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Composite Indicators - Boon or bane?

16th Scientific Colloquium

German Federal Statistical Office and German Statistical Society

Ralf Münnich

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Economic and Social Statistics Department

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Wiesbaden, 22. November 2007

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Press Release of the EU

Stagnation of R&D intensity a major threat to the European knowledge-based economy

...
The "Key figures 2005 for science, technology and innovation" show worrying trends in R&D investment and innovation in Europe. The growth rate of R&D intensity (R&D expenditure as % of GDP) has been declining since 2000 and is now close to zero. Europe is on track to miss the objective it set itself to boost spending on R&D from 1,9 to 3% by 2010.

IP/05/968 vom 19.07.2005

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European Commission: DG Research in cooperation with DG ECFIN and DG ESTAT

Framework Programme 6
Integrating and Strengthening the European Research Area
Policy Orientated Research

KEI

Project Period:
1. September 2004 – 30. November 2007 (30. April 2008)

`http://kei.publicstatistics.net`

EC contribution: 1.58 M€

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Aims of the KEI project

- KEI will focus on indicators and composite indicators
  - Review of state-of-the-art methodology
  - Main thematic areas in relation to Lisbon and Barcelona objectives
  - Forward looking policy and indicator analysis
- Development of innovative approaches
  - Appropriate and improved statistical methodology
  - Multi-criteria methods
  - Aggregation and weighting techniques
  - Elaboration of sensitivity analysis
  - Evaluation of analytical properties of indicators
  - Investigation of adequate presentational techniques
  - Support by large-scale simulation study
  - Scenario analysis in co-operation with Commission services

$\longrightarrow$ **Policy-orientated research** (FP6)

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Partners of KEI

Eberhard Karls University of Tübingen: Dominik Ohly (ACO)
imputation, simulation analysis

Joint Research Center, Ispra: Andrea Saltelli
sensitivity analysis, simulation analysis, composite indicators

Katholieke Universiteit Leuven: Tom Van Puyenbroeck
composite indicators, benefit-of-the-doubt method

University of Maastricht, MERIT: Anthony Arundel
definition and selection of indicators, innovation in indicators

Statistics Finland: Mikael Åkerblom
multinationals, indicators, statistics

University of Trier: Ralf Münnich (SCO)
data quality, properties of indicators, simulation analysis

Example 1: LinuX OS test

		Weights	OpenSuse 10.3	Ubuntu 7.10
Speed	Installation	1	1	0
	Package installation	1	1	0
	Boot time	4	4	2
Security	Firewall	2	1	2
	Safe passwords	1	1	0
	Cryptographic partitions	1	1	0
	AppArmor	1	1	0
	Rootless	1	0	1
Package management	Graphical PM	2	2	2
	Simplified PM	1	0	1
	Actualisation	2	2	2
	One-click install	1	1	0
Multimedia	Codec support	2	1	2
	Driver support	2	0	2
	Browser plugins	2	1	2
	3D desctop	1	1	1
	DVD	1	0	1
	DVD encrypted	1	1	0
Hardware support	Printer	3	3	6
	Scanner	2	2	4
	DVB-T stick	1	1	0
Result			25	28

LinuX User 12/2007, pp. 76

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Example 2: University Rankings

The TOP 10:

1	Harvard University	6	Princeton University
2	University of Cambridge	7	California Institute of Technology
2	University of Oxford	7	University of Chicago
2	Yale University	9	University College London
5	Imperial College London	10	Massachusetts Institute of Technology

Financial Times, 08. November 2007

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Example 2: University Rankings

The TOP 10:

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2	University of Cambridge	7	California Institute of Technology
2	University of Oxford	7	University of Chicago
2	Yale University	9	University College London
5	Imperial College London	10	Massachusetts Institute of Technology
26	Ecole Normale Supérieure, Paris	60	Heidelberg

Financial Times, 08. November 2007

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Overview of Selected Composite Indicators

- EU goals:
  Lisbon Strategy
  Barcelona Council
- Examples for composite indicators
  - DG RTD: Knowledge-based Economy
    - Investment
    - Performance
  - DG RTD: KEY Figures 2003 - 2004, KEY Figures 2005
  - DG MARKT: Internal Market Index
  - DG ENTR: e-Business Readiness
  - Environmental Sustainability Index (Yale & Columbia)
  - Human Development Index (United Nations)
  - Current Competitiveness Index (World Economic Forum)
- JRC / OECD: Composite Indicators

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Investment for the Knowledge-based Economy

