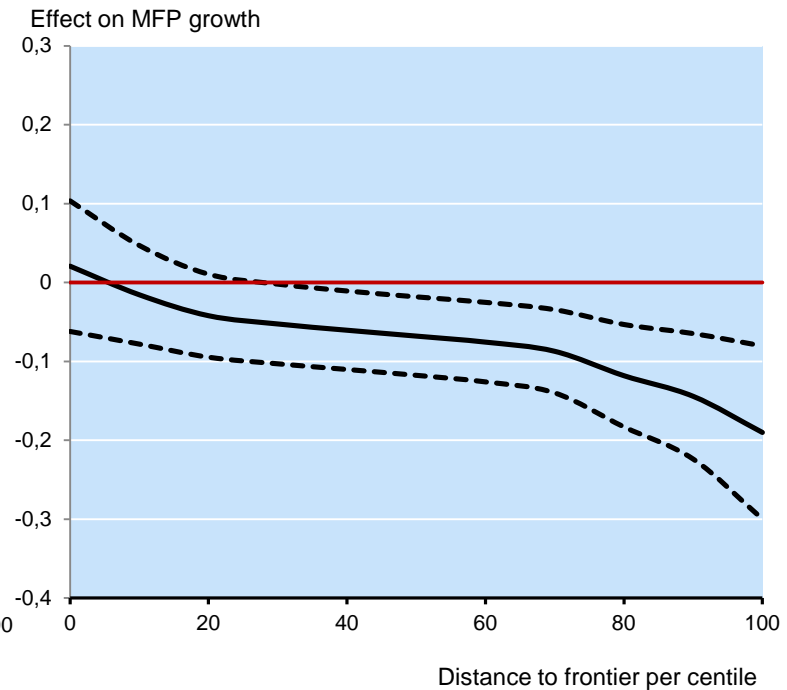**Non-market based**

Estimated marginal effect
- - - - 95% confidence interval
- - - - 95% confidence interval

Estimated marginal effect
- - - - 95% confidence interval
- - - - 95% confidence interval

Effect on MFP growth

Effect on MFP growth

Distance to frontier per centile

Distance to frontier per centile

Note: 95% confidence intervals are reported (dotted lines).

Indicators of "Burdens on the Economy due to Environmental Policies" (BEEP)

