New governance arrangements in science policy

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Abstract

This WZB discussion paper is a collection of five papers dealing with current shifts in the boundaries between science and politics and their consequences on governance arrangements in science policy. In his article, Dietmar Braun analyses international developments in publicly funded research systems, diagnosing a currently emerging model of "network governance" – a policy approach based upon the management of interdependence of autonomous public (and private) agencies in horizontal relations. Daniel Barben takes an internationally comparative and transnational perspective and examines changes in science and policy regimes together with the interaction between them. His article stresses the value of the "regime" concept to analyse complex and interdependent transformations in science and politics. Henry Etzkowitz discusses his "triple helix" model developed to understand the joint innovation processes of science, industry and the state. His article specifically points out the implications of triple helix innovation processes for the state, manifest for example in economic policies and on the regional policy level. Peter Weingart criticises the often inadvertent consequences of assessment procedures and bibliometrical measurement on the science system. He argues for a critical reflection and reform of the peer review system in order to improve the instruments for research evaluation and quality assurance in science. These articles represent a promising and growing field of scholarship combining approaches of science policy studies with those of science and technology studies.

Zusammenfassung

Dieses WZB Discussion paper umfasst Beiträge, die sich mit aktuellen Veränderungen im Verhältnis zwischen Wissenschaft und Politik und deren Konsequenzen für Governance-Ansätze der Wissenschaftspolitik beschäftigen. Dietmar Braun analysiert in seinem Beitrag internationale Entwicklungen in öffentlich finanzierten Forschungssystemen. Er diagnostiziert die Herausbildung eines Modells von „Netzwerk Governance" – ein Politikansatz, der auf dem Management der Interdependenzen von unabhängigen öffentlichen (und privaten) Einrichtungen in horizontalen Beziehungen beruht. Daniel Barben untersucht in einer international komparativen und transnationalen Perspektive Veränderungen im Wissenschafts- und im Politikregime sowie die Interaktionen zwischen beiden. Sein Beitrag unterstreicht den Wert des Regimekonzepts für die Analyse komplexer und interdependenter Transformationen in Wissenschaft und Politik. Henry Etzkowitz diskutiert sein „Triple Helix"-Modell, das zum Verständnis der wechselseitigen Innovationsprozesse von Wissenschaft, Industrie und Staat entwickelt wurde. Ein spezielles Augenmerk gilt den Folgen von Triple-Helix-Innovationsprozessen für die Politik, wie sie sich etwa in der Wirtschaftspolitik oder auf regionalpolitischer Ebene manifestieren. Peter Weingart schließlich kritisiert die zahlreichen nicht-intendierten Nebenfolgen von Evaluationsverfahren und biliometrischen Messtechniken auf das Wissenschaftssystem. Er fordert eine kritische Reflexion und Reform des Peer-review-Systems zur Verbesserung der Evaluations- und Qualitätssicherungsinstrumente in der Wissenschaft. Die hier versammelten Beiträge stehen für ein viel versprechendes und wachsendes Forschungsfeld, das Ansätze der Science Policy Studies mit solchen der Wissenschafts- und Technikforschung verbindet.

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Introduction

Shifting Boundaries between Science and Politics – Recent Work on New Governance Arrangements in Science Policy

Martin Lengwiler, Dagmar Simon

In current science policy debates, the boundaries between science and politics are significantly redrawn – a process observed and commented by many authors in science studies.[1] Thus, the boundary area between the two institutions became a particularly dynamic field. In recent years, science policy actors increasingly demanded social and economic legitimation from publicly funded research (guided by external, output-oriented categories), which put basic research above all under a hitherto unknown political pressure. Today, science and research are commonly seen as important if not decisive driving forces for dynamic economies in the 21st century. At the same time, research in science studies and in science policy studies indicates that the couplings between science, industry and the public – as well as between basic and applied research – are intensifying. Some authors have stated a fundamental shift from disciplinary academic research to a new mode of knowledge production responding more directly to social and environmental problems and co-operating with civil actors outside academe. The consequences of this process, in particular for the governance of science, are still the object of scholarly debates (Nowotny et al. 2001; Etzkowitz 2001; Rammert 2003; Braun 1997). Are changes in science policy gradual or fundamental, and to what extent is the concept of a "regime change" adequate? Are the traditional instruments of science policy out of date or can they be reformed and adapted? Are the procedures for the assessment and funding of innovative research still adequate?

[1] The contributions to this publication were originally presented at an international conference on "Shifting Boundaries between Science and Politics – New Research Perspectives in Science Studies", initiated by Martin Lengwiler and Dagmar Simon (of the WZB Project Group "Science Policy Studies") and held at the Social Science Research Center Berlin (Wissenschaftszentrum Berlin für Sozialforschung, WZB). For this publication, we collected the papers dealing specifically with new forms of governance arrangements in science policy. For more information on the conference, see the program attached in the annex.

These current debates are set within a specific historical context. From a historical perspective, most studies on the development of science policy in Western countries converge on a similar picture. Authors usually distinguish between two periods since the Second World War. The first period is usually set between 1945 and the early 1970s. In this era, science policy was based upon a "social contract for science", under which the relations between science and politics were guided by the principle of "blind delegation" granting science wide autonomies of self-regulation (Guston 2000). Since the 1970s or 1980s, as most scholars argue, this social contract has been replaced by new forms of governance in science policy. As part of this process, the seemingly clear-cut boundary between science and politics was redefined and science in particular was held more accountable to political authorities and to the public. The current literature offers different interpretations for this process: some understand it as the contemporary answer to the "delegation problem of principal-agent-relations" (Braun/Guston 2003); others see the process as the emergence of complex, heterogeneous "government arrangements" (Rip 2002) or as a new regime of "collaborative assurance" in science aiming at increasing the integrity and productivity of research (Guston 2000: 144f.); again others highlight the changing models of innovation, distinguishing the traditional linear from a new co-evolutionary model of innovation as illustrated, for example, in the "triple-helix" model (Etzkowitz/Leydesdorff 1997). Finally, there is a wide literature on the changing research practices, stressing the rising significance of interdisciplinary or transdisciplinary approaches when research is increasingly done in applied contexts with close interactions between theoretical and practical work (Rammert 2003; Nowotny et al. 2003). All studies agree that the social sub-systems of science, industry and the state are increasingly interacting – often indeed with differing intentions and expectations – and that this process has led to new approaches in science policy.

This conventional wisdom forms the starting point for the arguments of the following articles. They all deal with empirical manifestations of these new arrangements in science policy. Although the distinction between the "old" model and current developments seems to be quite clear, the final contours of the "new model" are still debated and not discernible yet. In particular, it is still an open question whether the old model will be replaced or rather amended by elements of a new model in order to meet the future social and economic challenges. The boundaries between science and politics are not fixed and a priori given entities anymore, but continually and controversially redefined areas. Actors involved in this reformulation process include political and scientific actors but also business and industry representatives or actors speaking for the public. The following articles not only present empirical cases to analyse current shifts in science policy, in national and transnational perspectives; they also ask for their theoretical implications.

In his article on "How to govern research in the 'age of innovation': Compatibilities and incompatibilities of policy rationales", *Dietmar Braun* analyses international developments in publicly funded research systems and their consequences for science policy. The current "age of innovation", he diagnoses, is marked by an increasing entanglement between actors of knowledge production; examples are co-operations between universities and industries, public-private partnerships or the co-ordination of industrial and research policies. Braun argues for an interactive model of innovation and strategic research governed by key trends such as 'value for money', efficiency and participation. Braun suggests that an adequate answer to these new forms of knowledge production can be seen in the currently emerging model of "network governance" – a policy approach based upon the management of interdependence of autonomous public (and private) agencies in horizontal relations, consensus orientation in policy making and coordination between different governance organisations.

Daniel Barben also states a changing role of science and research policy, stressing that they are at the same time objects and agents of transformation processes. In his article on "Changing Regimes of Science and Politics: Comparative and Transnational Perspectives for a World in Transition", Barben takes an internationally comparative and transnational perspective analysing changes in science and policy regimes together with the interactions between them. The article stresses the value of the "regime" concept to analyse transformations in science and politics without underestimating the complexity of interactions between science and technology, institutions and organisations, discourses and practices. Based upon a methodological combination of science and technology studies with science policy studies, Barben argues for a research agenda dedicated to the development of a general framework of regime analysis.

The conditions of a meta-innovation system, encompassing the whole spectre of basic and applied research and clearly distinct from the traditional linear model of knowledge and technology transfer, are at the centre of *Henry Etzkowitz'* article on "Meta-Innovation: The optimum role of the state in the Triple Helix". His "triple helix" model sheds a light on the complex interactions between science, industry and the state allowing for example for adequately analysing organisations such as academic spin-offs or entrepreneurial universities. A research and technology policy supporting these interactions and acting in co-operation with universities and industrial organisations can also have implications for economic policies, in particular on a regional level. Etzkowitz estimates that indirect, decentralised forms of innovation policy are significantly more efficient than traditional forms based upon a linear concept of transfer. A dynamic co-operation between different levels of governments and different institutional spheres is seen as the "hallmark of an innovative society".

