

Towards a taxonomy of innovation systems

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Based on Godinho, Mendonça and Pereira (2004)

Structure of the presentation:

Part 1 → Questions, aim, and conceptual considerations

Part 2 → STEP 1 (Mapping NISs)

2 exercises

Part 3 → STEP 2 (Cluster analysis)

Part 4 → A possible taxonomy + conclusions

Part 1

Questions

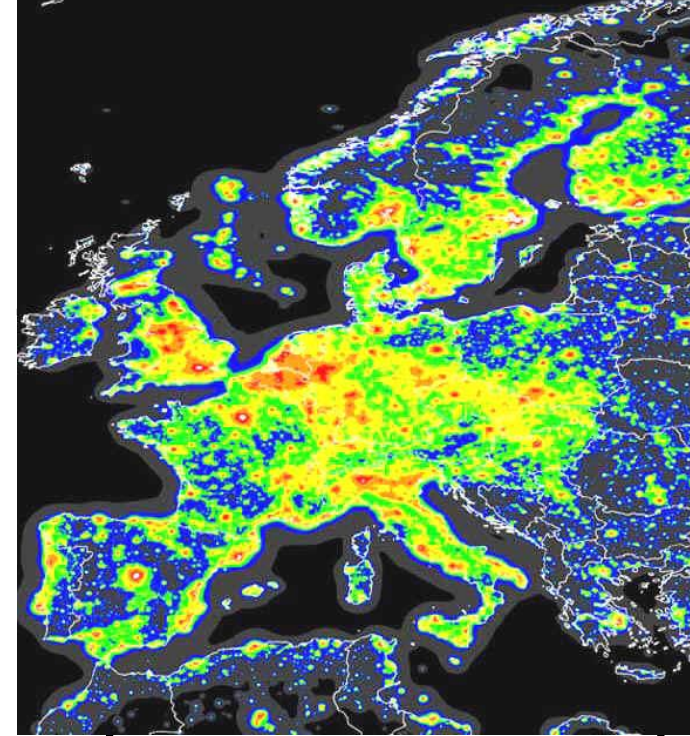
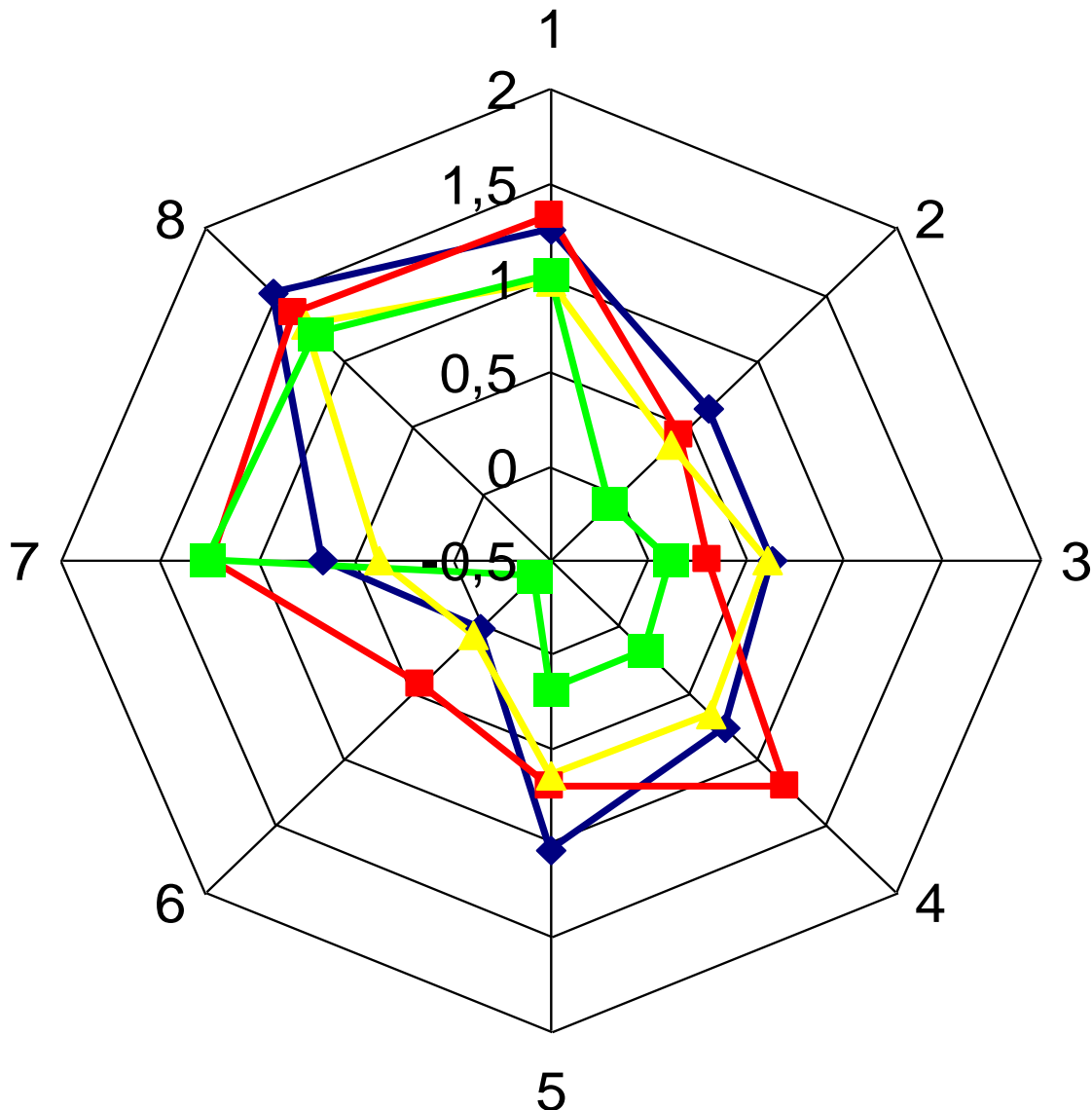
- Is it possible to measure the development and maturity of NISs?
- What specific technique can be used for that?
- Can we apply that technique to both the advanced and the catching up economies?