What are <u>the design and implementation features </u>of environmental policies that can burden entry & competition?
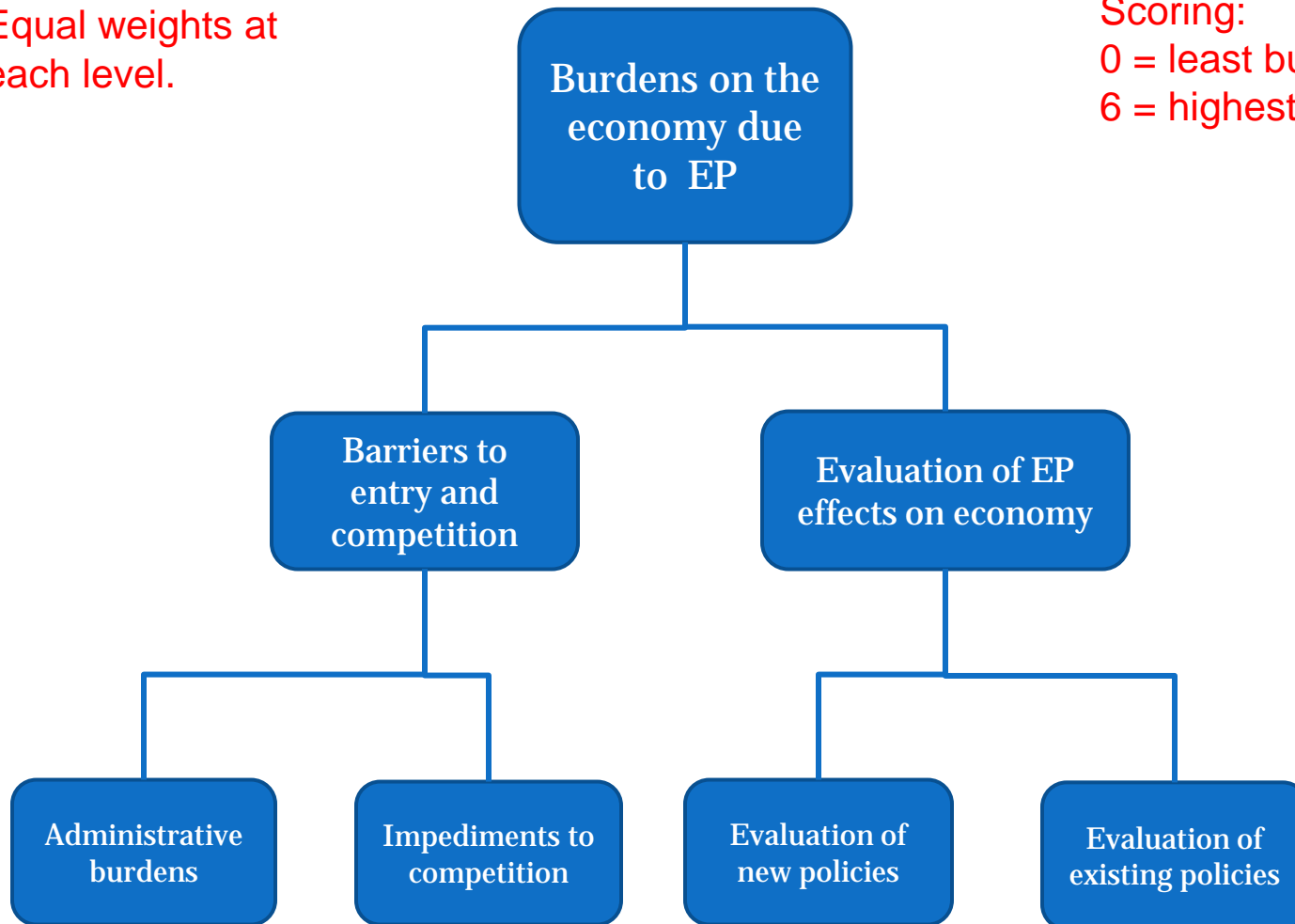
Approach

- Questionnaire:

  - Annexed to the 2013 Product Market Regulation exercise

  - Replies from 34 countries (2 non-OECD: ZAF & HRV)

  - One point in time (2013)

  - 4 domains, ~12 question per domain

  - Simple aggregation strategy tested and adopted

Burdens on the Economy due to Environmental Policies – index structure

Equal weights at each level.

Scoring:
0 = least burdensome
6 = highest burden

Burdens on the economy due to EP

Barriers to entry and competition

Evaluation of EP effects on economy

Administrative burdens

Impediments to competition

Evaluation of new policies

Evaluation of existing policies

Koźluk, T. (2014), *OECD Economics Department Working Papers*, forthcoming.

What aspects is the index capturing?

- <u>Administrative burdens of permit /license procedures</u>
  - ➤ Integrated permits, one stop shop, legal time limits on approval, silence-is-consent rule

- <u>Direct impediments to competition</u>
  - ➤ Vintage Differentiated Regulations (e.g. ELVs), taxes/subsidies that discriminate against new entrants

