Institutional Reforms and Scientific Change: Changing conditions for developing four intellectual innovations in four European countries

by

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Recent changes to the funding and governance of academic research in many OECD countries are altering the authority of different groups and organisations over scientists' research strategies and careers.

This is especially significant where most research is conducted in university institutes that combine research, teaching and administrative activities under the direction of a senior professor.

In particular, four major shifts in authority relationships:

- Increasing dependence on scientific elites for project-based funding and reputations
- Increasing state steering of research priorities towards public policy goals
- Increasing central managerial authority over research strategies, resources and results in universities that are having to compete more directly for resources and prestige
- Increasing legitimacy of commercial interests in setting research priorities in many fields

can be expected to affect scientists' commitment to developing different kinds of intellectual innovations through altering:

- the level of **protected space** afforded to researchers, and

- the **flexibility** of standards governing the allocation of resources and reputations

in different disciplines and science systems.

The level of **protected space (P. S.)** is the period of time in which scientists have discretion over the use of resources to pursue particular problems without suffering severe reputational and career consequences.

This affects their ability to undertake long term projects with highly uncertain outcomes.

Flexibility refers to the willingness of scientific elites to be flexible and open to new approaches when applying established quality norms to the assessment of grant applications and intellectual contributions.

Two types deal with the flexibility of standards governing:

- the allocation of **resources** for different kinds of problems, methods and knowledge where results are highly uncertain,
- the evaluation of the merits of scientists' contributions and **reputations**.

The development of different kinds of scientific innovation, i. e. substantial changes of skills/models/materials/problem choices and approaches by a large number of researchers in one or more fields, has been supported by different levels of protected space and flexibility of standards.

This can be seen by comparing four recent innovations in the physical, biological and human sciences that varied in their resources requirements and challenge to dominant priorities and approaches.

Four scientific innovations

1. Realisation of Bose-Einstein Condensates (BEC)

   i.e. cooling gases very close to absolute zero (100 Nano kelvin) so that particles become immobile, lose their individual identities and coalesce into a single blob.

2. Experimental Evolutionary Developmental Biology (Evo-Devo)

   i.e. analysing the impact of developmental mechanisms in different organisms on their patterns of evolution.

3. International large-scale school student performance assessments (ILSA)

   i.e. measuring and comparing the effectiveness, efficiency and quality of national education systems using international surveys such as PISA (Programme for International Student Assessment).

4. Computerised corpus linguistics (CCL)

   i.e. investigating language systems and linguistic performance by constructing and analysing written and spoken corpora electronically.

Key Characteristics

Characteristics	BEC	Experimental Evo-Devo	ILSA	CCL
Competition with established priorities and approaches	**Low**	**Considerable**	**Considerable** with humanist educational studies, **limited** with psychology and economics of education	**High** with Chomskyan rationalists, **limited** with natural language students
Resources needed	**High**	**Medium** for partial switchers**, high** for full switchers	**Low** for social scientists experienced in analysing large datasets, **high** for more humanist education researchers	**High** for corpus builders, **low** to **medium** for most corpus users
Research potential	**High**	**High**	**Limited** for established fields in educational research, **considerable** for policy-related areas	**High** for empirical language studies
External relevance and support	**Low**	**Low**	**High**	**Considerable** for publishers and translators

Levels of protected space and flexibility supporting the development of four scientific innovations

Innovation	Level of protected space	Level of flexibility
Experimental BEC	**High** (although some modularity for publications)	**Considerable** for resources because of uncertainty, **limited** for reputations given centrality to AMO physics.
Experimental Evo-Devo	**Medium** for partial switchers, **high** for full switchers	**Medium** to **high** for both resources and reputations
ILSA	**High** for conducting the surveys and their use by humanist researchers, **lower** for quantitative social scientists	**Considerable** for resources and reputations in many educational research fields, **lower** in most other social sciences
CCL	**High** for building corpora and unskilled users, **lower** for those with access to computer expertise	**High** for resources in building corpora, less for most users. **High** for reputations in general linguistics, **lower** for reputations in natural language fields. Reduced for resources with advent of PCs.

These levels of protected space and flexibility for researchers who had developed these innovations in four European countries, Germany, the Netherlands, Sweden, Switzerland, were provided by a variety of different means.