The article of *Peter Weingart* on "The Ritual of Assessment and the Seduction of Numbers" also deals with the changing relation between science, politics and the public.[2] The manifest and rising needs of legitimation of science and research have led to an increasing role of quality control and quality assurance in science. Weingart

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[2] The article here is printed in German; for an English version of the argument, see reference in footnote 1 on page 83.

analyses the impact of bibliometrics upon the science system, with a particular interest for the inadvertent consequences of this process. Although the spread of evaluation and assessment techniques forms a broad trend, their impact on the scientific system is rarely studied and therefore hardly known. Moreover, there is a good chance for the occurrence of unintended effects such as ”oversteering”. A minimal condition for the use of ranking and rating data is the continuous quality control of the underlying data and the professionalisation of assessment practices. Weingart particularly argues for a critically reflected application of peer review approaches, amended by the collection and analysis of bibliometric data, as an improved, reasonable instrument for research evaluation and quality assurance.

Theoretically and methodologically, the articles represent a promising and growing field of scholarship marked by two often distinct, but increasingly overlapping approaches: science policy studies on the one and science and technology studies (STS) on the other hand. In recent years, the correspondences between the two research fields have intensified. Science policy studies have started to take constructivist STS and its findings into account, whereas work in STS has increasingly opened up to macro-level analyses. Of course, STS has always been interested in the notion of the political ever since the field emerged in the 1970s. The sociology of scientific knowledge already pointed out the social and political interests involved in the production of scientific knowledge; the social construction of technology programme revealed the hidden "politics" of artefacts; and more recent work, inspired by a social anthropological perspective, criticised the historical divide between the realms of nature and of society (including politics), calling for an encompassing "parliamentary of things" (Cambrosio et al. 1990; Latour 2004). But over the past years, STS has increasingly examined the political institutions themselves and their relevance for science (Jasanoff 2004; Guston 2000: 27-30). We hope that this collection of articles encourages other researchers to enter this fascinating field and continue investigating the relations and boundaries between science and politics from an internationally comparative and historically reflected perspective.

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How to Govern Research in the "Age of Innovation": Compatibilities and Incompatibilities of Policy Rationales

Dietmar Braun

Introduction

If one looks at the latest OECD publications dealing with the governance of public sector research (OECD 2003, 2004a, 2004b), one finds an astonishing variety of changes to governance instruments during the last two decades. To mention just a few and in no particular order: a shift from institutional to competitive grants: more (inclusive) priority setting: the transfer of intellectual property rights to the performing institutions; increasing use of centres of excellence and public-private partnerships; the establishment of contracts with public sector research and funding institutions; a greater autonomy for such institutions; increasing attempts to coordinate policy formulation as well as fostering cooperation between research institutions; an increasing role of foresight mechanisms and advisory bodies; ex ante, ongoing and ex post evaluation of funding schemes and research performance; an increasing integration of stakeholders in funding and research institutions; a stronger role for higher education institutions compared to other public sector research institutions. Without a doubt, the change in the use of research policy instruments has been important. However, one wonders to what extent these changes have been the result of an overall change in the guiding principles and "rationales" of research policy makers? Is there any coherence in the use of instruments?

Without applying any serious content analysis, one can discern a number of key terms that are used by the OECD to explain why these instruments were implemented. Here one finds in close association to each other: strategic thinking, learning, reflexivity, thinking in relational and systemic terms, competition, accountability, efficiency, control, autonomy, enhancement of economic and social benefits of research, responsiveness to the civil society, cooperation, trust building, the fostering of networks, and the sustainability of academic research. Even a cursory glance reveals that the co-existence of such rationales is unlikely to be the result of one unifying paradigm that has taken control of the governance design across research policy making. The effort to promote autonomy and control; cooperation and competition; priority setting; the enhancement of economic and social benefits of research on the one hand and serendipity and the sustainability of academic research on the other suggest that there are tensions that may derive from the different building blocks of the policy rationales in the research sector.

It is my contention in this article that policy makers and administrators of research are subject to several and varying ideational influences that give rise to a "mix of policy rationales and instruments". A mix does not mean that it cannot work or that it is inefficient. My intention here is only to identify the various "ideas" or "rationales" that may influence the governance design at a given point in time and reveal their impact on the creation of research policies. Another study would be needed to investigate in more detail the extent to which the different instruments used are in conflict with each other or may have synergetic effects.

I will proceed as follows: The next chapter serves to distinguish between three cognitive levels that influence the decision-making in sectoral policy areas. This distinction is the access point to the further discussion on ideational developments in the "age of innovation". It will be demonstrated that the emerging policy-mix of instruments we find today is the result of changes in rationales on all three cognitive levels. A number of these changes is compatible with each other and brings forward a powerful new governance design during the 1980s and 1990s. Though not yet institutionalised in a similar manner, this design is contested by a new governance design based on systemic and network thinking. This new design will be discussed in the second part of the article.

1. Analytical distinctions

Decisions on the design of governance consist of different cognitive influences which must be combined and reconstructed to fit the particular policy sector in question. Such "constructive work" is seldom taken into account in research policy studies. In particular, it is rarely understood that part of the cognitive influences in a policy sector are coming from "outside", i.e. they are developed in a larger context and do not emerge as part of the work of research policy makers and administrators.

Analytically one can discern at least three different cognitive influences on the governance design in a policy sector managing a particular resource (e.g. knowledge in research policy, the environment in environmental policy, or health in health policy): the level of practical experiences of policy makers and administrators in the policy sector (1); ideas deriving from theories on the production, maintenance and diffusion of the resource (2); global ideas about the role of the state in society and the organisation of state action (3).

(1) Policy makers considering change in a policy sector base their decisions at least in part on their past experiences ("goodness-of-fit") and the experiences of other countries. Powerful influences include the experiences of strong and successful competitors and/or countries that have a high reputation in managing the resource. In the case of research policies we find a long tradition of countries that are considered "leaders" in research performance in different historical periods, with France,

Germany, the United Kingdom, the USA and Japan among the main examples. Learning from such examples or emulating the policy practices of these countries has always been a major strategy for countries coping with problems in innovation or research. A governance design developed on the base of "emulation" is, therefore, developed at the sectoral level by policy makers and administrators who are coping with governance problems and/or who are busy with improving the performance of the policy sector in question.

(2) Emulation as part of the development of a governance design can be distinguished from general cognitive "frames" that actors use when interpreting the world, i.e. in our case when they are assessing performance and governance structures (for the notion of frames see Rein and Schön 1991; Kahnemann and Tversky 1982; Esser 1999; Lindenberg 2000). The first cognitive frame is developed in direct relation to the production of the resource in question and can also be considered a sectoral-bound ideational level.

Such cognitive frames take the characteristics of the resource into account and discuss structures and dynamics of resource production and diffusion. In research these are theories about knowledge production and diffusion. As a well-known example, the "science-push theory", presented after the Second World War by V. Bush (1990), furnished for a long time not only a rationale for how best to innovate, but also how policy makers should behave in order to best support the production and diffusion of the resource. Theories on knowledge production and diffusion are, therefore, almost always accompanied by suggestions for political governance. In the case of the science-push model, the recommendation was to abstain from political intervention and to distribute government money to funding agencies or research institutions led by scientists and leave it up to the scientific community to deal with the efficient distribution of money. In addition, it was not necessary to take into account any interlinkages between production and diffusion or between academia and industry, as the theory promised an automatic spin-off of basic research knowledge into technological application. Government interference was not needed. In the research and innovation field such theories are usually developed by sociologists (sociology of science) and economists. Ideas may then be communicated by "policy entrepreneurs" like Vannevar Bush or by scientists themselves in advisory bodies.

(3) The third level of rationales – what one might label the "global governance frame" – is valid for a large number of policy areas, representing general ideas of the government on how to organise state intervention and governance. The belief anchored in Keynesianism, for example, of being able to actively intervene into the economic cycle also had side effects on the use of policy instruments in social policy or research policy. Confidence in the possibility of planning research and guiding the behaviour of scientists in desired directions was prominent in research policies in the 1960s, during the heydays of Keynesianism. Policy makers and administrators within the different policy sectors are required to integrate such frames on global govern-

ance and make them compatible with other more sectoral-bound frames. Changes in the global governance frame can arise from complete exogenous influences, such as a change in the overall ideology of the government from Keynesianism to neo-liberalism which do not take into account the peculiarities of the governance of a particular resource or its performance.

Changes in the design of governance can result from changes in either type of cognitive influence. First, failing performance may lead to intensified activities to find better functioning examples and build policy-instruments using examples from other countries. However, it will be difficult to do this when these examples are in conflict with existing cognitive frames. Second, there may be changes in the scientific analysis of the resource and the emergence of new theories that inform policy-making. This will, in the long run, affect the use of instruments. Finally, there may be independent changes at the level of global governance that need to be integrated in the research sector by changing governance processes, which also influences the choice of instruments. It is possible that a change may occur at all three levels and this may create new and potentially contradictory information for policy makers who must then attempt to integrate these influences into the governance design (or filter them so that coherent governance design is possible).

In what follows I will analyse the changes in the governance design during the "age of innovation", commencing at the beginning of the 1980s, by using this analytical framework which distinguishes between "emulation", "production frame" and "global governance frame" to assess how coherent the current governance design is.

