

# **Models of innovation, policy rationales and measurement The persistent high-tech myth**

Attila Havas  
Institute of Economics, CERS, HAS

2014 Eu-SPRI Conference  
*Science and Innovation Policy: Dynamics,  
Challenges, Responsibility and Practice*  
18-20 June, 2014

# Main Theses

The systemic view offers a more relevant framework to analyse innovation processes and performance than the science-push (SP) model of innovation

The market failure (MF) argument lends scientific support to the SP of model innovation

Significant opportunity costs of STI policies based on SP and MF

Yet, the SP approach is still highly influential in the EC

- observations, propositions in policy documents
- indicators to monitor/ assess performance

# Main Theses (2)

## *Possible reasons:*

SP and MF: simple, straightforward reasoning

- can be quantified, looks rigorous  $\Rightarrow$  compelling
- focal point for orchestrated political action
- Triadic competition

Systemic view: too complex, [can be] perceived as 'vague'

- hardly any formal models (history-friendly models, simulation)
- no simple, 'one size fits all' recipes
- systemic failures: a demanding task to identify them
- dialogue with stakeholders
- STI and other policies
  - the latter have strong(er) impacts on innovation performance
  - a daunting challenge to orchestrate them

Sociological factors, too

# Outline

## Motivation

## Policy rationales

- derived from theories
- in the EC practice

## Indicators: neutral measurement tools or heralds of policy concepts?

- the European Innovation Scoreboard
- another EC league table

## Discussion and conclusions

- a persistent devotion to high-tech and its pitfalls
- possible reasons for the persistence of the high-tech fad
- the relevance of the systemic view of innovation to underpin policies

# Motivation

Rival theories – firm behaviour

managerial implications

Rival theories – policy rationales, policy practice

efficacy of public spending

- EU funds
- potentially strong influence of the EC on national STI policies, especially in the new member states

**NB:** The weight of other factors influencing policy practice

# **MODELS OF INNOVATION AND POLICY RATIONALES**

# Models of Innovation

## Linear models

- science-push: basic research is the main source of innovation
- market-pull: demand is the main source of innovation

## Systemic (or: networked) models

- 'chain-linked' model
- 'multi-channel interactive learning model'

# Contrasting Policy Rationales

## Market failures in generating new *information*

- unpredictability of knowledge outputs from inputs
- inappropriability of full economic benefits of private investment in knowledge creation
- indivisibility in knowledge production

(Nelson, 1959; Arrow, 1962)

## Policy advice (justification for intervention)

- boost private R&D expenditures
  - subsidies
  - protection of intellectual property rights
- fund public R&D activities

# Contrasting Policy Rationales (2)

## System failures in generating, diffusing and exploiting *knowledge*

- types and sources of knowledge
  - R&D-based and practical knowledge  
engineering activities: design, scaling up, testing, tooling-up, trouble-shooting;  
ideas from suppliers and users; inventors' ideas; practical experiments, ...
  - knowledge embodied in materials, equipment, software, ...
- modes of learning
  - formal (R&D, both intra- and extramural)
  - informal: learning by doing, using and interacting
- properties of innovation systems  $\Rightarrow$  types, quality and frequency of interactions  $\Rightarrow$  learning, capabilities to exploit knowledge

# Contrasting Policy Rationales (3)

## Policy advice (justification for intervention)

- tackle system failures that hamper generation, diffusion and utilisation of any type of knowledge required for successful innovation
  - promote learning (individuals, organisations)
  - facilitate co-operation, networking to generate and disseminate knowledge

# EU STI Policy Practice

The systems approach has become widespread in academic and policy-making circles, esp. at the EC and the OECD

(Sharif, 2006; Dodgson *et al.*, 2011)