- <u>Evaluation of new policies</u> & <u>of existing policies</u>
  - ➤ Are policy makers are obliged to evaluate:
    - ▪ Effects on competition, on entry; administrative, statistics and reporting burdens
    - ▪ Implementability, costs and benefits of using alternative tools
    - ▪ Possibilities for streamlining obligations imposed
  - ➤ Evaluation guidelines, stakeholder consultations
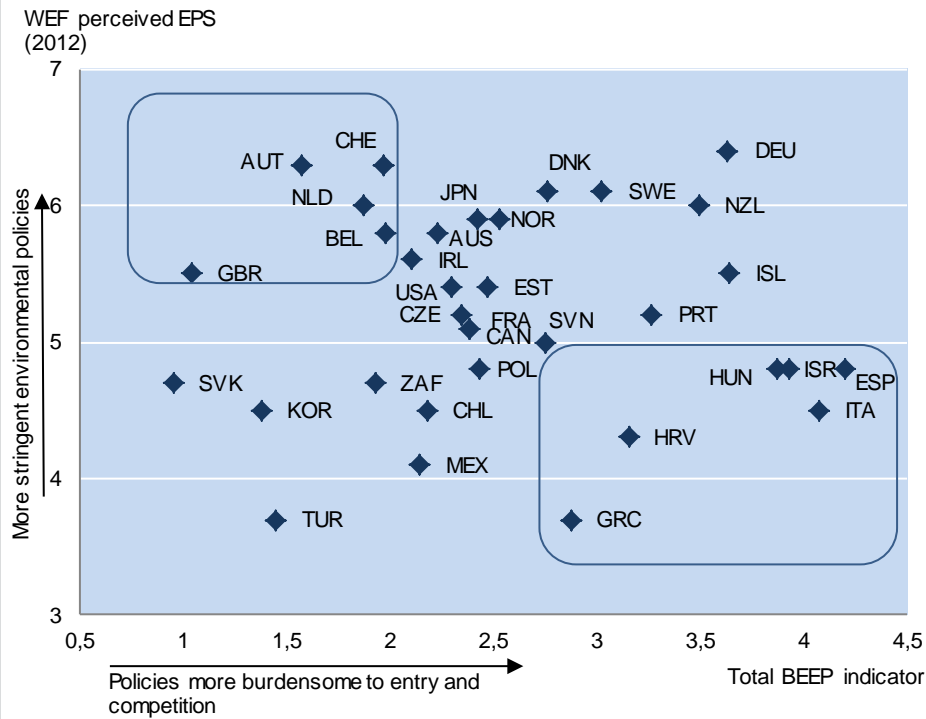 - ➤ Transparency & communication