2. Learning by competition and the rise of an interactionist frame of knowledge production

From the early 1980s onwards one sees the rise of new funding instruments linked to the exemplary model of Japan and to the emergence of new theories on the production of knowledge and diffusion, in particular the "new growth theory". Both types of cognitive developments can be seen as reinforcing rather than incompatible.

In the 1980s, European countries realised that there was an increasing "technological gap" between Europe and the USA and, above all, Japan. Declining productivity and the trend towards globalisation forced policy makers in poorly performing countries to think about how to deal with such a gap. The importance of the technological gap became even more obvious when the "new growth theory" in economics pointed to the fact that technological knowledge had been a significantly underrated factor in the search for economic growth with astounding advantages in the competition between nations (Arrow 1962, Romer 1986, 1987, 1994; Lucas 1988). Investment in knowledge has the potential to bring "increasing returns" to enterprises instead of "constant returns" as expected in older growth theories which focused on investments in capital and labour as the main growth factors (Solow 1957). To increase knowledge rather than capital and labour creates opportunities for nearly boundless growth (Cortright 2001). As new ideas are never scarce they do not suffer from marginal utilities or decreasing returns. If one recognises therefore that new knowledge is the essential driver of economic growth, one should invest as much as possible in infrastructure and institutions that are able to constantly generate new ideas. Though one cannot, of course, make any direct causal links between the trend towards emulation of Japan's joint technological projects on the one hand (see below) and the new growth theory on the other, one can state nevertheless that "ideas were in the air" that helped to argue for more investments into technological research. Moreover, these ideas suggested a close link between industrial, economic and research policies. While old industrial policies mostly consisted of subsidies to decaying sectors in order to save jobs, the new industrial policies, which emerged from the beginning of the 1980s, focused on investments in new technologies and new ideas. Science and technology policies became an integral part of such strategies and funding for technological research in general became more "high politics" than "low politics" by its affiliation to industrial and economic policies.

Under intensive brokerage and guidance by the industrial ministry in Japan (MITI), the country had since the 1960s promoted a substantial number of large scale programmes to catch up with the technological development in more advanced countries. Such projects involved working relationships between governmental labs and industry. The implementation of the "Next Generation Programme" of MITI since 1981 as well as the "Comprehensive Joint Research" in the same year financed by the STA, brought several changes. First, it was now openly acknowledged that Japan wanted to become a forerunner in key technological areas rather than an emulator of existing technologies (Freeman 1987; Pempel 1998; Sigurdson 1995; Braun 2004). Second, this required a more intensive process of identifying key areas with a major potential for economic returns. Thus, "foresight procedures" became a part of research policy-making and, since then, have been institutionalised in almost all OECD countries (Martin 1995; Grupp and Linstone 1999). Third, the development of new generic technologies like biotechnology and ICT were dependent on a much closer interaction between basic research and technological research. Direct collaboration in public private partnerships or "consortia" between academic researchers in universities and industrial enterprises became the main organisational principle in setting up research programmes in this context (see Odagiri et al. 1997; Hayashi 2003). The role of the government was mainly to create the necessary infrastructure to select the key areas and to help to build the consortia. Usually, a large part of the research projects was financed by the enterprises themselves (Sigurdson 1995).

These three components – identification of key areas of technology, collaborative research projects between industry and academia, and an active brokering role for the government – became the new model for organising innovation research from the early 1980s onwards.

The development of such research collaboration was further supported by new cognitive frames concerning the production of knowledge. The already mentioned "new growth theory" pointed to the importance of "learning by doing" and knowledge development on the job as well as to the influences of technological knowledge on basic research (Romer 1986). Stokes (1997) summarised these lessons in his model of "Pasteur's quadrant" by pointing out the significance of interaction between the basic and technological trajectory for innovation. Irvine and Martin (1984) had earlier identified the new type of research that was emerging in this context and labelled it "strategic research", i.e. research that is still strongly anchored in basic research but with obvious applications in mind. Such strategic research, set up in potential key technological areas, was obviously what Japan used in its promotion of research programmes during the 1980s and 1990s.

This new model of research collaboration was copied in many countries. In Germany, for example, the "Verbundprojekte" or joint projects were being implemented by the Research Ministry since the early 1980s (Lütz 1993). The Netherlands developed their "large technological projects" with considerable success (OECD 2003). All these programmes followed the same model of close cooperation between academic research, technological research and user participation in consortia or comparable organisational forms. Research policy-makers, now often including the economic departments, were active in organising the exchange and ensuring that promising areas were developed. Elzinga and Jameson (1995: 592) speak of an "orchestration policy" that obliged scientists to participate and that was built on an alliance between, what they called the "economic" and "bureaucratic" cultures.

In summary, one sees in the 1980s an increasing tendency among policy makers to look for new ways to organise knowledge production and diffusion given the technological gap between many European countries on the one hand and the USA and Japan on the other. The most obvious solution for research policy makers was to imitate what was going on in the more successful countries Japan became the leading example of a successful path to economic growth according to the "new growth" principles. New growth theory and other contributions in the sociology of science supported the new model by pointing to the importance of technology as a growth factor and the importance of business in the production and diffusion of knowledge. A new type of research was identified, i.e. strategic research, that seemed to have the potential to make new discoveries in the field of new generic technologies like biotechnology and ICT, i.e. technologies that can be used in many areas with unpredictable outcomes and discoveries. Foresight was a rational measure for investing money efficiently and effectively by selecting research areas that seemed to have the best potential for future returns.

3. Global Governance: Steady State, Efficiency State and Good Governance

At the level of "experiences" of policy makers and the cognitive frame about the production of knowledge we find changes that are directly linked to each other and which come to similar conclusions concerning the organisation of research and its governance. It is not possible to make any conjectures about which ideational level has influenced the other. It suffices here to see that cognitive developments on these levels were compatible with each other.

The cognitive level of global governance ideas however, follows an autonomous development and changes at this level in the 1980s have little to do with the governance of knowledge. However they have influenced how the governance of knowledge developed in the 1980s and 1990s.

The new emerging governance model did not contradict, but rather strengthened, the "orchestration policy" by influencing the choices of research institutions and scientists. The underlying philosophy of government action became neo-liberalism. It had two main effects on the organisation of governance in policy sectors: first, it led to the "steady state" which made public funds scarce and, second, it promoted the development of the "efficiency state" which was dedicated to enhancing efficiency and effectiveness measures in public policy making. A third cognitive frame, "good governance", which emerged in the 1990s, was not linked to neo-liberalism, but rather to the rise of democratic participatory ideals. This also became an important influence on the organisation of governance in the research sector.

3.1 Neo-liberalism

Neo-liberalism has been the main ideological influence since the end of the 1970s in many countries. The trademark of neo-liberalism as implemented by Margaret Thatcher in the U.K. and, to a lesser degree, by Ronald Reagan in the U.S. was a profound distrust of the ability of the state to steer society. Neo-liberalism meant the retreat of the interventionist state from market affairs and the emphasis of market mechanisms as the primary coordination mode in the delivery of public services. Deregulation and devolution should strengthen the capacity of public sector units to act in the (quasi-)market. The government should act to structure the market, by the distribution of property rights, in such a way that optimal outcomes from competition can be expected.

One of the first objectives of neo-liberal policies was to attack the deficit burden of many states. In this context not only was a more efficient public sector envisaged (the "efficiency state", see below) but cuts to funding for the different public services were implemented. These policies resulted in what John Ziman (1987) called the "steady state", i.e. a situation where actors could no longer count on increasing resources, but instead were required to deal with scarce resources under the label of "value for money".

3.2 The "Steady State"

The influence of neo-liberal "global ideas of governance" on the research sector – as on many other policy sectors – was profound. The first obvious change was that the whole public sector, including the research sector, lost its privileges in terms of financial security and relatively unrestrained and uncontrolled functioning. The whole public sector had to prove their value to the government and to the public at large.

It was therefore probably not cuts in budgets as such which mattered, though one finds a clear policy of disinvestment by governments from the 1980s and throughout the 1990s when it comes to financing public sector research institutes (which were also partly privatised). Cuts have been less spectacular for universities though one finds a downturn in the first half of the 1990s. Nevertheless, scientists really felt the lack of resources when an increasing number of promising research fields were at hand and needed additional financing (Calvert and Martin 2002). More important than budget cuts was the change in governance philosophy, as already indicated. Neo-liberalism sought a clear demonstration of "value for money" in the public sector. This principle trickled down to funding agencies, which had to adjust their selection process for the funding of research projects. Funding agencies came under pressure – and of course public sector research institutions in general – to demonstrate their ability for promoting "useful science"[3]. This often led to a reshuffling in the distribution of funding money from investigator initiated grants to program grants with strings attached. More visible funding projects like centre grants gained hold to the detriment of smaller and less directed projects. Whole institutes started discussing how to better "sell" their products.

Thus, the free choice of scientists to select research projects of their liking was reduced and there were tendencies to rush into those areas promoted by political or economic interests while other fields of scientific research tended to become neglected. Though the financing of basic research never completely dried up, scientists were drawn to more applied research and to research areas that seemed to promise results for policy makers and enterprises. Researchers were obliged to develop more skills and better coping strategies to find their research resources and they were subject to more competition. Whether this changed the "value systems" of scientists, as Ziman (1987) has claimed (see also Rip 1994), is debatable, but one does find the co-existence of traditional scientific norms directed to universality and objectivity, as Merton (1973) summarised them, alongside the more "proprietary", "local" and "applied" norms induced by the steady state.