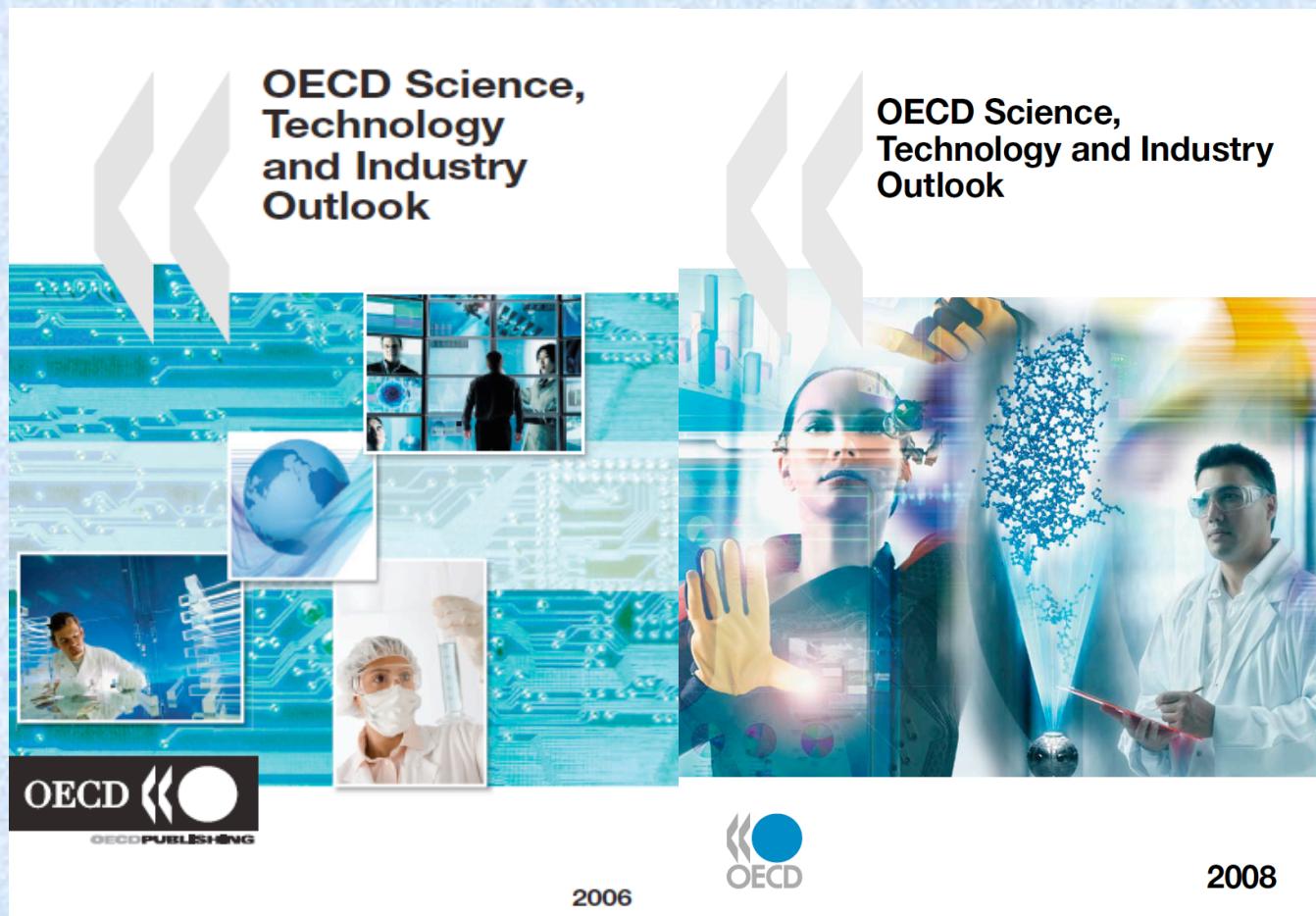
Yet, a persistent devotion to high-tech can be observed

- „Fundamental R&D, mostly undertaken and funded by governments, provides the foundation for future innovation. Science is vital to innovation, especially to generate ‘step changes’ such as the discovery of the transistor or vaccines.” (OECD, 2010: 3-4)
- EC, 2013: „investment in knowledge”, „knowledge intensity”, „knowledge upgrade”; knowledge = R&D
- images on the covers of EU and OECD publications
- monitoring tools, too  
**ranking** on scoreboards, league tables ⇒ **attention** of politicians, policy-makers (opinion leaders)

# Eurostat covers



# OECD covers



**INDICATORS:**

**NEUTRAL MEASUREMENT TOOLS OR HERALDS  
OF POLICY CONCEPTS?**

# Selection of Indicators

Systematic efforts to measure RTDI since the 1960s

Widely used guidelines: Frascati (R&D) , TBP, Oslo (innovation), Patents, and Canberra (HR) Manuals

Yet, it is not straightforward to find the most appropriate way to assess R&D and innovation performance

R&D: a complex, multifaceted process  $\Rightarrow$  it cannot be sufficiently characterised by 2-3 indicators

That applies to innovation *a fortiori*

The choice of indicators: an important decision; reflects the explicit or implicit views of those experts and policy-makers who have chosen them.

