A New Indicator of Technological Capabilities for Developed and Developing Countries

Daniele Archibugi and Alberto Coco
London School of Economics and Political Science
and
Italian National Research Council

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Inspiration for the Research

- UNDP, *Human Development Report 2001*, Technology Assessment Index

- Sanjaya Lall, Research carried out for UNIDO

- *Global Competitiveness Report*

- Pavitt, Patel, Cantwell work on measuring the capabilities of advanced countries

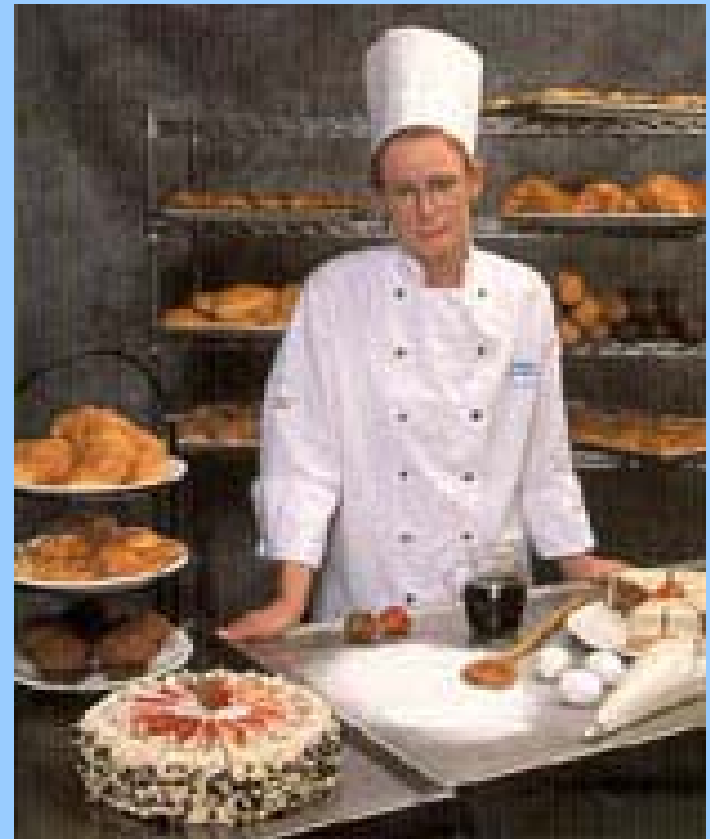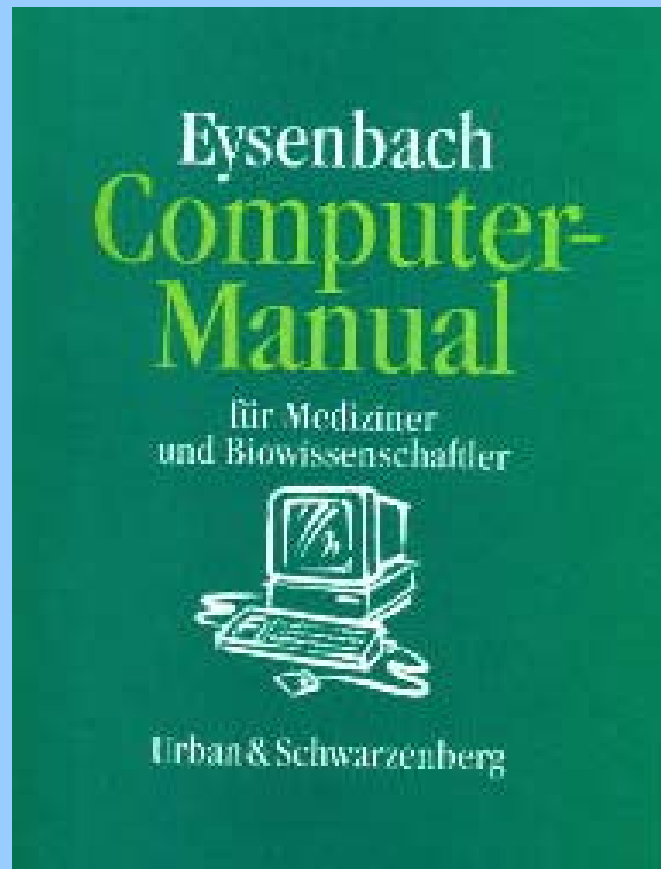- Regular science and technology work for OECD and European Union