[3] Or as Calvert and Martin say: "There were increasing pressures on scientists to be accountable for the money they were spending on research" (2002: 23)

In summary the steady state has undoubtedly opened the "ivory tower" of science. It curtailed the traditional protection of basic research institutions and tried to reduce risks in research investments by holding scientists more accountable. Its intention was to bring returns more clearly into sight and thereby improve the justification for the use of public money. Neo-liberalism had the effect of depriving scientists of their independence in using research money from the state. The research sector became one policy sector among many others and was subject to the same control and evaluation as all the other sectors were. A shift towards an increasing use of instruments with strings attached occurred.

The ideas brought in by the cognitive frame of neo-liberalism and the steady state were not incompatible with the changes in the model at the operational level of knowledge production. On the contrary, the need to be accountable and to find resources under competitive conditions as well as the pressure to apply for research resources in more strategic and applied fields has made it more attractive for a large number of scientists working in fields linked with the new generic technologies to engage themselves in collaborative projects with industry. Analysing the developments in the 1990s, this statement seems to be confirmed if one takes into account the increasing amount of business money flowing into universities, the rising number of university and public research labs being established and the growing number of collaborative projects (OECD 2004b).

3.3 The Efficiency State

The steady state oriented the public sector towards "value for money" by curtailing and programming resources of public sector institutions. The "efficiency state", which is influenced by neo-liberal philosophy in general, and by new public management ideas, public choice theory and rational choice institutionalism in particular, attacked the inefficiency of public administration by reorganising authority and service structures in the public sector (the classic reference is Osborne and Gaebler 1992). This had effects on all policy sectors including the research sector. While some of the rationales offered by this approach seem to be immediately compatible with the emerging model in research (for example, the quest for objectives and the use of foresight were complementary), there are other features such as the more active role of the top administration in "guiding" and "steering" which seemed to go beyond what has been asked by the "broker model".

One of the main challenges for neo-liberalism was to provide guidance to the public sector (programming research for example) without falling into the trap of overcommitted planning and without violating the basic philosophy of maintaining market coordination and a reduced role for the state. New public management was successful because it offered an answer to this problem. At the same time, it incorporated sufficient ideas of steering and guidance that even left leaning governments accepted the basic ideas of new public management. In this way, this approach swept over countries and profoundly changed the organisation of public services (Pollit and Bouckaert 2000). The main idea was that, in order to have an efficient and effective public service, it needed clear objectives, monitoring and evaluation as well as public sector institutions that were embedded in a market context.

The "efficiency state" argument runs as follows; in a turbulent, changing and increasingly complex world command and control lines, standardised rules and behaviour are outdated and useless. New reflections are needed on how to organise public bureaucracy so that public organisations can adapt flexibly to changing circumstances without, however, having complete discretion. In fact, one of the major aims in new public management, derived from "corporate governance", was to maintain, or introduce general political guidelines directing the behaviour of public organisations without preventing bottom-up initiatives in these organisations.

New public management used notions of principal-agent theory, as developed in the framework of bounded rationality (Williamson 1975), to set up new governance structures in the public sector. Policy makers should fulfil the role of principals and dedicate themselves to the task of steering, though steering was mainly restricted to the development of strategic visions, the conclusion of contracts and monitoring of the activities of "agents". Public sector institutions as "agents", on the other hand, were granted "operational autonomy", which allowed for the flexibility necessary to react in a turbulent environment. Agents "rowed", which does not mean that they simply executed what policy makers had conceived, but rather they implemented in an intelligent way, according to local contexts and within the general guidelines prescribed. They were bound to the principal by contracts that stipulated what the agents had to achieve, what time-frame was allowed, and what could be expected as outcomes. One notices immediately that such authority structures correspond perfectly with the general idea of "value for money"; new public management allowed for a more concrete and precise definition of the value of public sector activities. In this sense, the efficiency state was instrumental for the steady state.

The ability to steer depended on more intensive activities at the political top level. Here "foresight" is useful. Steering meant having sufficient information and a rational process of selection and decision making. Foresight in research policy could help to deliver useful and prospective information. The rise of numerous advisory bodies since the 1990s demonstrates that policy makers became more active and eager to develop policy guidelines in an intelligent way.

The setting up of "delegation" relationships is, however, prone to "moral hazard" as principal-agent theory explains: agencies may abuse the (operational) discretion they have received. In order to avoid moral hazard, principal-agent theory suggests three major organisational principles that should be followed:

(1) Delegation relationships should, as stated above, be organised by contracts, which stipulate general objectives, time-span, "deliverables" and, if possible, sanctions. The use of contracts within the public sector introduced a new and important element into the system which altered relationships fundamentally. While bureaucratic agencies in the old bureaucratic model were regarded as pure implementing bodies bound by hierarchical authority command lines, contracts in delegation relationships are concluded between equal partners, though, in reality, there are clear asymmetries in power. Nevertheless, the important point is that public agencies were not only recognised, but also promoted as quasi-autonomous entities able to enter into contractual relationships.

Delegation in the form of the new public management thus changed the functioning of public sector institutions and is behind the development of such institutions as "actors" who are able to fulfil contracts, who have incentives to use resources efficiently and who develop a clear sense of responsibility for their action. Hierarchical command and control lines of authority in the public sector became a rarity. In the research sector research institutions and funding agencies were seldom organised in the "Weberian" style of command and control. The unpredictability of knowledge production has always demanded a certain amount of flexibility and autonomy for institutions. Nevertheless, the efficiency state also changed the working of research institutions. While traditionally the general objectives of research institutions have been very broad, the development of contracts now demanded more specific descriptions of objectives and more precise time frames. Previously policy makers' expectations were seldom precisely articulated, now output criteria were developed and used to measure the performance of research institutions. These exigencies demanded, as explained above, a much stricter internal organisation and management that was able to pursue the contractual obligations by rational strategies. Thus, even research organisations became increasingly like "corporate enterprises".

Such a change was conducive to the development of collaboration with industry. Universities and research institutes learned how to behave as "entrepreneurs" in a turbulent environment and how to be more active in relation to demands from industry and other stakeholders. Becoming an entrepreneur meant searching for opportunities to improve the performance of the institution and bidding for contracts and money from different organisations. The "entrepreneurial university" is one outcome of changes to the governance of the public sector (Etzkowitz et al. 2000).

(2) In order to avoid moral hazard, control became a second component of the new authority structure of delegation. Control was needed to monitor whether contractual obligations had been fulfilled and assess whether it was necessary to change contractual conditions or use sanctions etc. Ex post evaluation of the activities and output of institutions was one of the major reforms in governance structures. The research sector was not exempt, though it was particularly difficult to define reasonable output criteria. Notwithstanding this fact, there was real growth of output meas-

urement in the industry and evaluations began to emerge that changed the practices and habits of research institutions.

For policy makers control was a major requirement of the efficiency state. Only in the case of constant evaluation of performance could one select the best agencies, avoid mismanagement and make the overall system "fit for the future" by constant adaptation (see Schick 2003). Pressure built up in the system due to the linking of resource allocation to the outcome of performance measurement. In this way, even research agencies had to think in terms of "profits", i.e. in terms of survival and performing better than competitors even though this was often artificial as "quasi-markets" had to be established to uphold the principle of competition. This brings us to the third principle of how to avoid moral hazard.

(3) The conviction that market principles of coordination are superior forms of organisation has been another important cognitive influence on the organisation of the efficiency state with profound consequences for governance in research. With the introduction of "quasi-markets", policy makers hoped to raise the quality of services as well as the efficiency of public sector organisations. As early as 1971 we find forerunners of such thinking in research policy in the famous "Rothschild Report" in the UK where the "customer-contractor" principle was introduced in order to raise the accountability of research councils. This is a good example for the introduction of quasi-markets. In this report, ministries were considered to be the customers of research councils, which were then supposed to address at least a part of their research money directly to the needs of a ministry. This demanded negotiations with and clarification from the ministry about what it actually wanted from research councils. It often happened that the determination of demands was quite difficult so many of these first quasi-markets broke down (Braun 1997). New public management revived these ideas and research institutions were increasingly supposed to think in terms of customer and contractors which could mean relationships with industry, but also with other stakeholders and, of course, with ministries. Supply and demand were brought together and research agencies learnt how to satisfy and even anticipate demands from stakeholders. In this way, the "marketisation" supported the "accountability" of research institutions as well as the "value for money" principle. At least part of the research should be inspired by the wishes of stakeholders and the agencies should learn to develop sensors and organisational procedures to identify and "hear" their customers. So, research policy makers could, by obligating research agencies to enter the frame of "customer-contractors", strengthen their grip on these agencies as it became easier for them to know what to expect.

