

# The European Commission's science and knowledge service

Joint Research Centre



# The Innovation Output Indicator

**Dániel Vértesy**

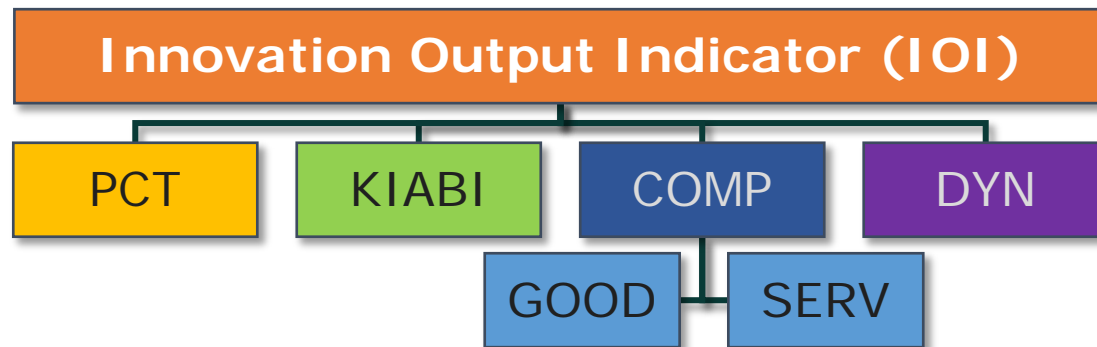
COIN CoP 2017 – Composite Indicators & Scoreboards Community of Practice: 2nd Annual Meeting  
09-10/11/2017, Ispra (IT)

# What does the IOI measure?

## Innovation output:

“the extent to which innovative ideas can reach the market”

- A composite index of 4 components (5 variables):



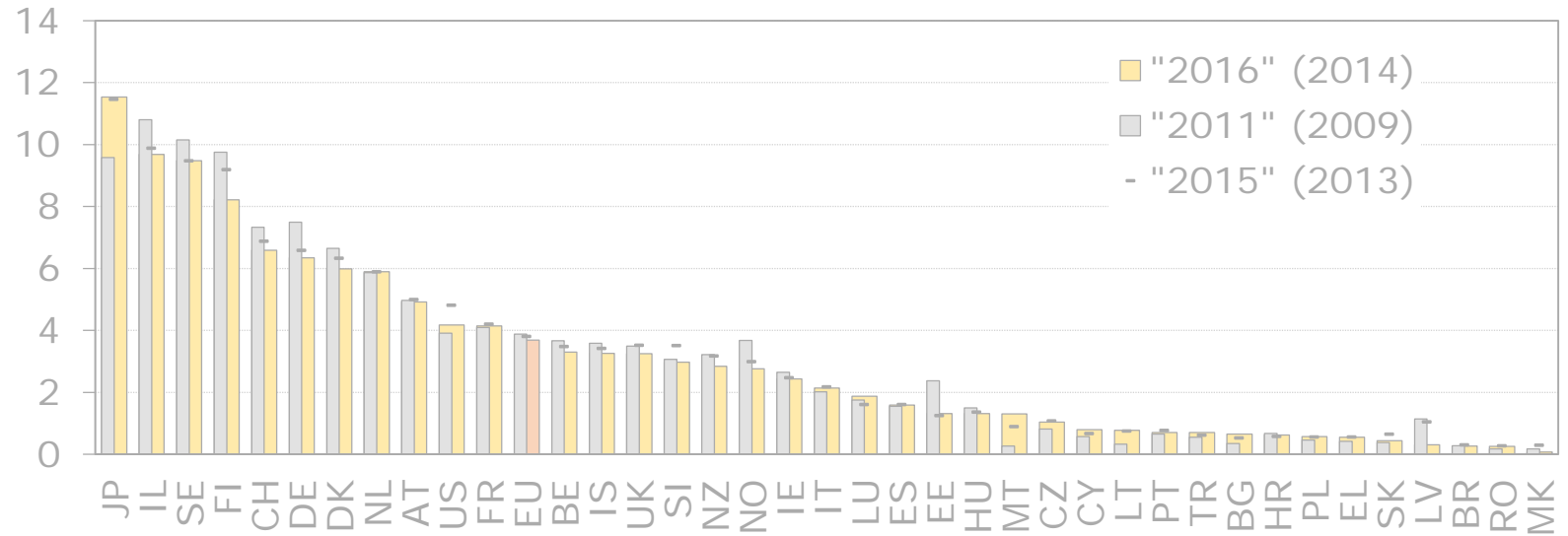
- Published by DG RTD since 2013
- Methodology developed with JRC/COIN support



# Components

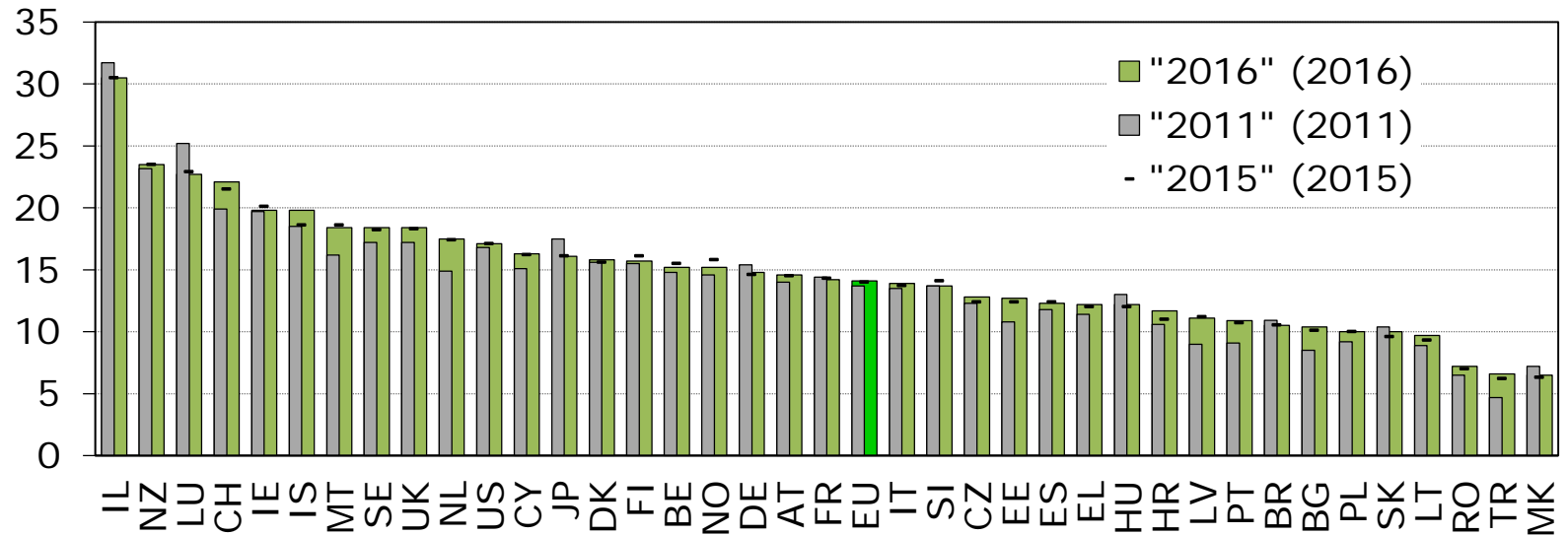
## PCT

PCT patent applications per billion GDP (in PPS)