Learnt Lessons on Technological Capabilities

- **Embodied** and **Disembodied** components
- **Tacit** and **Codified** Knowledge
- **Generation** and **Use** of technology
- Technologies arrive in **Clusters**, with a different life cycle and patterns of geographical diffusion
- The importance of clusters of technology is **Multiplied** when they are integrated
- The various innovation sources are **Complementary** and not alternative

Learnt Lessons on Capabilities
Embodied and **Disembodied**

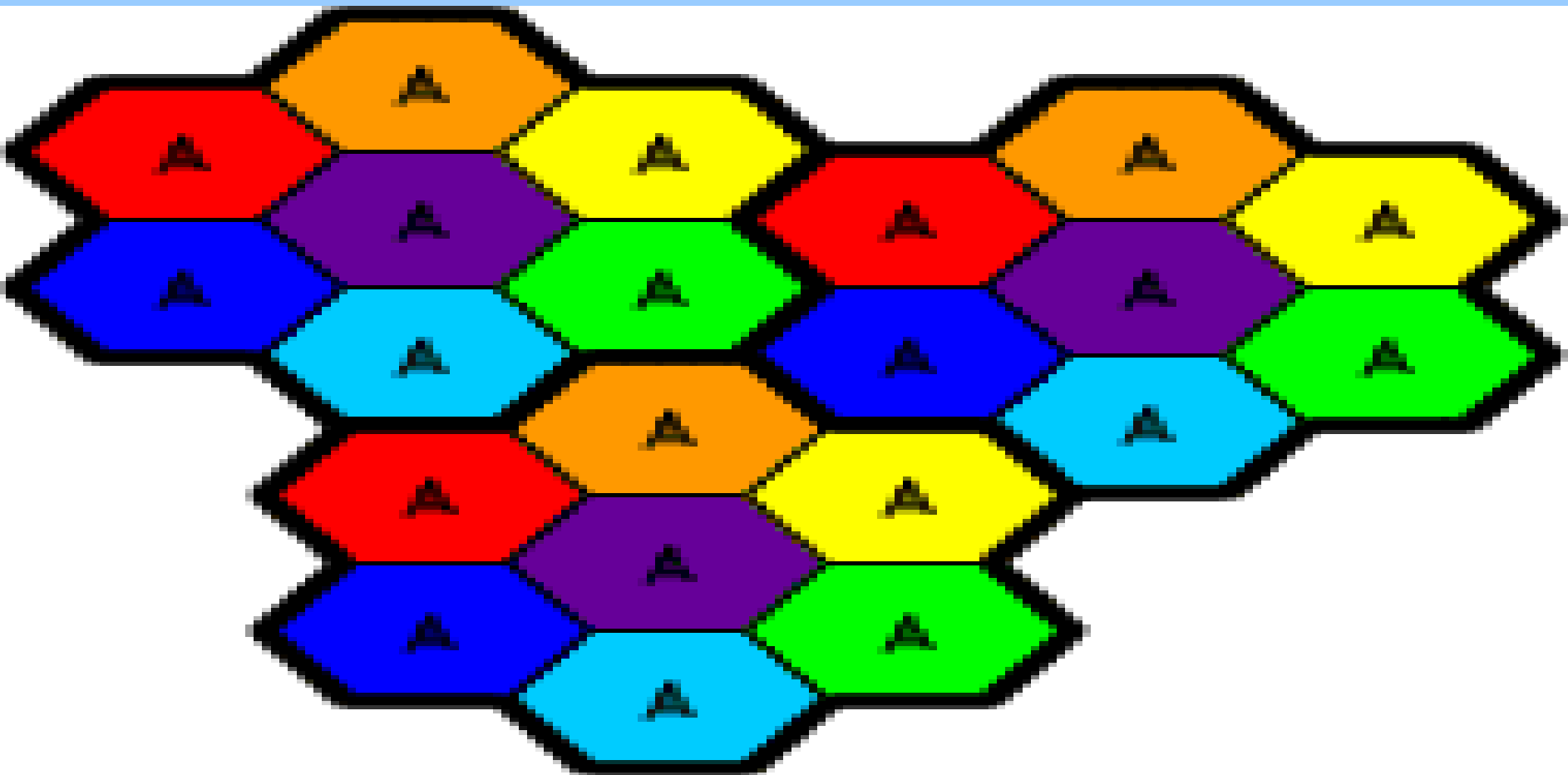# Learnt Lessons on Capabilities
Codified and **Tacit**

