National Innovation Capacity Index and its application to countries of Central and Eastern Europe

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Workshop *"Promoting innovation as a source of international competitiveness"*

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Outline

- National Innovation capacity framework and its application to CEE and SEE
- Technology upgrading in Eastern Europe and its metrics: discussion
- Conclusions

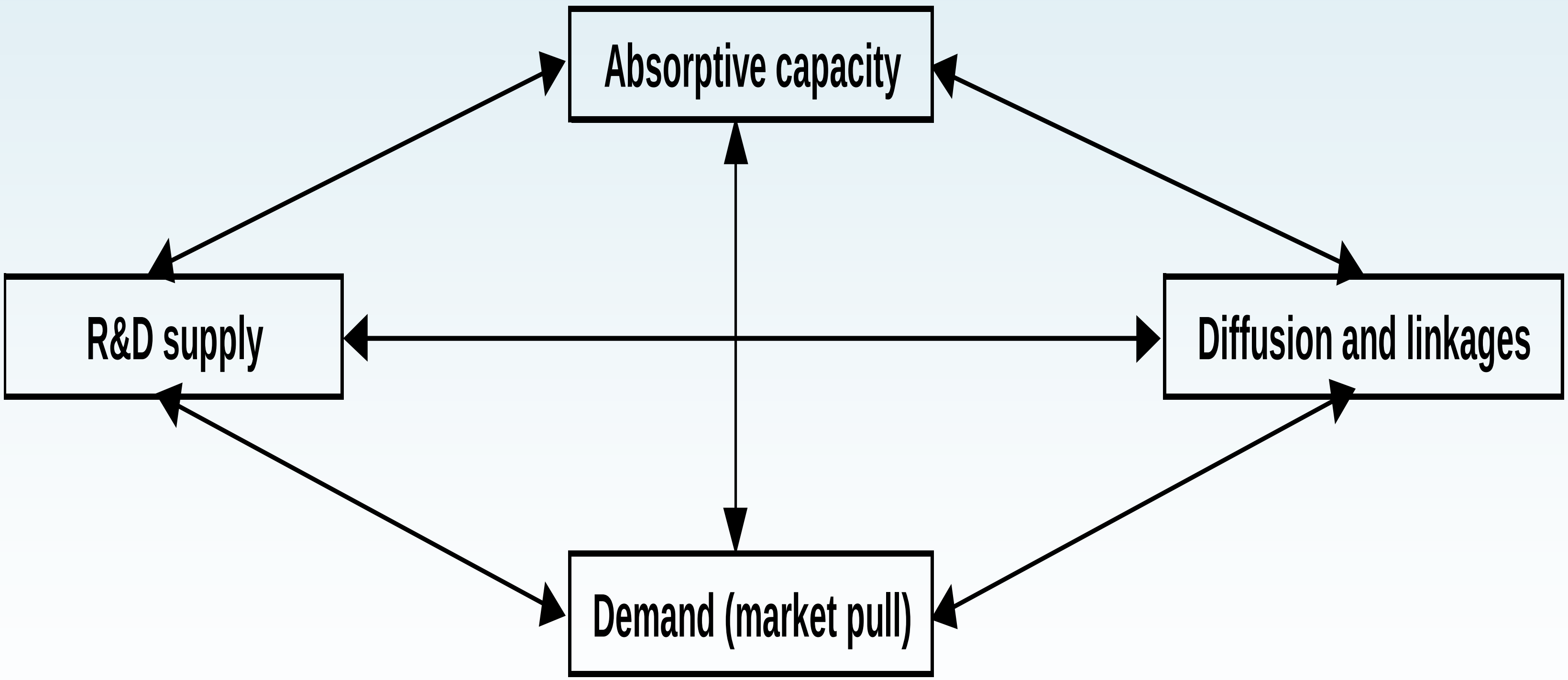
Two applications of the NIC framework

- Kutlaca Dj. and S. Radosevic Innovation Capacity in the South East Europe Region', In Thomas Döring and Dietmar Sternad (eds) *Handbook of Doing Business in South East Europe*, Palgrave Macmillan, 2011
- Radosevic, S. 'A Two-Tier or Multi-Tier Europe?: Assessing the Innovation Capacities of Central and East European Countries in the Enlarged EU', *Journal of Common Market Studies*, Vol. 42, No. 3, pp. 641-66, September 2004

Approach

- **Theoretically and empirically robust conceptual framework**
  - **simplicity, choice of variables and their availability**
- **NIC: beyond R&D to understand innovation capacity.**
- **The National Innovation System based:**
  - **R&D supply,**
  - **absorptive capacity,**
  - **diffusion**
  - **demand**

National innovation capacity framework



Framework elements

- **Absorptive capacity:** the ability to absorb new knowledge and adapt imported technologies > especially important for catching-up economies (Cohen and Levinthal, 1982)
- **R&D capability:** important not only to generate new knowledge but also as a mechanism to absorb it (dual function of R&D)
- **Diffusion**: the key mechanism for reaping economic benefits from investment in R&D and for increasing absorptive capacities. (Davies, 1971)
- **Demand for R&D and innovation:** the key economic mechanism that initiates wealth generation processes in R&D, absorption and diffusion activities (Easterly, 2002).

Absorptive capacity

1. Expenditures on education in % of GDP
2. S&E graduates (in % of 20-29y population)
3. Population with 3rd level education
4. Participation in life long learning (in % of working age population)
5. Employment in high tech manufacturing
6. Employment in high tech services

1-3: education and learning aspects of absorptive capacity (capacity to learn)

5-6: the structural potential for catch up > structurally more favourable potential if economies are specialized in technology intensive sectors

R&D supply

1. Public R&D expenditures (in % of GDP)
2. Business R&D expenditures (in % of GDP)
3. R&D personnel per 1mn labour force
4. EPO high tech patents per 1mn pop
5. USPTO high tech patents per 1mn pop
6. Resident patents per capita

1-3: capacity to generate new knowledge

4-5: capacity to participate in world technology frontier (50% weight each)

7: capacity to generate new innovation related knowledge

Diffusion

1. Training enterprises in % of all enterprises
2. CVT in % of labour costs of all enterprises
3. Internet users per 1000 inhabitants
4. PC per 100 inhabitants
5. ICT expenditures (n % GDP)

1-2: capacity to absorb/diffuse existing/new technologies

3-5: technical capacity for diffusion of information and knowledge

Demand

Finance

1. Stock market capitalisation in % of GDP
2. Domestic credit provided by banking sector (in % of GDP)

Competition

3. Share of FDI in GDP
4. Share of trade in GDP
5. Index of patent rights

Stability

6. Registered unemployment
7. Consumer price index

- 1-2: the more developed financial system the better it can articulate demand for innovation, given equal technological opportunities.
- 3-5: the intensity of competition. FDI > effects on market and industry structure > competition enhancing + competition reducing effects.
- 6-7: macroeconomic stability > by extending planning horizon for entrepreneurs stability promotes demand for innovation.

