CWTS
Meaningful metrics

Capturing R&D Excellence

country-level performance indicators and international statistics

Robert Tijssen and Jos Winnink

Leiden University, Netherlands

Universiteit Leiden

STI 2017 Conference, 6-8 September 2017
ESIEE Paris, Champs-sur-Marne (France)

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

Data sources (CWTS, Leiden University, Netherlands)**:**

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

Information items:

- cited WoS-indexed publications (2001-2013)
- 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?

Macrolevel statistical studies

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	Gross Domestic Product 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

Global Competitiveness Index

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

General observations and conclusions #2

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**

For more information,
please contact:

tijssen@cwts.leidenuniv.nl
winninkjj@cwts.leidenuniv.nl