# *Knowledge based economy indicators*

## *and their relevance and application to the SEE countries*

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# Outline

- What is KBE? What makes KBE new ?
- KBE proxies: individual and composite indicators
  - European Innovation Scoreboard
  - EU Global Innovation Scoreboard
  - World Bank Knowledge Economy Index
  - World Economic Forum Global Competitiveness Index & Business Competitiveness Index
- RTD/KBE in SEE
- Conclusions

# What is KBE ?

- ‘Economies which are directly based on the production, distribution and use of knowledge and information’. (OECD, 1996)
- The knowledge driven economy (…) one ‘in which the generation and the exploitation of knowledge has come to play the predominant part in the creation of wealth’. The UK Department of Trade and Industry (DTI) (1998)
- The KBE (…) ‘one that encourages its organisations and people to acquire, create, disseminate and use (codified and tacit) knowledge more effectively for greater economic and social development’ (Dahlman and Andersson, 2000, p. 32/OECD and the World Bank)

# Knowledge as a ‘commodity’ with fuzzy boundaries

- K. is not produced in a ‘knowledge sector’.
- Non-rivalrous ‘commodity’ but consumption of k. is excludable
- The costs of k. dissemination are marginal vs. transferability of knowledge
- Codification (knowledge > information), can be costly.
- The most complex aspect of knowledge is the varying degrees of its embodiment
- The value of knowledge depends greatly on the cognitive capabilities of the recipients of the knowledge.

# What makes KBE new ?

- The term KBE is *misleading* as long as it suggests that ‘knowledge production’ can be *detached* from established economic activities and can be a source of long-term growth and productivity
- The radically reduced costs of access to information > the technical opportunity to amass and process large amounts of information at very low cost has potentially far reaching effects on all economic activities. How?
- The qualitative novelty of the KBE > the opportunities offered by the integration of ICTs into already established technologies and their subsequent transformation into ‘information intensive production systems’

# In nutshell

- The KBE cannot be reduced to a single sector, for example dot.coms or IT sector
- Its long-term growth effects should be sought in the knowledge and information intensification of ‘old’ sectors
- Whether the effects of the KBE will spread beyond ICT into other sectors depends on a variety of socio-institutional changes and on a critical mass of demand for ICT in other sectors
- There is not standard set of indicators of KBE

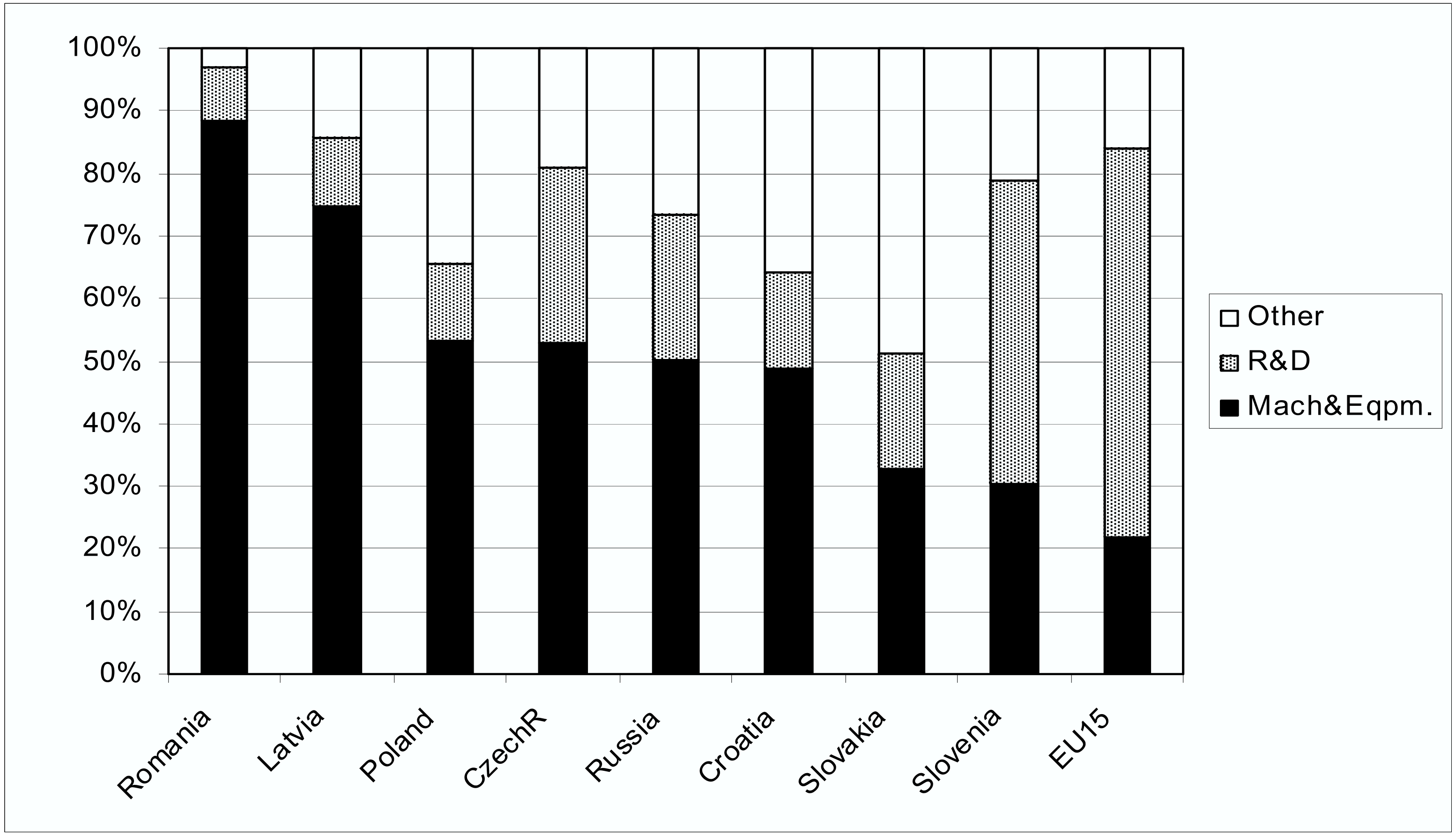
# KBE proxies: individual and composite indicators

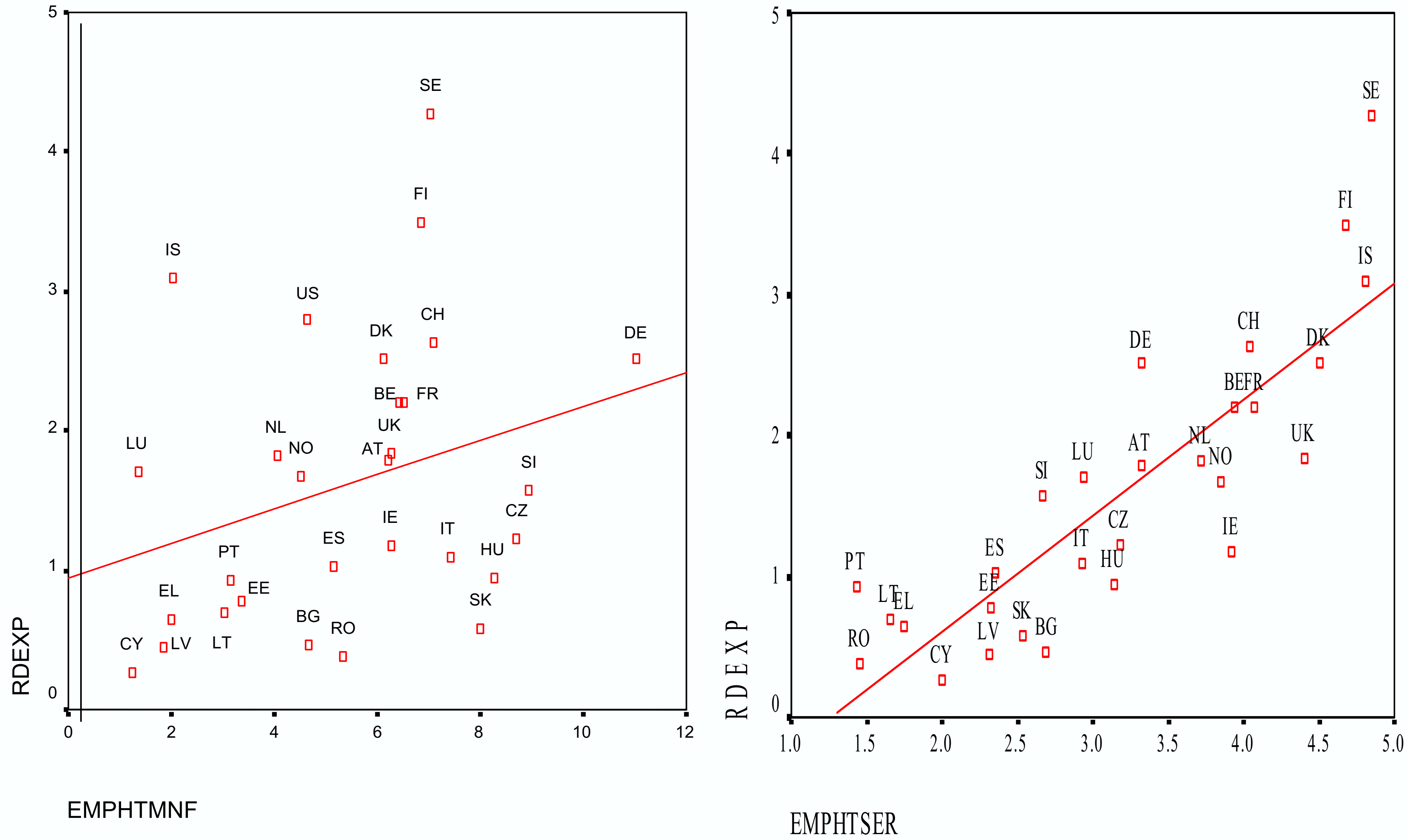
- **Individual indicators**
  - R&D and IT intensity
  - Knowledge Intensive Business Services (KIBS)
- **Composite indicators**
  - European Innovation Scoreboard
  - EU Global Innovation Scoreboard
  - World Bank Knowledge Economy Index
  - Competitiveness indexes which contain a variety of knowledge related indicators
    - WEF Global Competitiveness Index
    - WEF Business Competitiveness Index
    - IMD World Competitiveness Index
  - A variety of newly emerging scoreboards
    - ITU Digital Opportunities Index
    - UNIDO World Industrial Development Index
    - National Innovation Capacity Indexes (Porter et al, RP; Radosevic, JCMS)