In the case of **protected space**, these included:

- Tenured academic posts in universities and state research institutes
- Continuing research fellowships
- International careers and learning opportunities

In the case of **flexibility of resource provision** for researchers these included:

- Local research capacity (e.g. technicians, computers, experimental facilities)
- Recurrent block grant funding to PROs
- Diversity of funding agencies and programmes
- Funding agency delegation of resource use
- Extra-scientific support from political, bureaucratic and commercial interests

In the case of **flexibility of standards governing reputations** for researchers, these included :

- availability of career and employment opportunities in research organisations and university departments with diverse goals and approaches
- willingness to publish papers before successful experimental results had been achieved
- diverse audiences and publications.

All four countries had university systems organised around research and teaching institutes but differed in the variety of organisations that conducted published research.

They also differed in the extent to which they were implementing institutional reforms that changed the distribution of authority and provision of protected space and flexibility:

Most in the Netherlands, less in Sweden and Switzerland and least in Germany.

Conditions that supported the development of four innovations to different degrees in different countries

Providing Protected Space				
Innovations				
Supporting conditions	BEC	Experimental Evo-Devo	ILSA	CCL
Tenured posts	CH, DE, NL, SE (limited)	CH, DE, NL (until 2000s), SE	CH, DE (in state institutes), NL(subject to external income), SE	CH, DE, SE
Continuing research fellowships	CH, DE, SE	SE		SE
International careers and learning opportunities	CH, DE, NL, SE	CH, DE, NL (up to 2000s), SE	CH, DE	CH, SE

Providing Resource Flexibility

Innovations				
Supporting Conditions	BEC	Evo-Devo	ILSA	CCL
Local research capacity	CH, DE, NL (declining).	CH, DE, NL (up to 2000s), SE.	DE (in state institutes).	CH, NL, DE, SE.
Recurrent block grants	CH, DE, NL, SE (up to 2009).	CH, DE, NL (up to 2000s), SE.	DE (in state institutes).	CH, SE.
Diversity of funding agencies	DE, SE (lack in NL reduced support in 2000s)	DE, SE,	CH, DE, NL, SE.	DE, NL, SE.
Diversity of funding programmes	CH, DE	CH		CH
Funding delegation	CH, DE, NL. (lack in SE inhibited BEC)	CH, DE, NL, SE.		CH, DE, SE.
Political support and funding			CH, DE, NL, SE.	CH, NL.

Providing Reputational Flexibility

Innovations				
Supporting Conditions	BEC	Evo-Devo	ILSA	CCL
Diversity of career and employment opportunities	DE (Max Planck Institutes)	CH, DE, SE, (variety of university departments)	DE (state institutes, not universities)	CH, DE, SE.
Willingness to publish before successful results achieved	DE (lower significance in NL and SE reduced investment in BEC work)			
Diverse audiences and publications		CH, DE, SE.	CH, DE, NL, SE.	CH, DE, SE.

This suggests that protected space will be reduced if:

- tenured posts are reduced
- researchers are subject to more intensive and frequent evaluations tied to short term project outcomes
- international mobility and fellowships are reduced.

Resource flexibility will be reduced if:

- local research capacity and block grants are reduced
- public research funding is severely reduced and concentrated in one or two organisations using discipline-based advisors
- PROs impose strict budgetary boundaries between organisational units
- funding agencies reduce delegation of discretion over resource use.

But it may be increased where policy and/or commercial interests provide long term financing for non-mainstream research areas

Reputational flexibility will be reduced if:

- overlaps between organisations and departments are reduced
- strong research evaluation systems reinforce established disciplinary priorities
- establishing new publications and audiences becomes more difficult

In Summary

Many institutional reforms of public science systems are reducing the degree of protected space afforded to many researchers, especially senior ones in institute-based universities.

Some, though, could increase the flexibility of intellectual standards where states provide substantial long term funding for public policy purposes directly to qualified researchers.

Reforms are likely to reduce scientists' willingness and ability to develop unorthodox research strategies with highly uncertain outcomes, and hence intellectual variety, when:

- the concentration of authority and control over resources and careers in national public science systems is high,
- research problems are not easily decomposed into separate modules that can produce publishable results and facilitate "partial" switching,
- diversity of skills and audiences is low,
- overall public support for academic research is substantially reduced.