The index of patent rights (Ginarte and Park)

- The G-P index: a scoreboard of five features of patent protection:
  - (1) extent of coverage;
  - (2) membership in international patent agreements;
  - (3) provisions for loss of protection;
  - (4) enforcement mechanism; and
  - (5) duration of protection.
- Each of these categories is broken into several sub-components and weighted in such a way that each category ranges in value from 0 to 1.
- These categories are summed as unweighted components so the index value ranges from zero to five.
- Higher values of the index indicate stronger levels of protection.
- However, the index does not show the degree to which intellectual property rights (IPR) laws are enforced and IPRs are actually implemented
- **Smarzynska (2002) has developed an index that takes into account the actual degree of implementation of IPRs and that index is used here**

Table 1: Data and sources

	Indicator	Abbreviation	Year	Source
Absorptive capacity				
1	Expenditures in education in % of GDP	eductgdp	1999	Eurostat
2	S&E graduates (‰ 20-29 population)	segrdpop	1999	Eurostat
3	Population with 3rd level education	pop3educ	2001	Eurostat
4	Participation in life-long learning (% of working age pop)	llearng	2001	Eurostat
5	Employment high-tech manufacturing	emplhtec	1999	Eurostat
6	Employment high-tech services	emphsrvc	1999	Eurostat
R&D supply				
1	Public R&D expenditures. (% GDP)	pubrd	2000	Eurostat
2	Business R&D expenditures (% GDP)	besrd	2000	Eurostat
3	R&D personnel per labour force	rdpsnlab	2000	Eurostat
4	EPO high-tech patents (per mln pop)	epopc	2000	Eurostat
5	USPTO high-tech patens (per mln pop)	usptopc	2000	USPTO
6	Resident patents per capita	respat	2000	WIPO
Diffusion				
1	training enterprises as % of all enterprises	trainent	2000	Eurostat
2	CVT in % of labour costs of all enterprises	cvtlabct	2000	Eurostat
3	ISO 900 certifications per per capita	iso9kpc	2000	ISO
4	Internet users per 10,000 inhabitants 2001	internet	2000	ITU
5	PC per 100 inhabitants 2001	ppcpc	2000	ITU
6	ICT expenditures (% GDP)	ictgdp	2000	Eurostat
Demand (Finance/Competition/Macroeconomic stability)				
1	Stock market capitalisation in % GDP	stockmkt	1999	World Bank
2	Domestic credit provided by banking sector (%GDP)	domcredi	1999	World Bank
3	Share of FDI in GDP, 1999	fdigdp	1999	UNCTAD
4	Share of trade in GDP, 1999	tradegdp	1999	World Bank
5	Index of patent rights	iprindex	1999	Ginarte and Pack (1997) and Smarzynska (2002)
6	Registered unemployment	unempl	2000	UNECE
7	Consumer price index	cpi	2000	UNECE

Methodology

- Calculating NICs indexes
  - standardize data
  - multiply by assigned weights, if any
  - add up > summary component index
  - Summary NICs index
- Regression of NICs and its components on Lab productivity
- Cluster analysis of NICs and its components