- Countries: EU15 + accession countries + USA + Japan
- Time period: 1995 ... 2002, early *estimates* for 2003
- Indicators:

GERD	Total R&D expenditure (per capita: POP)
PhD	Total new science and technology PhDs (POP)
FTE	Total researchers (full time equivalent; POP)
GFCF	Total gross fixed capital formation (excluding construction; POP)
EGov	E-government
TEE	Total education expenditure (POP)
LLL	Life-long learning (per population aged 25-64 years participating in education and training; POP1)

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  Knowledge creation

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  Knowledge diffusion

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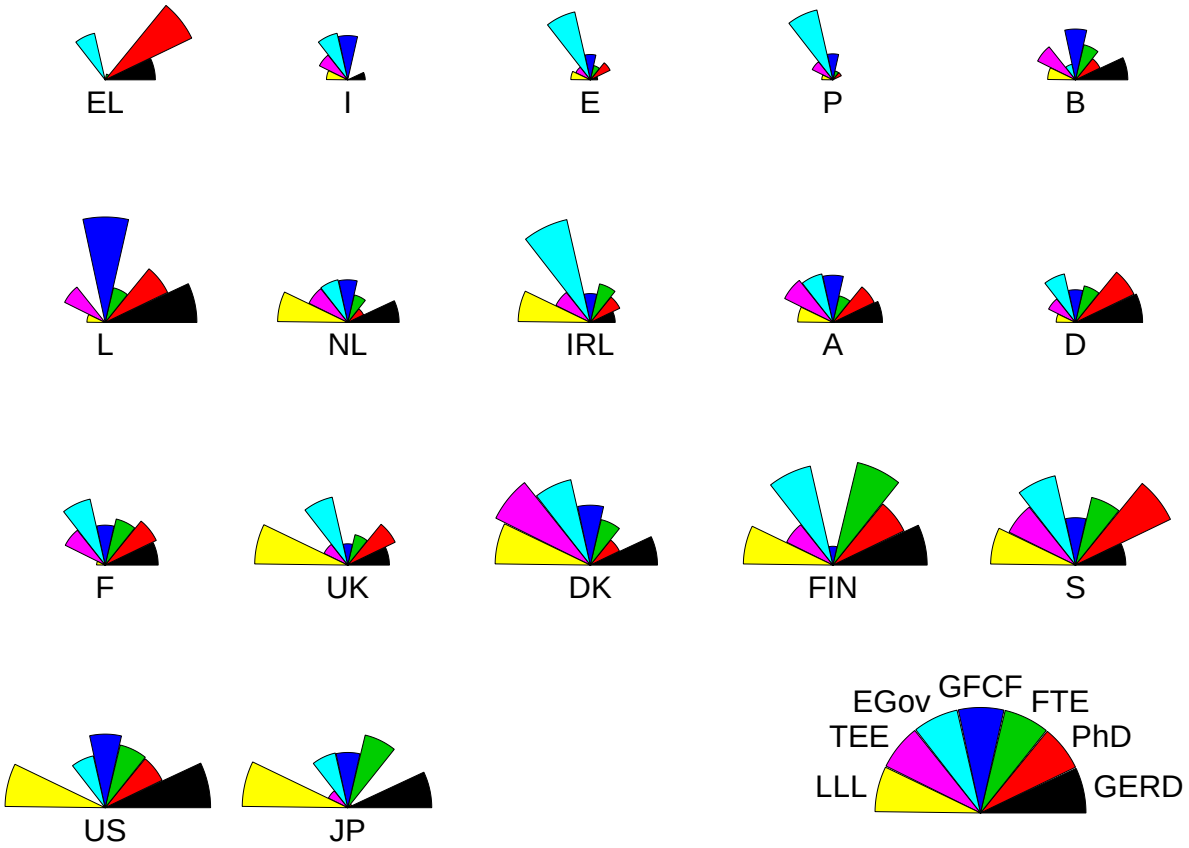
Investment for the Knowledge-based Economy in 2000

(across countries)