BEEP – overall results

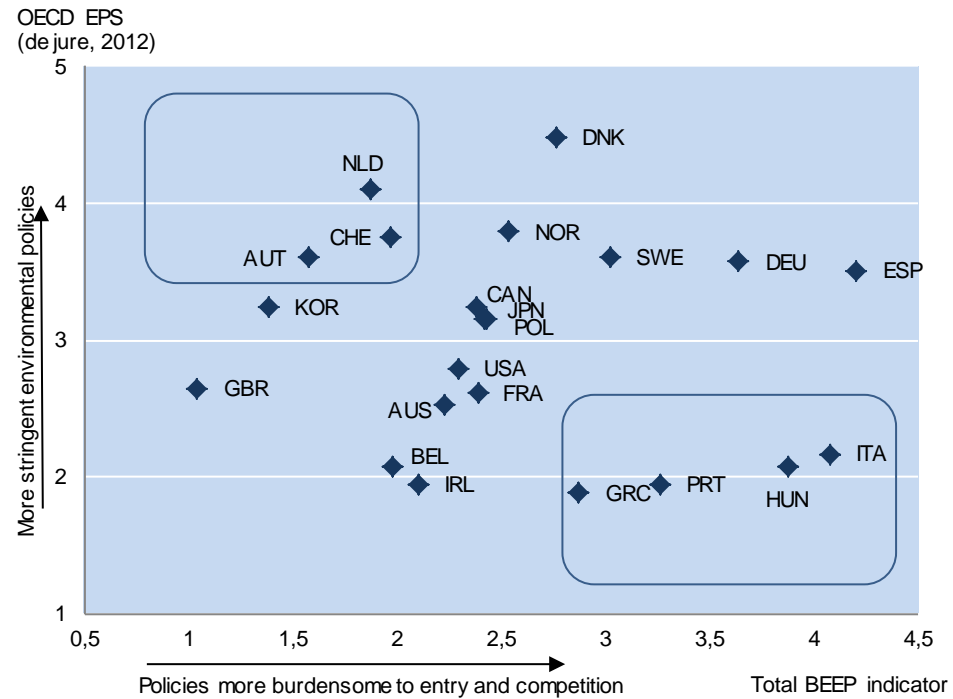Koźluk, T. (2014), *OECD Economics Department Working Papers*, forthcoming.
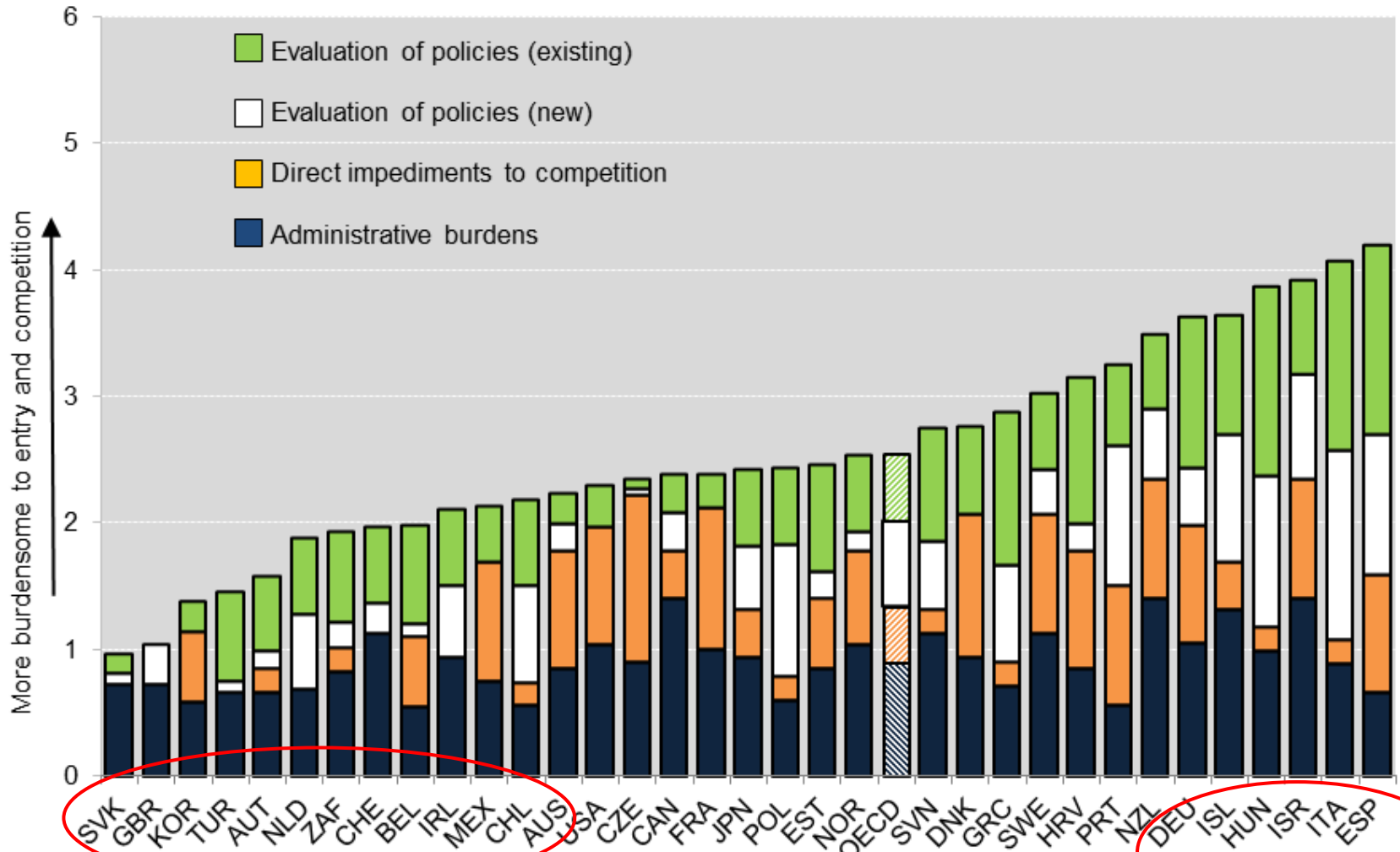
Are high barriers to entry/competition a must of stringent environmental policies?

A. **World Economic Forum – perceived environmental policy stringency**

B. **Environmental policy stringency proxy (OECD, de jure)**

Koźluk, T. (2014), *OECD Economics Department Working Papers*, forthcoming.

Conclusions (1)

Stringency necessary for addressing wellbeing objectives, nevertheless:

- Environmental policy stringency **does not have detrimental effects** on aggregate productivity.