Aim

1st step → Mapping NISs

**2nd step → With output of step 1:
generate a possible taxonomy of NISs**

Outcome: Mapping... ... and benchmarking



Conceptual questions (1) (...1 to 10)

Different NIS Concepts

- Freeman (1987) → organization of R&D in firms and role of government in Japan
- Nelson (1988) → high tech sectors and R&D system
- Lundvall (1988) → Inter-firm and user-producer interactions
- Amable, Boyer and Barré (1997) – Human Resources
- Aalborg school → late 1990s → “Learning economy”

Conceptual questions (2)

“NIS” → What is it?

A conceptual device that focus on the conditions that facilitate or hinder the generation and diffusion of innovations in a given economy

Conceptual questions (3)

“NIS” is a “system”

- Whole: more than the parts
- Dynamic economies of scale
- Agglomeration economies
- Network economies
- Pure knowledge spillovers

Source of increasing returns ...

... but also of entropy ...

Conceptual questions (4)

**'NIS' emerged in the literature as a
qualitative concept**

Is quantification possible, acceptable or desirable?

Quantification: allows for comparisons

But each NIS → Idiosyncratic

**(what in a context can be seen as a weakness
in another might be seen as a strength)**

Quantification: possible, desirable... but...

... caution needed in the analysis

Conceptual questions (5)

NIS purpose

- Allocation of resources for innovation and diffusion
- Speed up accumulation and distribution of knowledge
- Provide a favourable regulatory framework
- Expected performance:
 - capability accumulation, learning...
 - ... innovation, diffusion ...
 - (.... growth, development, sustainability...)

Conceptual questions (6)

“Innovation” vs. “Diffusion” in the IS

trade-off or complementarity?

**However in some NIS “diffusion”
more important than “innovation”**

**(in the limit “innovation”=0, but even
in this case we can speak of ‘NIS’)**

Conceptual questions (7)

NIS comprehends:

- **Actors** (diversity, roles, behaviours, strategies)
- **Their interactions** (linkages, channels, system density)
- **Institutions** (with given functions, enable or limit innovation and diffusion)

- **Relevance of "History"** (Learning and capability accumulation constrained by previous historical trajectory , path dependency, inertia...)

Conceptual questions (8)

The actors:

Firms

Consumers (other firms, final consumers, government, exports)

Markets (products but also finance and labour)

Government (procurement, laws, regulations, standards, competition policy, IPR...)

Knowledge producers and reproducers (universities and other education entities, training system, public labs...)

Entities of transfer, intermediation and support (technology centres, incubators, technology brokers...)

Conceptual questions (9)

NIS: not a closed system

Degree of openness depends on

- (1) Sophistication/backwardness of the domestic knowledge base
- (2) Size
- (3) FDI flows and external trade involvement

Conceptual questions (10)

NIS and 'economic structure'

- Concentration and size distribution in each industry
- Relative weight of different sectors
- International specialization of the economy

Part 2

Mapping NIS ("step 1")

Method

- **Decide what the relevant dimensions are**
- **Decide what variables shall/can be used**
- **All variables standardized**
- **Aggregate 2-6 variables into each relevant dimension**
- **Map those dimensions into bi-dimensional space**

Exercise 1

- **What relevant dimensions shall be selected to represent a given NIS ?**

Step 1.a – Eight NIS dimensions

- market conditions
- institutional conditions
- intangible and tangible investments
- basic and applied knowledge
- external communication
- diffusion
- innovation

**In order to materialise such 8 NIS dimensions →
→ n individual indicators selected**

**Definition of NIS dimensions and indicators' selection
respects theoretical and practical criteria**

Exercise 2

- **What indicators shall we select for each of the identified dimensions ?**

Dimension 1 - “*Market conditions*”

- Income per capita
- Overall GDP size
- Population density

Dimension 2 - “*Institutional conditions*”

- GINI index
- Youth of population
- Life expectancy
- Corruption index

Dimension 3 - “*Intangible and tangible investment*”

- Education expenditures as a percentage of GDP
- Education expenditures per capita
- GERD as a percentage of GDP
- GERD per capita
- Investment rate (GFCF as a percentage of GDP)

Dimension 4 - “*Knowledge*”

- Population with 2+3 Education as a percentage of total population
- Researchers as a percentage of labour force
- Scientific papers per Capita
- Tertiary enrolment in technical subjects as a percentage of the population

Dimension 5 - “*Economic structure*”

- Value Added in High-Tech & Medium High-Tech Activities (%)
- High-Tech & Medium High-Tech Exports (%)
- Sales of home-based top 500 global R&D companies / GDP

Dimension 6 - “*External communication*”