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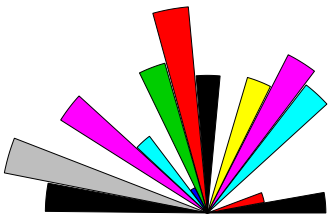
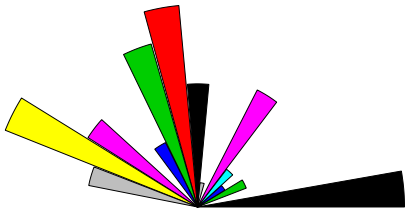
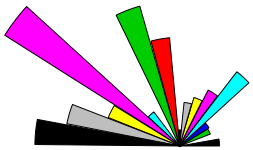
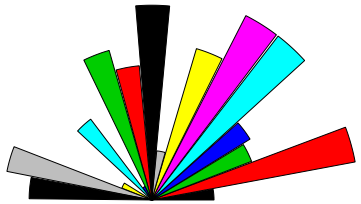
Investment for the Knowledge-based Economy in 2000

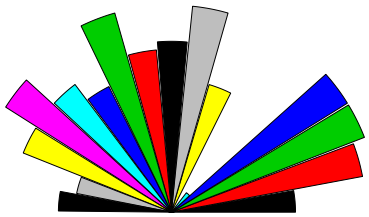
(as % of indicators total)

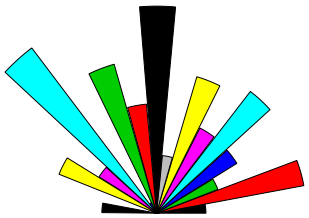

GERD

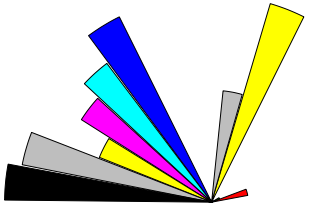

PhD

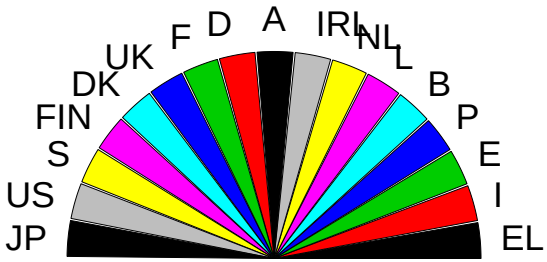

FTE


GFCF


EGov


TEE


LLL



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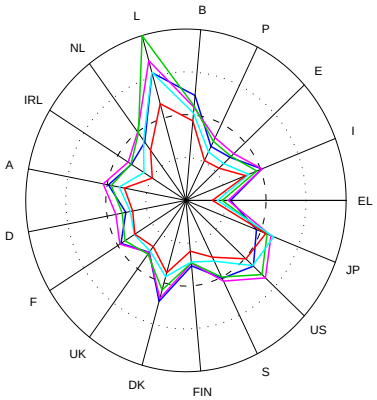
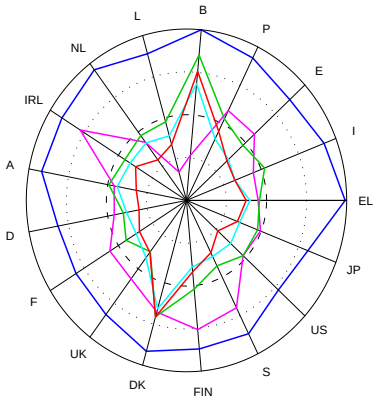
Knowledge-based Economy

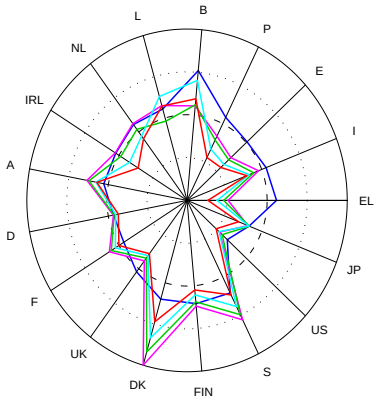
(Investment in %)