## KIABI

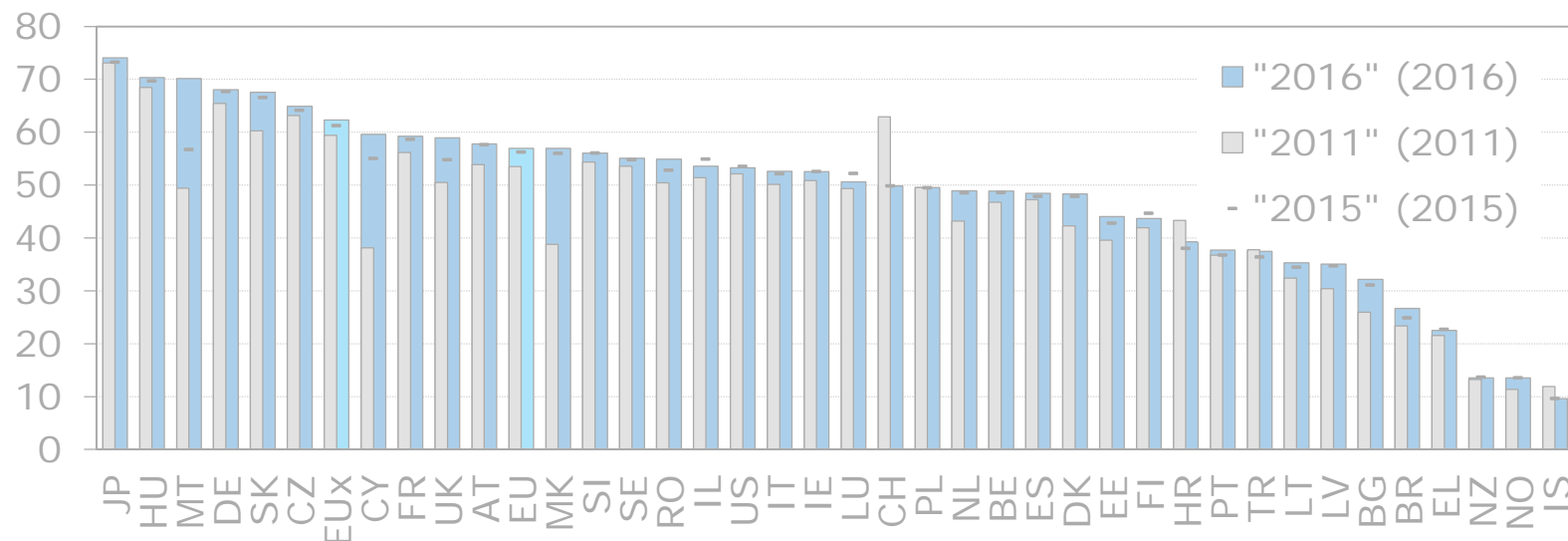
Share of employment in knowledge-intensive activities in business industries (in %)



# Components

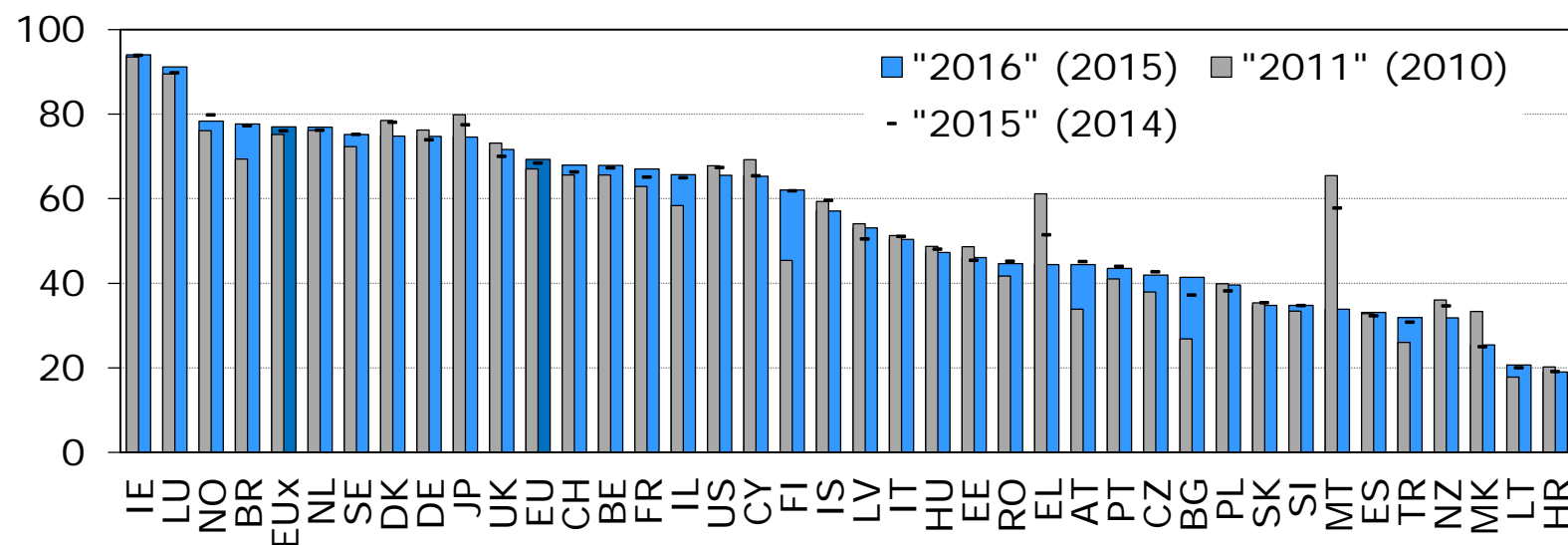
## GOOD

Exports of medium- and high-technology products as a share of total product exports (in %)



## SERV

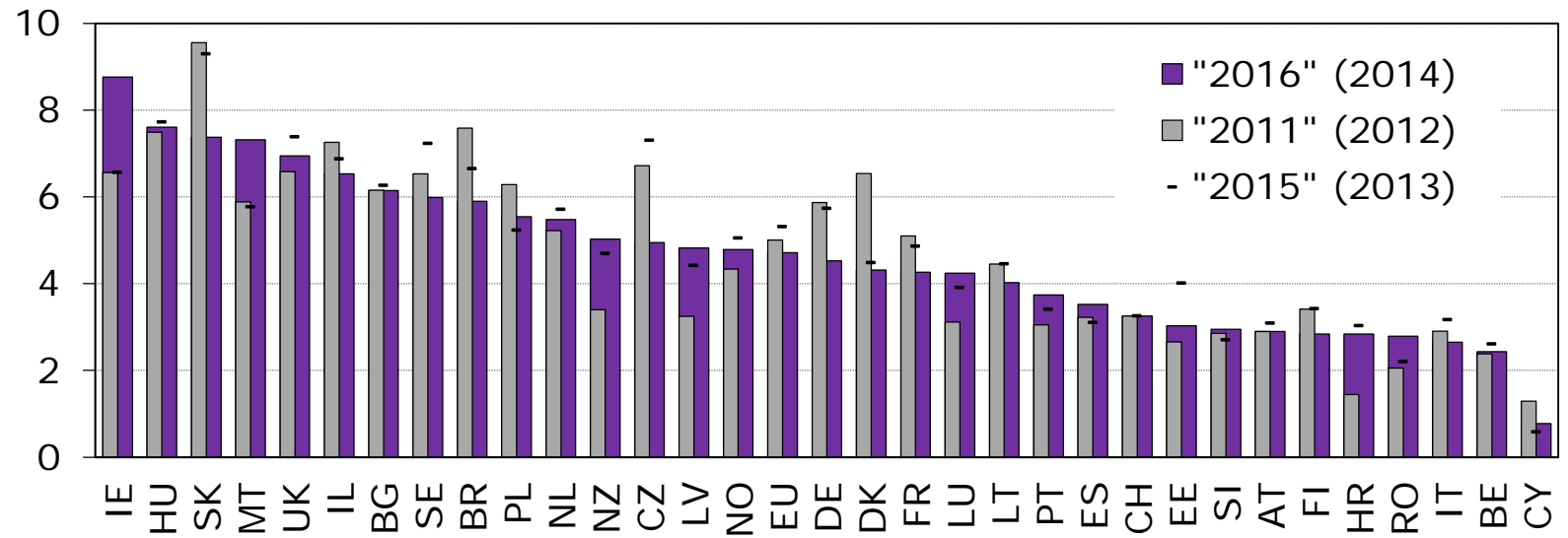
Knowledge-intensive services exports as percentage of total services exports (in %)



