

Measuring and benchmarking innovation performance

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Structure of presentation

Content

1. The NIS heuristic
2. An Innovation Indicator System
3. Composite Indicators for benchmarking
4. Summary and Conclusions

The heuristic model of Innovation Systems

Why are we here today?

- We do believe that policy matters
- Political decision have an impact on the outcome of the innovation system
- Framework conditions matter
- Regulations matter
- Culture matters
- ...

The heuristic model of Innovation Systems

"Technological innovation activities are all of the scientific, technological, organisational, financial and commercial steps, including investments in new knowledge, which actually, or are intended to, lead to the implementation of technologically new or improved products and processes."

(OECD & Eurostat (1997): Oslo manual, 2nd edition)

"An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations."

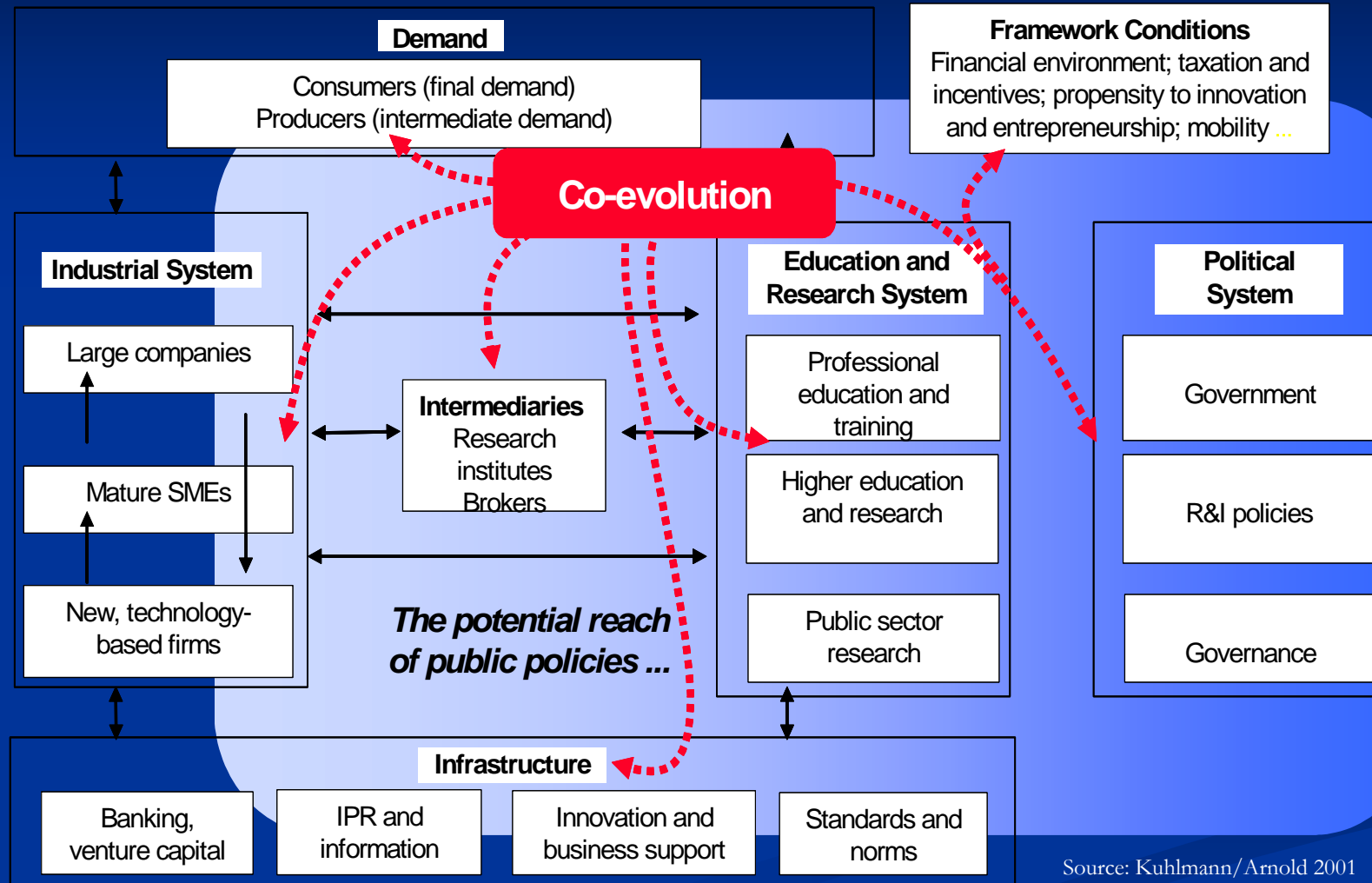
(OECD & Eurostat (2005): Oslo manual, 3rd edition)

The heuristic model of Innovation Systems

- Innovation covers more than only technological inventions (Schumpeter 1911)
- Innovation is not only the act of invention
- Innovation is influenced by science, research, finance, regulations, policy ...