## Employment in high and medium-high tech manufacturing and knowledge intensive services (share of total employment in 2003 in %)

| High and med high tech manufacturing | | Knowledge intensive services | |
|---|---|---|---|
| DE | 11.04 | SE | 47.23 |
| **SI** | **8.94** | NO | 44.55 |
| **CZ** | **8.71** | DK | 43.21 |
| **HU** | **8.27** | IS | 41.93 |
| MT | 8.16 | UK | 40.96 |
| **SK** | **8** | FI | 39.72 |
| IT | 7.42 | CH | 38.91 |
| CH | 7.09 | NL | 38.75 |
| SE | 7.03 | BE | 38.71 |
| FI | 6.85 | LU | 38.59 |
| FR | 6.5 | FR | 35.52 |
| BE | 6.42 | IE | 33.43 |
| IE | 6.28 | DE | 32.99 |
| UK | 6.27 | **EE** | **31.61** |
| *AT* | *6.21* | *AT* | *30.26* |
| DK | 6.12 | MT | 28.77 |
| **RO** | **5.32** | **HU** | **27.95** |
| ES | 5.15 | IT | 27.43 |
| **BG** | **4.66** | CY | 26.97 |
| NO | 4.53 | ES | 25.9 |
| NL | 4.06 | **CZ** | **24.47** |
| **EE** | **3.35** | **LT** | **24.22** |
| PT | 3.14 | **SI** | **24.19** |
| **LT** | **3.03** | **SK** | **24.16** |
| IS | 2.02 | **LV** | **23.97** |
| EL | 1.99 | EL | 22.65 |
| **LV** | **1.85** | **BG** | **22.06** |
| LU | 1.36 | PT | 19.88 |
| CY | 1.24 | **RO** | **13.02** |
| PL | . | PL | . |

# CEE: Innovation with low intangible content

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# CEE: shift to KBE ?

- A low R&D intensity of CEE is more linked to their generally low level of knowledge-based services than to presence of high-tech industries.
- The CEE has an undeveloped KIS sector where use of ICT is one of the key drivers of productivity.
- Also, high and medium-high tech manufacturing in CEE has a low share of intangibles, in particular R&D.

# European Innovation Scoreboard: a composite indicator (26)

- Innovation is a non-linear process and the EIS indicators are distributed among five categories that cover different key dimensions of innovation performance.
- Not all countries perform on the same level in each of these dimensions and some countries may even prove to be especially weak in one or several dimensions of innovation
- ***Innovation Inputs:***
  - Innovation drivers (5 indicators),
  - Knowledge creation (5 indicators),
  - Innovation & entrepreneurship (6 indicators)
- **Innovation Outputs:**
  - Application (5 indicators)
  - Intellectual property (5 indicators)

## EIS: Conceptual framework: inputs

# Innovation Input

- **Innovation drivers**, to measure the structural conditions required for innovation potential
- **Knowledge creation**, to measure the investments on human factors and on R&D activities, considered as the key elements for a successful knowledge based economy
- **Innovation & entrepreneurship**, to measure the efforts towards innovation at the microeconomic level

## EIS: Conceptual framework: outputs

# Innovation Output

- **Application**, to measure the performance, expressed in terms of labour and business activities, and their value added in innovative sectors
- **Intellectual property**, to measure the achieved results in terms of successful know how, especially referred to high-tech sectors.

# INPUT - Innovation drivers

- 1.1 **New S&E graduates per 1000 population aged 20-29**
  - Everything from 1 year BA to PhD
- 1.2 **Population with tertiary education per 100 population aged 25-64**
- 1.3 **Broadband penetration rate (number of broadband lines per 100 population).**
- 1.4 **Participation in life-long learning per 100 population aged 25-64**
  - Availability for SEE?
- 1.5 **Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)**
  - Supply of human capital of that age group

# INPUT - Knowledge creation

- 2.1 Public R&D expenditures (% of GDP)
- 2.2 Business R&D expenditures (% of GDP)
- 2.3 Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures)
- 2.4 Share of enterprises receiving public funding for innovation
  - Source: Innovation survey. Availability for Western Balkans (??)
- 2.5 Share of university R&D expenditures financed by business sector

# INPUT - Innovation & entrepreneurship

- 3.1 **SMEs innovating in-house (% of SMEs)**
  - All large enterprises innovate
  - Source: Innovation survey > Availability for West Balkan (??)
- 3.2 **Innovative SMEs co-operating with others (% of SMEs**
  - All large enterprises are involved in cooperation
  - Source: Innovation survey > Availability for West Balkan (??)
- 3.3 **Innovation expenditures (% of turnover)**
  - Source: Innovation survey > Availability for West Balkan (??)
- 3.4 **Early-stage venture capital (% of GDP)**
  - Dynamism of new business creation (?): seed and start ups
  - 2 year average due to fluctuations; MBO are excluded
  - Availability for West Balkan (??)
- 3.5 **ICT expenditures (% of GDP)**
- 3.6 **SMEs using non-technological change (% of SMEs)**
  - Source: Innovation survey > Availability for West Balkan (??)

# OUTPUT - Application

- 4.1 **Employment in high-tech services (% of total workforce)**
  - Telecom (NACE64), IT (NACE72) and R&D (NACE73)
- 4.2 **Exports of high technology products as a share of total exports**
  - OECD classification
- 4.3 **Sales of new-to-market products (% of turnover)**
  - Source: Innovation survey > Availability for West Balkan (??)
- 4.4 **Sales of new-to-firm not new-to-market products (% of turnover)**
  - Proxy for degree of diffusion of state of the art technology
  - Source: Innovation survey > Availability for West Balkan (??)
- 4.5 **Employment in medium-high and high-tech manufacturing (% of total workforce)**
  - Eurostat-OECD classification

# OUTPUT - Intellectual property

- 5.1 **New EPO patents per million population**
- 5.2 **New USPTO patents per million population**
- 5.3 **New Triad patents per million population**
  - Source: OECD
- 5.4 **New community trademarks per million population**
  - Relevance for the Western Balkans (?)
- 5.5 **New community industrial designs per million population**
  - Relevance for the Western Balkan ??

# Method of calculation

- Equal weighting for all indicators
- Re-scaling method:
  - the lowest country value = 0; the highest country value = 1 within the EU25
  - The SII is calculated as the average value of all re-scaled values
  - See next slide
- Normalisation to be based on relative to EU25
- Relative to EU25 data are calculated as the ratio between the most recent data for a country and the value of the EU25 in that same year
- Not imputation for missing data (Alternative: econometric estimation in case of time series?)