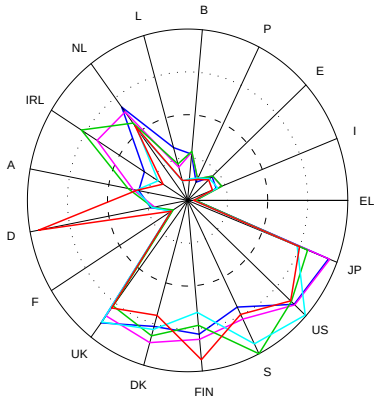
GFCF/POP



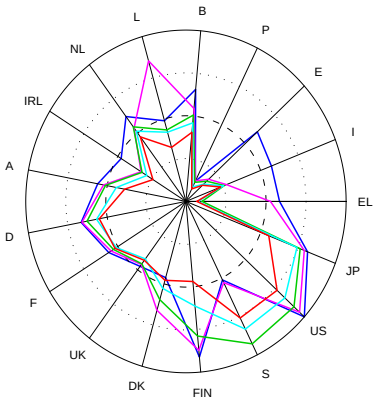
EGov



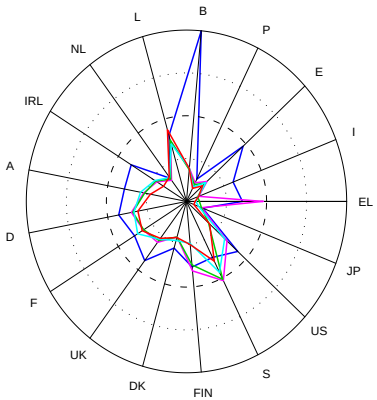
TEE/POP



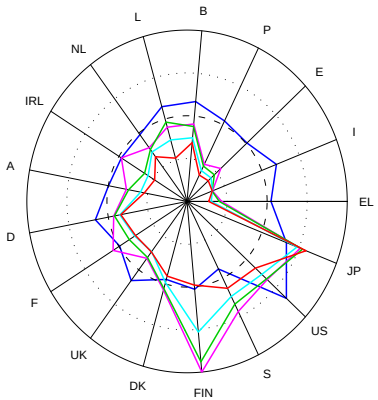
LLL/POP1



GERD/POP



PhD/POP



FTE/POP

2002
2000
1999
1997
1995

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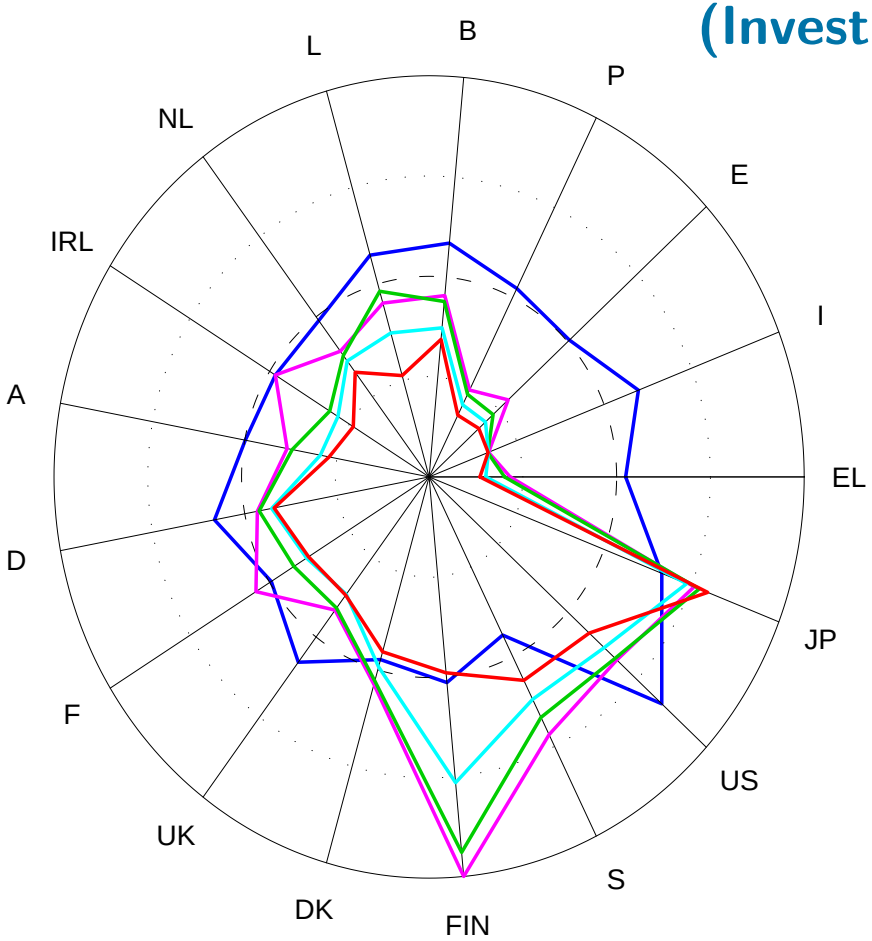
Knowledge-based Economy

(Investment in %)



2002

2000

1999

1997

1995

FTE/POP

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The KEI dataset

- 116 (124) indicators from:

  Administrative sources: 24
  Samples surveys: 70 + 9
  Combination: 13 + 3 + 5
- Each survey is conducted separately within the countries
- Certain variables are difficult to compare
- Missing data problem
  - 116 indicators from 2001 – 2004 for 25 EU countries (EU15, EU25), US and JP
  - Average number of observation in time is 2.35
  - 28 indicators on country average less than 1 observation
  - On average 2.35 values are available (in time)
  - Maximum average observations per country is 2.89

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Composite indicators

Definition 1

Let $y_{i,c}^t$ be the outcome of a *single* indicator i ($i = 1, \ldots, \nu$, with ν variables of interest), country c ($c = 1, \ldots, C$) and year t ($t = 1, \ldots, T$). A *composite* indicator is a function

$$\Psi_{c,t} = \Psi_{c,t}\left(y_{1,c}^t, y_{2,c}^t, \ldots, y_{\nu,c}^t\right) \quad : \quad \mathbb{R}^\nu \rightarrow \mathbb{R}^1$$

Goal of composite indicators

Benchmarking To build ranks between countries (of interest)

$$\Psi_{c_1,T} \gtrless \Psi_{c_2,T}$$

Development To view indicator development over time

$$\Psi_{c,T} - \Psi_{c,T-1} \text{ bzw. } \sqrt[T-1]{\Psi_{c,T}/\Psi_{c,1}} - 1 \text{ (mean growth rate)}$$

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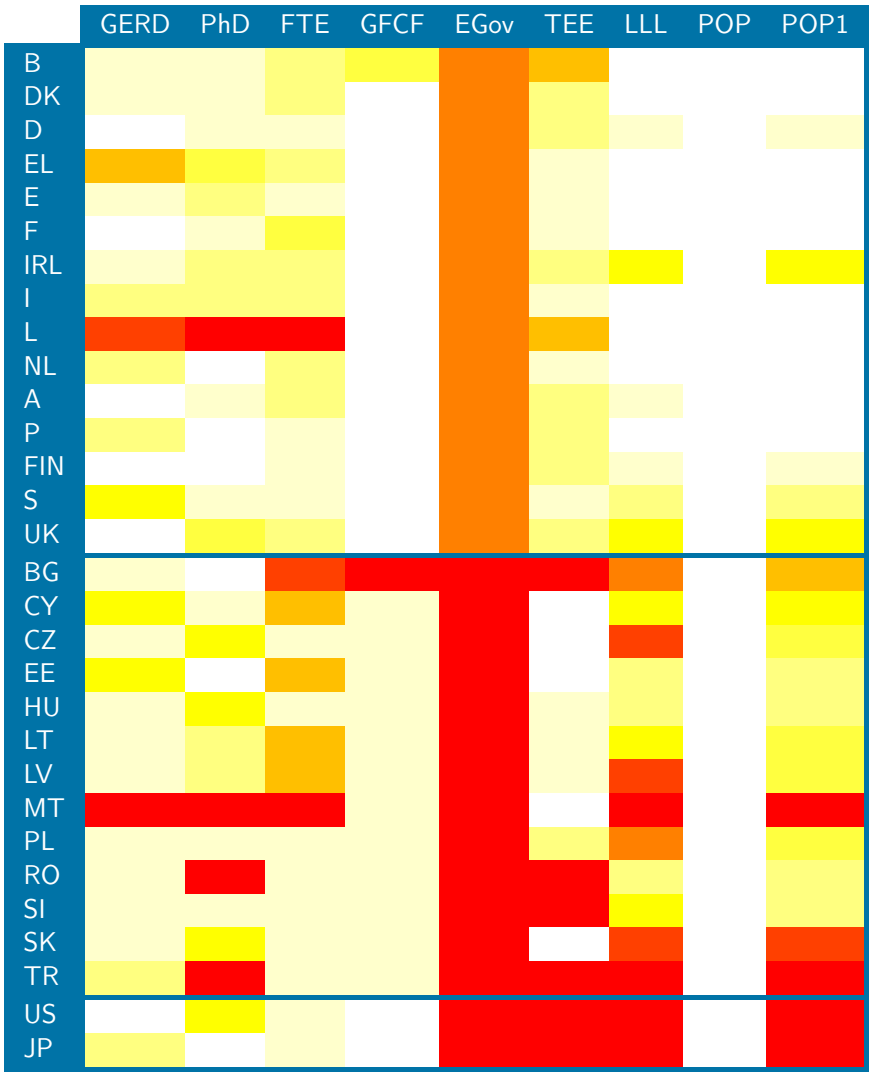
Missing Values in Original Dataset