Learnt Lessons on Capabilities
Generation and **Use**

Learnt Lessons on Capabilities
Technologies have an impact in **Clusters**
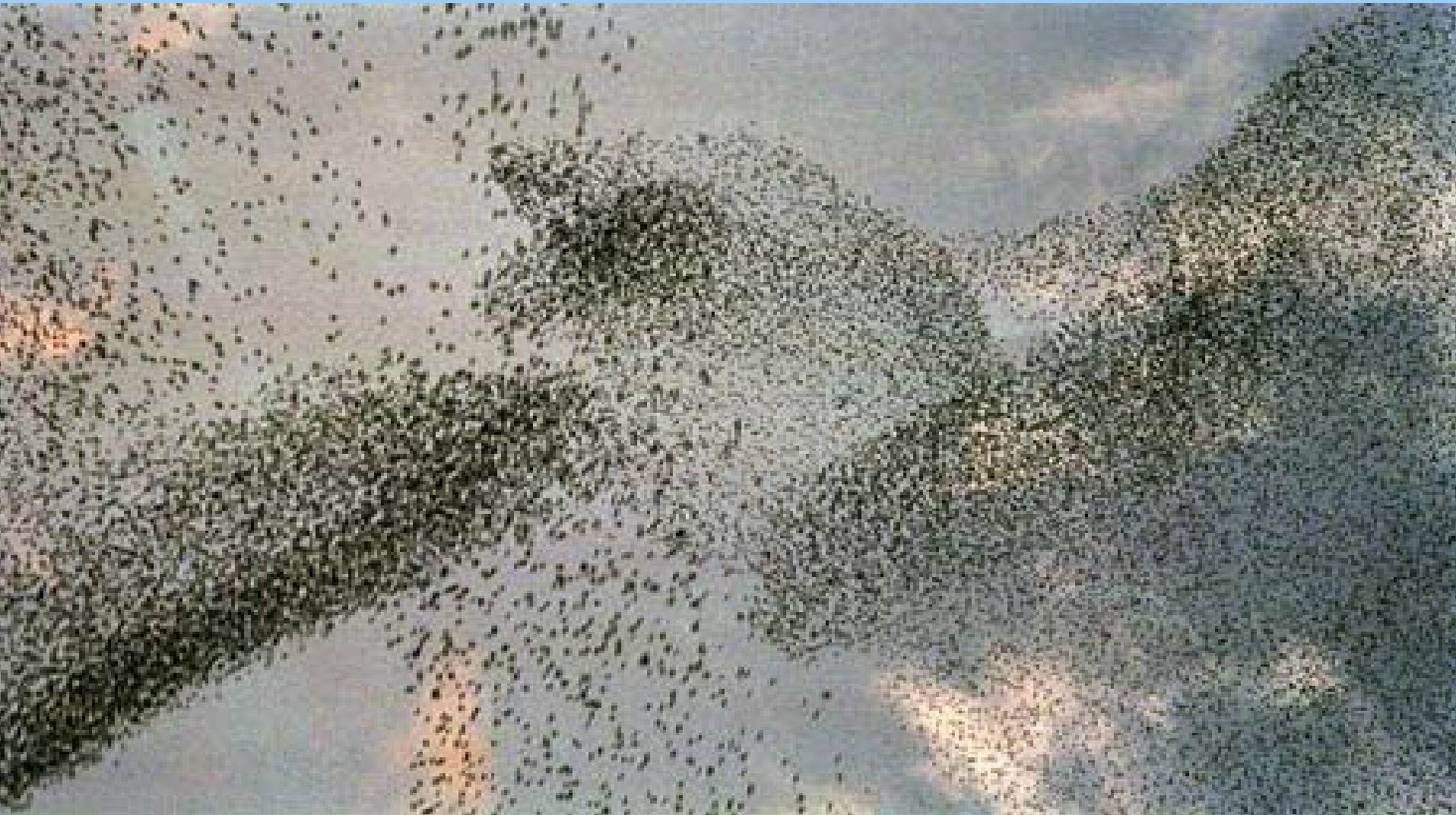
Learnt Lessons on Capabilities
Values of technologies are **Multiplied** when integrated