# Re-scaling method

Each indicator $x_{ic}^{t}$ for a generic country c and time t is transformed in

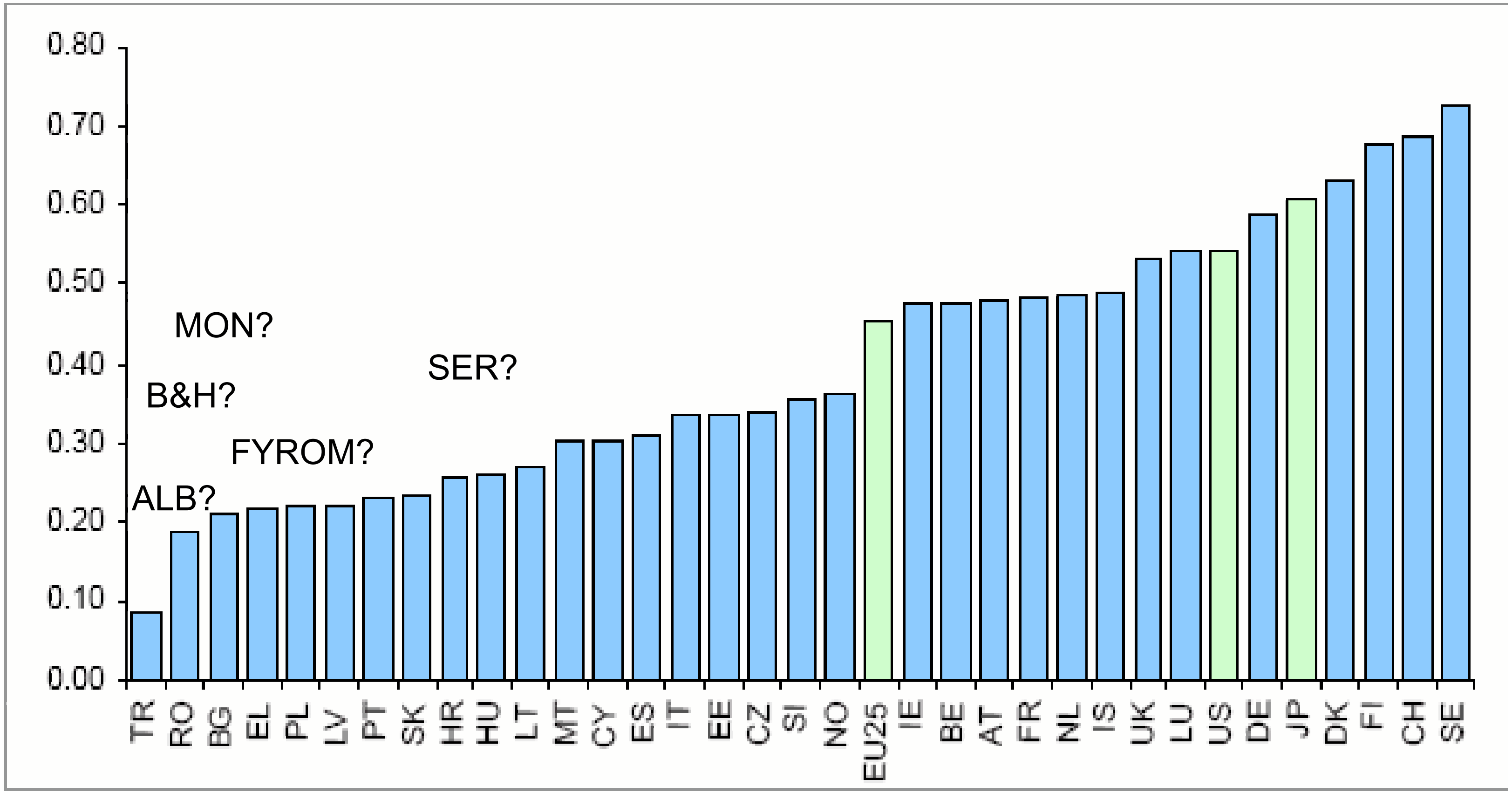
$$I_{ic}^{t} = \frac{x_{ic}^{t} - min_{c}(x_{i}^{t})}{max_{c}(x_{i}^{t}) - min_{c}(x_{i}^{t})}$$

where $min_{c}(x_{i}^{t})$ and $max_{c}(x_{i}^{t})$ are the minimum and the maximum value of $x_{ic}^{t}$ across all the countries *c* at time t. In this way, the normalized indicators $I_{ic}$ have values laying between 0 (laggard, $x_{ic}^{t} = min_{c}(x_{i}^{t})$) and 1 (leader, $x_{ic}^{t} = max_{c}(x_{i}^{t})$). The re-scaling normalizes indicators to have an identical range, in this case (-0.5;0.5). This range has been selected to maintain the symmetry around zero as in the z-scores method.

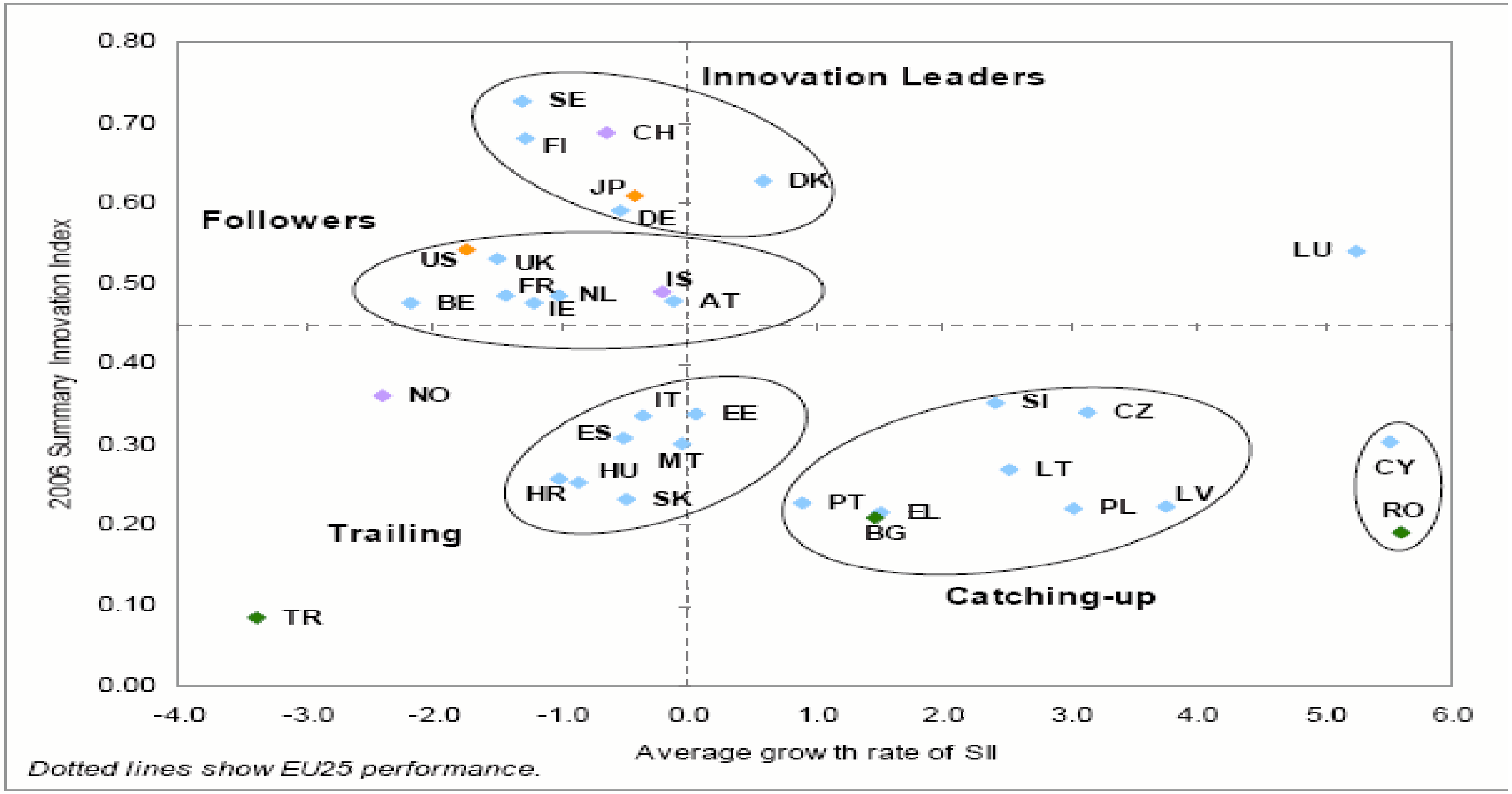
# Calculation of trends

- Trends are calculated as the annual percentage change between the last year for which data are available and the average over the preceding three years, after a one-year lag.
- The three-year average is used to reduce year-to-year variability; the one-year lag is used to increase the difference between the average for the three base years and the final year and to minimize the problem of statistical/sampling variability.
- For example, when the most recent data are for 2004, the trend is based on the percentage change between 2004 and the average for 2000 to 2002 inclusive. The results for 2003 are excluded in order to provide a one-year lag.
- For years T, T-1 and T-2 a summary innovation index is calculated using the MinMax-approach but using maximum and minimum values over the 3-year period;