=> Innovation is a process

The heuristic of national innovation systems



The heuristic model of Innovation Systems

- Non-linearity of innovation processes
- Path dependency
- Different actors and factors are relevant
- The heuristic of (N)IS fits with modern evolutionary economics
- Furthermore, it challenges the traditional Modernisation Theory, which has seen one path for all, whereas the NIS allows for different paths that lead to a similar result

Why innovation – why high-tech?

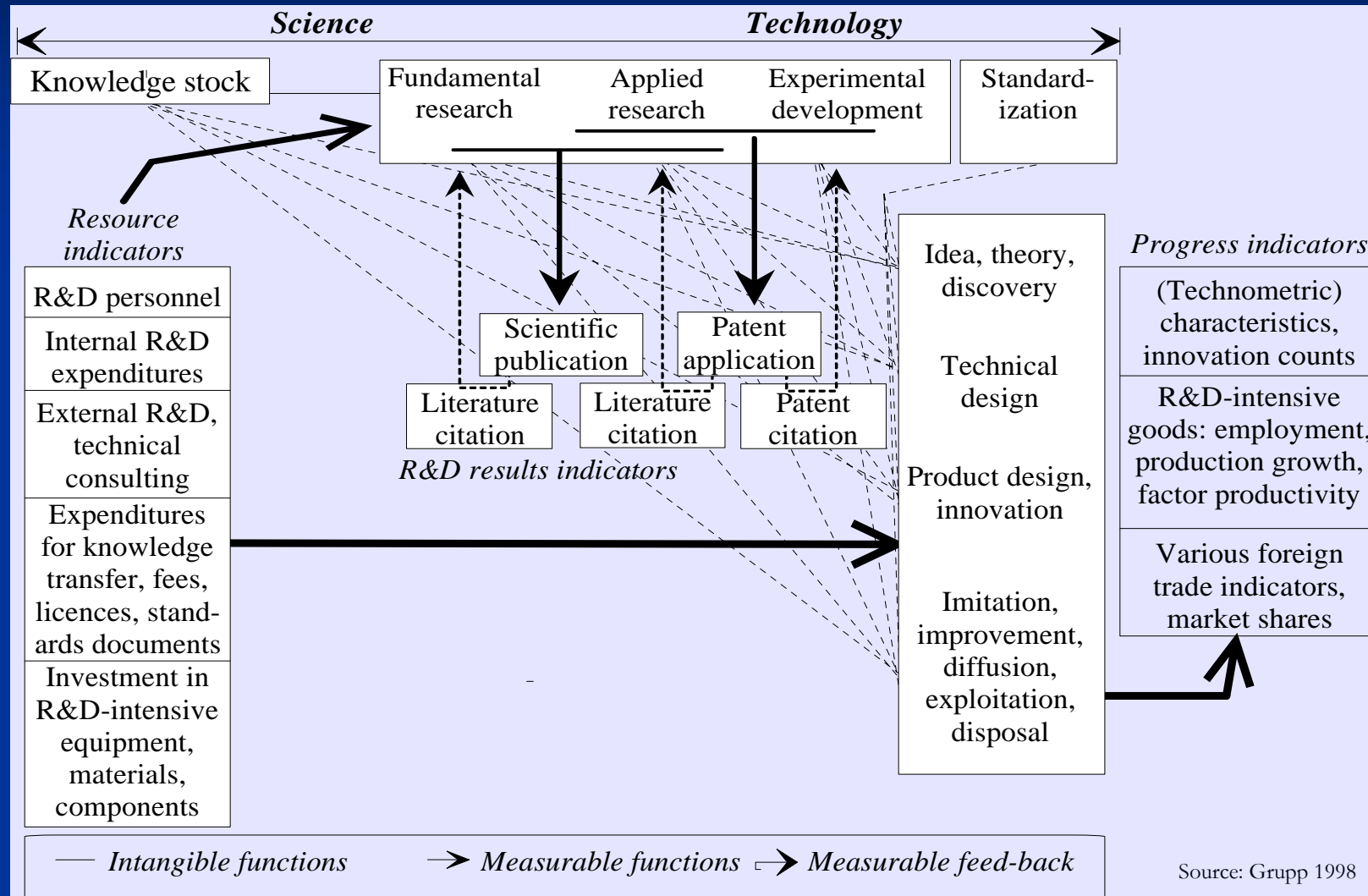
- Innovation lead to:
 - New products/services that others cannot offer
 - Increase in quality or decrease in costs of manufacturing existing products or services
- This can give a comparative advantage to companies and/or nations
- High-Tech are technologies that afford "large" investments in R&D (time, money, human capital)
- High-Tech products and processes – this is the basic idea – can be copied less easily and therefore give the innovative company/nation a "better" advantage