- (Exports + Imports) / GDP
- (Inward + Outward stocks of FDI) / GDP
- Bandwidth in international connections (bits per Capita)

Dimension 7 - “*Diffusion*”

- Personal Computers per capita
- Internet Hosts per capita
- Internet Users per capita
- Cellular Phones per capita
- ISO 9000 + ISO 14000 Certificates per capita

Dimension 8 - “*Innovation*”

- US Patents per Capita
- Trademarks per Capita

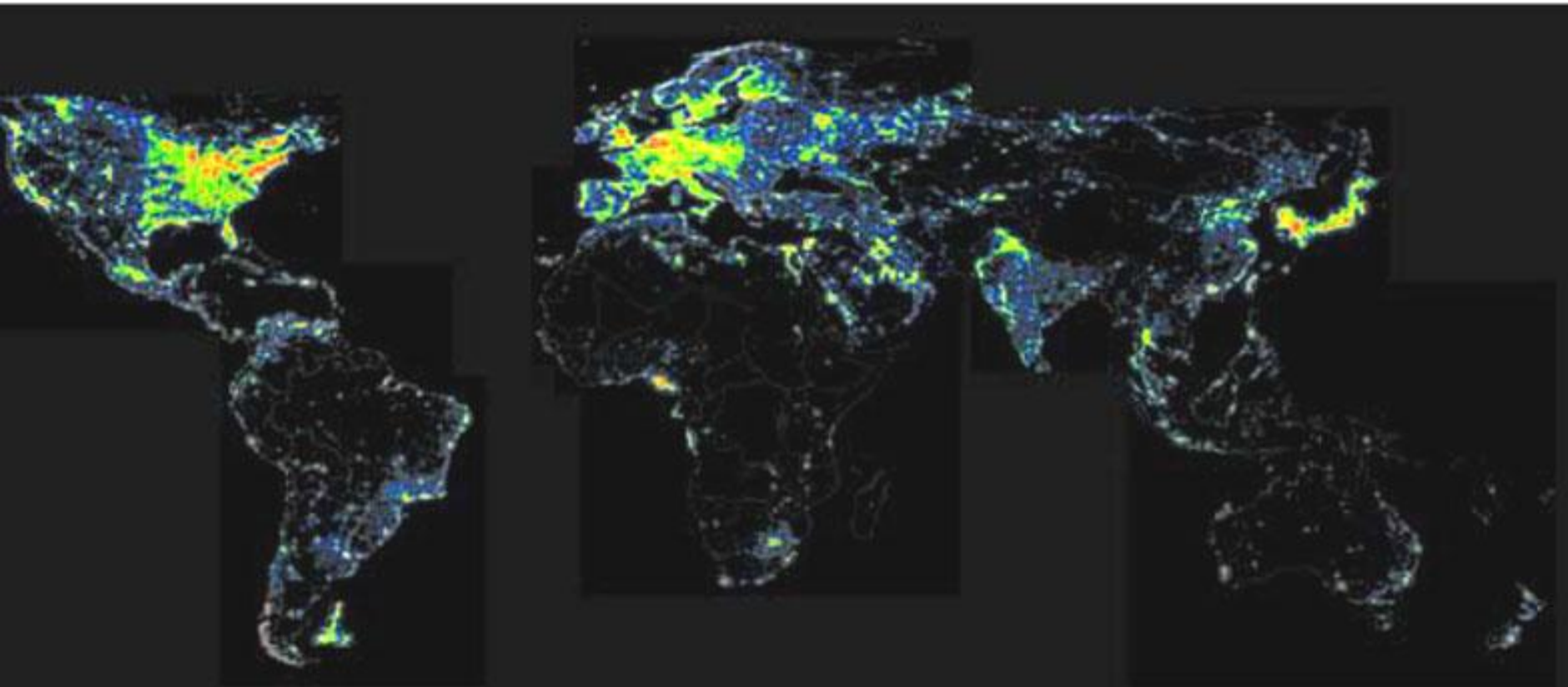
STEP 1.b – Country Selection

Countries: developed; emerging; and developing economies

- **The OECD economies**
- **EU members + candidate countries**
- **“Asian tigers” included
(even tough not all of them “nations”)**
- **For the rest, the criterion was to include all countries with at least 20 million inhabitants**