# Components

## DYN

Employment in fast-growing enterprises in the top 50% most innovative sectors as a percentage of total employment (in %)



# Why measure innovation output?

- Innovation key to **Europe 2020** strategy:  
*make the EU a “dynamic, sustainable, knowledge-based (‘smarter’) economy”*
- The political mandate from the European Council:  
Complement the Lisbon agenda’s 3% R&D [input] target with **output-oriented indicator(s)**
- Aim to complement the Innovation Union Scoreboard, and its Summary Innovation Index (SII), which measures overall performance, by zooming in on **a reduced set of dimensions**



High-level panel on the measurement of innovation proposed a **short list of indicators**:



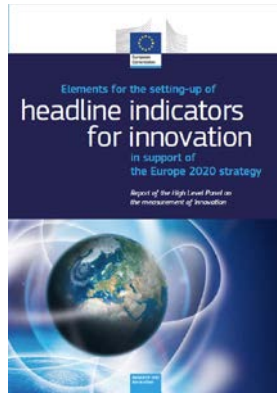
*“Each of them, alone, yields only a partial view of the innovation phenomenon, but together they provide if not for a perfect, at least for a clearer assessment”*

EC (2010)



# Why multiple indicators?

- Single indicator: hourly labor productivity: indirect measure
- Short list of indicators offering a clearer picture of the innovation phenomenon
- No ideal world:
  - Existing data: not good enough
  - Proxies based on data produced by official statistics are available
- Policy demand for a concise picture



# How: a composite index or a list of indicators?

- Disagreement: use a composite index or not?

## **Against:**

HLP's reservations: not easy to interpret

## **or... if there is a composite, HLP advised to:**

- keep the number of indicators limited to ensure transparency;
- Ensure a relative independence of components;
- Make possible to monitor the policies addressing the various components

→ **First solution:** a complex formula of 2 indices  
(sectoral innovation performance, sectoral innovation dynamics)

- Make use of innovation coefficients computed by OECD and Eurostat's new employment in high-growth enterprises data

$$II_c = \sum_i y_{ic} \frac{E_{ic}}{\sum_i E_{ic}}$$

$$MID_c = \sum_i y_{ic} \frac{E_{ic}^{HG}}{\sum_i E_{ic}^{HG}}$$

## **Stakeholder reservation:**

Too complicated; insufficient coverage!

# How: a composite index or a list of indicators?

- Political decision to go for a composite index

## **For:**

Summarize an admittedly multi-dimensional phenomenon

Useful for delivering policy messages (factors hampering R&I system performance)

Easy to interpret

- Inter-service Task force (DG RTD, ECFIN, ESTAT, GROW, JRC, TRADE, etc.) established to develop an index from a list of 4 components

# JRC team's role in developing the index

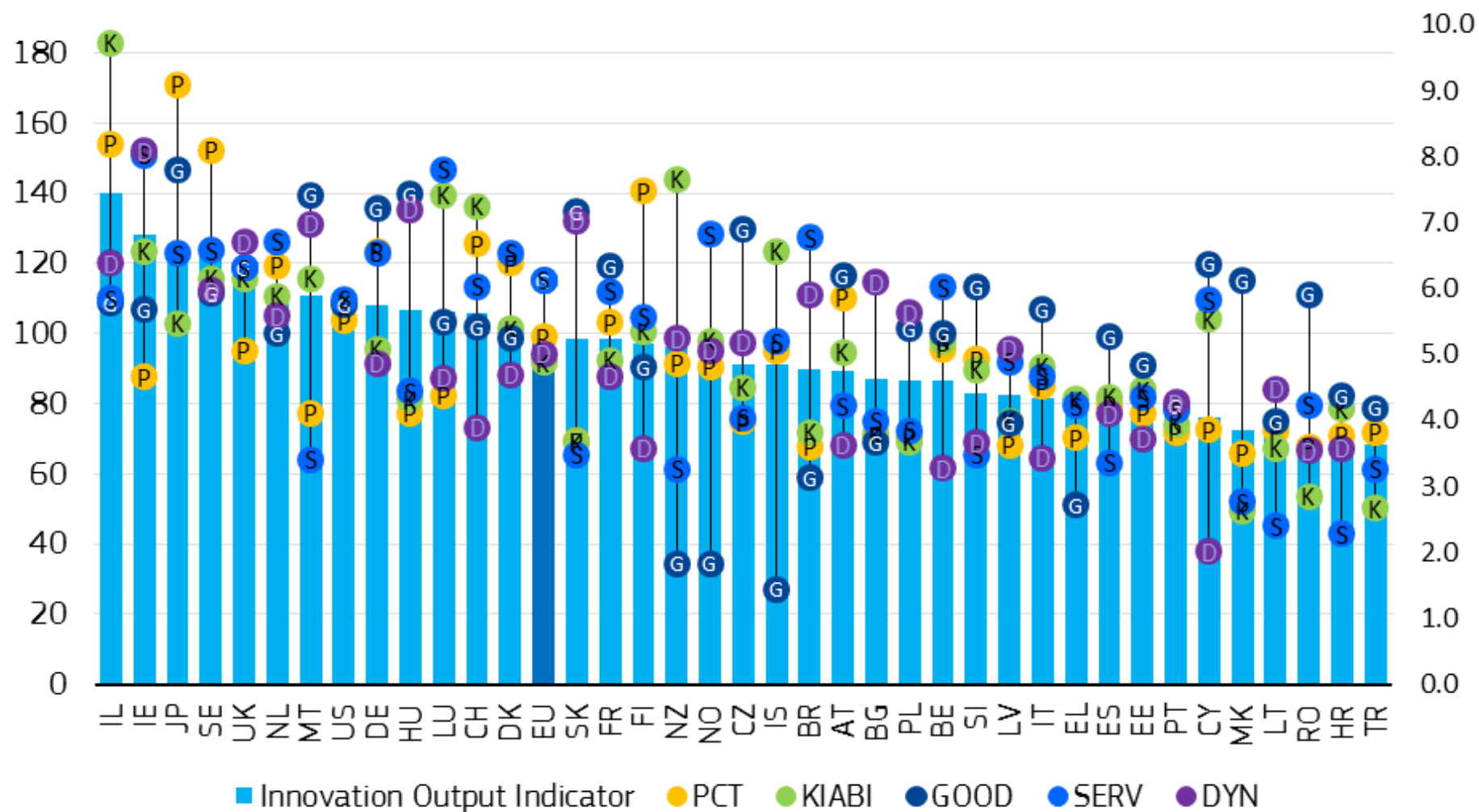
- Building indicator
- Improve robustness
  - Statistical validation:
    - checking conceptual and statistical soundness;
    - Perform global sensitivity analyses (MC simulations, alternative weights, DEA, etc.)
  - Computing scaling factors:
    - Decision to address statistical imbalances across dimensions using effective equal weights