Indicators for the knowledge-based economy

Number of missing values between 1995 to 2002 with respect to country and indicator:

cf. DG RTD:
Key Figures 2003 – 2004 / 2005

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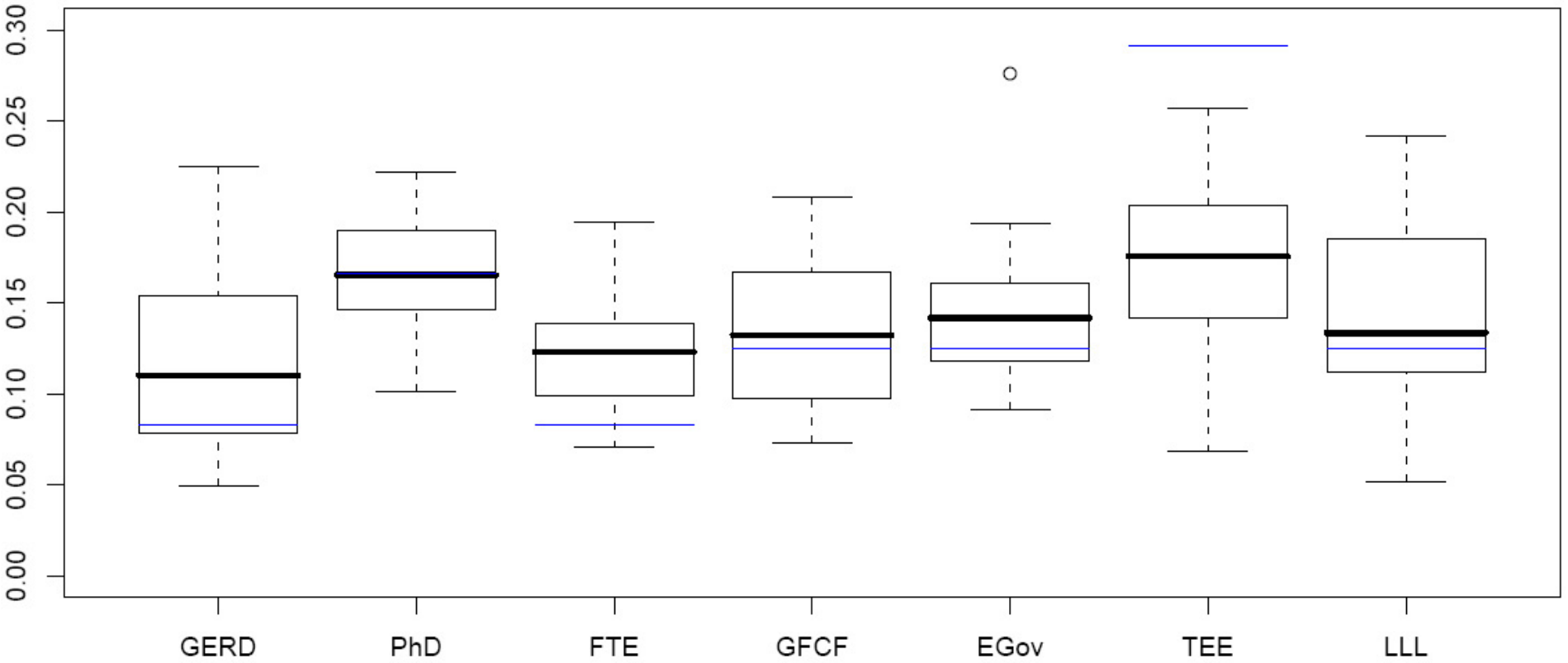
Weighting of Imputed Data Sets via FA/PCA