69 Countries

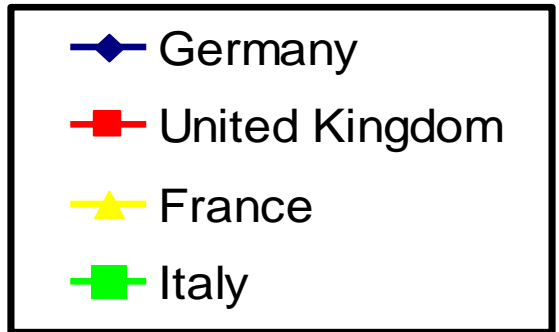
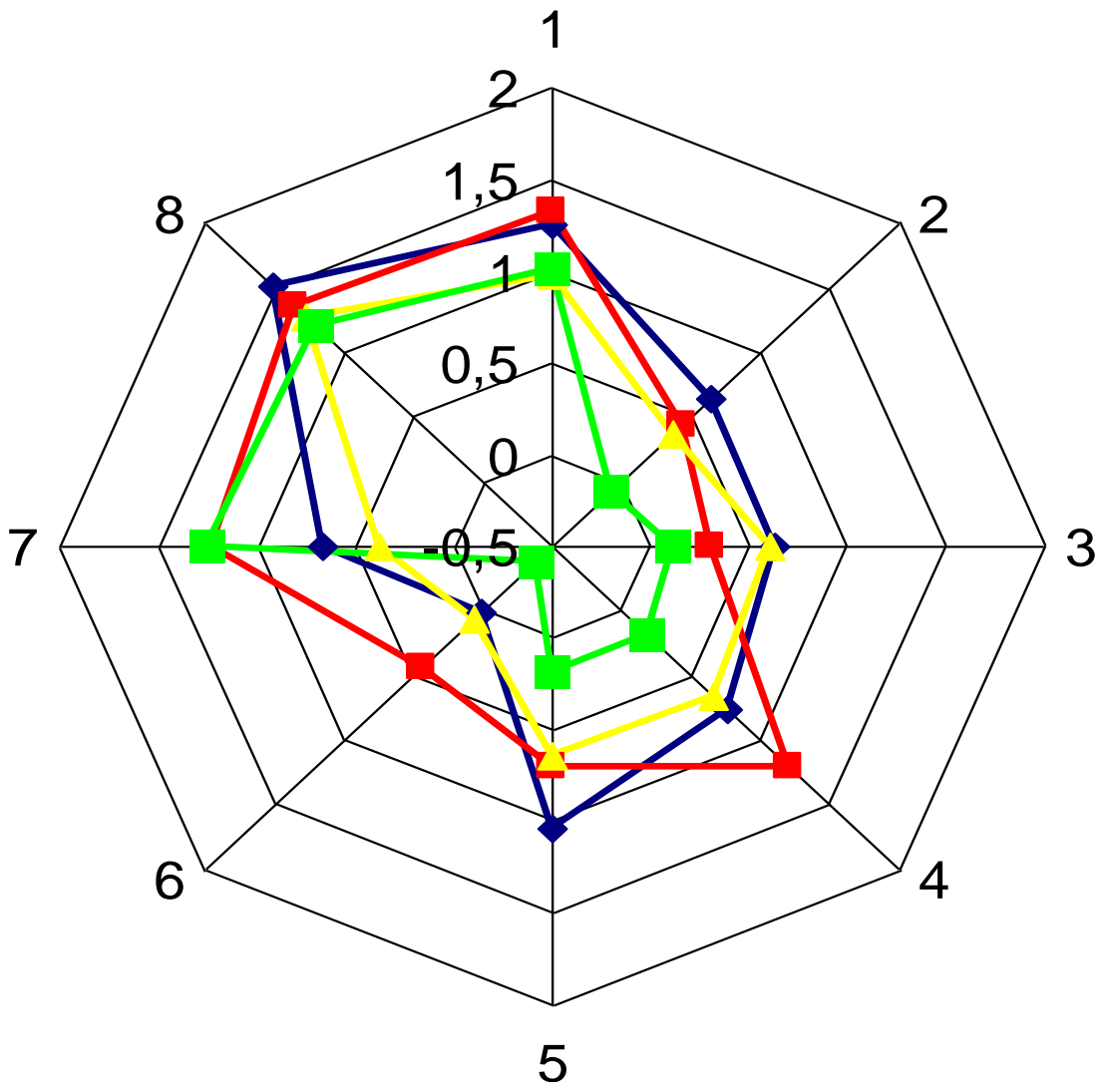
- Developed, emerging and developing economies
- Countries with > 20 million inhabitants
- Overall: 87.4% of the world population