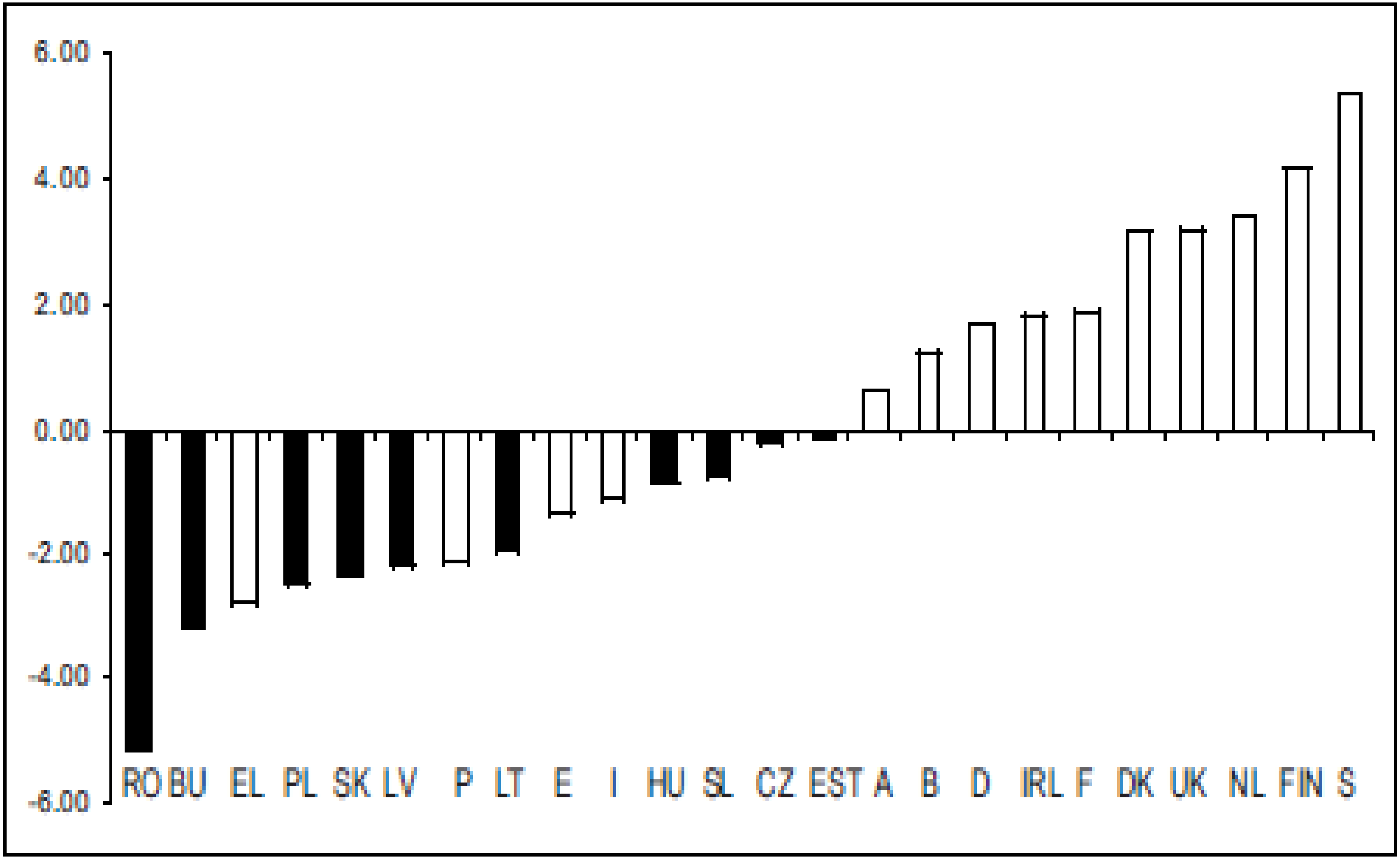
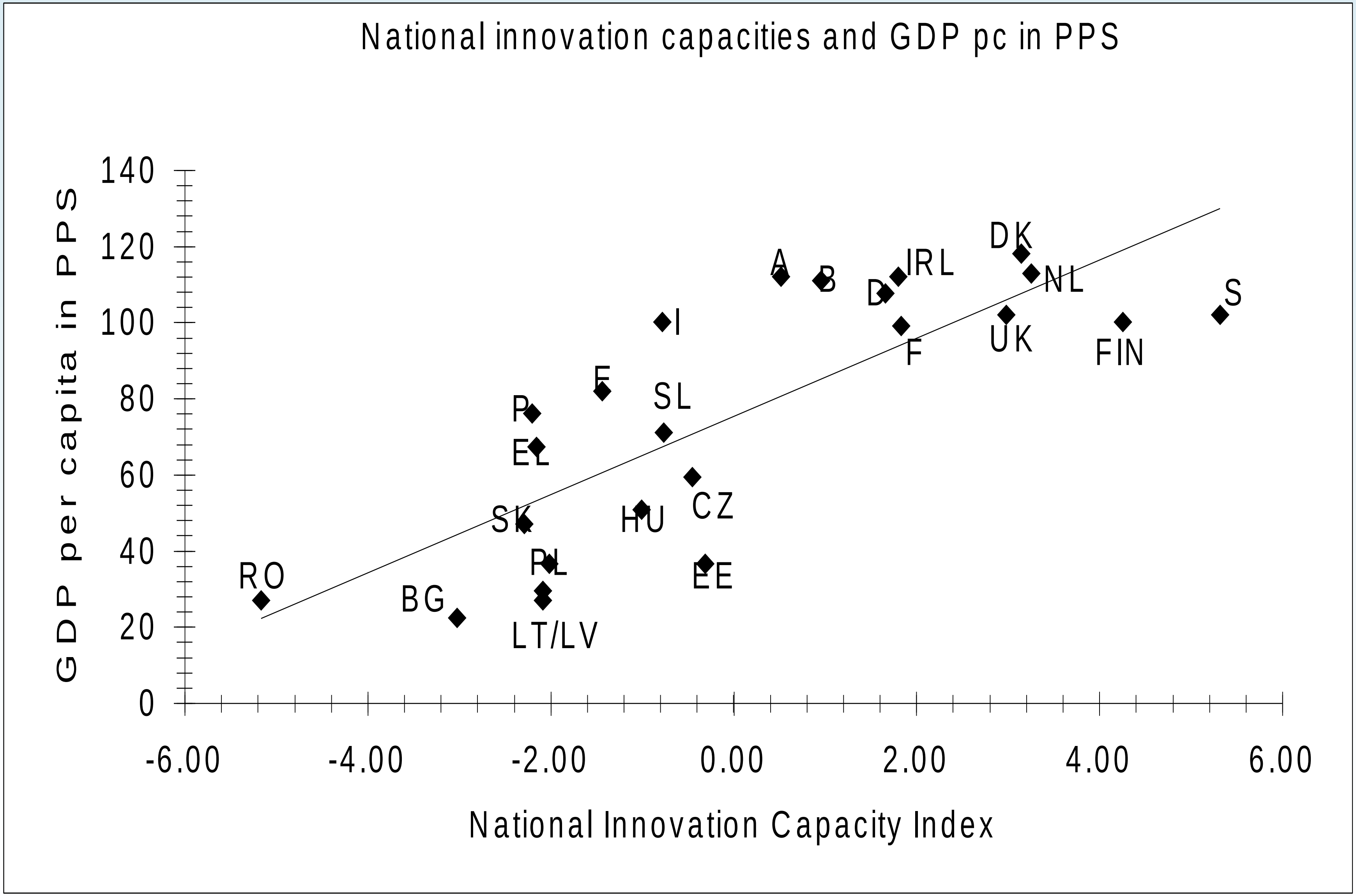


Figure 3a: National Innovation Capacities

Summary

- All CEECs are below the EU NIC average
- EU /5.32/ vs CEECs /4.85/
- Ranking does not follow simple East - West divide


National innovation capacities and GDP pc in PPS
GDP per capita in PPS
140
120
100
80
60
40
20
0
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
National Innovation Capacity Index
RO
BG
LT/LV
PL
SK
EL
P
E
I
SL
HU
CZ
EE
A
B
D
IRL
F
DK
NL
UK
FIN
S