# THE 2006 SUMMARY INNOVATION INDEX (SII)



# Summary Innovation Index and trends



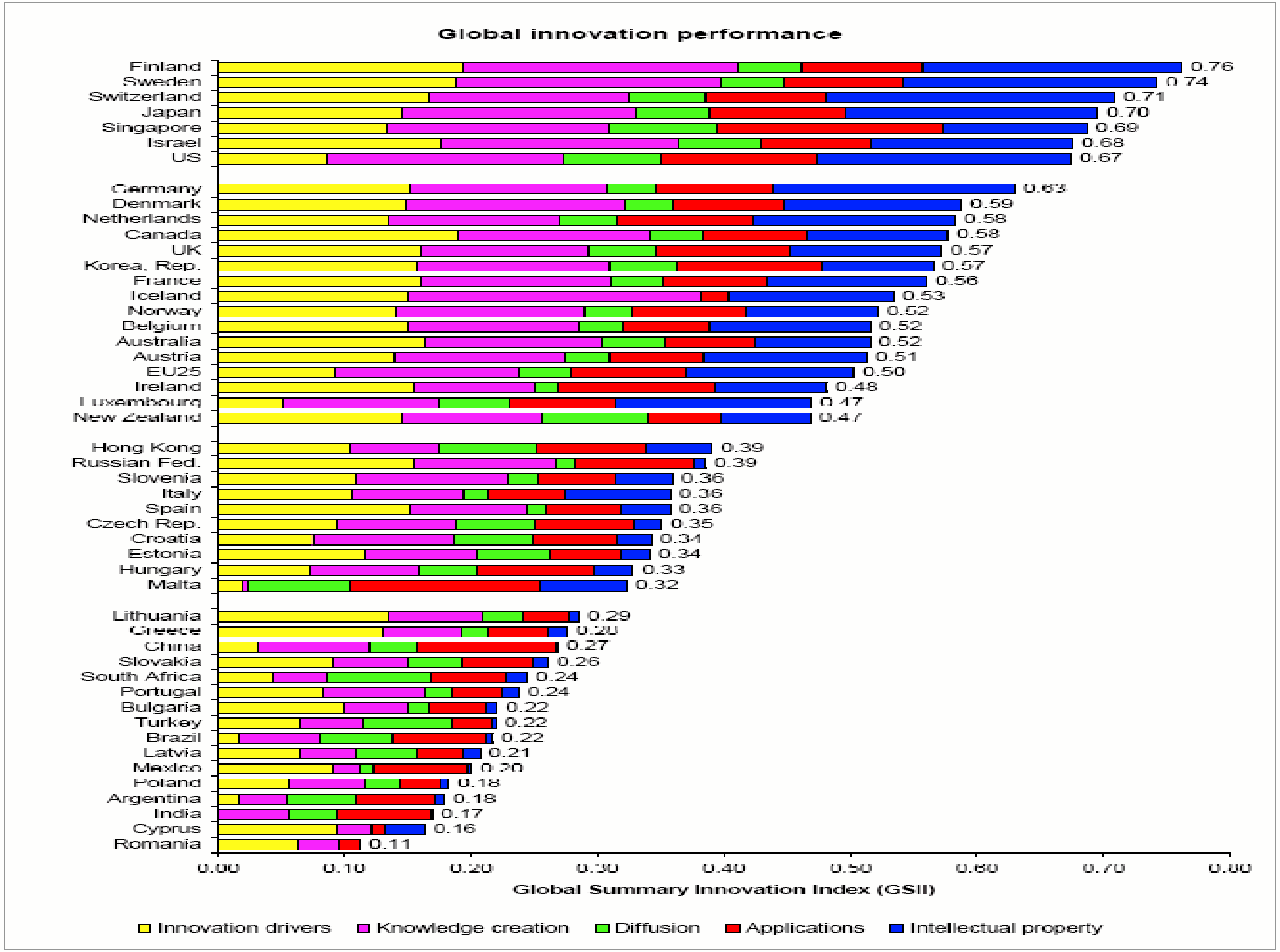
# 2006 “Global Innovation Scoreboard” (GIS) Report

Table 2: GIS indicators and sources

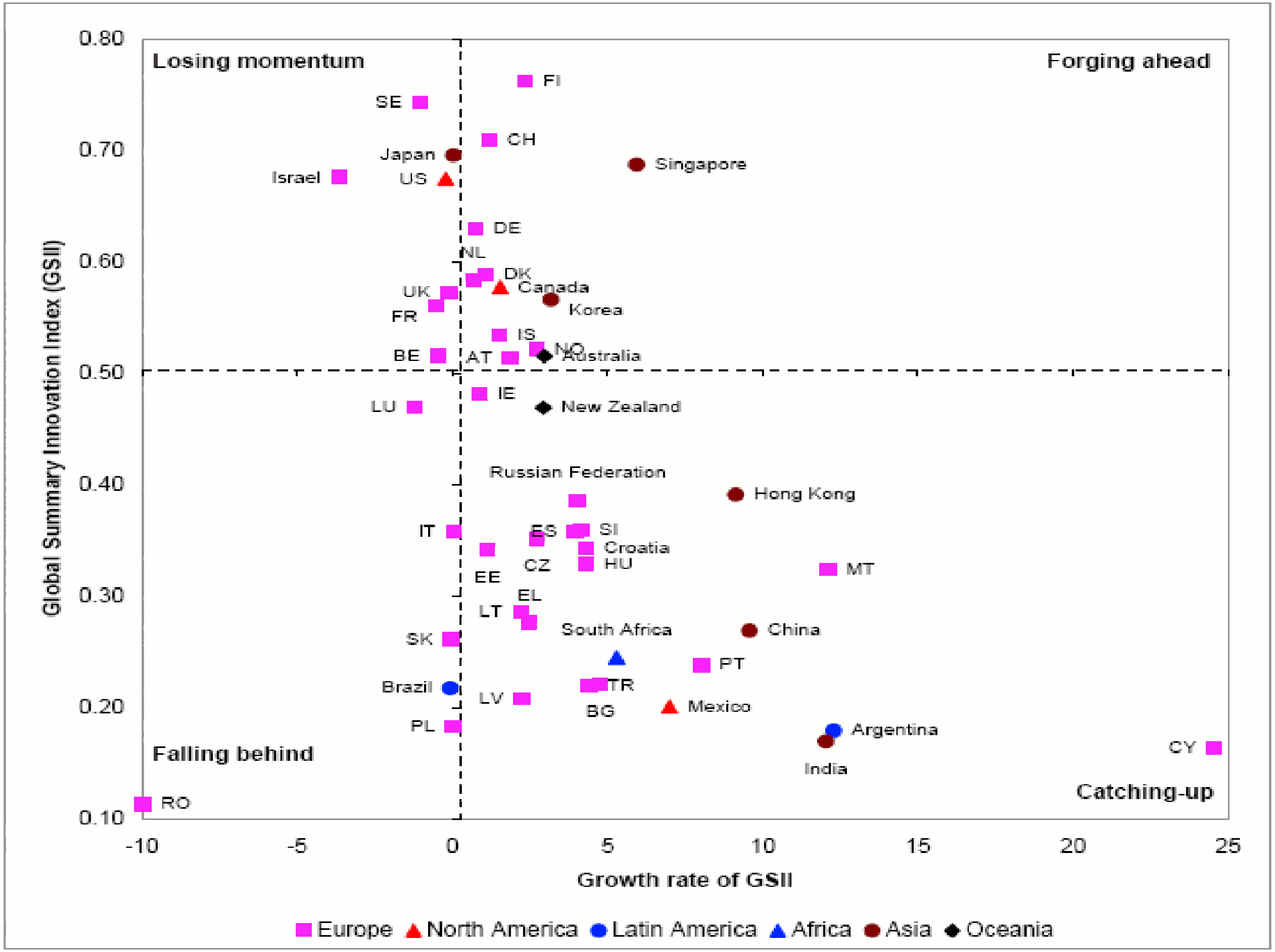
| | | |
|---|---|---|
| **1 INNOVATION DRIVERS** | | |
| 1.1 | New S&E graduates | UNESCO |
| 1.2 | Labour force with completed tertiary education | World Bank (World Development Indicators) |
| 1.3 | Researchers per million population | World Bank (World Development Indicators) |
| **2 KNOWLEDGE CREATION** | | |
| 2.1 | Public R&D expenditures | OECD (Main Science and Technology Indicators), World Development Indicators, own estimates |
| 2.2 | Business R&D expenditures | OECD (Main Science and Technology Indicators), World Development Indicators, own estimates |
| 2.3 | Scientific articles per million population | World Bank (World Development Indicators) |
| **3 DIFFUSION** | | |
| 3.1 | ICT expenditures | WITSA/IDC (Digital Planet 2004) |
| **4 APPLICATIONS** | | |
| 4.1 | Exports of high-tech products | World Bank (World Development Indicators) |
| 4.2 | Share of medium-high/high-tech activities in manufacturing value added | UNIDO (Industrial Development Scoreboard) |
| **5 INTELLECTUAL PROPERTY** | | |
| 5.1 | EPO patents per million population | OECD (Main Science and Technology Indicators) |
| 5.2 | USPTO patents per million population | OECD (Main Science and Technology Indicators) |
| 5.3 | Triad patents per million population | OECD (Main Science and Technology Indicators) |