Weights from DG RTD

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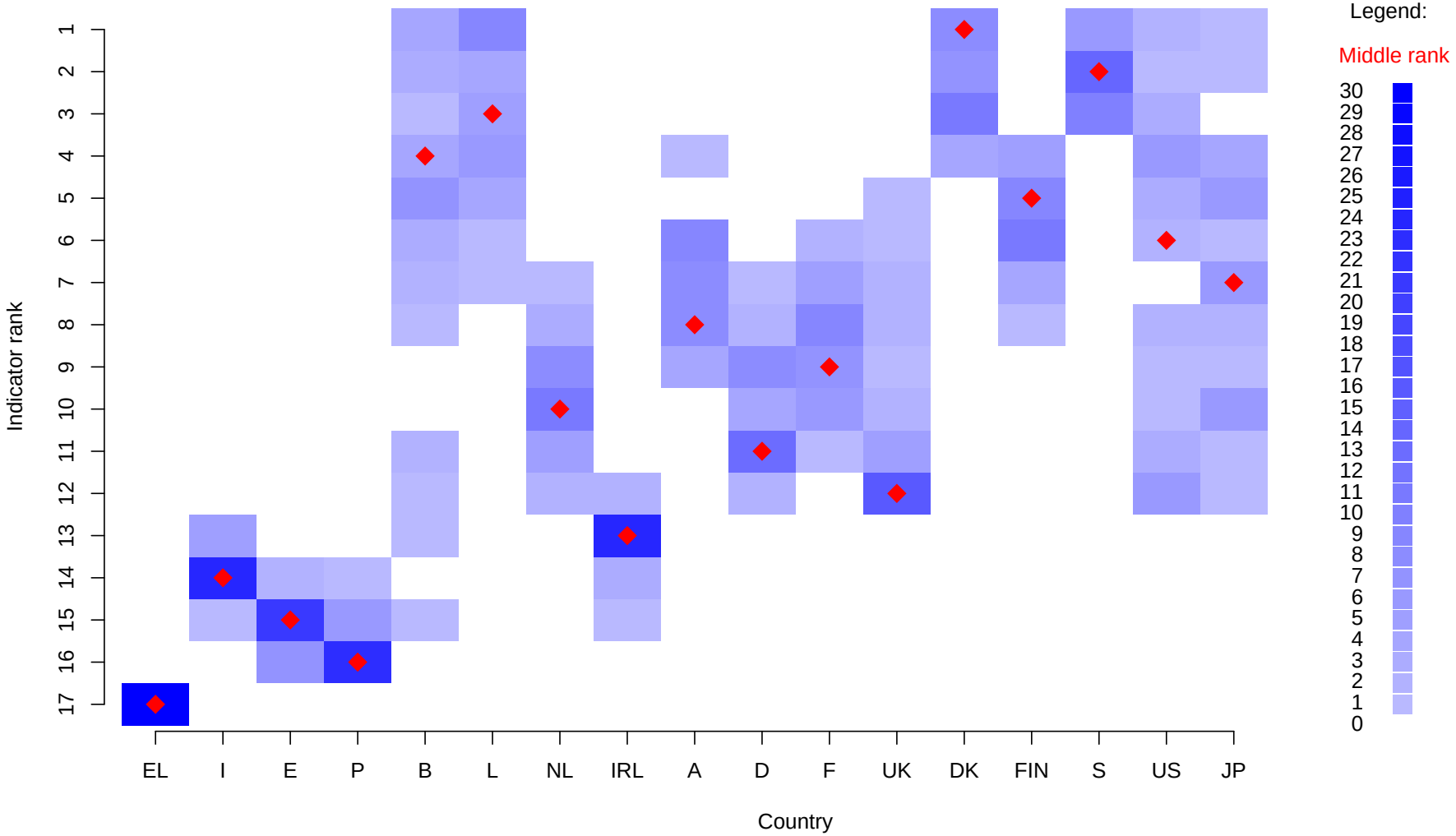
MI and Indicator-Ranking