- Technologically advanced firms and countries: **temporary boost** in productivity growth - especially relying on more **flexible instruments** (e.g. taxes, ETS):
  – Best suited to grasp new opportunities and innovation
  – Relocate and trim down activity

- Low-productivity firms: **temporary fall** in productivity growth
  – Higher investment to comply
  – Less able to adjust
  – Part of the adjustment may be due to entry/exit.

- Effects do not depend on initial EPS levels

Conclusions (2)

Achieving both economic and environmental objectives requires new ideas, technologies and business models.

- There is **no evident trade-off** between stringency of environmental policies and competition-friendliness.

- Ensuring swift reallocation of resources (reducing barriers to entry and competition) can help assure economic outcomes are in line with productivity gains.

Next steps

To better understand the mechanisms behind the effects on productivity:
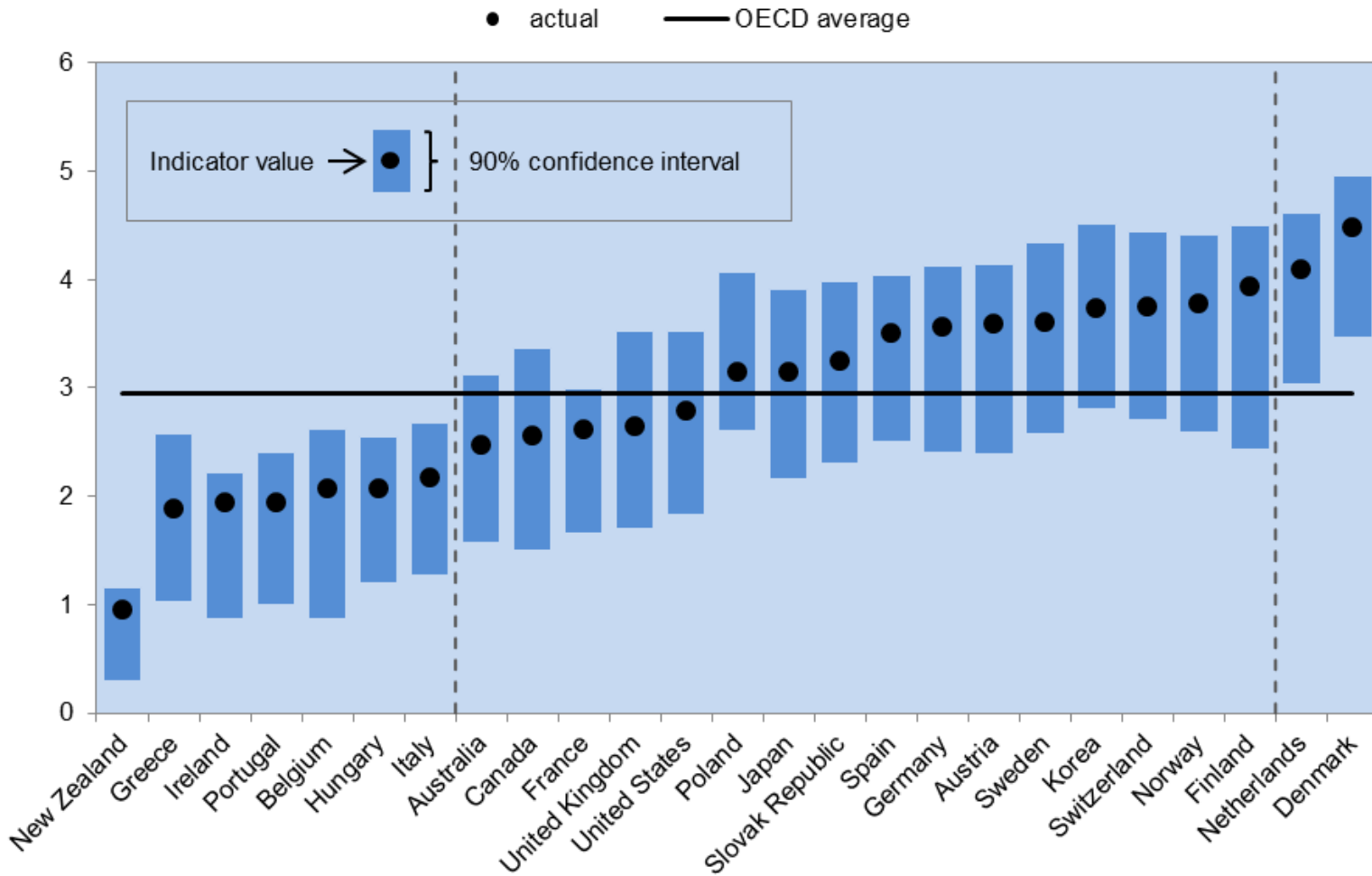
- Investment
- Trade in value added - BRICS

Thank you!