Source: Hugo Hollanders and Anthony Arundel

Figure 1: Global innovation performance

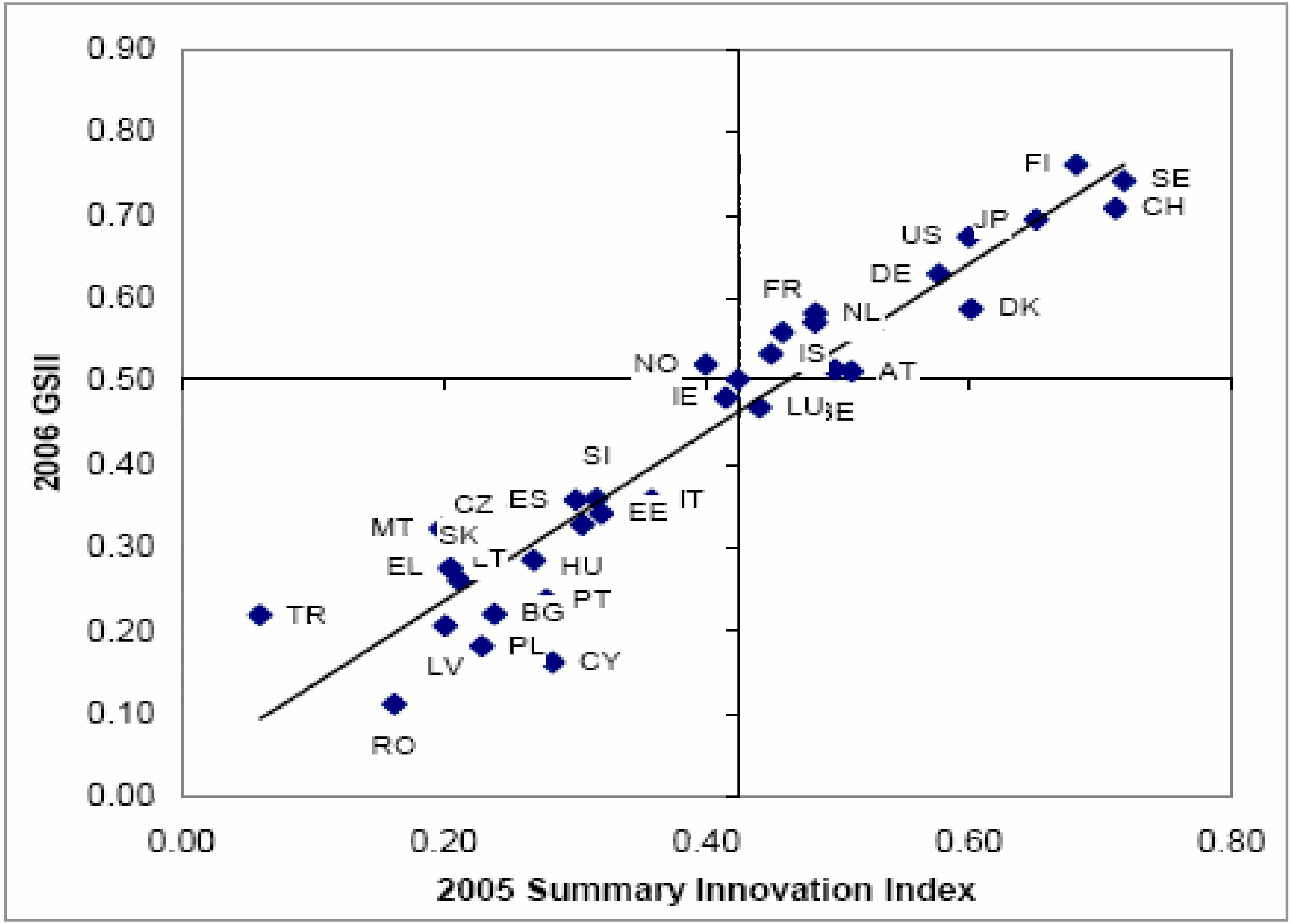


## Figure 7: Global innovation trend performance




Dotted lines represent average EU25 performance.

Figure 8: 2005 EIS and 2006 GIS performance



# Knowledge Assessment Methodology (KAM) of World Bank

- The KAM consists of 81 structural and qualitative variables for 132 countries to measure their performance on the four Knowledge Economy (KE) pillars:
  - Economic Incentive and Institutional Regime,
  - Education and Human Resources
  - The Innovation System
  - Information and Communications Technologies.
- Variables are normalized on a scale of zero to ten relative to other countries in the comparison group.
- Normalized (u) = 10*(Nw/Nc)
  - The number of countries with worse rank (Nw)
  - The total number of countries in the sample (Nc) with available data

## The KAM Knowledge Index (KI)

- a country's ability to generate, adopt and diffuse knowledge.
- an indication of overall **potential** of knowledge development in a given country.
- the simple average of the normalized performance scores of a country on the key variables in **three** Knowledge Economy pillars – education and human resources, the innovation system and information and communication technology (ICT).

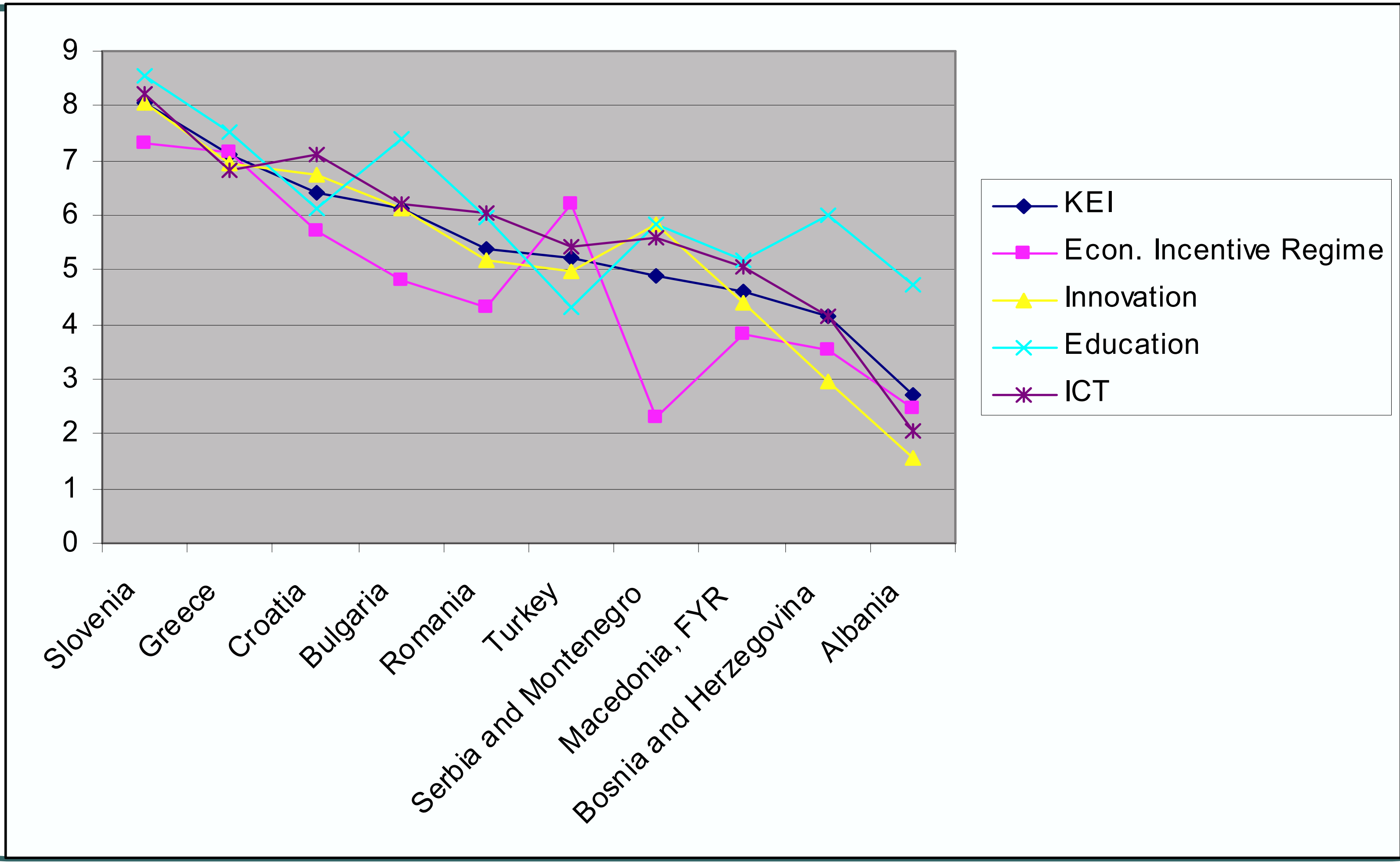
## The Knowledge Economy Index (KEI)