Demand: the only component with the pronounced East - West division

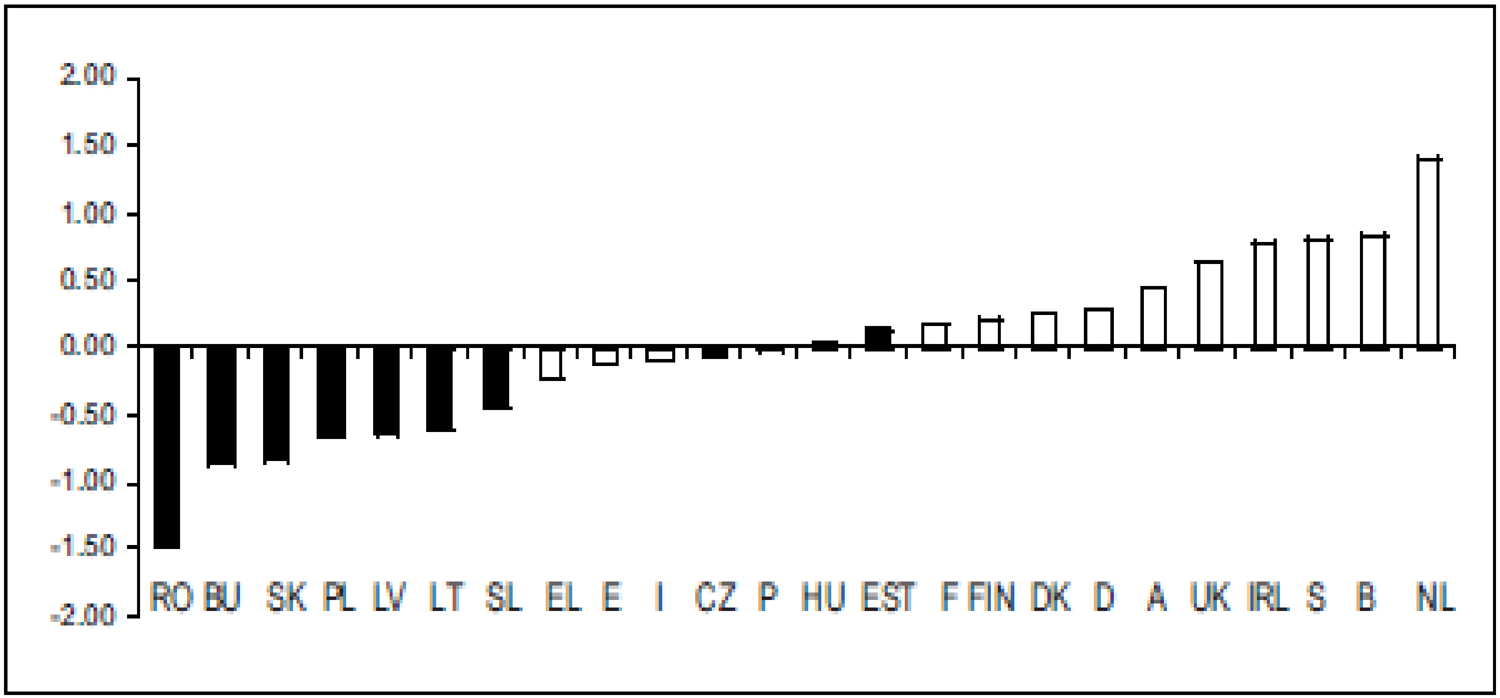


Figure 3e: Demand Capacities

Clustering of national innovation capacities

Non-hierarchical (K-means) clustering

Cluster 1	CEE6 + EU3	(BG, LT, LV, PL, RO, SK, + E, EL, P)
Cluster 2	EU3	FIN, S, UK
Cluster 3	EU6 + CEE4	(A, B, D, F, I, IRL + CZ, EE, HU, SL)

Clustering of absorptive innovation capacities

Cluster 1	CEE 3 + EU1	(Baltic states + NL)
Cluster 2	EU4	(DK, FIN, S, UK)
Cluster 3	CEE7 + EU9	(BG, CZ, HU, PL, RO, SL, SK + A, B, B, E, EL, F, I, IRL, P)

Clustering of R&D supply

Cluster 1	EU6+ CEE1	(A, B, D, NL, UK + SL)
Cluster 2	EU2	(F, DK)
Cluster 3	CEE9 + EU5	(All CEE except SL + E, El, I, IRL, P)
Cluster 4	EU2	(S, FIN)

Clustering of diffusion capacities

Cluster 1	CEE5 + EU2	(BG, LT, LV, PL, RO + E, P)
Cluster 2	EU6 + CEE5	(CZ, EE, HU, SL, SK + A, B, D, EL, F, I)
Cluster 3	EU6	(DK, FIN, IRL, S, NL, UK)