# Updates and refinements

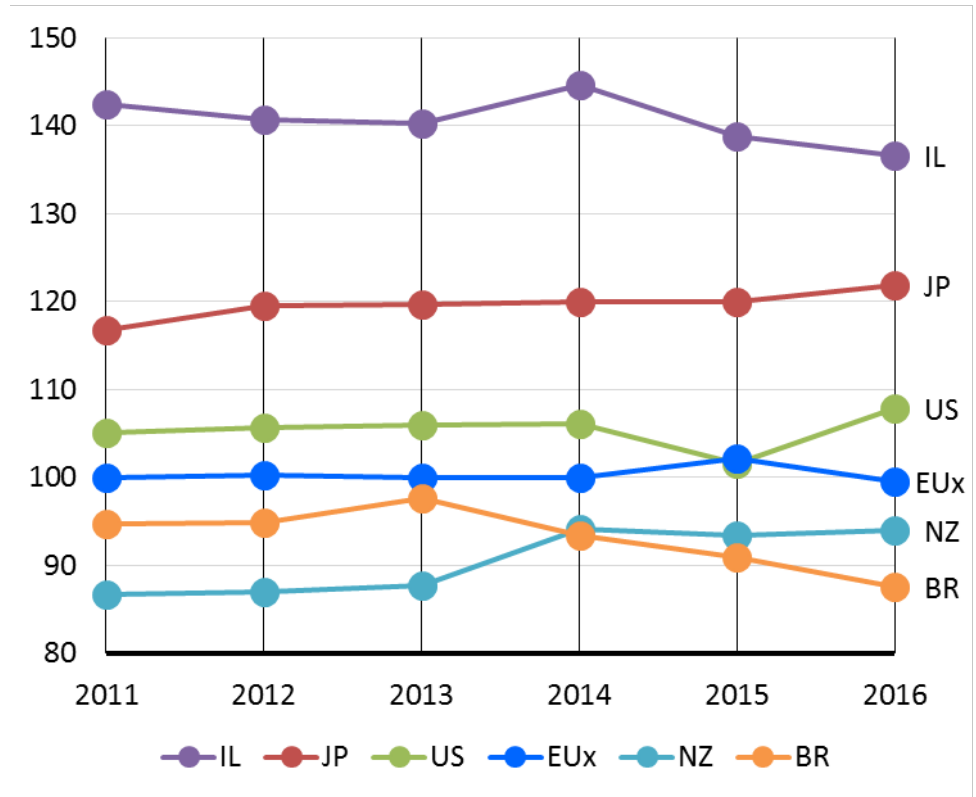
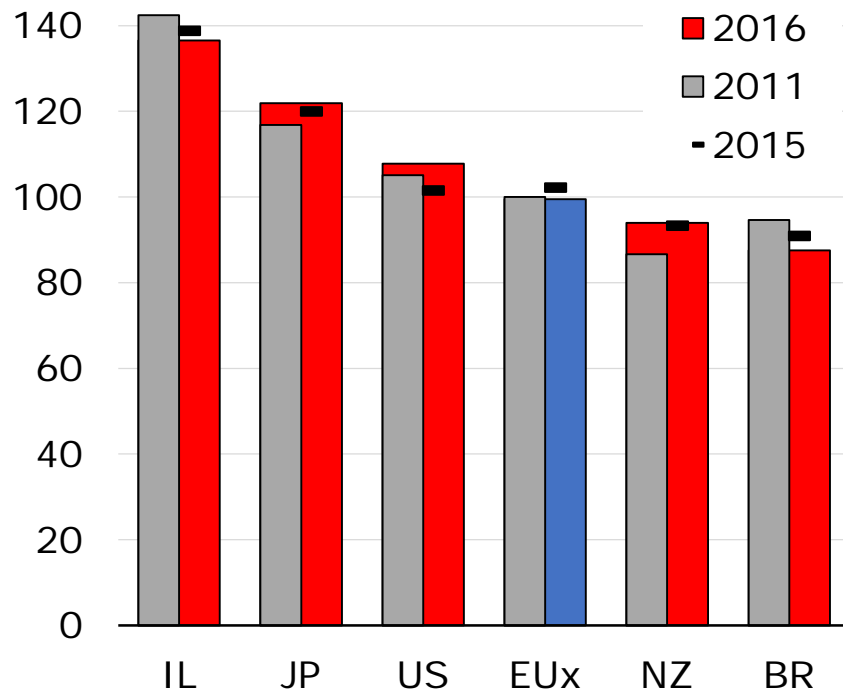
- Communication challenge: align with EIS
  - Similar measures: avoid different message
  - Frequency of publication: align or not?
- Refinements: “if you want to measure change, better not change the measurement”
  - Increase country coverage (given data availability)
  - Indicators refined



# Results



# The EU in international comparison







# JRC - COIN Statistical Support

**Balancing components**  
(Computing scaling  
coefficients) for annual  
updates

**EW= 0,25**  
4 components in IOI

## Correlation between IOI and components

Weights	Components	Pearson correlation coefficient	R^2	R^2
0,25	PCT	0,79	0,62	
0,25	KIABI	0,76	0,58	
0,25	COMP	0,74	0,55	
0,25	DYN	0,55	0,30	

EW result in an unbalanced contribution  
of components to the IOI







# JRC - COIN Statistical Support

**Balancing components**  
(Computing scaling  
coefficients) for annual  
updates

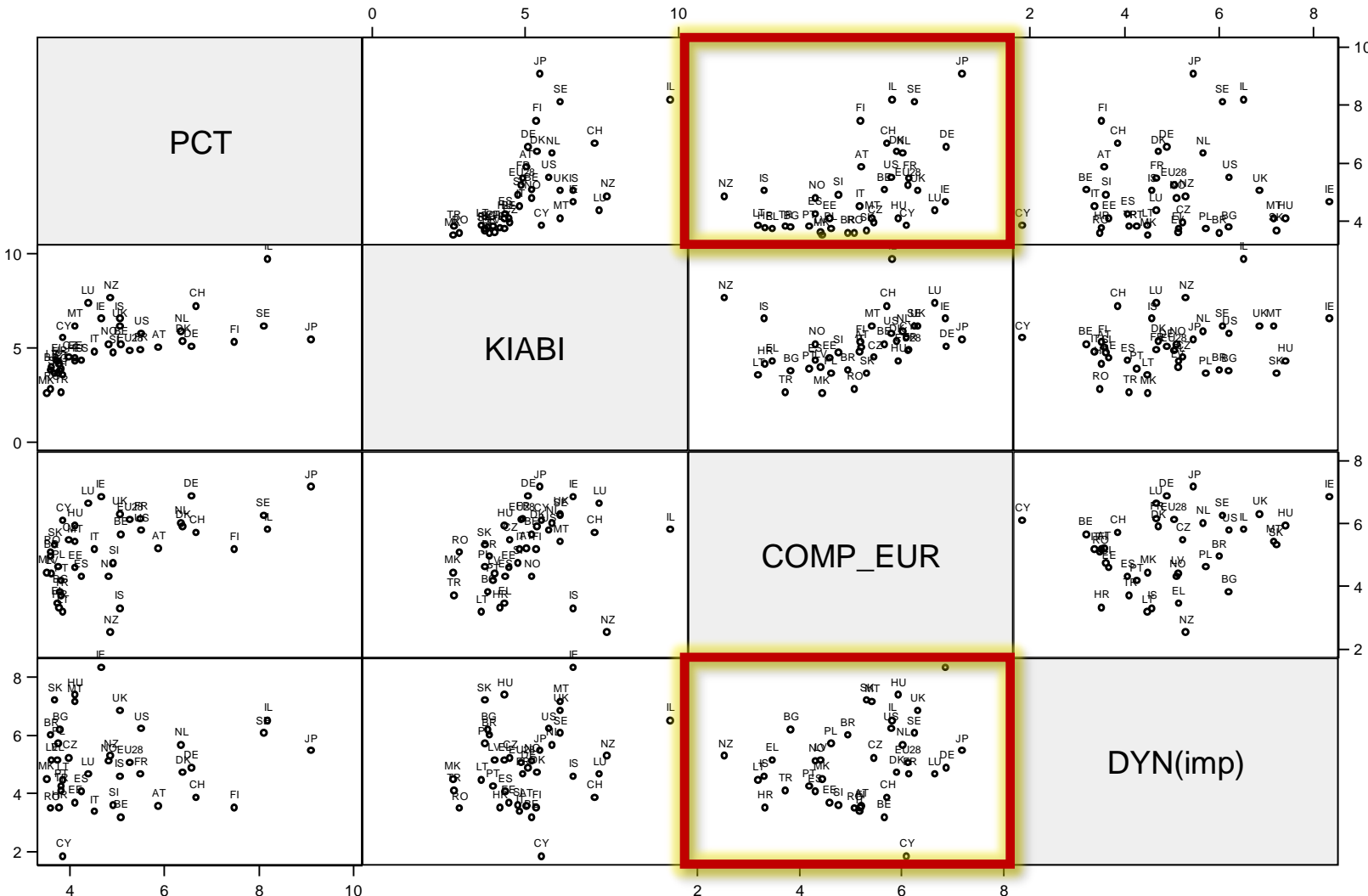
## Adjusted weights

### Correlation between IOI and components

Weights	Components	Pearson correlation coefficient	R <sup>2</sup>	R <sup>2</sup>
0,22	<b>PCT</b>	0,72	0,52	
0,22	<b>KIABI</b>	0,70	0,49	
0,22	<b>COMP</b>	0,71	0,51	
0,34	<b>DYN</b>	0,67	0,45	

Adjusted weights result in a more balanced  
contribution of components to the IOI

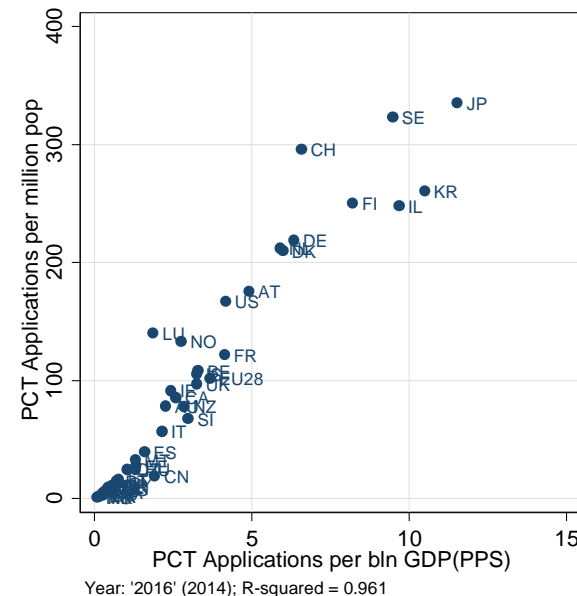
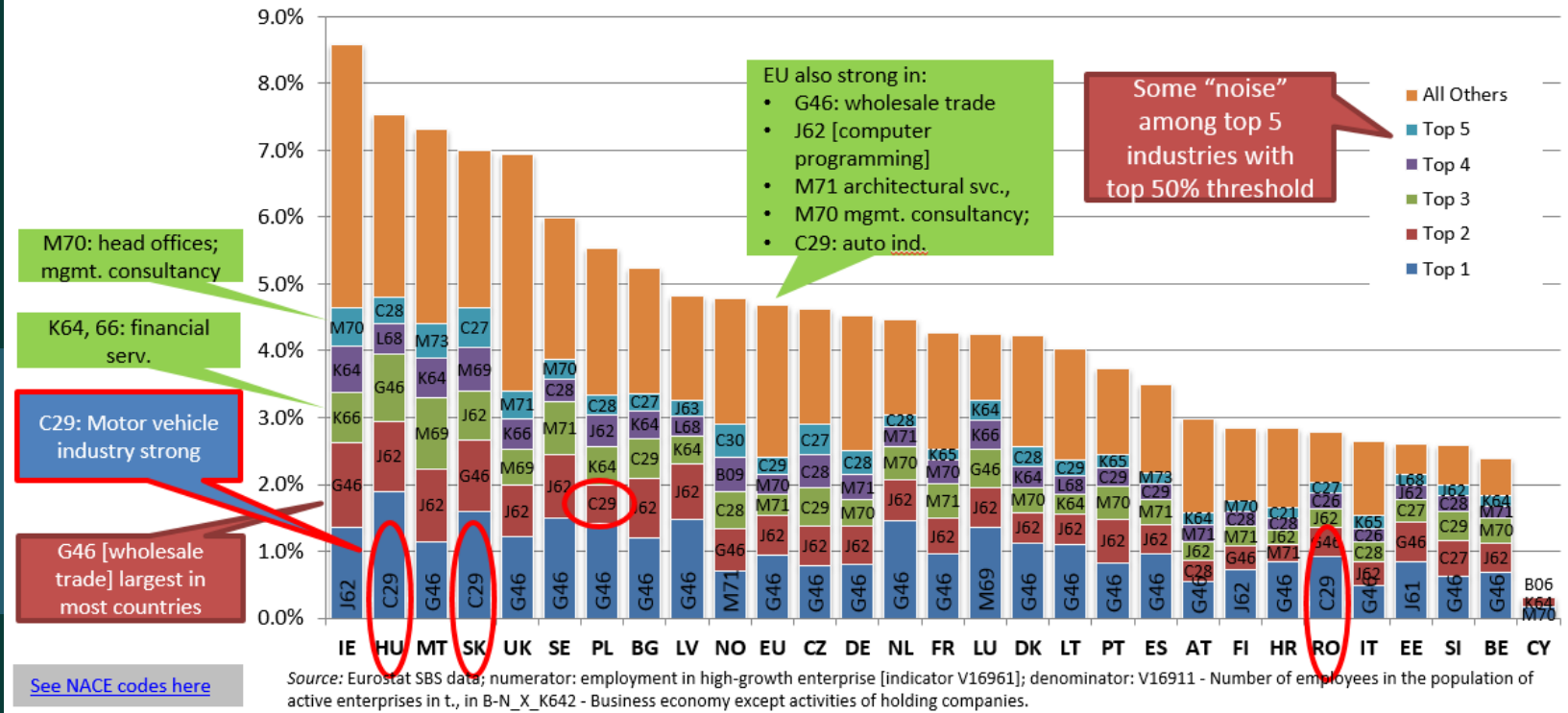
# Statistical coherence



	PCT	KIABI	COMP <sub>EU</sub>	DYN <sub>imp</sub>
N.Obs.	234	234	234	234
Min	3.5	2.1	2.5	1.7
Max	9.4	10.1	7.5	9.0
Mean	5.0	5.0	5.0	5.0
Std. Dev.	1.5	1.5	1.1	1.5
Skewness	1.2	0.9	-0.1	0.3
Kurtosis	0.5	1.4	-0.7	-0.4
Correlation				
PCT	1.000			
KIABI	0.583	1.000		
COMP <sub>EU</sub>	0.524	0.414	1.000	
DYN <sub>imp</sub>	0.112	0.123	0.286	1.000

# JRC - COIN Statistical Support

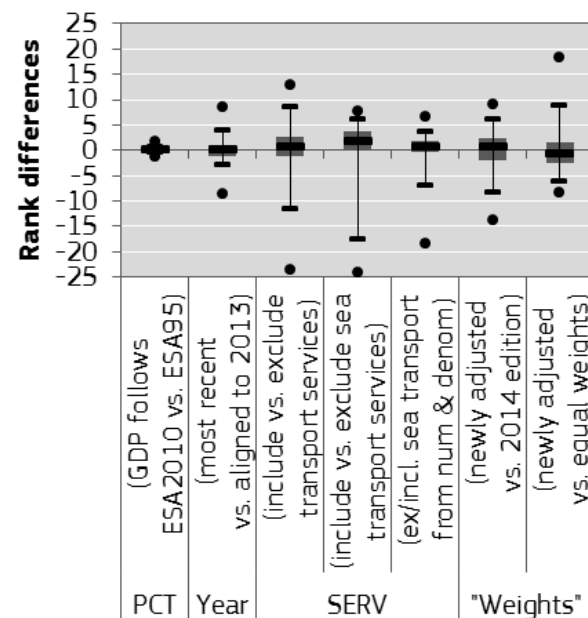
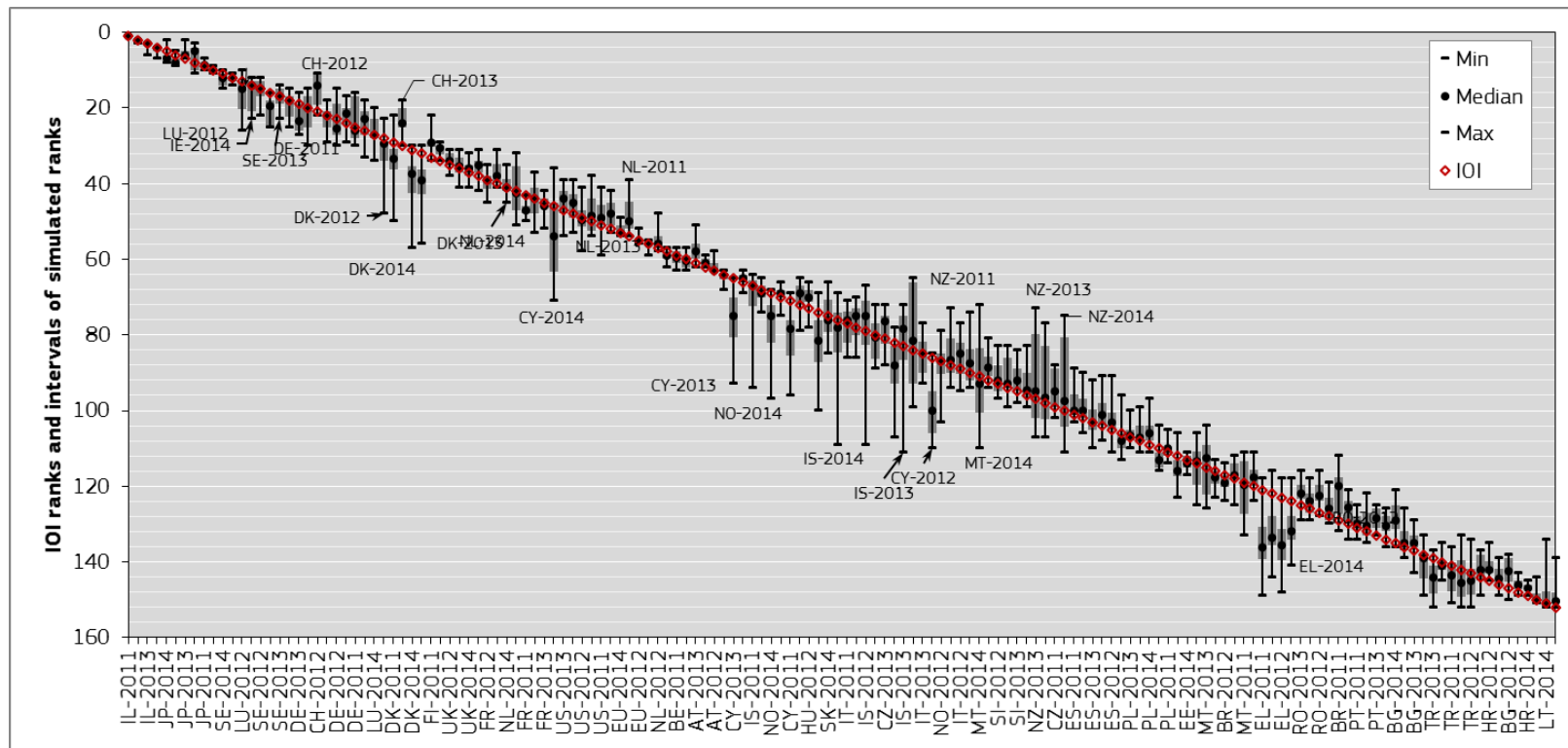
Developing alternatives  
Alternative ways of  
measuring components –  
i.e., DYN



# JRC - COIN Statistical Support

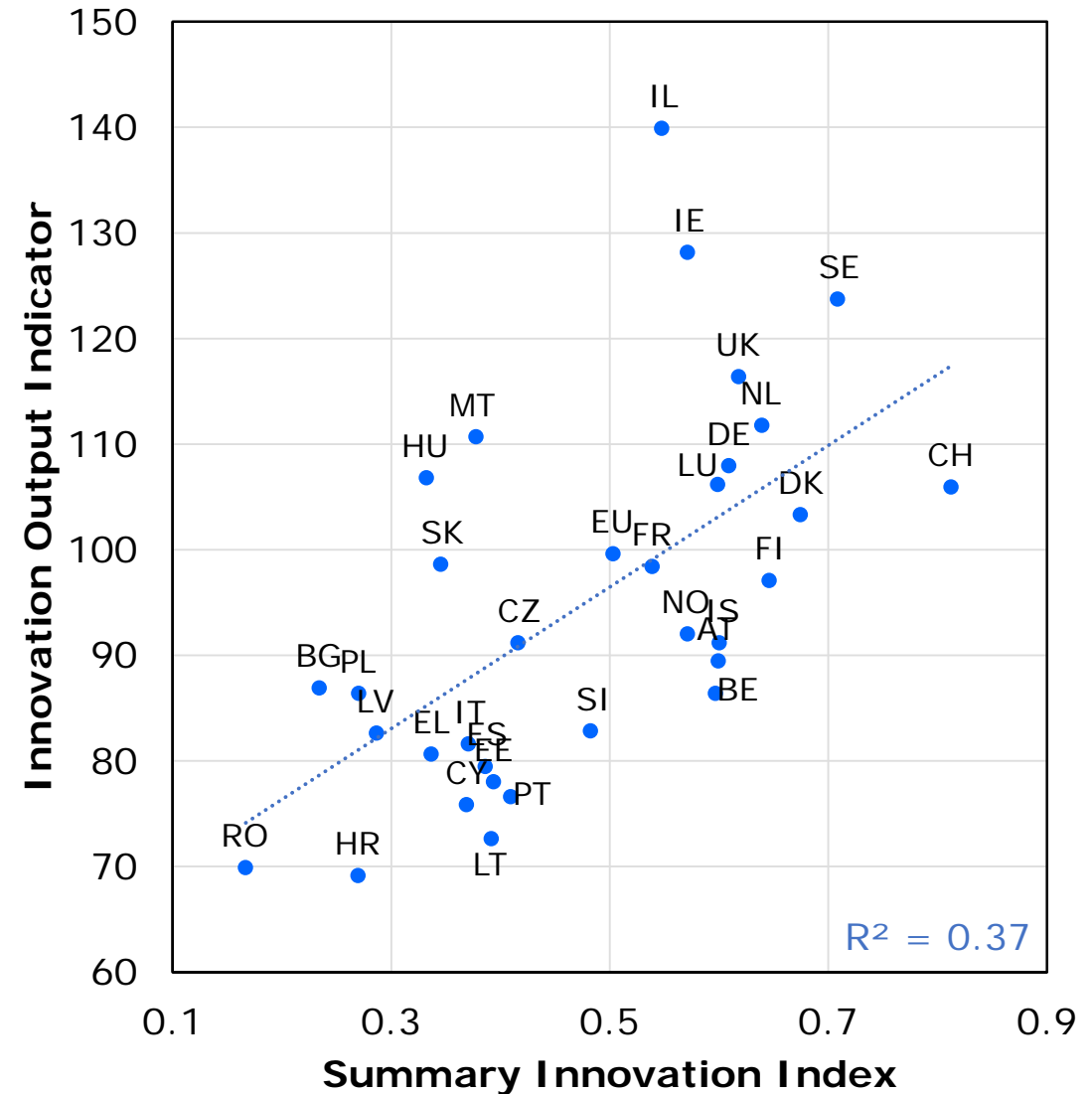
**Robustness analyses**  
when revising components

**Sensitivity analyses** to  
reveal impact of changing  
modelling assumptions



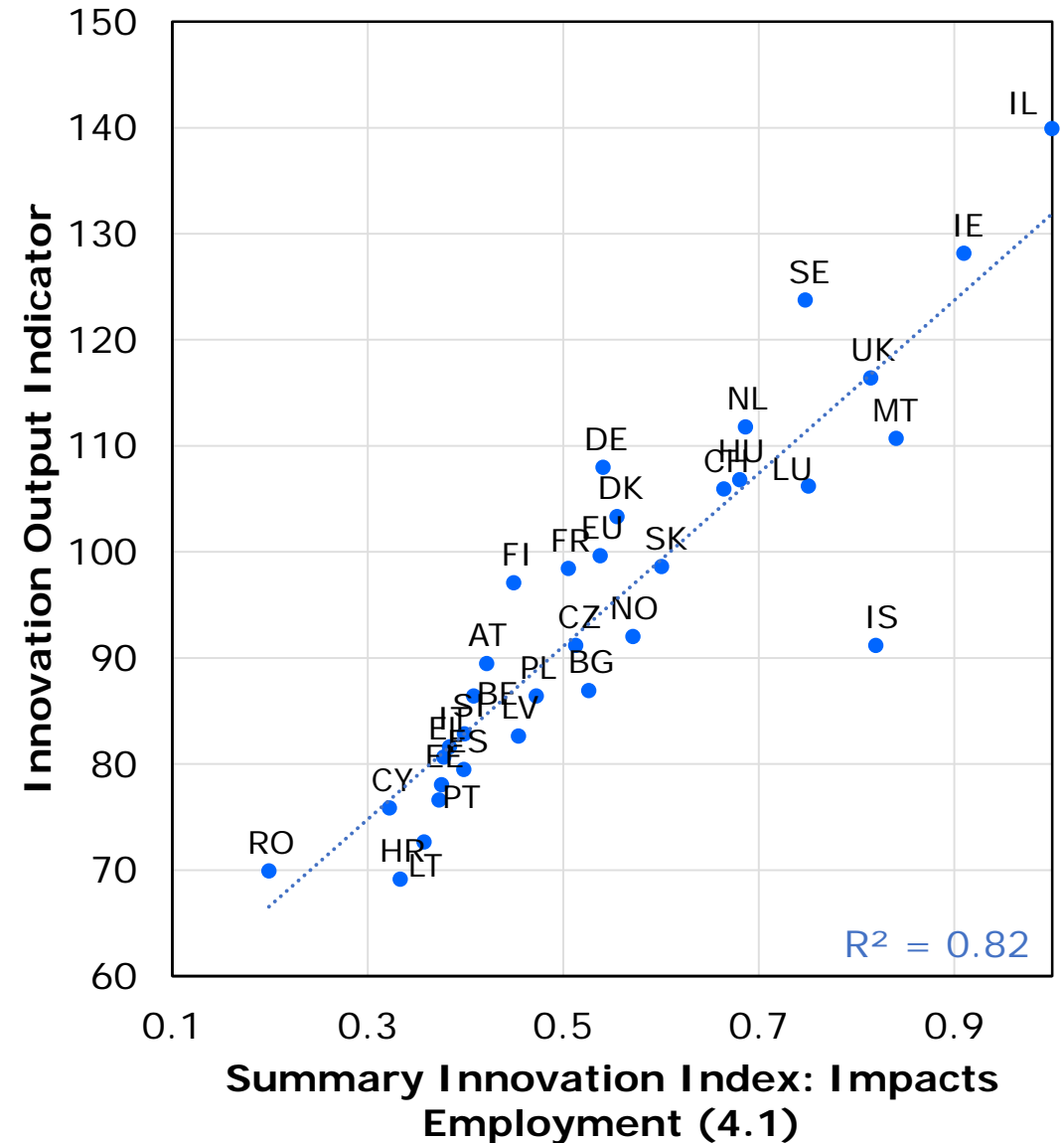
# Comparing scores: IOI vs SII

- Moderate, positive association:
- SII: relatively stronger influence of science and R&D-based innovation activities;
- IOI: relatively stronger influence of firm dynamics



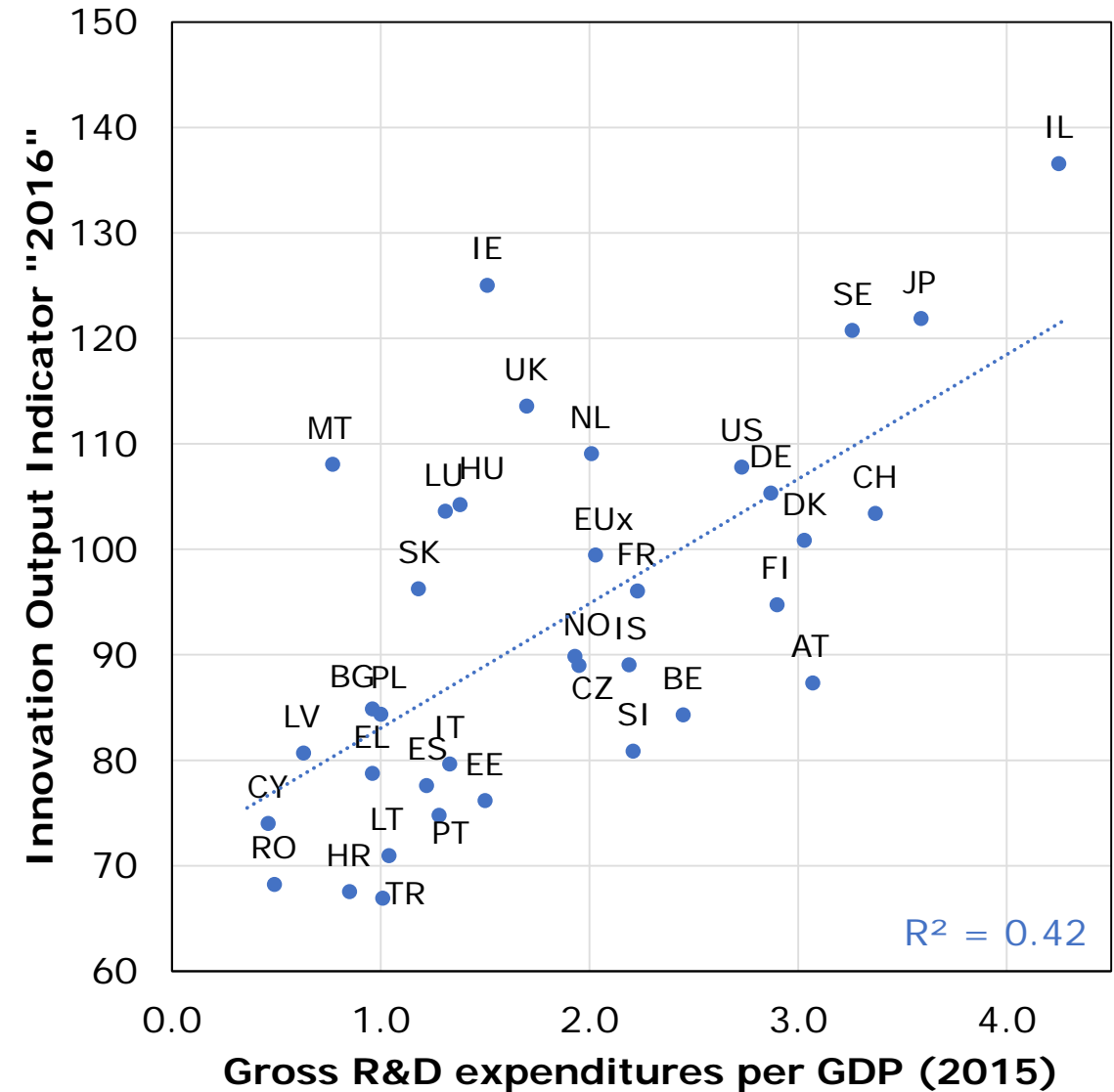
# Comparing scores: IOI vs 'Employment Impacts' of EIS

- Strong positive correlation:
  - SII: high-growth, innovative firms component receives stronger relative weight
  - Still some differences: consider Sweden, Germany

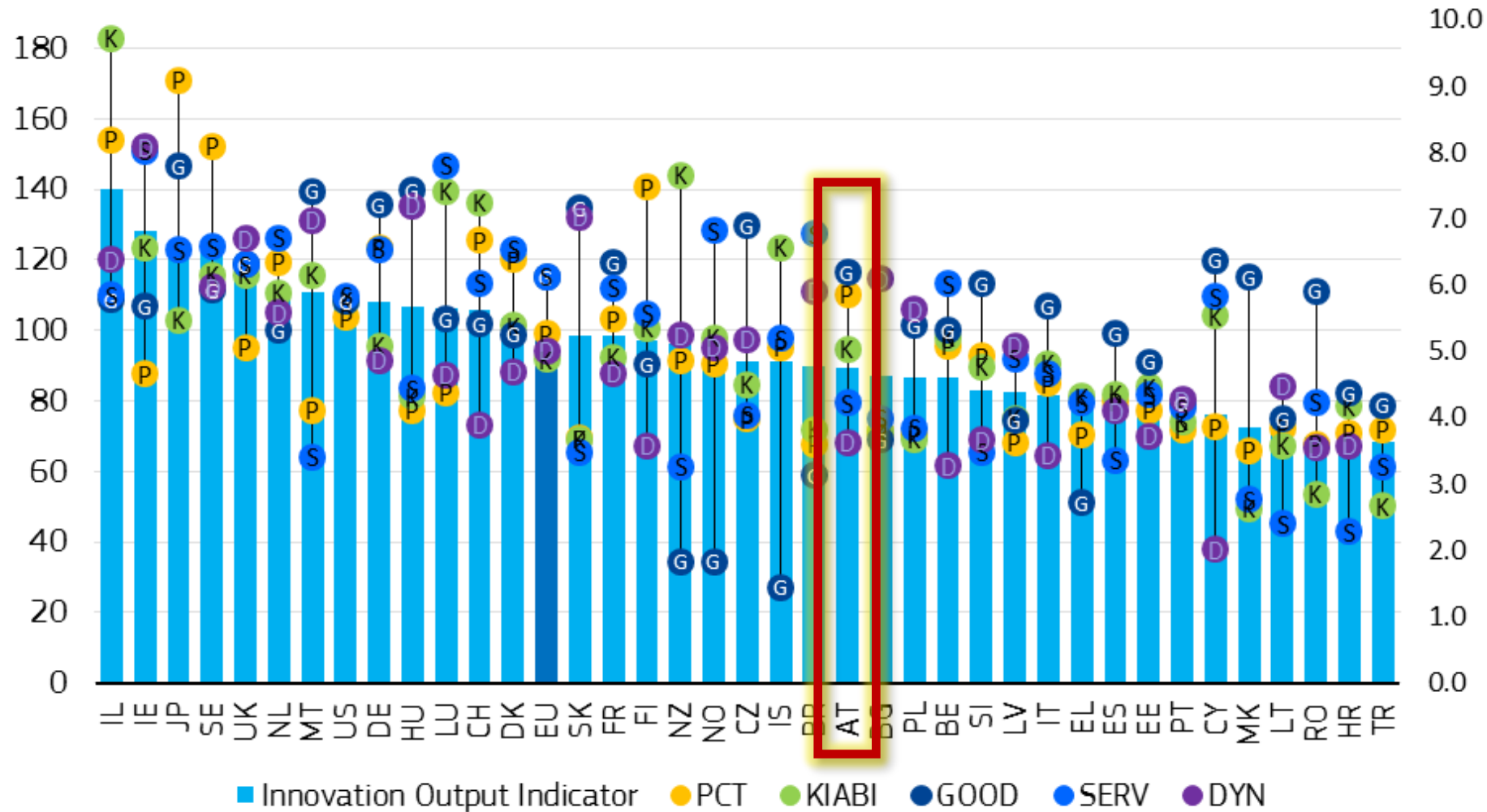


# Output vs Input: IOI vs R&D expenditure

- Moderate, positive association
- Gives a different picture
- Caveat:
  - Not all innovation is R&D based;
  - No linear relationship,
  - considerable time lag
- Yet, high spenders feel “not rewarded” (i.e. AT)



# Results





# Limitations, debates

- Structural differences across countries:
  - i.e., what do exports measure?
  - Indicators affected by geography, natural resource endowments (< > smart specialization?)
- Economic impact of innovation output: where is it realized?
  - transnational companies vs. national borders
- DYN: conceptually as well as statistically different from the rest of the indicators
  - International comparison limited: different benchmarks
- Is there a validator: a single measure of innovation?
  - HLP: hourly labour productivity



# Challenge for innovation indicators



## Advocacy tool

- 15+ years of experience (think of SII; GII!)
- Innovation policy (more than technology!) now high on the agenda *"innovate out of the crisis"*
- Advocacy for data improvements

## Analytical tool



- Contents of "the rest of the reports"
- Data challenges:
  - Established official statistics (i.e., R&D);
  - Improving official statistics: (i.e., CIS surveys, 20 years);
  - Emerging data sources: **experimental** → **mainstream** /admin, balance-sheet data, 'big data' (i.e., introduction and diffusion of new products, their consumption)/  
=> make it useful for policy monitoring



# THANK YOU

Welcome to email us at: [daniel.vertesy@ec.europa.eu](mailto:daniel.vertesy@ec.europa.eu)  
[jrc-coin@ec.europa.eu](mailto:jrc-coin@ec.europa.eu)

**COIN in the EU Science Hub**

<https://ec.europa.eu/jrc/en/coin>

**COIN tools are available at:**

<https://composite-indicators.jrc.ec.europa.eu/>

The European Commission's  
Competence Centre on Composite  
Indicators and Scoreboards



# References

EC (2010) *Elements for the setting-up of headline indicators for innovation in support of the Europe 2020 strategy: Report of the High Level Panel on the measurement of Innovation 2010.*