System of Innovation Indicators

- Innovation and innovative capabilities cannot be quantified and measured directly
=> Indicators are used to measure latent variables

- Indicators can be classified by three categories (Grupp 1998):
 - Input or "Ressource" Indicators
 - Throughput or "R&D results" Indicators
 - Output or "progress" indicators

System of Innovation Indicators



Composite Indicators

- For some people, these indicators are much too complicated and too complex to interpret
- They ask for Composite Indicators (CIs)

| Pros |
|---|
| <ul style="list-style-type: none">• Can summarise complex or multi-dimensional issues in view of supporting decision-makers.• Easier to interpret than trying to find a trend in many separate indicators.• Facilitate the task of ranking countries on complex issues in a benchmarking exercise.• Can assess progress of countries over time on complex issues.• Reduce the size of a set of indicators or include more information within the existing size limit.• Place issues of country performance and progress at the centre of the policy arena.• Facilitate communication with general public (i.e. citizens, media, etc.) and promote accountability. |

Source: OECD 2005: Handbook on Constructing Composite Indicators – Methods and User Guide, OECD Statistics, Working Paper, Paris.

Examples of Composit Indicators

- **Growth Competitiveness Index (GCI) by the World Economic Forum**
- **Human Development Index (HDI) by UN**
- **Technology Achievement Index (TAI) as part of the HDI**
- **European Innovation Scoreboard (EIS) by the European Commission**
- **The German "Innovationsindex Deutschland"**
- **many more ...**

The "ideal" composition of CIs

Three levels of construction (Cherchye et al., 2004)

- selection of indicators (and sources)
- Method of pre-treatment or normalisation
- Finding/applying an aggregation rule or procedure

According to the OECD (2005) handbook at least two more levels have to be taken into account:

- Theoretical Framework
- Robustness and sensitivity checks

!!! The construction may fail at EACH of these steps !!!

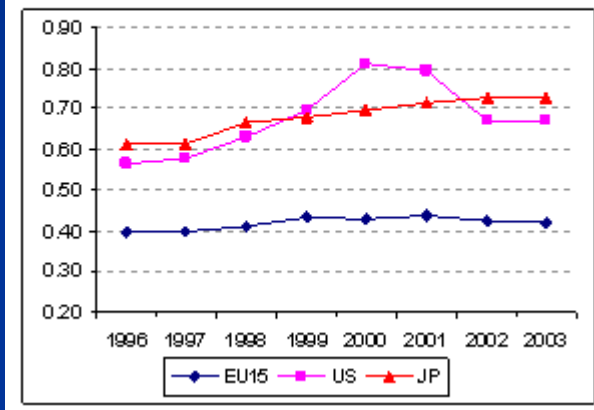
When composition fails: normalisation

| Original value | | | | |
|----------------|-----|-----|-----|-----|
| Country | CI | CI | CI | CI |
| A | 100 | 100 | 100 | 100 |
| B | 95 | 95 | 95 | 95 |
| C | 90 | 90 | 90 | 90 |
| D | 85 | 85 | 85 | 85 |
| E | 80 | 80 | 80 | 80 |
| F | | 70 | 50 | 20 |
| | | | | |
| Min | 80 | 70 | 50 | 20 |
| Max | 100 | 100 | 100 | 100 |
| Normalised | | | | |
| Country | CI | CI | CI | CI |
| A | 7.0 | 7.0 | 7.0 | 7.0 |
| B | 5.5 | 6.0 | 6.4 | 6.6 |
| C | 4.0 | 5.0 | 5.8 | 6.3 |
| D | 2.5 | 4.0 | 5.2 | 5.9 |
| E | 1.0 | 3.0 | 4.6 | 5.5 |
| F | | 1.0 | 1.0 | 1.0 |