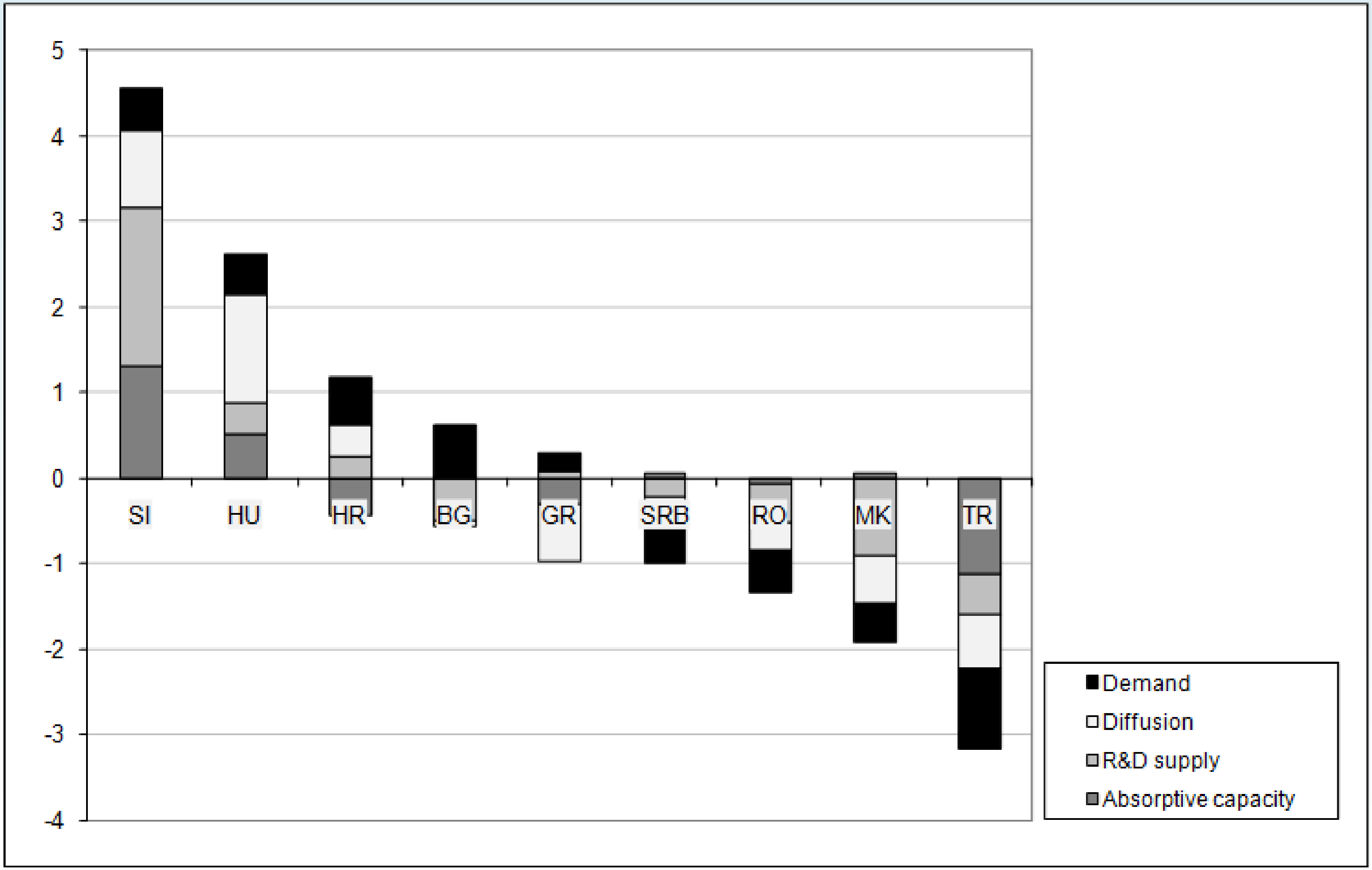
Clustering of demand for innovation

Cluster 3	CEE 8 + EU2	(All CEECs except RO and SK + EL, P)
Cluster 2	CEE2	(RO, SK)
Cluster 1	EU12	(All EU except EL, P)

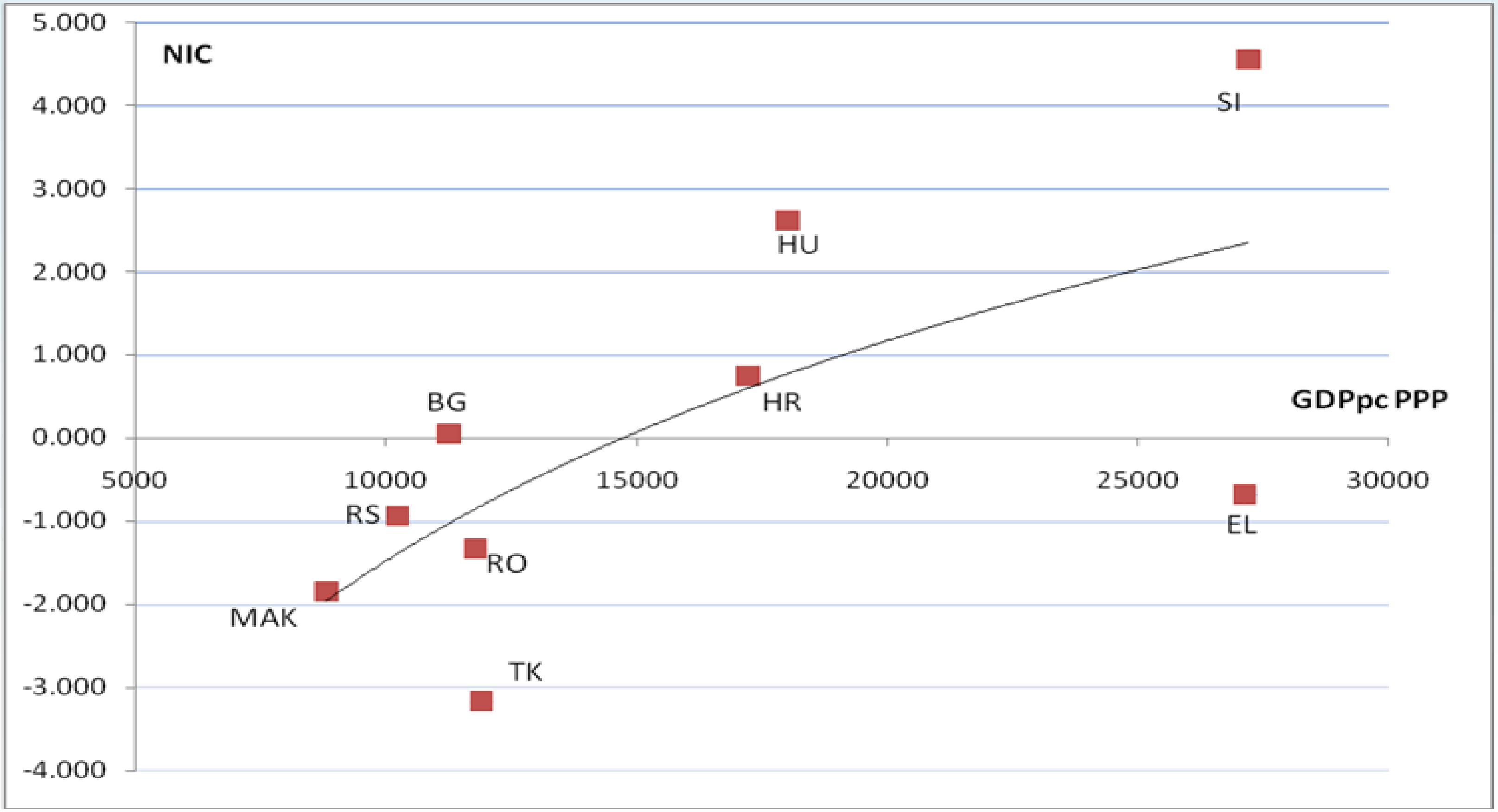
Conclusions I:

- Productivity depends not only on R&D but also on absorptive, diffusion and demand capacities (regression analysis)
- Ho on divergence effects of enlargement should be qualified > CEE can make it actually more ‘coherent’
- Potential for convergence to their ‘equilibrium income – NIC levels’ for some CEECs is very high but not for their convergence to the EU average
- Ordering policy priorities: demand, R&D, diffusion, and absorptive capacities

National innovation capacity of the SEE countries



Relationship between national innovation capacity index (NIC) and GDP per capita at purchasing power parity (GDPpc PPP) (2008)



Technology upgrading in Eastern Europe and its metrics: discussion

- Composite indicators should be useful metrics for measuring technology upgrading of countries
- However, countries operate at different distances from technology frontier
- The most useful is metrics which takes into account different technological positions of countries (distances) and has underlying theory of industrial upgrading (growth)
- Are available metrics' measuring activities **relevant** to CEE/SEE/CIS?
- Metrics that measure world frontier technology activities are not very useful for countries that grow based on standard technologies (i.e.. production capability)