$\Rightarrow$  Indicators are 'subjective' in that respect, but perceived as 'objective' (expressed in numbers)

# The European Innovation Scoreboard

22 indicators used to compile the EIS 2004

“... no harmonised data that could be used to construct measures of *learning by doing and using [DUI]*. We would contend, though, that these limitations of the data reflect the same *bias at a deeper level*. The on-going development of harmonised S&T indicators over the post-war period has resulted from political initiatives at the EU and international levels. The lack of DUI measures reflects *political priorities and decision-making rather* than any inevitable state of affairs.” (Jensen *et al.*, 2007: 685; emphasis added – AH)

DISKO survey

both DUI and STI modes of innovation are important in DK  
combining DUI and STI modes improves innovation  
performance

(Jensen *et al.*, 2007)

# The European Innovation Scoreboard (2)

## EIS 2003

“The EIS has been designed with a ***strong focus on innovation in high-tech sectors***. Although these sectors are very important engines of technological innovation, they are only ***a relatively small part of the economy*** as measured in their contribution to GDP and total employment. The larger share of low and medium-tech sectors in the economy and the fact that these sectors are ***important users of new technologies*** merits a closer look at their innovation performance. This could help national policy makers with focusing their innovation strategies on existing strength and overcome areas of weakness.” (EC, 2003: 20; emphasis added - AH)

# The European Innovation Scoreboard (3)

Renamed as Innovation Union Scoreboard in 2012

IUS 2013: 24 indicators

- 10 only relevant for R&D-based innovations (S&T mode)
- 4 mainly capture R&D-based innovations
- 6 could be relevant for both S&T and DU mode
- 5 reflect DU mode

(next slides, from Havas, 2014)

## A half-full or half-empty glass?

- an improvement compared to the EIS 2003 or 2004
- the economic weight of LMT sectors; the importance of the DU mode of innovation ⇒ still a lot to do

A better reflection of innovation processes and performance by the IUS is needed to underpin effective and sound STI policies

# The 2013 Innovation Union Scoreboard indicators

	Relevance for R&D- based innovation	Relevance for non-R&D- based innovation
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	X	
Percentage population aged 30-34 having completed tertiary education	b	b
Percentage youth aged 20-24 having attained at least upper secondary level education		X
International scientific co-publications per million population	X	
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	X	
Non-EU doctorate students as a % of all doctorate students	X	
R&D expenditure in the public sector as % of GDP	X	
Venture capital investment as % of GDP	x	
R&D expenditure in the business sector as % of GDP	X	
Non-R&D innovation expenditures as % of turnover		X
SMEs innovating in-house as % of SMEs	b	b
Innovative SMEs collaborating with others as % of SMEs	b	b
Public-private co-publications per million population	X	

# The 2013 Innovation Union Scoreboard indicators (2)

	Relevance for R&D-based innovation	Relevance for non-R&D-based innovation
PCT patents applications per billion GDP (in PPS€)	X	
PCT patent applications in societal challenges per billion GDP (in PPS€) (environment-related technologies; health)	X	
Community trademarks per billion GDP (in PPS€)		X
Community designs per billion GDP (in PPS€)		X
SMEs introducing product or process innovations as % of SMEs	b	b
SMEs introducing marketing or organizational innovations as % of SMEs		X
High-growth innovative firms	b	b
Employment in knowledge-intensive activities (manufacturing and services) as % of total employment	x	
Contribution of medium and high-tech product exports to the trade balance	x	
Knowledge-intensive services exports as % total service exports	x	
Sales of new to market and new to firm innovations as % of turnover	b	b
License and patent revenues from abroad as % of GDP	X	

# A new league table

	R&D intensity (2011)	Excellence in S&T (2010)	Knowledge-intensity of economy (2010)
Ireland	1.72	38.11	65.43
Sweden	3.37	77.20	64.60
United Kingdom	1.77	56.08	59.24
Belgium	2.04	59.92	58.88
France	2.25	48.24	57.01
Netherlands	2.04	78.86	56.22
Denmark	3.09	77.65	54.95
Finland	3.78	62.91	52.17
Hungary	1.21	31.88	50.23

Germany, Austria, EU27 average?!?

Source: EC (2013a): 5

# “Knowledge-intensity of economy”

Knowledge = scientific knowledge; *misleading name*

High-tech export

FDI

## Share of high-tech goods in industrial exports, 2007-2009

	2007	2008	2009
Ireland	46.6%	48.9%	52.2%
Hungary	29.9%	30.6%	35.5%
Netherlands	27.4%	25.2%	29.1%
United Kingdom	26.1%	25.1%	:
France	22.5%	23.0%	:
Finland	20.0%	19.7%	17.1%
Slovak Republic	16.9%	19.4%	:

Source: own calculation based on OECD.Stat data, extracted on 9 Sept 2013

# “Knowledge-intensity of economy” (2)

IR, HU: High-tech export by foreign-owned firms  
products developed outside IR and HU  
assembly of high-tech goods  
semi-skilled, low-paid workers