- whether the environment is conducive for knowledge to be **used effectively** for economic development.
- the overall level of development of a country towards the Knowledge Economy.
- the average of the normalized performance scores of a country or region on all **four** pillars related to the knowledge economy - economic incentive and institutional regime, education and human resources, the innovation system and ICT.

# Each pillar is represented by three key variables

- **The Economic Incentive and Institutional Regime**
  - Tariff & Nontariff Barriers (*the Heritage Foundation's Trade Policy index*)
  - Regulatory Quality (*Governance indicators WB*). (the incidence of market-unfriendly policies such as price controls or inadequate bank supervision)
  - Rule of Law (*Governance indicators WB*). (perceptions of the incidence of both violent and non-violent crime, the effectiveness and predictability of the judiciary, and the enforceability of contracts)
- **Education and Human Resources**
  - Adult Literacy Rate
  - Secondary Enrolment
  - Tertiary Enrolment
- **The Innovation System**
  - Researchers in R&D
  - Patent Applications Granted by the US Patent and Trademark Office
  - Scientific and Technical Journal Articles
  - These three variables are available as scaled by population and in absolute values.
- **Information and Communication Technology (ICT)**
  - Telephones per 1,000 people
  - Computers per 1,000 people
  - Internet Users per 10,000 people

# Knowledge Economy Index in South East Europe



# Clustering of the SEE countries within the 'EU periphery'

- Clustering 18 countries based on 9 pillars of competitiveness as defined by the World Economic Forum *Global Competitiveness Report 2006-07*.
- Pillars of competitiveness:
  - institutions,
  - infrastructure,
  - macroeconomy,
  - health and primary education,
  - higher education and training,
  - market efficiency,
  - technological readiness,
  - business sophistication
  - innovation
- Scale 1-7
- Hierarchical and then K-means cluster analysis were used

# Distance between cluster centres

- Cluster 1: Slovenia, Ireland, Portugal, Czech R and Estonia
- Cluster 2: Serbia and Montenegro, Macedonia, Bosnia and Herzegovina and Albania,
- Cluster 3: Hungary, Latvia, Lithuania, Poland, Bulgaria, Romania, Croatia, Turkey, Greece and Slovakia

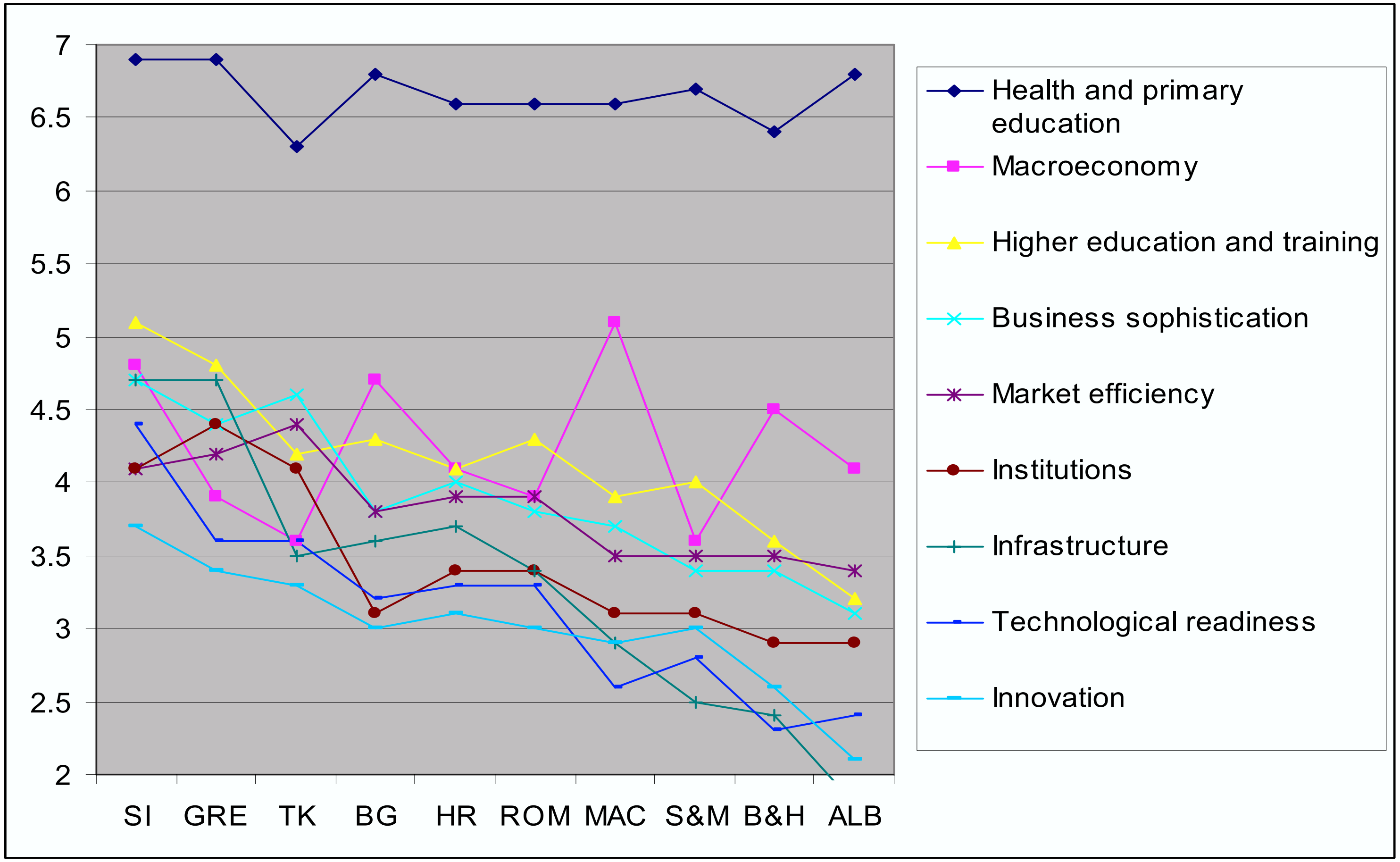
| Cluster | 1 | 2 | 3 |
|---|---|---|---|
| 1 | | 4.385 | 1.974 |
| 2 | 4.385 | | 2.542 |
| 3 | 1.974 | 2.542 | |

# Results

- SEE is present in all 3 clusters – not yet region …
  - S&M, FYRM, B&H and ALB share more similarities in their competitiveness among each other then with the rest of the countries in our sample.
- … but a set of sub-regions
- Implication: the role of S&T will also largely differ in different SEE countries