EU INNOVATION SCOREBOAD WITH FOUR CIS COUNTRIES

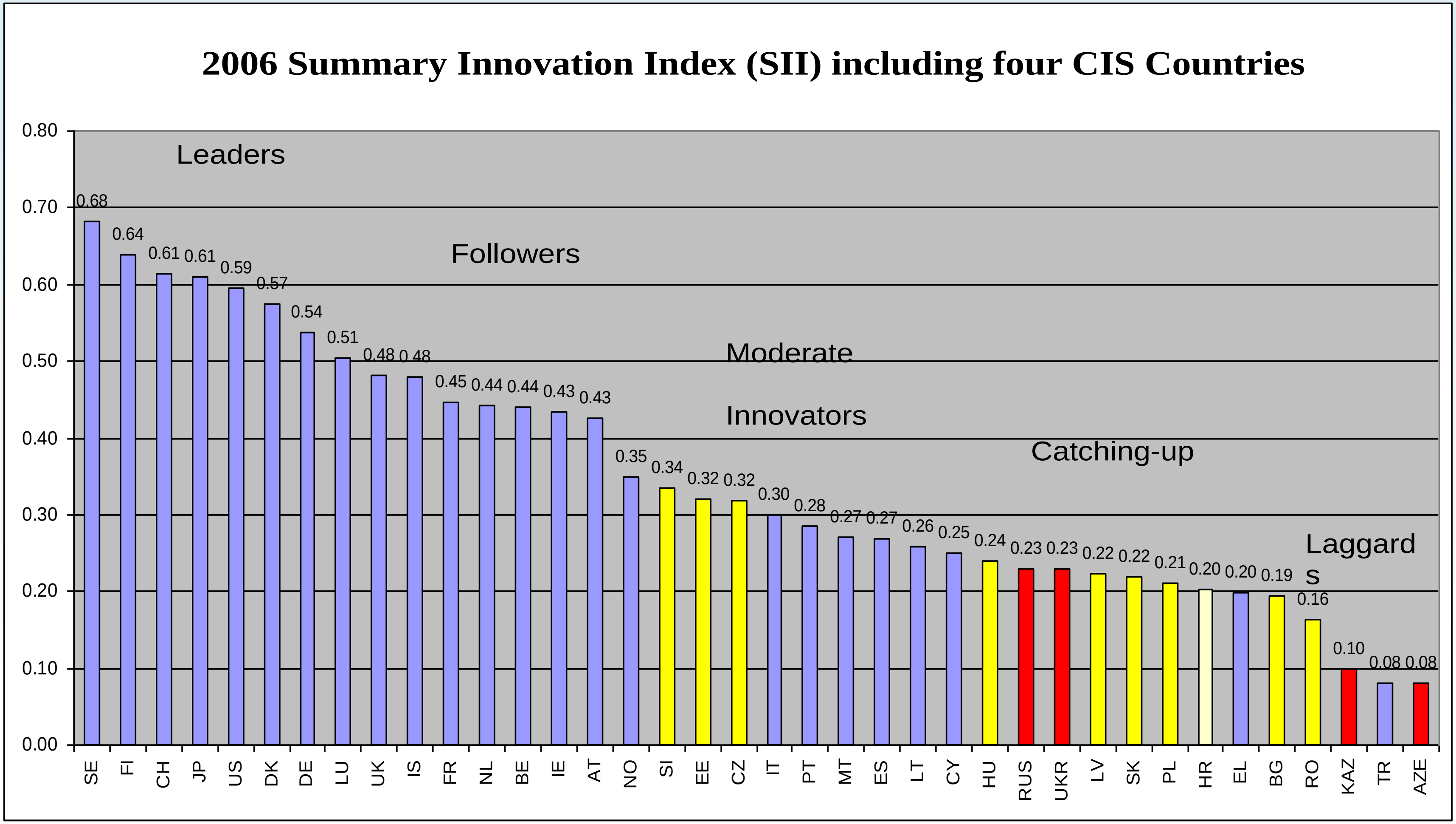
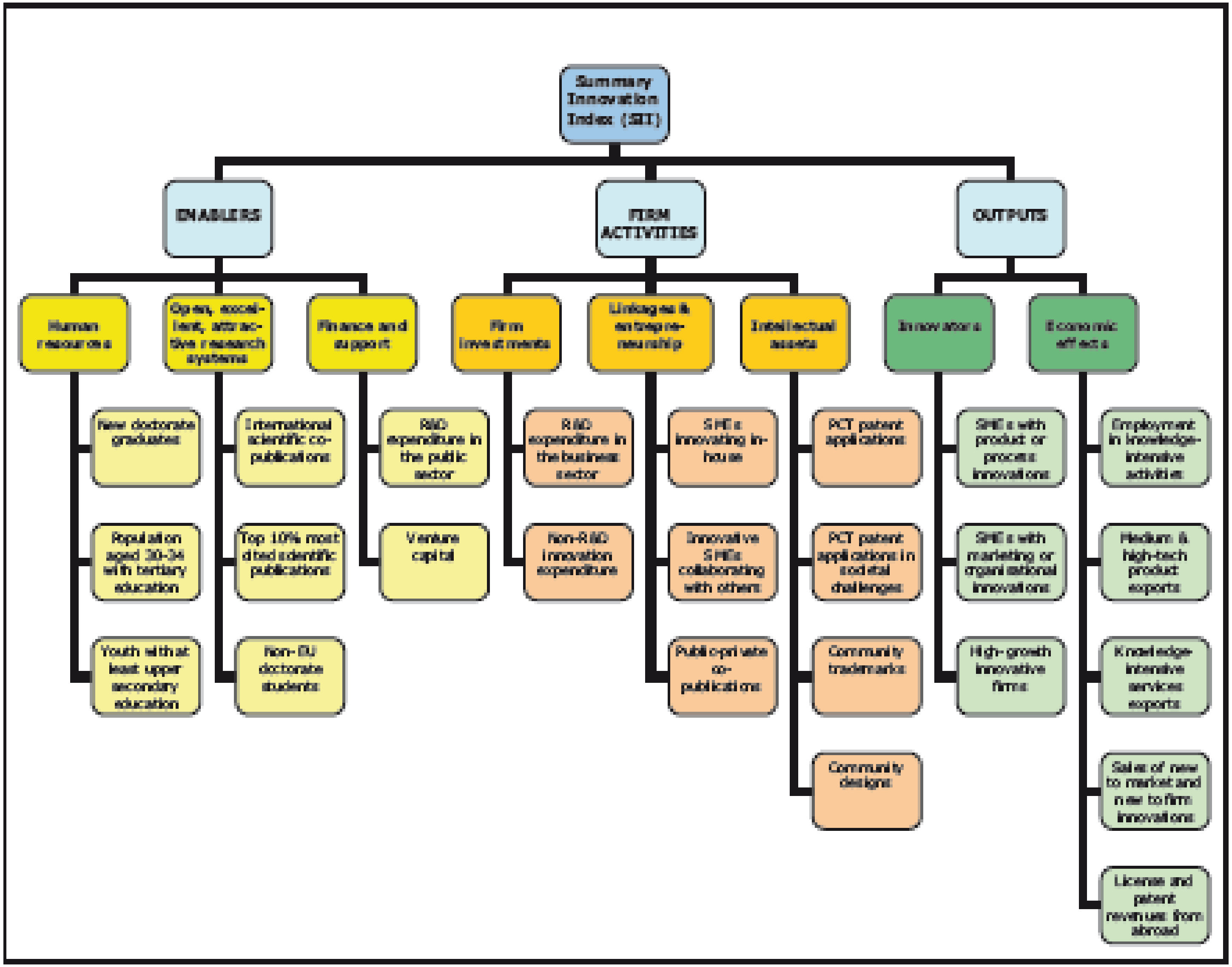