The customer-contractor principle was one part of the market rationale with competition as another key aspect. Of course, scientists are always more or less competing, especially if they are dependent on scarce resources. But it is quite a different story when we consider institutions. For a long time research institutions were financed by block grants without ever – perhaps with the exception of research mission agencies in the U.S. – getting into serious trouble. Research agencies did not usually compete with each other. Often they were active in different fields of science or were busy pursuing different stages of research. Relationships were therefore considered to be more complementary than competitive. As already indicated, this view changed with the diffusion of new public management ideas. Competition among "contractors" is one of the most important principles for efficiency and innovation on the market. Rivalry is supposed to be one of the keys to lowering costs and raising quality in the public sector.

In the research sector the market rationale flourished under the influence of new public management. Quasi-markets were created where research agencies could bid for money. As is indicated in the latest publications by the OECD (see the introduction), a majority of countries deliberately reduced block grants and further funding (the share depends on the "proximity" of research agencies to stakeholders) was expected to be found in the "private market" or from another part on the "public market", i.e. with different ministries or departments within one ministry. Research councils had to compete with each other for their budgets. So by artificially reducing the resources and introducing a quasi-market, as well as demanding activities on the private market, research agencies were increasingly subjected to "marketisation".

The consequence for the role of policy makers in the governance of research was to abstain from command and control and instead use "indirect steering" by changing the constitutional principles of research agencies. Previously political governance relied on direct steering mechanisms such as financial incentives directed to researchers. The governance philosophy of the efficiency state changed the "software" of research institutions by "programming" these institutions in such a way that efficiency, performance and accountability become part of the functional logic of these organisations. This creates the conditions for a functioning "market" in research and for higher performance. One should not see financial incentives and structuring as opposing principles: to the extent that institutions and, in due course, their researchers follow the rules of new public management, it becomes easier to find scientists interested in research programmes which have strings attached. In this sense, then, both the steady state and the efficiency state create the structures that are needed to overcome the self-induced isolation of the academic enterprise and open it up to the demands of stakeholders. Though neo-liberalism had little to do with the search for solutions in the research sector, it created favourable conditions for the solutions that emerged by emulation and cognitive scripts about the production of knowledge.

3.4 Good Governance

More recently these insights from new public management theory have been complemented by another dimension in a move towards the framework of "good governance" (see especially the latest report of the Independent Commission on Good Governance in Public Services in the UK; 2004). Good governance has been built on the experiences of corporate management (see OECD 2004c) and the introduction of democracy in former authoritarian states. It is more practical and normative driven than scientifically informed. Nevertheless it has achieved a high status in the thinking of top administrators and policy makers in the last decade or so. Good governance can be seen as the mix of a number of principles that have been put forward by new public management and the insight that the success of administrative measures depends to a large extent on the consent and cooperation of addressees. Therefore, the participation of stakeholders becomes an important asset in the working and effectiveness of governance structures. Accountability means not only identifying probable customers and preparing work for them but also integrating these customers, i.e. the public in general, into the processes of decision making. Nowotny et al. (2001) analyse this dimension and demonstrate the extent to which "socially robust knowledge" must become a primary preoccupation of scientists in the age of innovation. Without going into too much detail here, one can point to new initiatives to open the scientific world to the public, i.e. being transparent about what has been accomplished, openly defending and explaining research activities, building platforms with the public and institutionalising permanent participation of stakeholders in research agencies.

Though the integration of stakeholders into the priority setting of research can without a doubt technically be considered an improvement of the effectiveness of governance structures in the sense that local information is flowing in and a consensus can be created that is needed when objectives are implemented, the participation dimension has different connotations from the neo-liberal perspective. It does not originate from public choice theory but is inspired by preoccupations with the establishment of democratic structures in developing countries. There is a normative dimension behind this notion. Good governance has nevertheless become a "script" for policy makers and administrators in many institutions and the participation of stakeholders has become a constant topic in the discussion of contracts between "principal" and "agent", especially in the research sector because of the negative image that has emerged since the Club of Rome Report at the end of the 1960s and in the context of biotechnology and genetic engineering. Ethical questions are more important today and this justifies the early integration of stakeholders in discussions on research objectives and instruments.

Participation of stakeholders is added to the framework of good governance alongside the other notions of steady and efficient states, i.e. to accountability, effectiveness, transparency, responsibility. It, therefore, adds to the complexity of action in research institutes which must now reorganise their internal structures, develop contracts, undergo permanent evaluation procedures, bid for money in competition with other agencies, look for financial support among stakeholders and become entrepreneurs with good relations with industry. In addition, they must pay attention to the sensibilities of the public and use information from stakeholders to become successful.

4. From vertical to horizontal governance

The steady state and efficiency state are not just policy rationales but have been transformed into governance design and policy instruments which have been implemented on a large scale in many OECD countries (see Pollit and Bouckaert 2000). The research sector was no exception as numerous OECD publications testify. One sees a restructuring of funding habits and instruments as well as a reorganisation of governance structures throughout the 1980s and 1990s. Some countries were advancing ahead (like the UK) while others followed later.

The important point is that in many ways these changes, which were promoted in the "age of innovation", developed a dynamic of their own that resulted in new problems and which in turn, demanded new solutions. The development of public-private partnerships, for example, had profound consequences on the scientific system and how it operates. The introduction of "agents" into governance structures and the resulting inclination towards "entrepreneurial strategies" produced new and multiple interdependencies between increasing numbers of institutions that often worked in different systems. Since the mid 1990s, discussion about the role of government shifted from the efficiency state to the question of how to manage interdependencies and coordination between the various institutions and actors in the research sector.

Similarly, one finds new ideas and rationales at the global governance level. As a reaction to new public management, partly to its consequences (decentralisation and empowerment lead to more active units and need for horizontal cooperation), partly to its failures (strategic management suffers from information overload and planning failure), a new "narrative" or rationale of state intervention appears on the agenda of administrative scientists (the "network approach" in organisational sociology and public administration), sociologists of science (see for example Geuna et al. 2003) and policy makers. In contrast with the efficiency state, this new rationale still lacks sufficient institutionalisation to speak of a change in the governance of knowledge production and diffusion. However, there is a forceful epistemic community that is bringing the new rationale to the agenda and there are some preliminary findings that suggest some of the governance design and practices are beginning to move in the direction of what one might call the "network state".

At the practical cognitive level of policy makers, we do not find fundamental reforms. Though the U.S. increasingly replaces Japan as a model, this does not mean new cognitive frames or scripts for governance. One finds a more active role that universities play in the collaboration with business, the development of "science districts", an interest in the geographical proximity of the organisation of collaborative research projects, and "tacit knowledge" as well as for the handling of intellectual property rights. More important for our discussion on governance structures is the development of ideas at the level of production where a number of approaches emerge that try to cope with the increasing complexity and the "network structure" of research due to the need for collaboration in the age of innovation. These theories present some new and insightful recommendations for the role that policy makers should play in the governance of research. At the level of global governance ideas new organisational theories gain importance.

The major cognitive step that is taken with regard to the governance of research is the shift from a "vertical approach" where governance is manifested by the "delegation" and "contract" perspective to a "horizontal approach" where the management of interdependencies becomes the main preoccupation.

4.1 Changes in ideas about the production of knowledge

The new "production" theories that develop in economics and sociology since the 1980s, accentuate key terms of "post-modern" thinking like evolution, complex systems, uncertainty and non-linear relationships.[4] Both knowledge production and knowledge diffusion become an interactive project between knowledge producers and knowledge users. This has already been identified in the above-mentioned "new growth theory" but this aspect gains momentum in theory-building as research collaboration for the benefit of technological innovation is becoming a more regular feature of research. Taken together, these approaches stress the non-linearity of the knowledge process, the increasing interdependence and entanglement of basic, applied, and technological research, the complex recursive relationships and particularly the blurring of boundaries and co-evolution of until recently well confined functional areas. In terms of governance the message is clear; in a world of strong interdependence and interaction, the prediction of results is extremely difficult. Contingency becomes a buzzword in this context, meaning that there are so many influences entering into the matrix of actions that one cannot intervene in a pointed and goal oriented way. The message for the policy makers is to shift from "optimising" to "adaptive" policy making, to improve framework conditions instead of developing grand designs, to enable actors in the innovation process to organise the process and to

[4] I would briefly subsume the "mode-2" approach (Gibbons et al. 1994); the "triple helix" approach (Etzkowitz and Leydesdorff 1998; Leydesdorff 2000); "evolutionary economicy" (Nelson 1982, Krugman 1996; Metcalf and Georghiou 1998; Kline and Rosenberg 1986); and the "system of innovation" approach (Lundvall 1992; Edquist 1997) to this type of reasoning.

learn. Moreover, policy goals in such a process become contingent. The process of defining policy goals must be flexible enough to adapt to changing circumstances. This directly contradicts the democratic vision of the "responsible policy makers" fostered in the "good governance" vision.

4.2 The Network State

At the level of global governance frames one finds a rising number of organisational studies, advisory reports and practitioners' reflections that address visible structural (and often negative) consequences of the efficiency state by constructing a different "narrative" about how the state should govern in general and how knowledge production in particular should be governed. In what follows I will endeavour, by referring to a number of publications, to unravel this narrative and its consequences for the governance of knowledge production.