# Quality of Pillars of Competitiveness of South East European Economies

**(Ranking based on scale 1-7)**

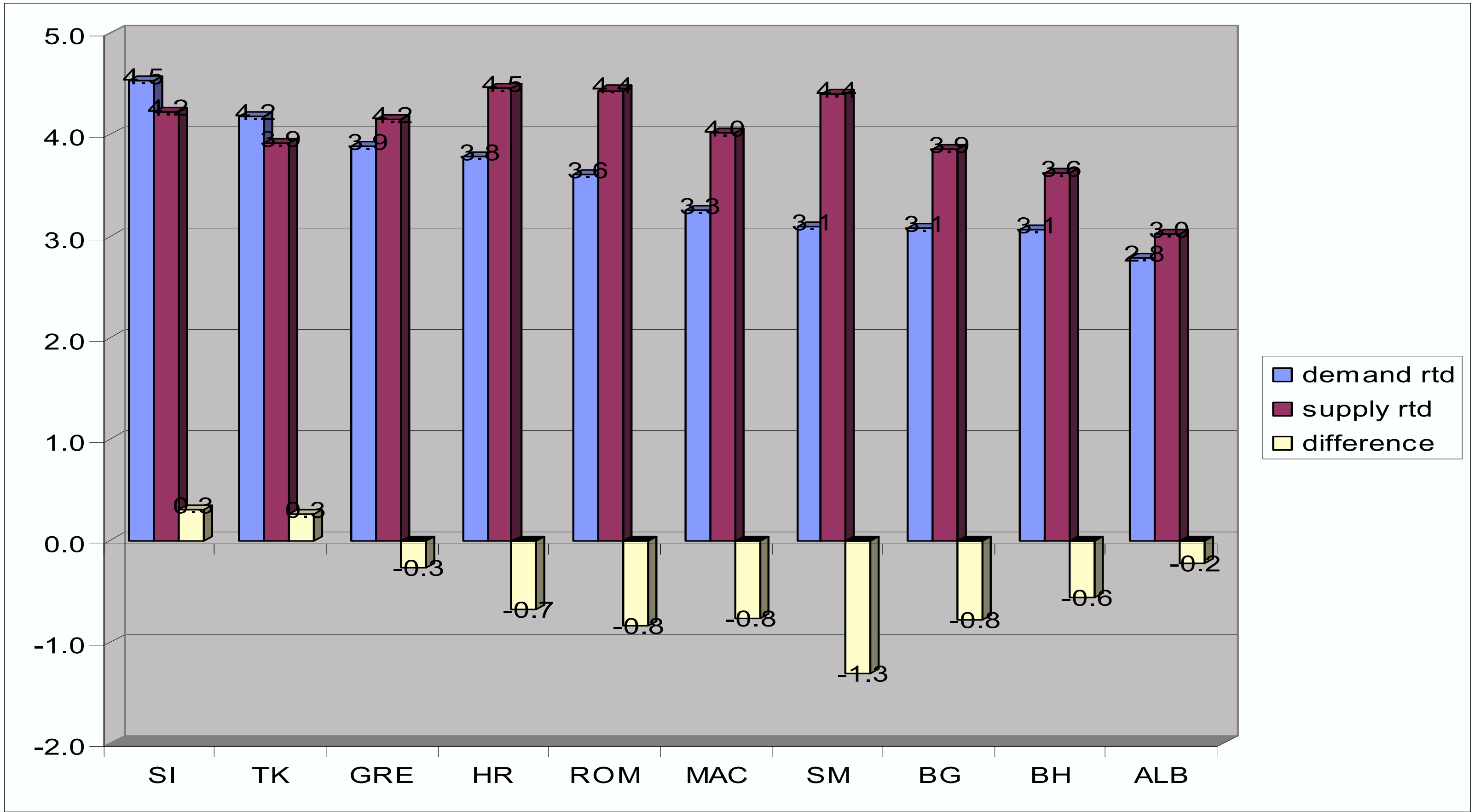


# Proxies for quality of supply and demand for RTD in SEE

- **Supply**
  - Quality of education
  - Quality of math and science teaching
  - Local availability of spec. research and training
  - Quality of public (free) schools
  - Quality of scientific research institutes
  - Availability of scientists and engineers
- **Demand**
  - Extent of staff training
  - Firm level technology absorption
  - Production process sophistication
  - Buyer sophistication
  - Customer orientation
  - Company spending on R&D
  - Government procurement adv. techn products
  - Capacity for innovation

Note: These are responses of local business communities which are assessing demand and supply for RTD from the perspective of their economy, Not some objective external benchmark.

# Assessment of demand and supply for local RTD in SEE



# Results

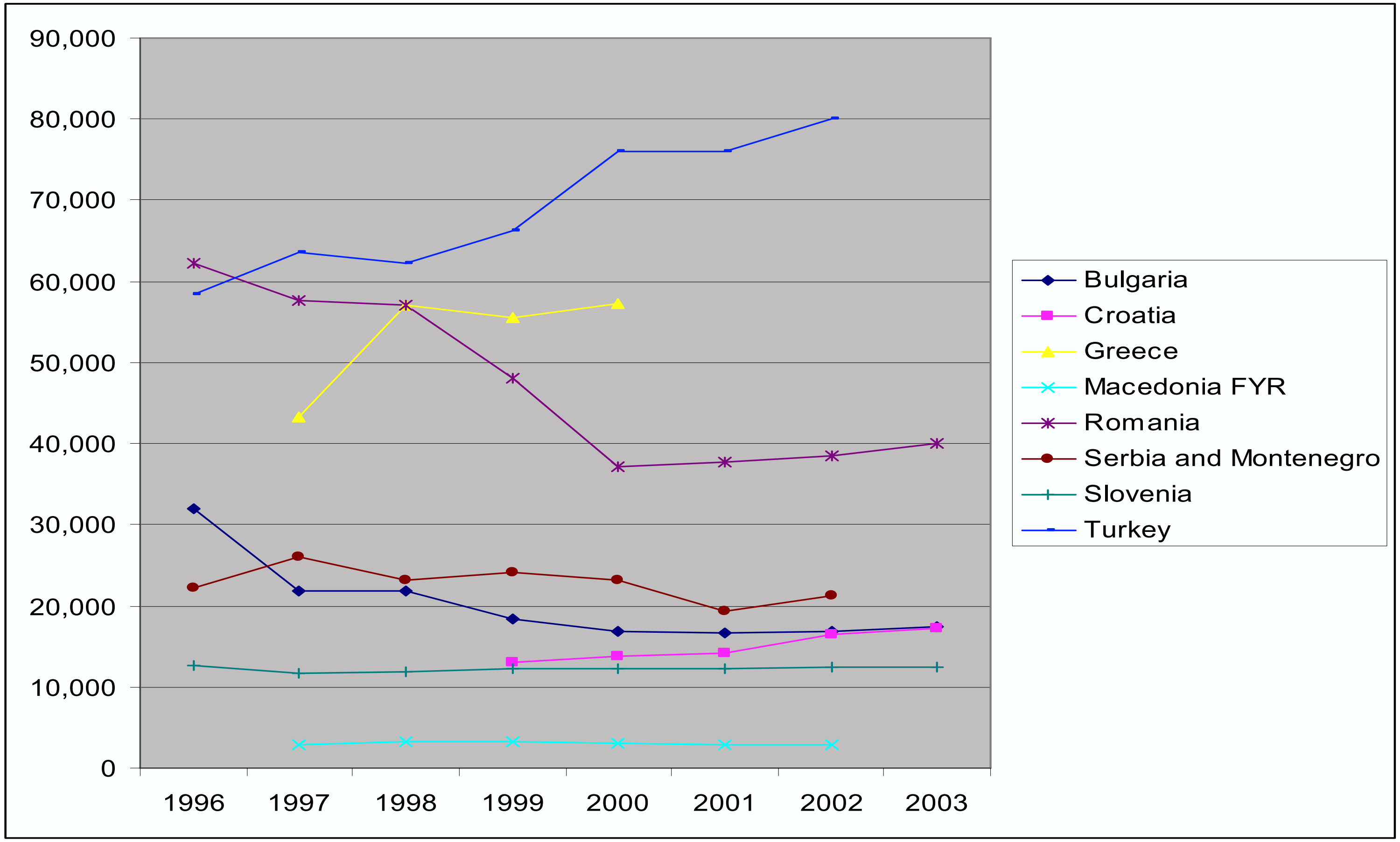
- **The most of the SEE countries have RTD demand gap** i.e. they are not able to employ their RTD capacities effectively
- Causes: factors like low sophistication of businesses processes which do not use new technologies or inappropriate structure or quality of RTD capacities.
- Serbia and Montenegro have the biggest demand – supply gap.
- **SI and TK show signs of RTD supply gap** i.e. limited RTD capacities or possibly types of capacities given state of their demand for RTD.
- Greece suffers from weak demand for RTD which probably is caused by its industry structure which is dominated by small firms in traditional industries.
- A small RTD demand – supply gap for Albania is mainly sign of very low levels and quality of demand and supply for RTD > a ‘low level equilibrium’
- A bigger but still small RTD gap in case of Bosnia and Herzegovina should be interpreted from similar perspective but which have to take into account its specific post-war situation.