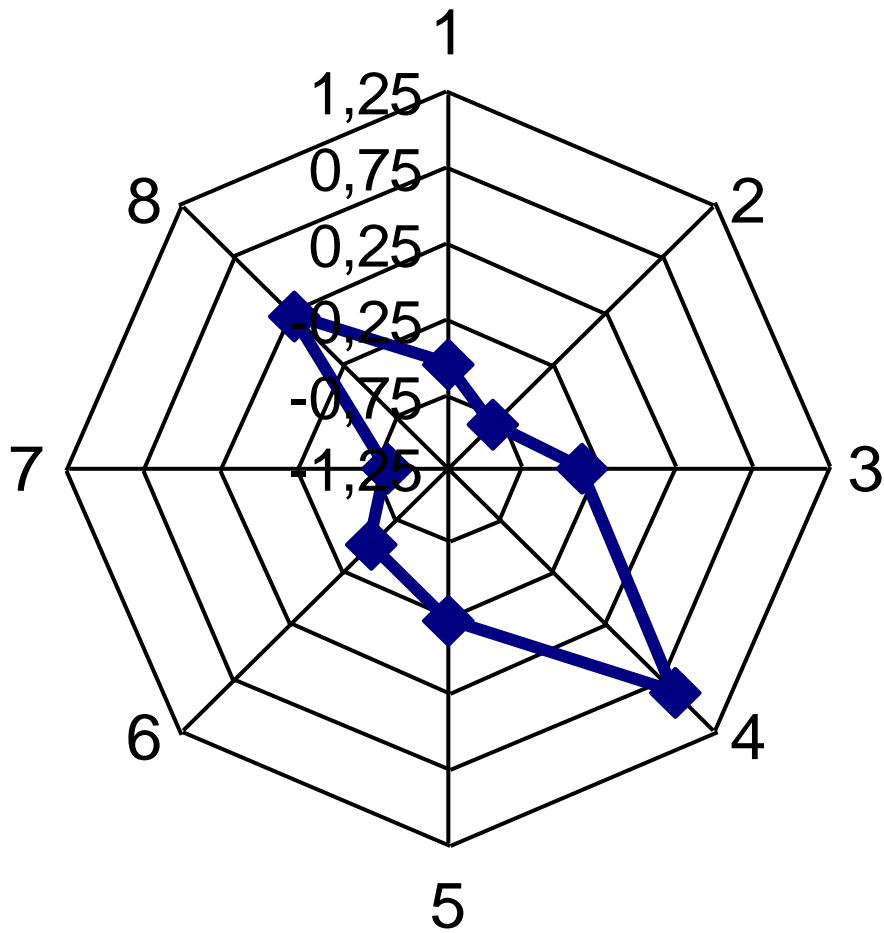


STEP 1 → Possible outcomes

- **Mapping**
- **NIS evenness**
- **NIS ranking**

4 largest EU economies





NIS ranking_

1. Switzerland	1,15	24. Hungary	0,27	47. India	-0,39
2. Sweden	1,13	25. Czech R.	0,23	48. Turkey	-0,42
3. Netherlands	0,91	26. Slovenia	0,23	49. Ukraine	-0,43
4. Denmark	0,90	27. New Zealand	0,21	50. Egypt	-0,43
5. Finland	0,90	28. Portugal	0,13	51. Romania	-0,45
6. Hong Kong	0,90	29. Malta	0,05	52. Venezuela	-0,52
7. United Kingdom	0,88	30. Malaysia	0,05	53. Bulgaria	-0,56
8. United States	0,86	31. Slovak R.	0,00	54. Indonesia	-0,58
9. Singapore	0,86	32. Greece	-0,07	55. Morocco	-0,59
10. Japan	0,85	33. China	-0,10	56. Viet Nam	-0,59
11. Germany	0,81	34. Estonia	-0,11	57. Colombia	-0,63
12. Ireland	0,81	35. Poland	-0,12	58. Algeria	-0,67
13. Korea (R. of)	0,67	36. Mexico	-0,23	59. Peru	-0,68
14. France	0,62	37. Cyprus	-0,26	60. Iran (I.R.)	-0,75
15. Taiwan	0,60	38. Thailand	-0,26	61. Bangladesh	-0,77
16. Austria	0,57	39. Brazil	-0,27	62. Pakistan	-0,82
17. Norway	0,51	40. Lithuania	-0,29	63. Nigeria	-0,89
18. Belgium	0,50	41. Chile	-0,29	64. Kenya	-0,94
19. Spain	0,50	42. Russia	-0,30	65. Ethiopia	-0,97
20. Canada	0,44	43. Latvia	-0,30	66. Myanmar	-0,98
21. Italy	0,44	44. Argentina	-0,35	67. Tanzania	-0,99
22. Austrália	0,40	45. South Africa	-0,35	68. D.R. Congo	-1,05
23. Luxembourg	0,38	46. Philippines	-0,36	69. Sudan	-1,06

Part 3 - STEP 2 (Cluster analysis)

The object of the analysis was a matrix with

- 69 countries in the sample as the individual “cases”**
- 8 NIS dimensions as the “variables” to be analysed**

The interpretation of the results led us to the definition of a three level structure of clusters

- 1st level → “Megaclusters”**
- 2nd level → “Clusters”**
- 3rd level → “Subclusters”**

Possible NISs classification for 1st and 2nd level of the 3-level structure

Megacluster 1 – Developed NIS	Cluster 1.1 – Dynamic innovation systems
	Cluster 1.2 – Performing innovation systems
	Cluster 1.3 – Unevenly developed NISs
Megacluster 2 – Developing NIS	Cluster 2.1 – Catching up NISs
	Cluster 2.2 – Hesitating NISs
	Cluster 2.3 – Unformed NISs

