

The Impact of Science – Truisms, Insights, and Conclusions

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Basic or 'Frontier Research'

Term 'Frontier Research' reflects the fact that:

- it is at the leading edge in developing new knowledge
- it is intrinsically risky, in that it is often not yet clear which approach may eventually prove most fruitful;
- there are no boundaries between disciplines, nor between basic and applied research; frontier research is concerned both with both new knowledge about the world and with generating potentially useful knowledge at the same time, and
- by its very nature, it transcends national borders.



http://ec.europa.eu/research/future/pdf/hleg_fullreport_frontier_research_april2005.pdf

Constructing 'impacts'

Identification of impact of (public) action:

- scientific, technological, economic, societal, political, ...
- past/future, direct/indirect, intended/non-intended, ...

Condition: Model of input/output relation, of cause/effect, of actors and beneficiaries ...

“Impact” → a rational construction, more or less complex

Dimensions of science impact

<i>Main domains of impact of public spending</i>	<i>Direct positive impacts</i>		<i>Indirect positive impacts</i>	
	<i>Short-term</i>	<i>Long-term</i>	<i>Short-term</i>	<i>Long-term</i>
Science ("Wissenschaft") Typical impacts	scientific findings	knowledge	improved teaching	industrial spill-overs
Economy and society Typical impacts	improved technology	improved technical know-how	increased productivity	improved competitiveness
Policy Typical impacts	improved understanding	problem-solving	increased problem awareness	increased general satisfaction

Also: Unintended impacts, positive or negative

Source:
Airaghi et al. 1999

A conflicting relationship

- What are the reciprocal interactions between frontier research, society and the economy?
- Since the birth of modern science there has been a, sometimes insufferable, tension (see e.g. Orhan Pamuk's searching scholars in 17th century Istanbul) between
 - the pursuit of systematic scientific rigour, constricted by no mundane concern
 - and political, societal, later also industrial hopes for all kinds of promising “impacts”, urging the scientists to cope with non-scientific rationales.

Frontier research in society

Two apparently antithetic truisms:

- Since frontier research, based on methodological systematic, is in the first place a **creative enterprise**, often fed by serendipity, its processes and its impact on society and economy are elusive and hardly to control. **Pushing** for effective impact would **undermine** the very working of science.
- **Without requests** from society/government and economy from science and without their investments in frontier research there was **no organised, sustainable science** – hence there is good reason to expect and control for useful and effective science impact.

Conference insights

- 1) The relevance of science and frontier research for modern society and economy was confirmed.
- 2) Theoretical explanations were debated, combined with a historical overview of the evolution of the science, society and economy interaction.
- 3) The implications, societal, scientific and economic, were addressed. In addition, the political implications for the practice of frontier research and its funding were discussed.
- 4) Scientific opinions and practical examples of science impact evaluation were presented.

(1) Frontier research is central

- A public good of increasing relevance for high-income economies (K. Aiginger)
- Highly beneficial in the long term, provided there is ...
 - sufficient funding, freedom and numerous interfaces across sciences and with technology and industry (H. Harari)
 - responsible discourse bridging the gap between dreams of or fears about fantastic science impact on the one hand and mundane, cumbersome daily practice of science at work on the other (S. Jasanoff)

(2) Theory: History, technology and globalisation matter

- Historic economic growth and technological development are closely intertwined; science plays in this process a role like modern-day open-source developers (J. Mokyr)
- Most frontier research and “basic innovation” builds on advanced techniques, instruments, technologies, embedded in socio-technical networks (A. Webster)
- Changing frame conditions: Frontier research is a globalising process (digitalisation, mobility). Relative contribution of most countries’ science policy to global science production is small (L. Soete); in EU too low investment by industry
- Need for better understanding of the dynamic interrelationship of science, research, technology, knowledge - and “impact” (Hessels; Katzir)

(3) Funding models: to be tailored

- Funding (national, international) of science has to cope with tensions due to different research and innovation requirements across fields (mature vs. emerging themes; small vs. large scale) (I. Halliday) – need to understand knowledge dynamics
- To achieve sustainable societies, research policies need to preserve social orienting mechanisms and develop new ones (S. Cozzens)
- Involvement of “users” in programmed science funding facilitates knowledge transfer and impact (C. Mommers; T. Bechtold), based on transparent mechanisms (S. Wong)

(4) Impact evaluation:

Broader view uncovers rich harvest

- After 100 years of science impact measurement it is time for a definition of 'impact', a theory of knowledge transfer, and a typology of impact directions (B. Godin)
- In spite of many years of science impact assessment present-day evaluation practice does not capture the full spectrum of benefits (W. Polt)
- There is evidence of substantial benefits of frontier research coming in multiple forms and through a number of exploitation channels (B. Martin); meaningful impact assessments measuring wider public value of research are possible (Donovan; Kuitinen)

Conclusions (1)

- Economics underline that investing in science creates rich returns. “Knowledge-based economy” takes command
- History of science, sociology of science (Merton), and STS (Latour, ...) show that science and frontier research are a special, but socially constructed, not distinct social sphere of modern society – interwoven through different but overlapping social practice and values (not only since rise of “mode 2” narrative)
- Normative concept: Dedicated co-production of “desirable science impact” through “social shaping” (e.g. Constructive Technology Assessment in nano-science)

Conclusions (2)

- The more dedicated knowledge production becomes a dominant feature of modern society and economy ...
- ...the greater the need for vivid and broad, sometimes controversial communication of frontier research with potential “users” in society and economy
- Normative concept: “Disabled persons of all countries, unite!” (Callon 2005): Self-organising “orphan” stakeholders become step-wise “users” of frontier research as a source of creativity and desirable impact and innovation, thus turning weakness into strength

Conclusions (3)

- Public policy: Treat science and knowledge production intelligently and well if you hope for returns and impact
 - Think in terms of “post-national” science policy (local, international), both in terms of investments and search for impact; facilitate international competition and mobility
 - Aiming at “impact”, avoid one-size-fits-all policy concepts: Better understand variety of different knowledge dynamics (field growth, convergence, complementarity), related institutional and actor configurations, and the need for appropriate public policy mix (e.g. IT vs. chemistry vs. biotech vs. nanoscience ...)

Conclusions (4)

- Allocation of funds and performance assessment based on extended peer review and, in particular, extended understanding of impact dimensions (KNAW workshop, Amsterdam, Nov. 07)
- Need for a new thrust towards “post-national”, problem-oriented theory and analysis of science (impact) dynamics
 - comparative approaches (thematic, structural, historical ...) ...
 - coping with persistent causality and measurement problems
 - based on better, internationally agreed basic data formats, collection procedures, new structural indicators and methodologies, accessible data bases