Learnt Lessons on Capabilities
Innovative sources are **Complementary**
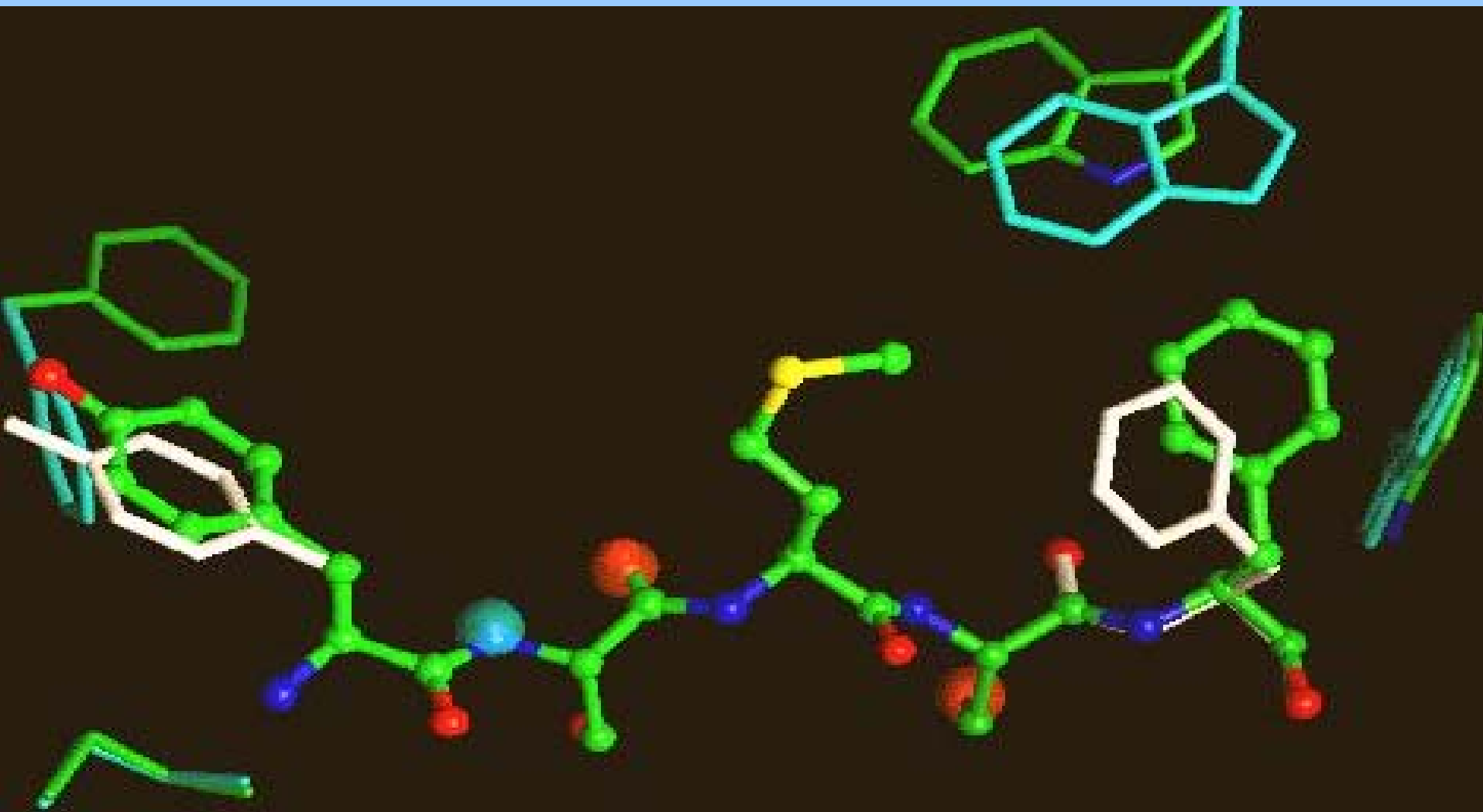
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Implicit Assumptions

- Is a cross-country analysis meaningful? Switzerland and Somalia

- Are countries still a significant unit of analysis? India and China?