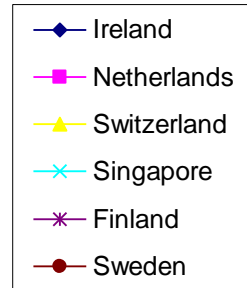
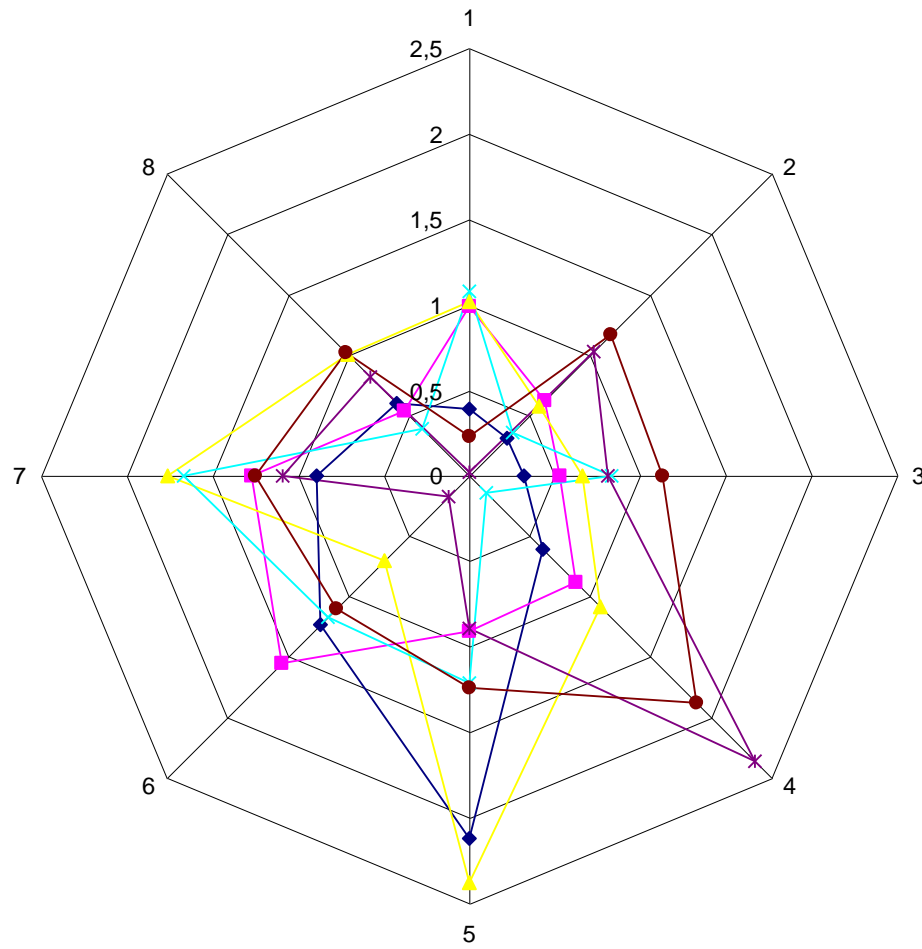
The cluster structure (Megaccluster 2 next slide)

MEGACLUSTERS	CLUSTERS	SUBCLUSTERS	Groups of Countries
M.0. Hong-Kong	C.0		G1
M.1.	C.1.1	Ireland + Netherlands + Switzerland + Finland + Singapore + Sweden	G2
		C.1.2	S.C.1.2.1 Germany + UK + France + Italy + South Korea + Taiwan
	S.C.1.2.2 U.S. + Japan		G4
	S.C.1.2.3 Canada + Norway + Australia + Austria + New Zealand + Spain		G5
	C.1.3	Denmark + Belgium + Luxembourg	G6

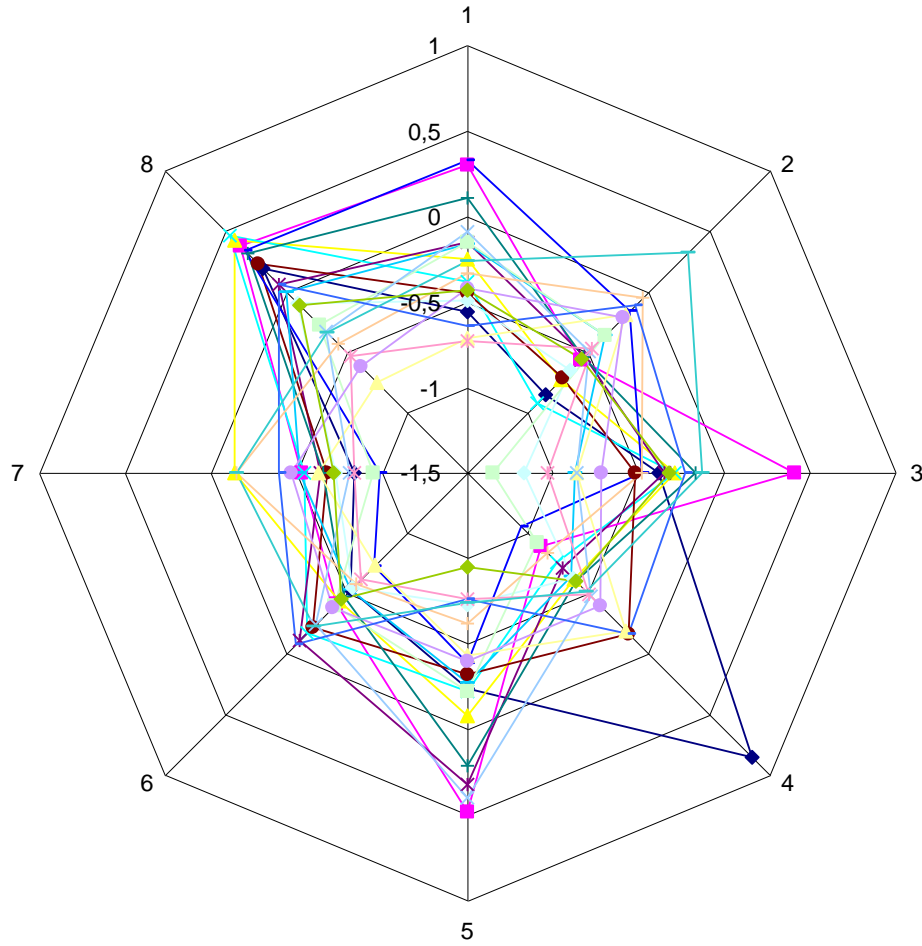
The cluster structure (only Megacluster 2 here)