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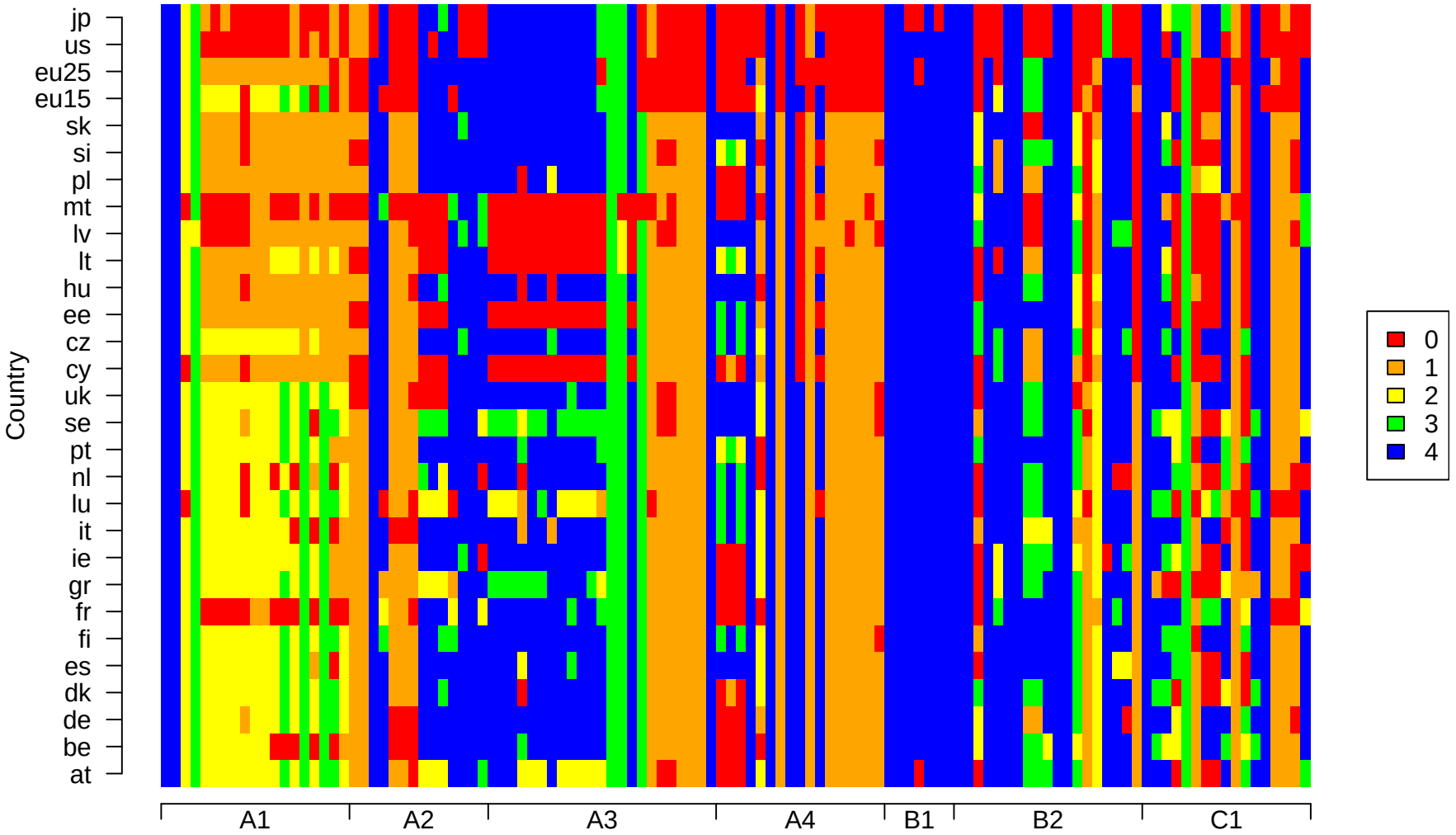
Data availability for KEI Dataset



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Researchers' and Methodologists' view

Economist's view

- Benchmarking countries' performance
- Development of countries
- Composite indicators

Statistician's view

- Data quality
- Accuracy measurement
- Missing data modeling

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Quality issues to consider

- Status quo:
  - NSIs provide detailed information on metadata and quality
  - Eurostat has to synthesize the information
  - AIM: availability at (e.g.) New Cronos
- Needs for further detailed quality report
  - accuracy information on important variables (indicators)
  - tracking of changes (and reasons)
  - provision of county level quality reports including accuracy information
- Needs for further understanding of using quality reports

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Composite Indicators: Boon or bane? Day 1

Asterios Chatziparadeisis Greek Ministry of Development
Political Impact of Composite Indicators

Stefano Tarantola European Commission, Joint Research Centre (JRC), Ispra
Coping with Complexity: the Role of Composite Indicators

Klaus Reeh and Nikolaus Wurm Eurostat, Luxembourg
The Relevance of Composite Indicators in the European Statistical System

Gyorgy Gyomai OECD, Paris
OECD Composite Leading Indicator System

Hans Wolfgang Brachinger and Walter Radermacher
Gerhard-Fürst-Preis

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Composite Indicators: Boon or bane? Day 2

Heinz-Herbert Noll GESIS–ZUMA, Mannheim

Summarische Maße von Wohlfahrt und Lebensqualität: Zum Für und Wider von *composite indexes*

Andrea Scheller Bundesamt für Statistik, Neuchâtel, Schweiz

Zwischen Einzelinformation und visueller Aggregation - Das Indikatorensystem MONET

Nicole Thees Universität Trier

Statistische Qualität zusammengesetzter Indikatoren am Beispiel der Wissensökonomie

Axel Dreher Konjunkturforschungsstelle der ETH Zürich

Globalisierungsindex

Susanne Schnorr-Bäcker Statistisches Bundesamt, Wiesbaden

Zukunft von Indikatorensystemen in der deutschen amtlichen Statistik