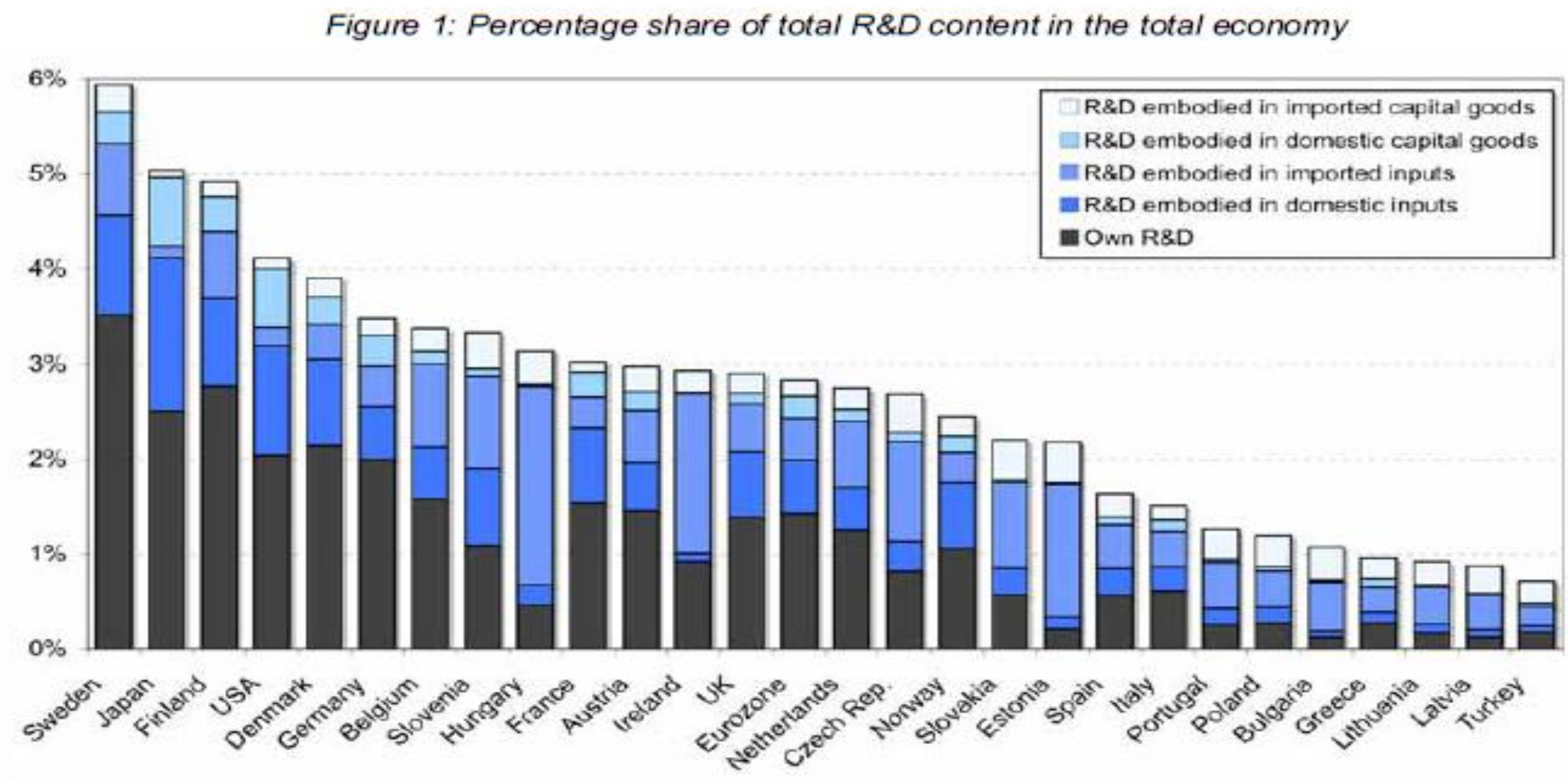
FIGURE 1: FRAMEWORK OF THE INNOVATION UNION SCOREBOARD



What the EIS (IUS) actually measure?