| | Loc. availab.of spec. R&D/train. services | Quality of sc. RI | Extent of staff training | Firm-level technology absorption | Prod.process sophistication | Buyer sophistication | Degree of customer orientation | Company spending on R&D | Capacity for innovation |
|---|---|---|---|---|---|---|---|---|---|
| Loc. availab.of spec. R&D/train. services | 1 | .874(**) | 0.545 | .693(*) | 0.592 | .648(*) | 0.572 | .865(**) | .686(*) |
| Quality of sc. RI | .874(**) | 1 | 0.405 | 0.51 | 0.47 | 0.541 | 0.482 | .783(**) | .698(*) |
| Extent of staff training | 0.545 | 0.405 | 1 | .759(*) | .924(**) | .857(**) | .914(**) | .687(*) | .801(**) |
| Firm-level technology absorption | .693(*) | 0.51 | .759(*) | 1 | .838(**) | .786(**) | .811(**) | 0.603 | 0.545 |
| Prod.process sophistication | 0.592 | 0.47 | .924(**) | .838(**) | 1 | .945(**) | .949(**) | .727(*) | .733(*) |
| Buyer sophistication | .648(*) | 0.541 | .857(**) | .786(**) | .945(**) | 1 | .965(**) | .802(**) | .789(**) |
| Degree of customer orientation | 0.572 | 0.482 | .914(**) | .811(**) | .949(**) | .965(**) | 1 | .750(*) | .815(**) |
| Company spending on R&D | .865(**) | .783(**) | .687(*) | 0.603 | .727(*) | .802(**) | .750(*) | 1 | .906(**) |
| Capacity for innovation | .686(*) | .698(*) | .801(**) | 0.545 | .733(*) | .789(**) | .815(**) | .906(**) | 1 |

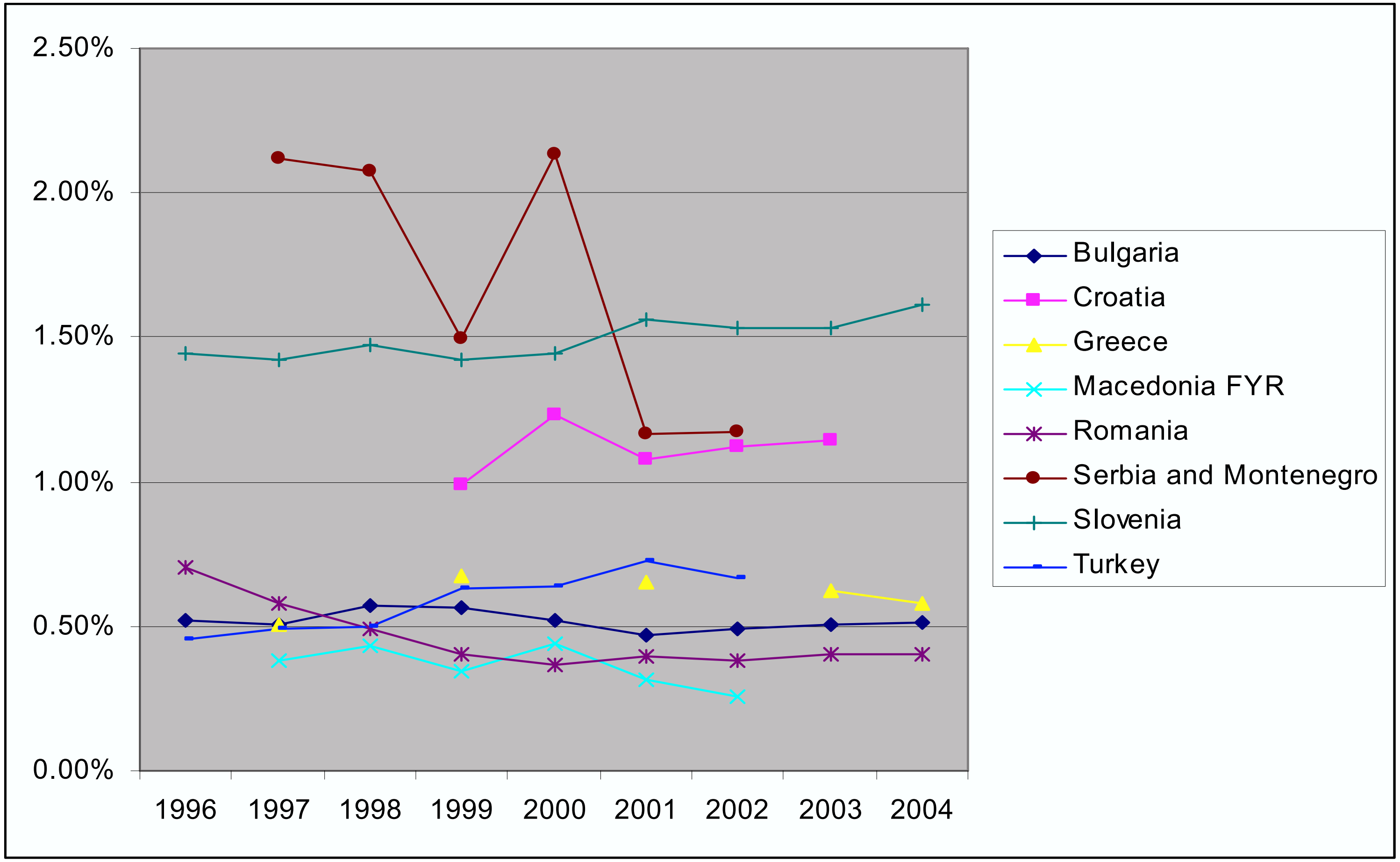
# A correlation of factors on demand and supply side: results

- Not significant correlation between aggregate S and D for RTD > **S and D factors are driven by different forces.**
- Not significant correlation between firm level technology absorption and company spending on RD across countries + not significant link between firm level technology absorption and capacity for innovation > **significant difference between innovation capacity and production capability/absorptive capacity**.
- Innovation variables (**capacity for innovation and company spending on RTD ) are strongly and significantly correlated to external RTD factors** (local specialised research and training, quality of scientific research institutes and to demand) and to **demand factors** (customer orientation, buyer sophistication).
- > External RTD factors are important component of firms innovation capacities
- > The importance of demand for firm RTD activities.

# R&D personnel employed in R&D in SEE Europe
### (in head counts)



# GERD as percentage of GDP in SEE countries



# Institutional structure of funding and performing R&D

| Funding | Country | Performing |
|---|---|---|
| **Business Enterprises sector (59%);** Government (35%); | Slovenia | **Business Enterprises sector (60%);** Government (22%); Higher education sector (16%) |
| Government (48%); **Business Enterprises sector (45%)** | Romania | **Business Enterprises sector (55%);** Government (34%); Higher education sector (10%) |
| Government (56%); **Business Enterprises sector (42%)** | Croatia | **Business Enterprises sector (43%);** Higher education sector (35%); Government (22%) |
| Government (51%); **Business Enterprises sector (41%)** | Turkey | Higher education sector (64%); **Business enterprise sector (29%)** |
| Government (47%); **Business Enterprises sector (31%)** | Greece | Higher education sector (49%); **Business enterprise sector (30%);** Government (21%) |
| Government (67%), **Business enterprise sector (27%)** | Bulgaria | Government (67%); **Business Enterprises sector (24%)** |
| ??? | Serbia and Montenegro | Higher education sector (52%); Government (44%) |
| ??? | Macedonia, FYR | Government (76%) |
| ?? | Bosnia and Herzegovina | ?? |
| ?? | Albania | ?? |

# Conclusions

- There is not standardised set of KBE indicators and there is a variety of models on offer
- ‘KBE indicators’ are driven largely by the increasing availability of standard S&T indicators and ICT indicators
- A great weakness of composite indicators is the big gap between conceptual and empirical (indicators) aspects
- A pronounced trend towards mixing ‘hard’ and ‘soft’ data
- If used at appropriate level composite indicators may be useful for analytical purposes; at aggregate level their analytical value is limited
- Western Balkan countries are lagging behind in making itself transparent and comparable to other countries
- The issue of relevance of different composite (KBE) indicators for countries of very different levels of development is an issue which should be explored more systematically