- Is it possible to add up different components? What is the meaningfulness of summing patents and electricity?

The components of ArCo

- **Technology Creation**
- **Technology Infrastructures**
- **Human Skills**

Each of the three is given equal weight (1/3 of the total value of the index)

Selection of Indicators

- **Reliability and, when possible, independent certification of national sources**

- **Availability for a large number of countries (162)**

- **Possibility to make time series comparisons**

Technology Creation

- **Patents granted in the United States**
- **Scientific Publications (8.000 journals of the Institute of Scientific Information, Science Citation Index)**

Both sources

certified by independent institutions

Limits of Patents

- **Patents granted in the US. Not reliable for the US itself. Estimation made**

- **Aggregate data sensitive to the industrial specialisation of nations**

- **No screening of the quality of individual patents**

The North-South Technological Divide

Patent applications
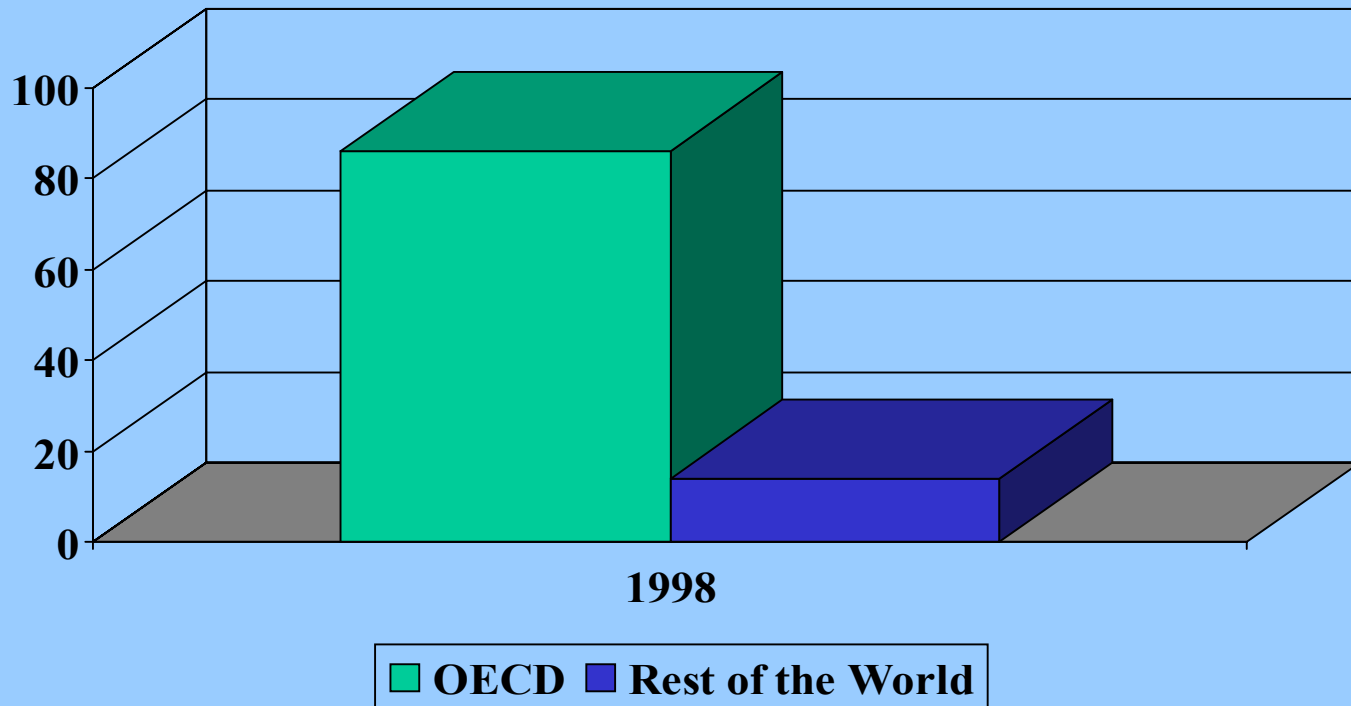
Limits of Bibliometric indicators