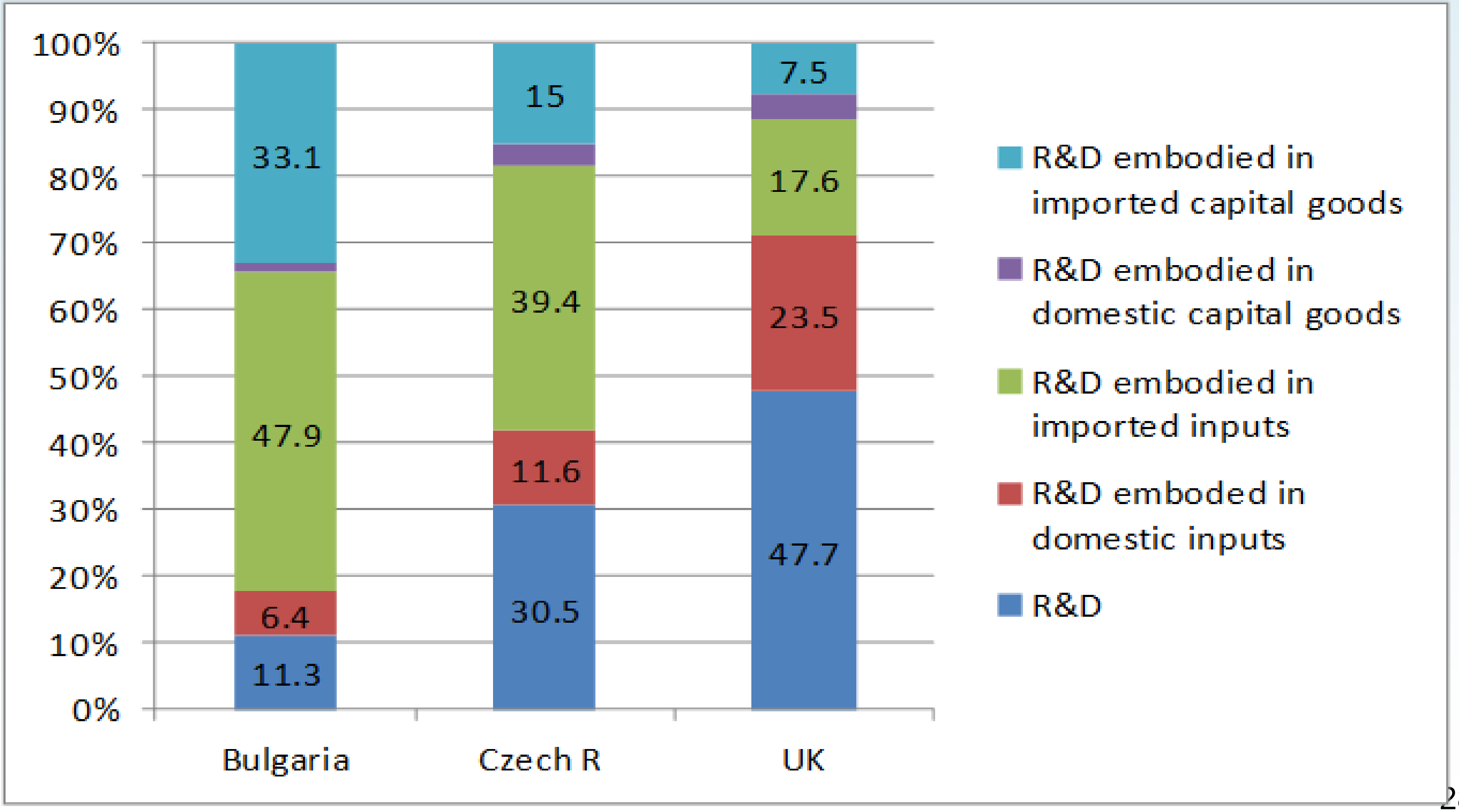
- The EIS indicates **the degree to which growth of economies is based on the world frontier innovation;**
- **This is not necessarily its major share of innovation capacity** which should include innovation activities typical for countries behind the technological frontier.
- CEE/SEE/CIS countries operate behind the technological frontier, with their **growth largely based on imported technology and on its adaptation and improvements**.
- > Is IUS (EIS) good approximation of the type of technology effort that takes place in these economies ?

R&D content embodied in imported equipment and inputs dominates in the EU 10



Source: Knell M. (2008), Embodied technology diffusion and intersectoral linkages in Europe. Europe Innova Sectoral Innovation Watch deliverable WP4. European Commission, Brussels.

Share in total R&D content: R&D and R&D Embodied in inputs and capital goods



Direct and indirect R&D content and pattern of technology upgrading

- A majority of the CEE/SEE/CIS are technology users and have a high indirect technology intensity

- Technology upgrading activities: adopt, modify and upgrade based on imported equipment > a need for metrics that can monitor technology upgrading of catching up economies

Pattern of technology upgrading in catching-up economies

1st stage: -> ***low overall technology intensity***. In this stage both direct and indirect R&D and other innovative activities are at comparatively low levels.

2nd stage: -> ***high indirect technology intensity***. In this stage R&D intensity is low, but R&D embodied in imported equipment increases.

3rd stage: -> ***average direct and indirect technology intensity*****.** Further upgrading requires the coupling of imported knowledge with own R&D activities, which increase to an average level.

4th stage: -> ***high direct technology intensity****.* As R&D intensity increases the relative share of indirect technology effort decreases and the country reaches the world technology frontier.

NIC vs. EIS/IUS differences

- EIS/IUS (29) and NIC (25) contain nine identical indicators
- EIS contains more indicators that measure activities associated with the **world frontier technology activities** like doctorate graduates, venture capital, technology balance of payment and export of knowledge-intensive services.
- NIC leans more towards measuring activities **behind the technological frontier** like resident patents and ISO 9000-certificates.

SEE economies based on the European Innovation Scoreboard index (SII)

Innovation follower	Slovenia
Moderate innovator	Greece (SII = 0.370), Hungary (SII = 0.328)
*Catching-up countries**	Bulgaria (SII = 0.231), Croatia (SII = 0.286), Romania (SII = 0.294), Serbia (SII = 0.227)

*No data for SII is available for Albania, for Macedonia and for Bosnia and Herzegovina, but these countries can confidently be grouped under the catching-up countries category.

Example: Greece in SEE: EIS = 2nd ; NIC = 5th

- Greece ranks much better when its innovativeness is measured by the extent to which the country relies on world frontier innovation activities than when it is measured by NIC.
- A high score based on world frontier innovation activities does not necessarily mean that a country will grow faster, or that its GDP per capita will necessarily be higher.

Conclusion II:

- Countries grow on the basis of the type of technology effort that is **appropriate** to their current level of development.
- For example, countries behind the technological frontier should grow at the highest rate if they improve their **technology imitation and absorption activities**.
- Policy implication: increase R&D but **in interaction** with R&D embodied in imported capital goods and inputs (indirect R&D) > integrate FDI into innovation policy
- **Key** for appropriate metrics: it should be based on country's pattern of technology/industrial upgrading not on other countries pattern, especially not if they operate at different technological level