- $Y=6*((x-\text{Min}(x)) / (\text{Max}(x)-\text{Min}(x)))+1$
- This normalisation method hurts the so-called IIA-assumption: Independence of Irrelevant Alternatives
- Other methods have similar disadvantages (e.g. z-transformation of highly skewed distributions)
- Other methods do not have this problem, but maybe others

When composition fails: selection

Figure I : Gap between the US and the EU measured by the SII



Findings/interpretation:

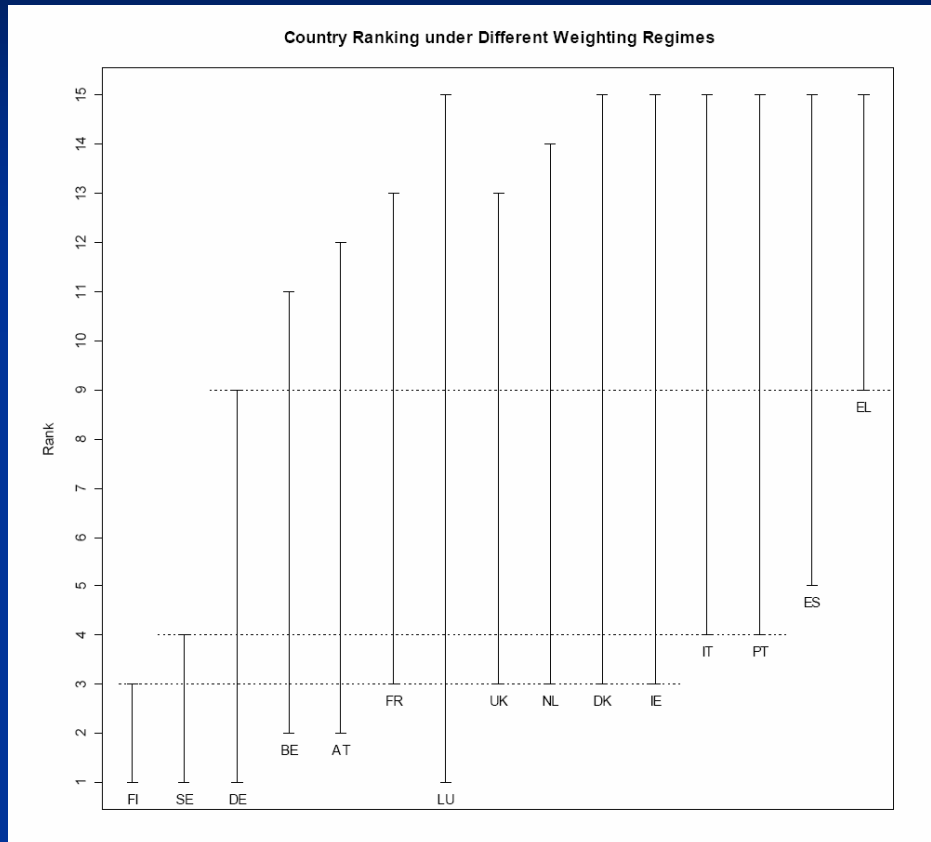
"The gap between the US and the EU can be largely explained by 3 indicators:

- Patents (50 % of the gap)
- Working population with tertiary education (26 %)
- R&D expenditures (11%) – mainly business R&D"*

- They used USPTO and EPO patents as input !!! => home-advantage of the US
- Why USPTO and EPO? Why not Triadic patents why not national patents?

* Source: European Innovation Scoreboard 2004 (EIS);
http://trendchart.cordis.lu/scoreboards/scoreboard2004/executive_summary.cfm