- Sub-part of the Academic literature
- Biased in favour of English-speaking countries?
- Variety in the impact of publications: US publications have a larger citation rate than in other countries
- No screening of the quality of individual articles

The North-South Scientific Divide

Scientific Articles

OECD   Rest of the World
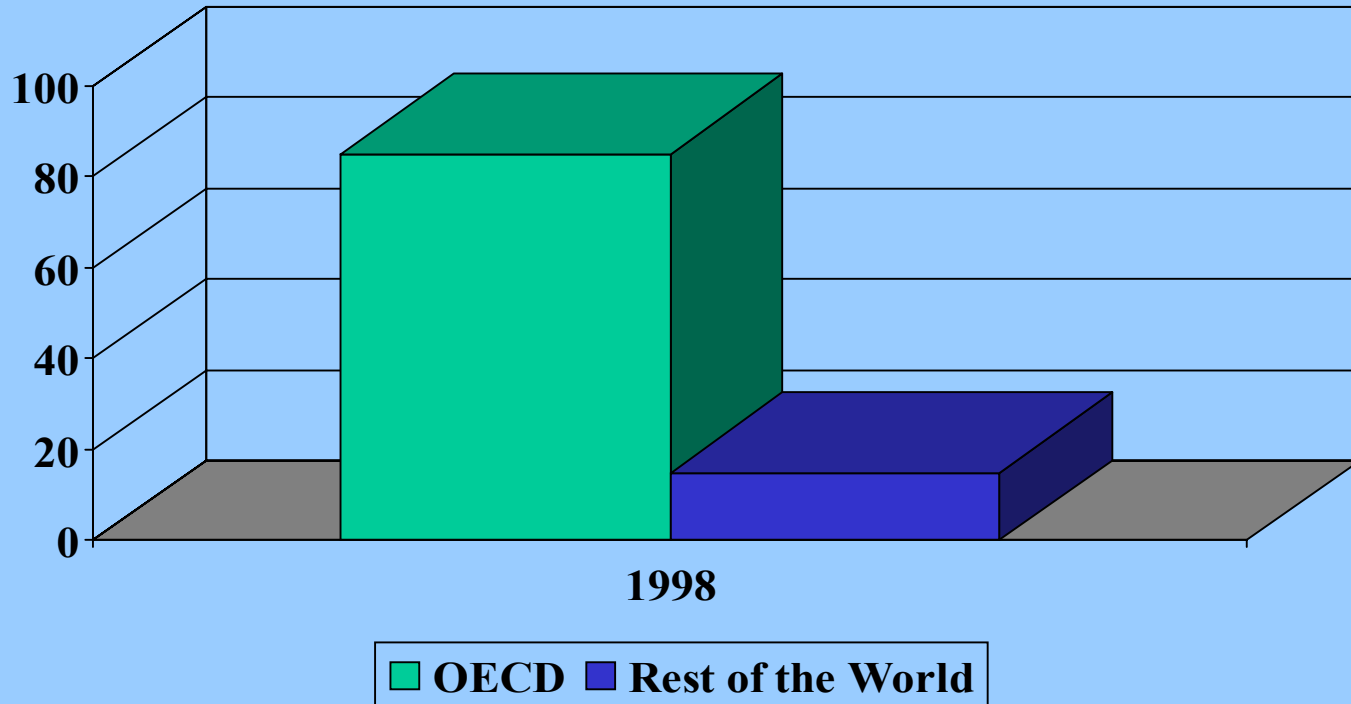
Technology Infrastrucutres

There Major Industrial Revolutions

- **Internet Penetration**
- **Telephone Penetration (ceiling)**
- **Electricity Consumption (ceiling)**

Human Skills

- **Percentage of youngsters enrolled in science and engineering faculties**

- **Average number of school years**

- **Alphabetisation rate**

The Application of the Index

$$\frac{\text{Observed Value - Min Observed Value}}{\text{Max Observed Value - Min Observed Value}}$$

Variation = 0 - 1

Two periods considered (1990 e 2000)

Aggregation

- **Arithmetic average of the indicators in the same subcategories (creation, diffusion, skills)**

- **Arithmetic average between categories**

- **The min and max values are considered for the two periods, allowing comparisons over time**