Activities, products, firms, sectors

‘Foot-loose’ vs. ‘anchored’ FDI

relocation, e.g. electronics industry in Scotland, Wales in the 1980s and early 1990s and then in CEE in the 1990s, 2000s

# **DISCUSSION AND CONCLUSIONS**

# A persistent devotion to high-tech and its pitfalls

The systems view of innovation has not become a dominant, systematically applied paradigm in policy circles, in spite of

- the rich set of policy-relevant research insights and
- some optimistic claims concerning the take-up of the systemic approach to innovation

## ‘Austrian paradox’

“On the one hand, macroeconomic indicators on productivity, growth, employment and foreign direct investment indicate that overall performance is stable and highly competitive. On the other hand, an international comparison of industrial structures reveals a severe gap in the most technologically advanced branches of manufacturing, suggesting that Austria is having problems establishing a foothold in the dynamic markets of the future.” (Peneder, 1999: 239)

# A persistent devotion to high-tech and its pitfalls (2)

STI policies based on the science-push model neglect

- the wide variety of types, forms and sources of knowledge
- the importance of distributed knowledge bases
  - collaboration among actors
  - the significance of institutions governing collaboration to generate, diffuse and exploit all types of knowledge required for innovation
- the LMT sectors

Massive opportunity costs

- lost improvements in productivity
- ‘unborn’ new products and services
- ‘unopened’ new markets
- ‘undelivered’ new jobs

Spending public money guided by an inappropriate – or at best incomplete – policy rationale is highly questionable

# Possible reasons for the observed persistence of the high-tech myth

*Simple*, straightforward reasoning

Unprecedented achievements of major R&D efforts during World War II

Major scientific results reported continuously since then

“As regards ***community creation*** it may be argued that a simple one-dimensional indicator (...) can be identified as a focal point for orchestrated political action: we can all unite on transforming Europe to a high-tech knowledge-based economy.” (Laestadius *et al.*, 2005)

# Possible reasons for the observed persistence of the high-tech myth (2)

## Triadic competition

- misplaced, misleading EU – US comparison
- major structural differences

## Sociological factors

- STI policy-makers
- finance ministry staff
- influential scientists as advisors (formal and informal channels)
- quest for evidence-based policies
  - formal modelling, quantitative analyses

# The relevance of the systemic view of innovation

Provides a more appropriate framework to analyse innovation processes and performance  
a rich picture on the modes of learning and innovation

But complex, and can be perceived as 'vague'

- no 'one size fits all', easy to digest and implement policy prescriptions (as opposed to the market failure argument)
- cannot be easily formalised  
history-friendly modelling, simulation; not as appealing as e.g. the endogenous growth models

Demanding in terms of analysis and policy design

- what type of system failure
- in which sub-system

# Evolutionary, system and policy failures: Difficulties for policy-makers

## Evolutionary failures

- generation of technological opportunities
- learning by firms (accumulation of capabilities)
- lock-in in inferior technology (competence trap), trade-offs
  - exploration **vs.** exploitation (current vs. future profits)
  - variety generation **vs.** selection
    - tough selection  $\Rightarrow$  low variety  $\Rightarrow$  lock-in
    - weak selection  $\Rightarrow$  ineffective firms, waste of resources, limited dynamics/ growth
  - tight IPR **vs.** exploration of new approaches/ diverse competence base

# Evolutionary, system and policy failures: Difficulties for policy-makers (2)

## System failures (problems)

- missing or weak elements ('nodes', actors)
- missing, weak, inappropriate connections among the actors
- transition (system dynamics)

## Policy failures

- weak learning (e.g. from previous practice, interactions, good practices)
- inflexibility in implementation
- lack of understanding of sectoral characteristics
- poor (no) vision-building
- ineffective co-ordination

(Malerba, 2009; cf. Bach and Matt, 2005; Smith, 2000)

## Unit of analysis/ policy intervention

- micro
- mezo
- macro

# Lost key and the lamp post?

Measurement: easy to measure      needs to be measured

Analysis: readily available data      needs to be analysed

OECD, Eurostat: political decisions

Jensen et al. 2007; similar claims by Godin

Measurement, analysis, policy-making

virtuous or vicious circles

# Further Policy Implications

Several policies affect innovation processes and performance, perhaps even more strongly than STI policies, and hence policy goals and tools need to be orchestrated across several policy domains

Analysts and policy-makers need to be careful when interpreting their country's ranking on 'scoreboards'

The choice of an economics paradigm to guide policy evaluation is likely to be decisive

Thank you!

[attila.havas@krtk.mta.hu](mailto:attila.havas@krtk.mta.hu)

AEGIS (EU RTD FP7, grant agreement No. 225134)

GRINCOH (EU RTD FP7, grant agreement No. 290657)