MEGA-CLUSTERS	CLUSTERS	SUBCLUSTERS	Groups of Countries
M.2.	C.2.1	S.C.2.1.1 Portugal + Greece + Poland + Hungary + Czech R. + Slovenia	G7
		S.C.2.1.2 Malaysia + Malta	G8
		S.C.2.1.3 Latvia + Estonia + Lithuania + Slovak R. + Ukraine	G9
	C.2.2	S.C.2.2.1 Russia	G10
		S.C.2.2.1 China + Brazil + South Africa + Thailand + Argentina + India + Mexico	G11
		S.C.2.2.3 Turkey + Colombia + Bulgaria + Indonesia + Philippines + Peru + Romania	G12
		S.C.2.2.4 Egypt + Cyprus + Chile + Venezuela	G13
	C.2.3	S.C.2.3.1 Algeria+Vietnam+Iran+Morocco+Bangladesh	G14
		S.C.2.3.2 Pakistan+Kenya+Ethiopia+Myanmar+Tanzania+Sudan+Nigeria+ D.R. Congo	G15

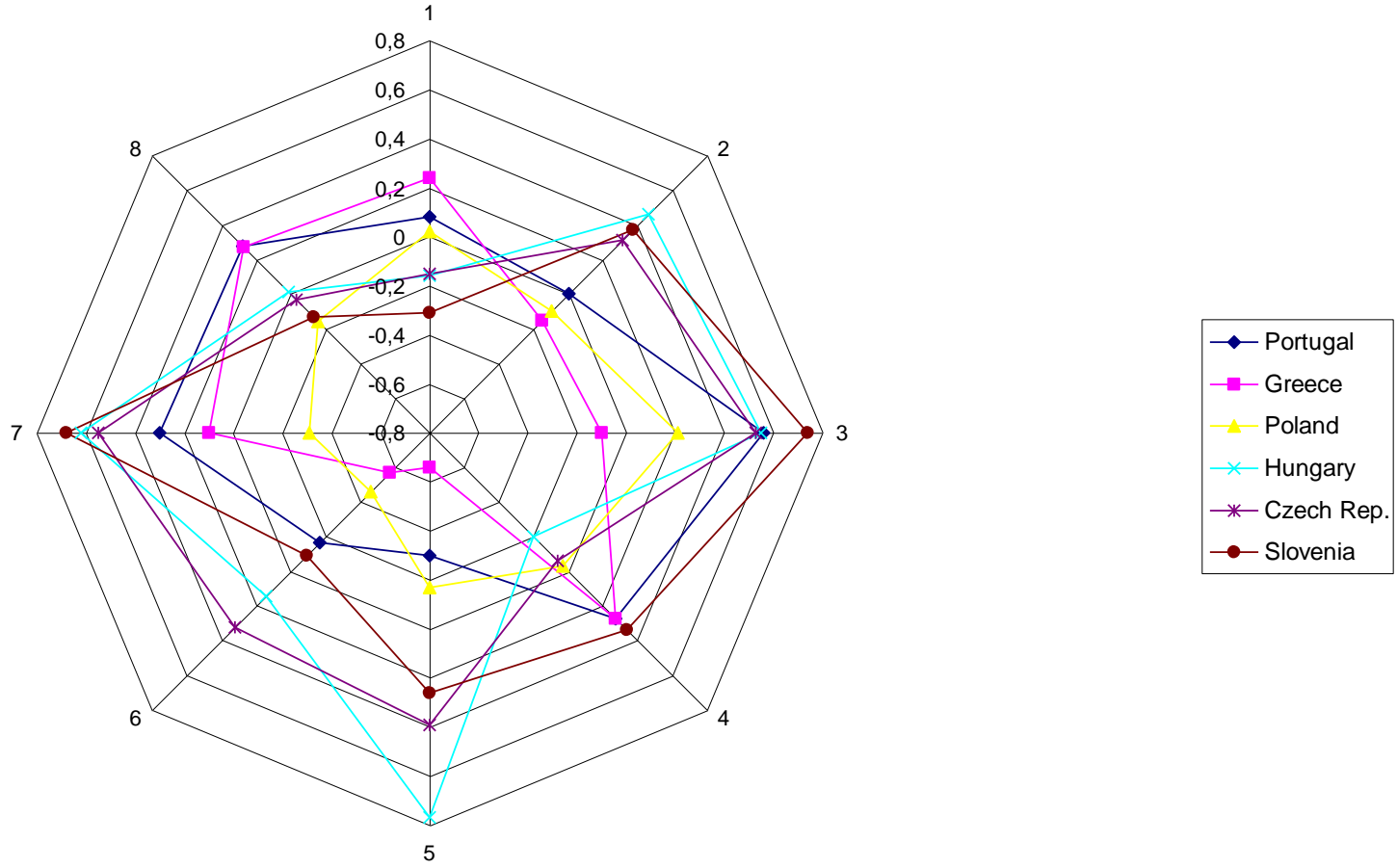
Cluster 1.1



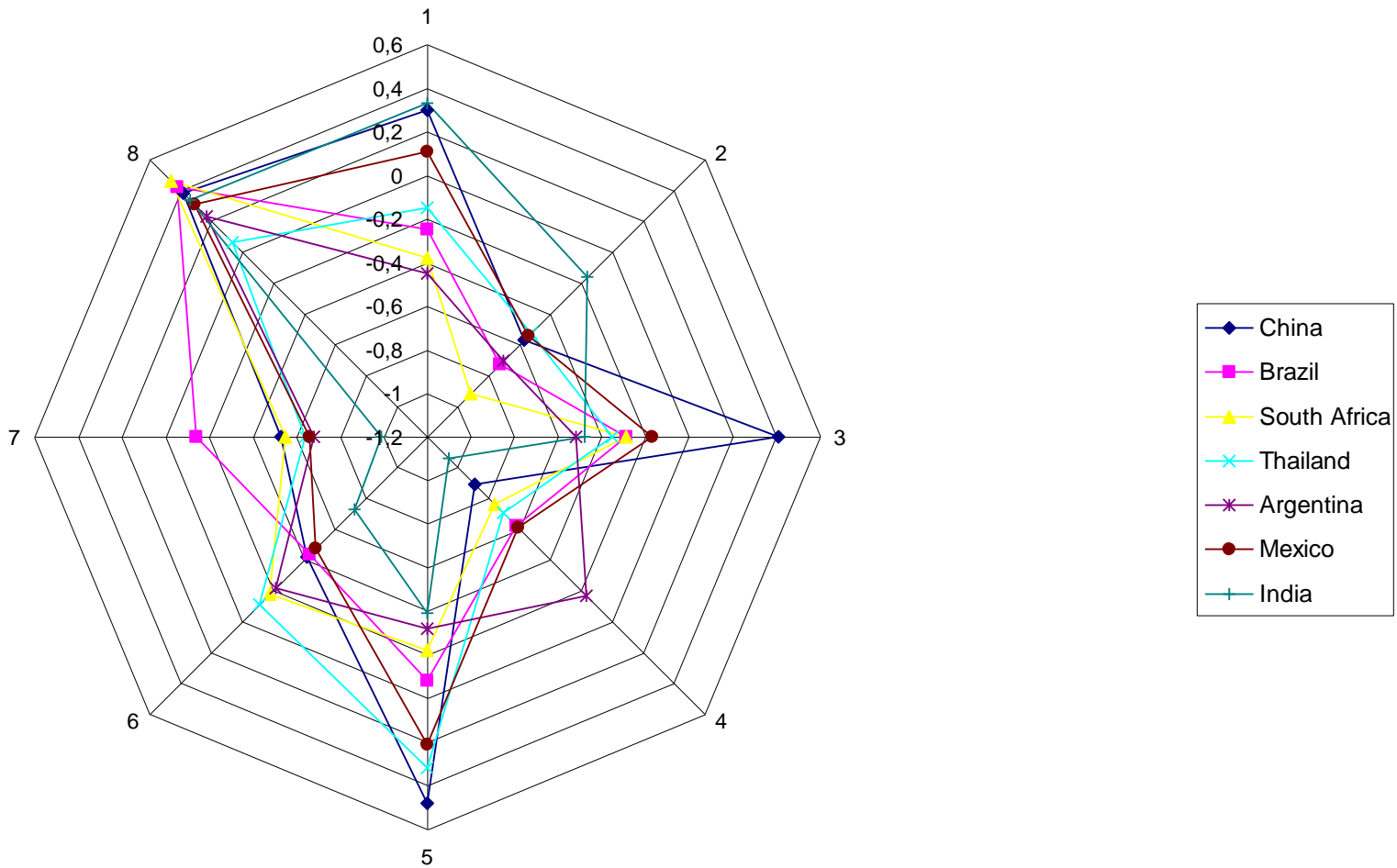
Cluster 2.2



SubCluster 2.1.1



SubCluster 2.2.2



Part 4

Towards a NISs taxonomy + Further remarks

1st conclusion

What differentiates most the countries in the sample is their performance in three critical dimensions:

→ *innovation*

→ *diffusion*

and (but to a lesser extent)

→ *knowledge*

- They separate clearly countries in M1 and M2**
- Further: between clusters
(and even between certain subclusters)
one can detect strong behavioural differences
along the first two dimensions**

2nd conclusion

**Another aspect that emerged
as important in differentiating clusters
(and subclusters as well)
is the overall country size (GDP, population)**

3rd conclusion

**Finally, natural resources
(being them minerals, forests, good grazing
lands or sun and beaches)