- **An update of the analysis will require to compute again all values**

Correlation Coefficients among the various indicators

	Patent index	Articles index	Internet index	Telephony index	Electricity index	Tertiary index	Schooling index	Literacy index	ArCo Index
Patent index	1,000	0,788	0,692	0,446	0,445	0,537	0,530	0,320	**0,706**
Articles index	0,788	1,000	0,825	0,560	0,558	0,690	0,661	0,413	**0,823**
Internet index	0,692	0,825	1,000	0,607	0,594	0,618	0,659	0,431	**0,806**
Telephony index	0,446	0,560	0,607	1,000	0,843	0,713	0,819	0,818	**0,889**
Electricity index	0,445	0,558	0,594	0,843	1,000	0,674	0,744	0,712	**0,853**
Tertiary index	0,537	0,690	0,618	0,713	0,674	1,000	0,707	0,617	**0,836**
Schooling index	0,530	0,661	0,659	0,819	0,744	0,707	1,000	0,805	**0,903**
Literacy index	0,320	0,413	0,431	0,818	0,712	0,617	0,805	1,000	**0,787**

Correlation Coefficients among the three sub-categories

	Technology creation index	Technology infrastr. index	Human skills index	**ArCo Index**
Technology creation index	1,000	0,662	0,623	**0,818**
Technology infrastr. index	0,662	1,000	0,894	**0,955**
Human skills index	0,623	0,894	1,000	**0,937**

Coefficients of Variations

	Actual	Past	Growth rate
Patent index	2,787	3,087	-9,7%
Articles index	2,040	2,177	-6,3%
Internet index	1,831	2,642	-30,7%
Telephony index	0,435	0,550	-20,9%
Electricity index	0,497	0,536	-7,4%
Tertiary index	1,018	1,034	-1,5%
Schooling index	0,549	0,590	-7,0%
Literacy index	0,279	0,352	-20,8%
Technology creation index	2,175	2,296	-5,3%
Technology infrastr. index	0,561	0,586	-4,2%
Human skills index	0,439	0,475	-7,5%
Ar.Co. Index	**0,579**	**0,590**	**-1,9%**

The first 25 countries

Actual ranking	Countries	Actual ArCo Index	Past ArCo Index	Past ranking	Growth rate from the last decade
1	Sweden	0,870	0,685	2	27,0%
2	Finland	0,830	0,617	6	34,7%
3	Switzerland	0,799	0,740	1	7,8%
4	Israel	0,763	0,647	5	17,9%
5	United States	0,757	0,667	4	13,5%
6	Canada	0,755	0,682	3	10,7%
7	Norway	0,726	0,586	9	24,1%
8	Japan	0,719	0,568	12	26,5%
9	Denmark	0,706	0,587	8	20,2%
10	Netherlands	0,690	0,570	11	21,1%
11	Australia	0,686	0,565	14	21,5%
12	Germany	0,680	0,594	7	14,4%
13	United Kingdom	0,679	0,567	13	19,7%
14	Iceland	0,670	0,483	18	38,6%
15	Taiwan	0,662	0,434	23	52,5%
16	New Zealand	0,645	0,575	10	12,1%
17	Belgium	0,642	0,524	15	22,5%
18	Austria	0,615	0,501	16	22,7%
19	France	0,604	0,500	17	20,9%
20	Korea, Rep.	0,601	0,414	31	45,2%
21	Hong Kong, China	0,568	0,429	26	32,5%
22	Ireland	0,564	0,450	20	25,2%
23	Singapore	0,563	0,395	37	42,7%
24	Italy	0,526	0,443	21	18,7%
25	Spain	0,513	0,409	34	25,2%

The Technological Performance of Brazil

	1990	2000
ArCo	0.28	0.33
Ranking	77	72
Tech Creation	71	59
Tech Infrastructures	66	59
Human Skills	90	90

Limits of the Analysis

- Low quality of the data for many countries
- Limits of the selected indicators
- Aggregate analysis only
- Analysis at the country level only

How can the Globelics Network use this index?

- Economic Growth

- Rate of Employment

- Analysis of Production

- International Trade

- Socially related aspects of the quality of life

- Data make it possible also a dynamic analysis