Contact:
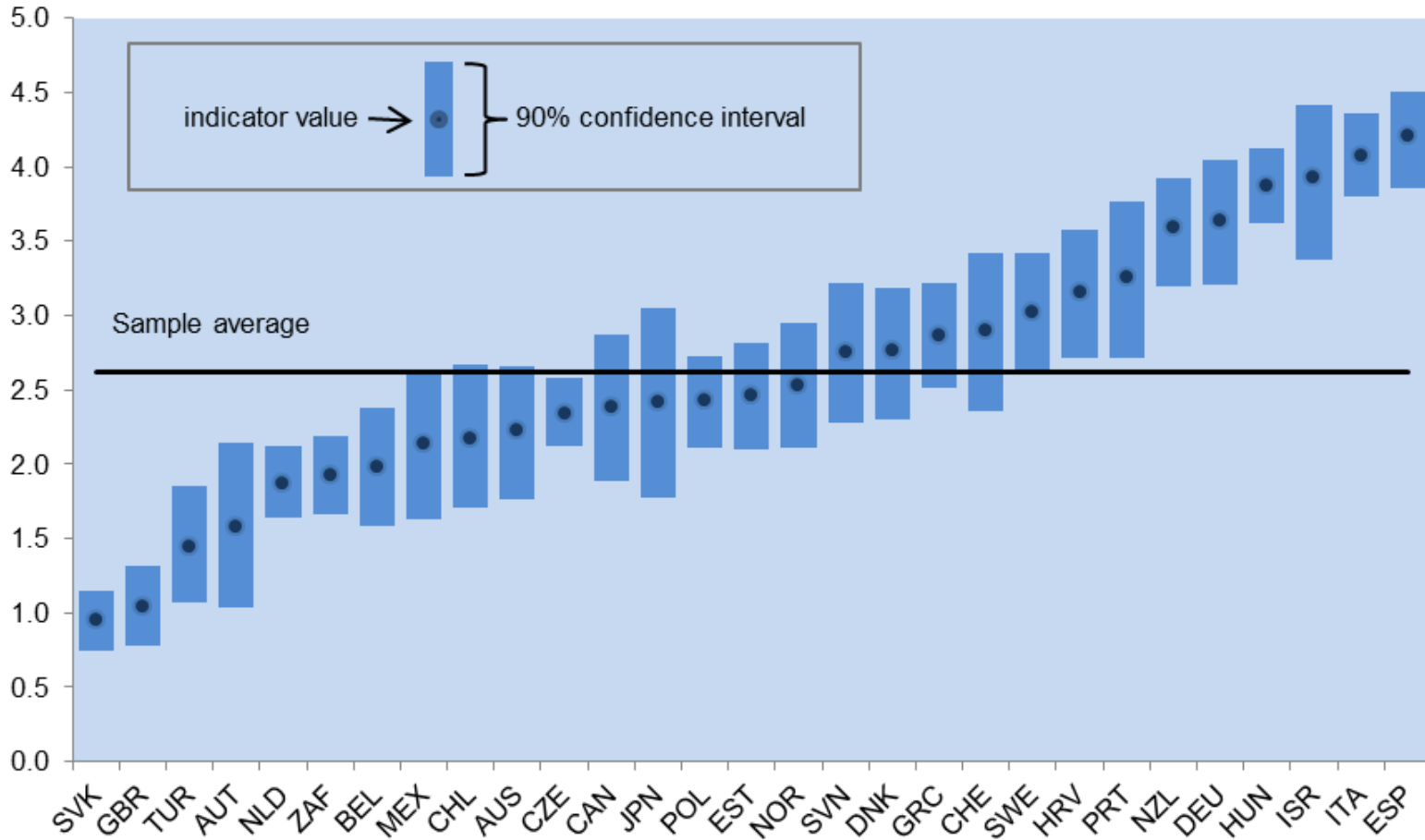
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EPS – random weights – robustness