seem to be relevant for some NIS's**

A possible taxonomy of NISs (based on the localisation of countries in "NIS space")

			Critical dimensions (Innovation, Diffusion...)					
			Absolute high values			Absolute Low values		
			Megaclusters					
			M. 0, M. 1			M. 2		
			Clusters and subclusters					
			Relatively High in Innovation and Low in Diffusion	Relatively Low in Innovation and High in Diffusion	Relatively Low both in Innovation and Diffusion	Relatively High in Innovation and Low in Diffusion	Relatively Low in Innovation and High in Diffusion	Relatively Low both in Innovation and Diffusion
Critical contingency factors	Country Size	Large/ /Very large	C.1.2			C.2.2.		
		Small/ /medium		C.1.1	C.1.3		C.2.1	C.2.3
	Good natural resources endowment				Subclust. 1.2.3			↑ (Nigeria, others?)

Further conclusions : methodological

→ Need of appropriate indicators

e.g.: on networking, on innovation in low and medium tech sectors, even detailed R&D data lacking

Further conclusions: policy application

Responds to policy demand for guidance

- Comparability/benchmarking
- Summary measures

Scoreboards have been produced

- But criticized on grounds of “reductionism”

Potential for policy-making purposes

(1) Compare different NISs

- visualize graphically each NIS relevant dimensions
- applicability to both the advanced and the catching up economies

(2) NIS auto-diagnosis

- observe weaker and stronger dimensions
- determine whether NIS is balanced/uneven
- assess evolution over time