4.2.1 The Consequences of the Efficiency State

It is argued in a number of administrative studies that the new organisational forms and governance principles of the efficiency state prepared the ground for its transformation[5]: The decentralisation of functions in the process of delegation and the increasing discretion public service agencies have been accorded, has contributed to the rise of relatively small autonomous organisations that are required to enter into exchange with organisations in different sectors and systems to fulfil their functions. Thus, horizontal contacts and interdependencies become more important. As these contacts often address specific problems and have specific purposes, they have a temporary character. So, one sees a constant grouping and re-grouping of organisations, a permanent re-shuffling of clusters of organisations. This demonstrates the need for constant adaptation to an increasingly turbulent environment. Frissen's (1999) evocation of an "archipelago" is very apt for describing these new horizontal relationships at the operational level. In such a world of interdependent clusters of organisations the role of the state in guiding in a goal oriented way what these organisations should do or when they should change strategies or decide on collaborations etc. no longer exists. The capacity to act in a decentralised and flexible manner demands the transfer of authority to such institutions in a more profound way. To cope with these transformations towards horizontal cooperation on the operational level, the state needs to learn, as Mayntz (1993) proposes, to *manage interdependencies*, i.e. to create the adequate conditions for cooperation and to accompany the process

[5] Functional pressures like shorter product life cycles, greater service variety and greater user choice sustain this transformation (see Ferlie and Pettigrew 1996). All these pressures demand more flexible modes of production, accelerate the pace of internal change and the need for organisational learning. Above all, *networks* can be helpful in opening up new information sources that are increasingly spread among sectors and institutions and which are becoming increasingly sophisticated and complex.

of adaptation and re-adaptation. In this unfolding context *enabling to learn* begins to be substituted for the main notions of the efficiency state, i.e. how to design and steer. Therefore, the implementation of new public management principles leads to some unintended outcomes. It becomes increasingly difficult to guide the behaviour of public sector organisations, even by using general frameworks and contracts. A vertical organisation of governance, even with operational discretion, is not adequate for the organisation of horizontal cooperation. The maintenance of specific and fixed policy goals in an environment where constant adaptation is needed seems to be counter-productive. Contracts must therefore become more flexible or should be abandoned altogether.

The literature on the "*hollow state*" has further evoked some of these arguments (Milward and Provan 2000; Klijn 2002; Lowndes and Skelcher 1998). This approach in the literature on public administration has focused on recent trends of "contracting out" many of the services of the state to so-called "third-party organisations" or to the private sector. Contracting out leads to an increasingly interdependent number of networks in public service provision. Joint production, however, has its own rationales and rules of organisation. In addition, one sees as a "result of specialization and growing demands of consumers….chains of networks of specialised firms" and a dispersion of specialised information among various actors (Klijn 2002: 156). Klijn arrives at the same conclusion as sketched above:

> *"This characteristic of interdependency increases the importance of horizontal relations at the expense of vertical relations. Quality of products and services increasingly rely on the chain between organizations instead of on the performance of one single organization" (ibid.).*

Also, at the level of political governance, there is a growing awareness of multi-faceted problems and the interactive effects of intervention measures. It is said that the new public management procedures are overly based on the logic of incentive setting in vertical principal-agent relationships and therefore fail to identify horizontal effects of these structures. New public management relies on "hierarchies of objectives, targets, and performance measurement" (Davies and Rhodes 2000: 96) that are not suitable for horizontal and inter-organisational contexts. In such a context a manager cannot impose objectives on other participating organisations. Scott (2003) asserts that centralised command and control structures become dysfunctional and obsolete as the increase of horizontal contacts shifts the centre of the organisation to the "boundaries" rather than to the core. Managers are obliged to learn to manage horizontally as well as vertically (ibid.: 12). Management by persuasion and objectives that are agreed between independent actors are needed in this situation. A "matrix management style" where managers build and uphold links and institutionalise strategic alliances seems to be more suitable in the "post-modern" context. The task of the network state is to refrain from the manipulation of behaviour and to foster "reciprocal relationships" in strategic collaborations as well as to install long-term relationships that are based on trust (ibid.).

In summary, the coordination and interdependence problem is identified in this "narrative" as the central problem in a complex world where apparently only alliances can still generate the necessary resources to survive in a world full of competition. Both in administrative theory and practice, we are experiencing a shift from "substantialist self-action" definitions of organisations to "substantialist interaction definitions" (Scott 2004: 13). Organisations change according to varying circumstances and they become "inseparable from the transactional context in which they are embedded" (ibid.). This conception of organisations adheres to a relational and process view. Even the identity of institutions is constructed through the process of interaction with other organisations.

A systemic and network approach can help to address these fundamental changes in the production of resources. The system approach allows interaction effects to be taken into account and helps to design more encompassing strategies. The network approach takes into account how actors and organisations behave in horizontal medium and long term relationships. Contracts, incentives and control, the trademarks of the efficiency state, have been replaced by notions of trust and social capital (Putnam 1993) which are at the heart of reciprocity and collaborative action in horizontal relations.

The message of this "post-modern" turn in global governance theory is that modern organisations must invest in both competition and cooperation and that the latter becomes a central aspect of organisational survival in a complex and interdependent world. The governance design of the efficiency state is too much focused on competition between agencies. In addition, the theoretical background of the efficiency state always assumes "opportunistic behaviour among organisations". The notions of trust and learning are not on the radar of the efficiency state and this has counter-productive consequences.

These reflections have unequivocal consequences for political governance. Just as managers at the operational level are supposed to delegate competencies to the "boundaries" of their organisation and deal with the organisation of "boundary contacts", political decision makers should not be striving for prescriptions, objectives and controllable targets. Governments should be satisfied with identifying a problem and framing the context of a situation (Paquet 2001). They should be there to stimulate learning and the finding of new and interesting solutions. As knowledge is widely dispersed, the stimulation of various decentralised solutions can be helpful (Klijn 2002: 161). The stress is on the stimulation of "permanent" learning in multiple places. One should not stop once a solution is found and the problem is fixed, but should continue to look for other solutions (Schick 2003). One shall not find – here evolutionary economics and the sociology of organisations agree – one optimal solution. In addition, each situation and country is different. As a consequence, policy makers should not focus on control and priority setting, but instead reflect on how to guide "learning processes" better and how to create the necessary conditions for learning. They should do everything to enable actors in the field to develop long standing horizontal contacts, to foster the building of social capital and networks. The state should be a catalyst for horizontal coordination across organisational and systemic boundaries (Lind 1992). A turbulent environment needs less steering from above and more adaptable models and flexible structures. In the new turbulent environment, strategic management is no longer sufficient. What is required instead is the development of capacities for collaborative action, the "collective action by dissimilar organisations whose fates are positively correlated" (Paquet 2004: 203).

In addition, reflexivity becomes an important asset of government action, i.e. the ability of the government to reflect on public sector arrangements as a whole system. This requires different information than that needed in the efficiency state; more encompassing and comprehensive diagnostic tools are required that are able to take into account the interaction effects of governmental action. However, without the intention to better control the system, but rather to learn how to better "structure" for improving the self-governing capacities of the autonomous and decentralised entities.

Perhaps, most important in this context – and here evolutionary economics has been the primary inspiration – is the question of policy objectives. In the 1960s, emerging research policy began to develop its own programmes and areas of concern that were financed by research grants with strings attached. In the age of the efficiency state objectives were broadly outlined in contracts and linked to ex post evaluations. In the network state political objectives should be restricted to structuring purposes for the benefit of good working networks. Even if objectives are defined for such networks, processes can result in an adjustment of such objectives and policy makers should be prepared to accept such a shift in objectives. Good working processes become more important than the linear realisation of objectives. A second dimension entailed in the enabling state is that policies become increasingly subject to interdependent decision making. New public management insisted on the authority of the principal to develop the general objectives. In the network state this should be the task of all parties involved. In other words, common problem solving becomes the dominant rationale of the governance design, especially in research policy (Hackman 2003). Policy making should emerge and evolve in collaborative relations and should not be planned and pursued. Priority setting is part of the management of interdependencies.

Such a change in orientation demands a considerable adjustment by policy makers. If one can no longer judge actors' performance in terms of objectives and output and if trial and error and emerging policies become part of policy making then the legitimacy of policy makers becomes a problem. Processes can seldom be sold in terms of success and failure of policy making and policy makers need a long breath to demonstrate the effectiveness of such a network approach.

5. Conclusions

The following table summarises the changes in rationales during the "age of innovation" characterising science, technology and innovation policies nowadays. They focus on interaction, "value for money", efficiency and participation.

Table 1: Key notions in the "age of innovation"

Level of experiences of policy-makers	Foresight Research collaboration between academia and industry; public-private partnerships Policy makers as active brokers and priority setters
Level of production ideas	Technology as a decisive variable for economic growth Industrial and research policy growing together Interactive model of innovation emerging Investment into knowledge creation on all levels (public sector, business, society) Strategic research as new category
Level of global governance: Steady State	Value for money Directing resources from unspecified to specified purposes Introduce active search for money in public sector, competitive tendering
Level of global governance: Efficiency State	Efficiency and effectiveness of governance processes Contracts with clear objectives, monitoring procedures and output criteria Markets and competition Accountability and responsiveness
Level of global governance: Good Governance	Participation of stakeholders

It was demonstrated above that the governance design in research policy making in the age of innovation was subject to changes on all three cognitive levels that were identified to be of relevance for the governance of research policies. While changes at the level of experiences of research policy makers and theories about the production of knowledge were certainly linked to and reinforced each other, developments at the global governance level were independent from the research sector. Nevertheless, the governance principles of the research sector had to be adapted to these broadly encompassing principles. Despite such autonomous changes at the global governance level, the analysis suggests that the principles pushed forward by neo-liberalism in the form of the steady and efficient states were conducive to the changes which simultaneously took place at the level of research policy making.