BEEP – random weights – robustness

Macro Results

Dependent variable: MFP growth	1	2	3	4	5	6
	Baseline	Baseline + controls	Baseline	Baseline + controls	Baseline	Baseline + controls
Growth of MFP of technology leader	0.355***	0.348***	0.351***	0.346***	0.273***	0.319***
	(0.0663)	(0.0700)	(0.0676)	(0.0697)	(0.0682)	(0.0774)
Technology gap in MFP levels (t-1)	0.115***	0.0982***	0.112***	0.0969***	0.102***	0.0866***
	(0.020)	(0.020)	(0.021)	(0.020)	(0.021)	(0.022)
EPS tightening (MA lags)	0.0146	0.0151*	0.00271	0.00766	0.0183*	0.0192**
	(0.0088)	(0.0077)	(0.0190)	(0.0187)	(0.0090)	(0.0089)
Effect of gap on EPS tightening (MA lags)			0.0339	0.0218		
			(0.062)	(0.055)		
EPS tightening (MA leads)					-0.0133**	-0.0109*
					(0.0047)	(0.0060)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	277	277	277	277	261	261
Adj. R-squared	0.691	0.704	0.691	0.703	0.722	0.735

Note: Robust standard errors in parentheses; *** denotes statistical significance at the 1% level, ** significance at 5% level, * significance at 10% level.

(MA): denotes the moving average of the EPS change over three-years-lags/leads.

Baseline specification includes the following controls: Output gap, growth rate of average hours worked per employee, time trend, dummies for crisis years 2007 and 2008. Baseline + controls specification includes cyclically adjusted general government primary balance as percent of potential GDP, trade openness, industry share in % of total activity, business expenditure on R&D as % of GDP, employment protection legislation, product market regulation and the change in real oil price.

Firm Results

Dependent variable: MFP growth	1	2	3	4	5	6
	Baseline	Baseline	Baseline + Firm controls	Baseline + Firm controls	Full sets of controls	Full sets of controls
Growth in MFP in the technology leader	0.0782***	0.103***	0.0987***	0.145***	0.139***	0.179***
	(0.0260)	(0.0245)	(0.0291)	(0.0258)	(0.0167)	(0.0131)
Gap in MFP levels (t-1)	0.175***	0.222***	0.208***	0.293***	0.222***	0.296***
	(0.0142)	(0.0076)	(0.0238)	(0.0128)	(0.0229)	(0.0122)
EPS tightening (MA)	0.219***	0.238***	0.184***	0.180**	0.143**	0.147**
	(0.0655)	(0.0750)	(0.0642)	(0.0748)	(0.0611)	(0.0715)
Effect of gap on EPS tightening (MA)	-0.0850***	-0.0981***	-0.0694***	-0.0748***	-0.0665***	-0.0788***
	(0.0221)	(0.0253)	(0.0196)	(0.0223)	(0.0188)	(0.0232)
Fixed Effect						
Country	Yes	No	Yes	No	Yes	No
Industry	Yes	No	Yes	No	Yes	No
Country*Industry	No	Yes	No	Yes	No	Yes
Standard errors clustered at country*industry level	Yes	Yes	Yes	Yes	Yes	Yes
N	647392	647392	625011	625011	313071	313071
adj. R-squared	0.091	0.114	0.102	0.138	0.099	0.131

Note: Robust standard errors in parentheses and they are clustered at country-industry level; *** denotes statistical significance at the 1% level, ** significance at 5% level, * significance at 10% level.

(MA): defined as the moving average of the EPS change over three years (lagged).

Baseline specification includes the following controls: output gap and dummies for crisis. Baseline + Firm controls include: employment and turnover (both lagged). The full set of controls additionally includes: employment protection legislation (OECD EPL), regulatory impact (OECD RI), financial development, trade openness and R&D expenditures.

Simulated effects of EPS tightening on productivity growth – industry and firm

Albrizio et al. (2014), *OECD Economics Department Working Papers*, forthcoming.