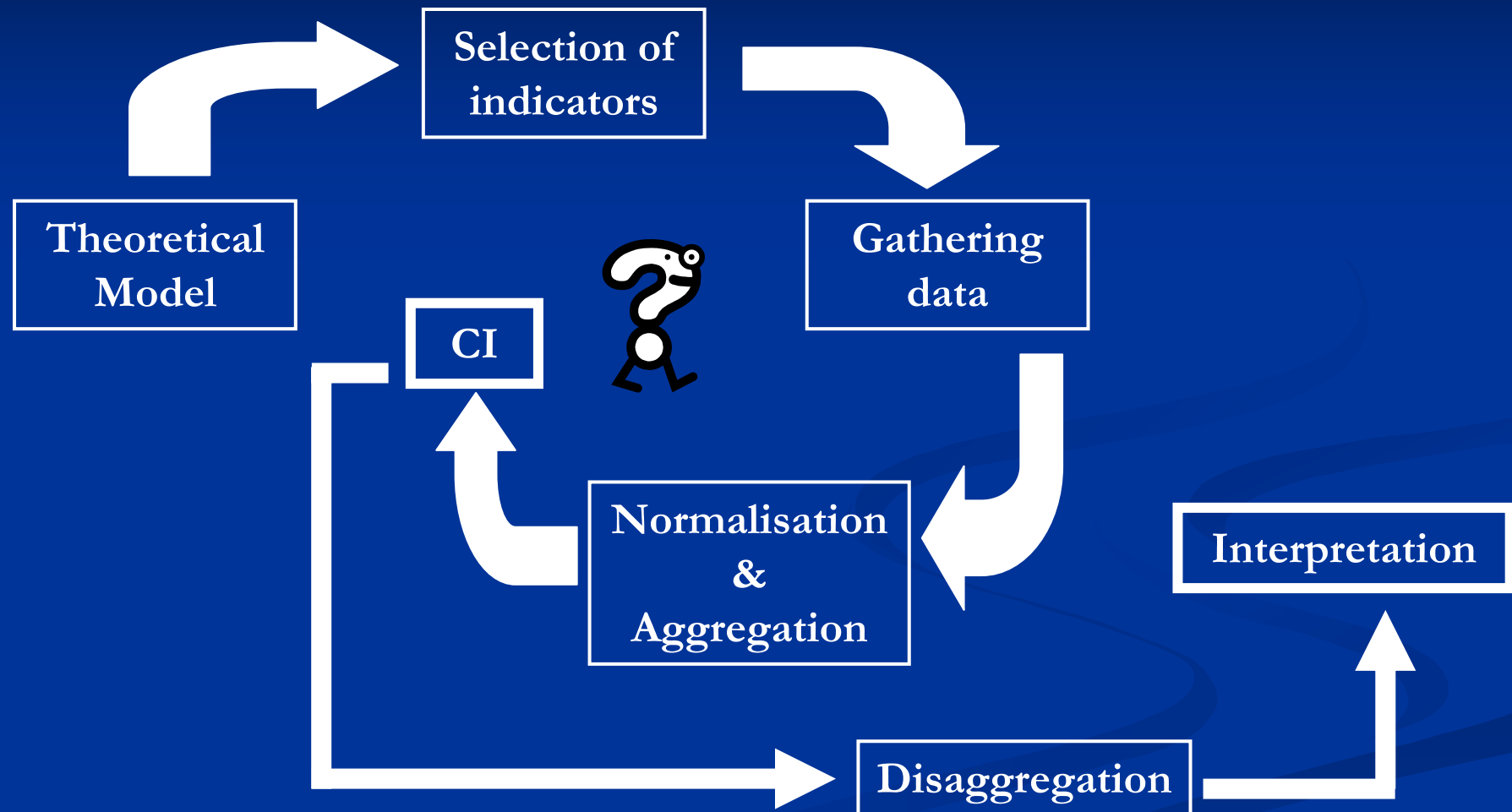
When composition fails: aggregation



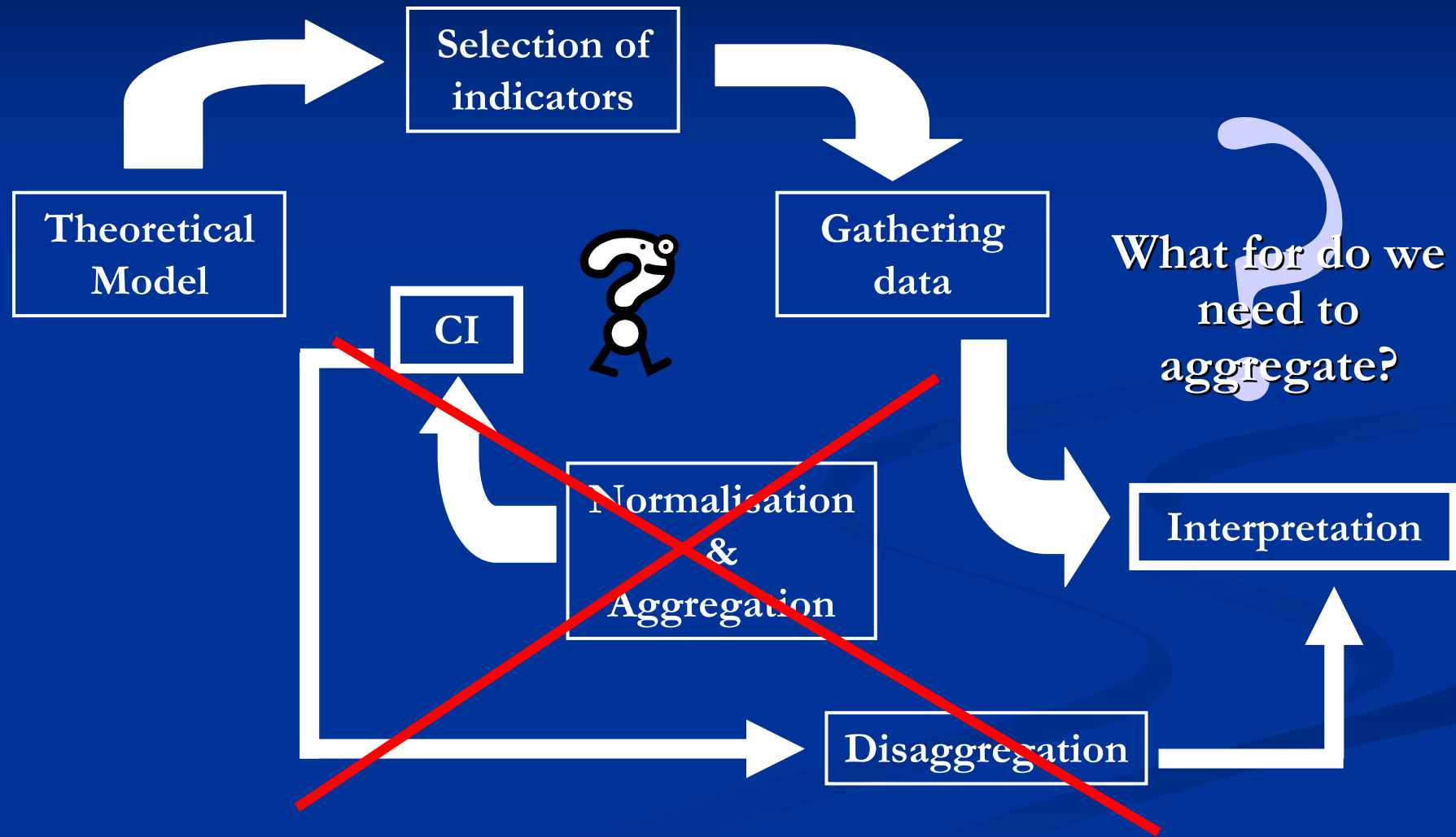
- Depending on the weighting of individual indicators, a country may reach any of the positions
- Luxemburg (LU) may be ranked first or last

Data source: European Commission, 2005; linear genetic programming Schubert, 2006; Grupp, H. & Moege, E. (2004). Indicators for National Science and Technology Policy. In H.F.Moed, W. Glänzel, & U. Schmoch (Eds.), Handbook of Quantitative Science and Technology Research. The Use of Publication and Patent Statistics in Studies of S&T Systems (pp. 75-94). Dordrecht: Kluwer Academic Publisher.

Do we really need CIs?



Do we really need CIs?



General criticism of CIs

- Reduction of dimensions of the influencing factors and actors to a few, sometimes even to only one figure
- Comparisons over time by CI assume a constant connection or interplay between the individual indicators
- Especially in highly dynamic systems this criteria is not met
- National idiosyncrasies are not taken into account
- Loss of information

Summary

- NIS are complex
- Indicators are used to measure the multi-dimensional performance of NIS
- CIs are constructed to reduce these dimensions not only to one dimension, but even to one single figure
- To be stressed: CIs are a legitimate approach to benchmark the performance of nations (in several aspects),

BUT:

Summary

- Compositions may fail
 - Dynamics are (usually) not reflected
 - The theoretical model, the selection and aggregation rules etc. are seldom taken into account by policy makers or other recipients of the final "benchmark"
- ⇒ Keep the heuristic of Innovation Systems in mind and try to find indicators that describe some/most of the sub-systems

Thank you for your attention!

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