The steady state supports the move towards closer cooperation in science/ innovation between academia and business enterprise by compelling public sector research institutions and scientists to become more responsive and look for resources outside of government.

The efficiency state makes public sector institutions “fit” for acting as “entrepreneurs”, by organising internal structures in more efficient and effective ways. The combination of fewer guaranteed resources and contractually agreed objectives leads to stronger interest from such institutions to collaborate with business. Though the changes in governance structures were not developed at the level of the research sector, they strengthen the trend for the opening of the research sector, and encouraged it to be more responsive and accountable.

This is strengthened by the emphasis on participation in good governance. Again, research institutions have to develop a more open attitude for their organisation. This dimension is, however, not directly linked to neo-liberalism. It adds complexity to the working of the research institutions. The efficiency advantage, however, is that, by integrating stakeholders in priority setting, more relevant information is made available and research projects become better aligned with the interests and problems of user systems.

All in all, there seem to be no overtly conflicting objectives in the policy rationales that have emerged since the 1980s. There are a number of relatively autonomous developments at each ideational level but these developments are compatible with each other. Though the global governance ideas were not designed to encourage collaboration in research, their adaptation by the research sector contributes in many ways to the feasibility of changing the attitudes of researchers and enterprises in the direction of an “innovation enterprise”.

While these rationales are more or less institutionalised in most countries’ innovation policies, the “narrative” of network governance is still emerging. In various parts it contests fundamental belief systems of the efficiency state. It focuses on the building of horizontal relations. The following figure summarises the key notions.

Table 2: Key notions in network governance

Level of experiences of policy-makers	USA as example Research collaboration between academia and industry; public-private partnerships continue to be the major aim; "entrepreneurial university" comes to the fore; organisation of "science-innovation interface"; changes in intellectual property rights: delegation to operating research institutions Policy makers as network brokers
Level of production ideas	Blurring boundaries; co-evolution of economy, science and politics; non-linear processes of innovation, unpredictable knowledge creation; foster learning processes; policy makers as "facilitator" and "adaptive agent" Systemic view of innovation
Level of global governance:	Management of interdependence of autonomous public (and private) agencies in horizontal relations; Creating trust and fostering reciprocal relations in networks; Consensus orientation in policy making; emergence of changing priorities in networks; Encompassing and reflexive view of problems and solutions Horizontal organisation of governance structures Not objectives but framing and structuring horizontal relations Enable to learn and react flexibly Coordinate different governance organisations

One sees that the new thinking is based on ideational developments both on the production and the global governance level. The key term becomes "evolution": Knowledge production and governance are seen as emerging phenomena. They are constructed in the process of making. As a consequence government should refrain from objectives, targets and ex post evaluation on the base of output. Networks must be flexible and it is more important to grant discretion to these networks than to determine in advance what should happen. There is a turn from "foresight", priority setting, target building, monitoring and control to facilitation, catalytic and reflexive activities of government. In fact, the accent here is less on government than on all actors that are involved in the managing and production of the resource knowledge. Government should have no dominant position in governance.

The analysis should have made clear that today there is not one uniform and coherent governance frame that is instructing policy makers what to do. The mix of policy-instruments we find today is not based on a "grand design" but is nourished by different ideational sources. This must not be a problem as long as the different rationales are compatible with each other. The analysis demonstrated that we find indeed for the major part such compatibilities in the governance design during the "age of innovation". The disturbing factor is the emergence of a new global governance design in the form of the network state that is contesting above all the role and function of the state in the governance of innovation. The emergence of this new frame seems to be linked to the autonomous dynamic on the level of knowledge production that is stimulated by emulation, new innovation theories and the efficiency state. New forms of knowledge production and diffusion emerge that seem to be in need of a different style of governance. As long as the efficiency state, in combination with good governance and the steady state, prevails, one can expect a rising tension between the operational mode and the governance design. In the long run we may expect a critical juncture that helps to institutionalise the network state as the adequate answer to the proliferation of horizontal relations in innovation policies. This, however, is only possible if this kind of tension is developing in most policy areas. Global governance frames do not change according to sectoral policy developments. They are reflecting the overall government philosophy on how to organise political governance. Only if the steady and efficiency state and good governance produce similar tendencies to the prevalence of horizontal relations in other policy sectors, the rationale of the network state has a chance to become the dominant governance model in innovation policy.

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Changing Regimes of Science and Politics: Comparative and Transnational Perspectives for a World in Transition

Daniel Barben

Introduction

These are times of rapid change. "Globalization," the "information age" and the "knowledge society" – our world is undergoing transformations that are often felt to be fundamental and new, yet at the same time seem unclear in their particular direction, quality, and outcome. The perceived changes have engaged both social scientists and the public. While distinctive, often catchy designations can help bring our attention to something new that otherwise might not be perceived, they also may overestimate the quality of the new, or neglect that it has already been there in one way or another. Critics have often claimed that these phenomena were not new at all. The fact that the terms pointing to "the new" could gain an overwhelming presence in scientific and public discourses does not indicate that they are simply right, but that they help chart these phenomena to a considerable extent. However, times of rapid or fundamental change render disputes about how best to qualify and understand them both unavoidable and necessary.

This also holds true for the role of science and politics as subjects and agents of change. For example, the term "mode 2" has become the focus of debates about a new mode of production of scientific knowledge and the importance of political robustness; or the term "triple-helix" has efficiently communicated new arrangements between research, business, and government as crucial for current science-based innovations (Gibbons et al. 1994; Etzkowitz/Leydesdorff 1997). In this article, I do not want to engage in these debates particularly, but rather in the more general themes of changing regimes of science policy and the shifting boundaries between science and politics.[1] Again, all these debates imply rather far-reaching changes in the configuration of science and politics, which requires further specification as to the extent to which a particularly new quality can be identified.

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In section one I will outline some elements of the presumed "old" configuration of science and politics. Hereby, science and politics become visible as separate from, but also as connected with each other in various ways. This portrayal will not be comprehensive, addressing primarily the post-World War II period. It will show that changes in the relationship between science and politics have taken shape for various reasons and at specific times in modern history.

Next, in section two I will outline more recent changes in the configuration of science and politics that have had a mutual effect on each domain. I will show that the "vertical" differentiation of politics at the national, supranational, and international levels affects not only social institutions, but also science. Then in section three I will demonstrate that the specific characteristics of particular sciences matter in respect to how they concern politics and social institutions at various levels. In these latter two sections I will focus on sciences that are closely related to the development of high-technologies. I suggest that the changing relationship between science and politics should be analyzed from the point of view of their interdependency and mutual shaping. Finally, I will articulate this perspective – which has recently been put forth prominently in the contexts of "social shaping of technology" and "co-production" (Sørensen/Williams 2002; Jasanoff 2004) – with a regime analytic framework. Such a framework suits the task of integrating the various scientific and technical, institutional and organizational, practical, discursive and normative dimensions of social life in ways such that conventional conceptual oppositions between structure and agency, macro and micro, stability and change can be transcended.

On this basis, the ultimate goal is to present elements of a framework for comparative analysis of science and politics. While an elaborate review of traditions of regime analysis cannot be undertaken here, in section four I will at least propose a generalized concept of regime that is able to integrate various contexts and traditions of regime analysis. It is important to note that to date there is no general regime theory or framework of analysis that provides the appropriate references for integrating the various contexts and issues at stake. The main argument that I am going to make in this article is that the complexity and dynamics of recent regime changes require comparative as well as transnational perspectives. I will end with some conclusions for science and technology studies and respectively science policy studies, the two main science-related social science fields.

1. The post-World War II order of science and politics

It has often been assumed that, up until the post-World War II era, there had been a clear boundary between science and politics (as well as, yet to a lesser extent, between engineering and industry). While it was considered the obligation of scientists and engineers to pursue true knowledge and efficient technologies, the application of science and technology was seen as the responsibility of government and industry. This distribution of obligations and responsibilities found its expression in institutionalized norms and codes of conduct (Price 1965). They were characteristic for both military and civil affairs: scientists and engineers would create new weapons but deny any responsibility for their application; and they would develop new products and processes but reject being held accountable for the consequences of their use.

Two major events have challenged this constellation. First, the engagement of prominent physicists in the Nazi efforts to develop an atomic bomb (as well as other weapons), and the actual launch by the Americans of two atomic bombs on the Japanese cities of Hiroshima and Nagasaki in August 1945, led to fundamental questions about the role of physicists. Physicians also came into question because of their involvement in Nazi medical experiments, which inspired the reformulation of basic medical ethics in the Nuremberg Code of 1947 that followed the war-crimes trials. In the face of these horrible events, scientists themselves started debating their power and responsibilities (Schweber 2000; Annas/Grodin 1992). Second, the new social movements that emerged in many countries between the mid-1960s and mid-70s criticized – in addition to the continuing importance of military Research and Development (R&D) – the social, in particular the environmental and health, impacts of industrial production as often severely dangerous but neglected in public until proven significant (Brand 1985; Sale 1993). The positive reception of such criticisms by various social groups led to a higher awareness of potentially unwanted impacts of industrial production, and/or the use of its products, on the part of those actors concerned with technology development in engineering, industry, and government. Thus also scientists and engineers in industrial R&D were forced or encouraged to take into account an ever broader spectrum of concerns and responsibilities in their work, among them various risk, ethics and privacy concerns. In the end, fundamental changes in the relationship between science, politics, and industry occurred which led to increased accountability concerning issues that were previously most often considered outside the domain of scientists and engineers (Ravetz 1971; Wynne 1992; Lash et al. 1996; Weingart 2001).

Before these exemplary events gained prominence in the 20th century and raised awareness of the political and societal impacts of science and technology, both science and engineering had long become part of various domains of society. For instance, they provided the knowledge and skill basis for an increasing number of sectors of modern industry, i.e. its processes, forms of organization, and products. With the industrial revolution, science and engineering had themselves become an important part of the enterprise of industrial capitalism, transforming the modes of production together with the infrastructures of society (Landes 1969; Freeman/Soete 1997). In consequence, governments developed more or less elaborate frameworks for funding research and for implementing science and technology policy. This led, among other things, to the founding of new institutions such as institutes of technology and polytechnics, the purpose of which was to carry out R&D and provide an appropriately skilled workforce. Furthermore, science and engineering became integrated into the procedures for regulating technological risks by providing measures and means for assessing them (Wynne 1989; Jasanoff 1995). An early example is the risks associated with the steam engine. However, connections between science, industry and politics that had emerged in the 19th century (and had even earlier roots) did not undermine the conventional notion of separate domains of human activity, their norms and values.

The post-World War II order established stability in the world in an unprecedented way. A basic condition for this stability was the balance of power between the two world super powers, the USA and the Soviet Union. This power balance was fortified by a huge arsenal of nuclear weapons on both sides of the Cold War division. By virtue of its potential for mutual destruction, the cumulated weaponry encouraged the peaceful behaviour of the two dominant powers. This situation also ultimately encouraged both super powers to enter talks about limiting the nuclear arms race. This context of international politics was the first in which a concept of international regime was developed. The political science discipline of international relations has also been the prime context of regime theory so far. The notion of international regime highlights the willingness of sovereign nation-states to shift power to a mutually agreed configuration of values and norms, rules and procedures – i.e. the core regime elements – in both the common interest and the nation-states' own interest (Krasner 1983; Mayer et al. 1995; Hasenclever et al. 1997).

In the decades after World War II, welfare state institutions flourished, enabling economic and societal prosperity in the most advanced countries of the West to a previously unknown extent. These fundamental changes inspired analyses of welfare state – as opposed to "laissez-fair" – regimes of capitalism. This context of regime analysis highlighted the relationship of politics and the economy at the national level, emphasizing that each historical phase provides a range of options for societal organization. While the political and economic configurations could be shaped depending on national institutions and traditions, nation-state societies would face not only problems specific to their own historical development but also problems that were common to other countries. Thus transnational dynamics of how to successfully adapt to new situations were also considered important. As regards science and technology, they were analyzed, if at all, in terms of their economic importance, but mostly without reflection on their form and content (Gourevitch 1986; Lipietz 1985; Esping-Andersen 1990; Jessop 1995).

The balance of power between the USA and the Soviet Union limited the range of options of societal and political change for both the main allied countries and the newly constituted "Third World" countries. The developing countries had successfully become independent through decolonization in the 1960s, a major process of political and social change in the 20th century. These countries would later become subject to modernization regimes, with science and technology considered fundamental for economic growth. Such regimes were usually shaped not only by national actors, but also by one of the super powers, or by international organizations (Sørensen 1990; Haggard/Kaufmann 1992).

At the international level, the stability of the world economy was supported by new international organizations, in particular the International Monetary Fund (IMF) and the World Bank – two core institutions of the "Bretton Woods" international economic regime (Schild 1995). The founding of these organizations was an answer to the economic crises of the 1920s and 30s on the one hand, and to the needs of reconstruction and development after 1945 (and after decolonization) on the other. The changes hereby represented were comprehended as "embedded liberalism," which appropriately characterizes the post-World War II order (Ruggie 1983). The United Nations provided a new framework for efforts to master challenges to the international community with respect to, among other things, peace and security, development, human rights, health and the environment, and cultural exchange. These areas of international politics also became the subjects of international regime analysis.

To sum up this brief sketch, I would like to draw three conclusions. First, the development of modern industry led to closer ties between science and technology, respectively – starting with physics and chemistry in the 19th century – to science-based technology and economic sectors. Second, the expansion of political functions, in particular in the form of welfare state and international institutions mainly after World War II, brought science – in particular economics, law, and political science – closer to politics. Thus the institutions of national and international politics were often associated with new bodies of scientific expertise that were to provide special knowledge for advising or legitimizing their policies. Third, both the engagement of scientists and engineers in bellicose projects of spectacular destruction – particularly in chemical warfare in World War I and, thirty years later, in nuclear warfare – and the environmental and health risks posed by industrial production and its products, generated claims for new forms of self-/regulation and accountability.

Against this historical background of various layers of connections between science and technology, politics and industry, the question becomes more pressing as to what has been changing in those relationships more recently. In the following, I will review recent changes in the configuration of science and politics. In modern societies, practices and institutions in both domains operate principally independent from each other, although they are often connected. I will first highlight changes in the configuration of politics at various levels, and then the changes in the configuration of science and science-based technologies.

2. Recent changes in the configuration of politics

At the international level – A historical event often presented to be a crucial starting point for recent international transformations is the suspension of the "Bretton Woods" regime in 1973 (Lipson 1983; Altvater/Mahnkopf 1996; Stubbs/Underhill 2000). Increased international trade and a number of financial crises put pressure on the international currency relations so that they became unmanageable under the rules that had been successful for almost thirty years. In consequence, the fixation of both the US dollar to the gold standard and the value of the world currencies to each other were given up. From then on, the currency relations would be left to the markets and not be supervised and supported by the IMF. Thus the global financial markets gained power over national governments in the sense that a widespread international disregard for a government's economic policies could lead to the dramatic fall in value of a national currency. An example is the drop of the French franc under the Socialist-Communist government of President Mitterrand in the early 1980s, which provoked a policy U-turn.

The IMF's main role since the 1970s and 80s became to assist countries in financial crises particularly through the so-called structural adjustment programs. In order to receive loans for overcoming an acute financial crisis, governments were required to take steps such as lifting trade barriers, suspending price controls, and reducing public spending and the budget deficit. The norms and rules steadily promoted by the IMF – and the World Bank – became later known as the "Washington Consensus" (Williamson 1990; 2000; Stiglitz 1998). While the IMF and the World Bank had initially been part of the UN system, they increasingly gained de facto primacy over the other UN organizations and programs, which is itself an indicator of fundamental change in the post-World War II era.

Economic liberalization became further strengthened by the founding of the World Trade Organization (WTO) in 1995 that succeeded the General Agreement on Tariffs and Trade of 1948 (GATT). Both institutions were based on the same values and norms of promoting free trade, but the WTO was granted more competence with respect to the realms in which free trade principles are valid and to the instruments by which these principles can be enforced (Hoekman/Kostecki 1995). Three agreements constituted the wide-reaching importance of the WTO: the updated GATT, the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS), and the General Agreement on Trade in Services (GATS). While GATT concerns the free trade in goods, the GATS requires the liberalization of the service sector, and the TRIPS agreement demands an extensive acknowledgment of intellectual property rights, among them patents to protect inventions. All member countries – as well as the countries wanting to become a member – are obliged to acknowledge the WTO agreements. In cases of conflict, the WTO possesses powerful institutional means for settling disputes and enforcing sanctions.

Put briefly, the consensus underlying the politics of globalization during the 1990s assumed that the liberalization of world trade, which includes the deregulation and privatization of economic affairs within the nation-state, would create more beneficial effects than any form of so-called protective government policy. In other words, the fundamentally liberal idea proclaimed that granting power to the free markets was in the best interest of economic, technological and social development in both advanced industrial and developing countries (for competing perspectives see Bhagwati 2002; Stiglitz 2002). As long as the principles of the "Washington Consensus" were not fundamentally challenged in the public, they were simply considered "good economic practice" and state-of-the-art economics. This changed after the violent protests at the WTO conference in Seattle in 1999. After this event, and similar events that would follow, fundamental criticisms of the predominant economic policies of globalization voiced by some developing countries, transnational NGOs, and non-mainstream economists have received much broader attention (MacEwan 1999; Tabb 2001; Cavanagh/Mander 2004).

In addition to the international economic regimes, international environmental regimes and international technology regimes have gained importance during the past decades not only as such, but also with regard to science. International environmental regimes regulate, among other things, the protection and use of particular territories, natural resources or species such as the arctic, the ozone layer in the atmosphere or whales (Gehring/Oberthür 1997; Lansford et al. 2002). