Capturing R&D Excellence

country-level performance indicators

and international statistics

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Research framework

• We define ‘R&D excellence’ in terms of scientific research contributing to ‘high end’ technology (‘excellence’ refers to the top segment of a statistical distribution based on internationally comparative performance scores)

• Our measurements are derived from frequency counts of literature references (‘citations’) between patents and research publications during the last 15 years

• ‘D’ in R&D: ‘excellent’ citing patents; the most influential patents worldwide (highly cited by other patents)

• ‘R’ in R&D: peer-reviewed research articles in international scholarly journals that are cited by these patents
Information sources (CWTS, Leiden University, Netherlands):

- Web of Science - Core Collection (WoS)
- PATSTAT

Information items:

- citing PATSTAT-indexed patent families in (2004-2013)

Sample size:

- 4,351,180 citing patents and 13,742,865 cited research publications
Research questions

What are the key ‘enabling factors’ that affect or determine R&D Excellence at the country-level ... 

• ... in high-income nations (with advanced science/innovation systems)?

• ... in medium-high and medium-income nations?
The independent variables:

- R&D Excellence – volume (cited research publication output)
- R&D Excellence – share (% cited research publications in total publication output)

Case study 1 (selected 20 OECD countries):

Economic/financial factors used as explanatory variables

Case study 2 (70 countries, incl. 40 OECD countries):

Non-economic factors used as explanatory variables
Top 20 high-income countries

Independent variables:
R&D Excellence – volume (cited research publication output)
R&D Excellence – share (% cited research publications in total publication output)

Explanatory variables:

1. OECD statistics:
GDP per capita  GDP per capita;
GERD  Gross total R&D spending;
BERD  Business sector R&D;
GOVERD  Government R&D spending;
HERD  Higher education R&D spending;
%HERD – by firms  Higher education R&D spending by the business sector;

2. University-Industry Collaborative publications (UICs)
%UIC – all firms  Share of UICs in total scientific publication output;
%UIC – domestic firms  Share of UICs in total scientific publication output that mention a domestic based business enterprise as research partner
OECD data are replaced by information on ‘science systems’ extracted from the annual *Executive Opinion Survey* (source: World Economic Forum’s *Global Competitiveness Index 2011-2012*).

Country-level performance indicators are:

**GCI Survey – UIC**  ‘University-industry collaboration in R&D’

**GCI Survey - R&D human resources**  ‘Availability of scientists and engineers’

**GCI Survey - science system quality**  ‘Quality of scientific research institutions’

Survey respondents score on a Likert scale from 1 (‘very low’) to 7 (‘very high’).
70 high- and medium-income countries

Independent variables:
R&D Excellence – volume (cited research publication output)
R&D Excellence – share (% cited research publications in total publication output)

Explanatory variables:

1. OECD statistics
   GDP per capita
   Gross Domestic Product per capita

2. University-Industry Collaborative publications (UICs)
   %UIC – all firms
   Share of UICs in total scientific publication output;
   %UIC – domestic firms
   Share of UICs in total scientific publication output
   that mention a domestic based business enterprise as research partner

3. Global Competitiveness Index
   Survey - UIC
   (University-industry collaboration in R&D)
   Survey - R&D human resources
   (Availability of scientists and engineers)
   Survey - Science System Quality
   (Quality of scientific research institutions)
General observations and conclusions #1

The main results emerging from this empirical study suggest that:

1. our limited set of factors offers **relevant insights** as to why countries seem to excel in ‘R&D Excellence’

2. although the size of a country’s science system matters, it’s the **size-corrected score** (‘R&D Excellence – share’) that is much higher correlated with science-related ‘enabling factor’

3. both size-dependent and size independent measures are needed for a **more comprehensive’and balanced view** of R&D Excellence
4. macro-level analysis of **explanatory factors** is inadequate to explain country-level **enabling factors** of R&D Excellence.

5. **studies of causality** would require an **extensive macro-level econometric study** of a highly complex and dynamic national R&D system, including spill-over effects from other countries and interdependencies with business sector innovation systems.

6. fuller understanding of enabling factors also requires **in-depth case studies** of industrial research and science-based inventions at meso- and micro-levels, notably within **regional R&D systems** and individual **industry-oriented ‘innovative’ research universities**.
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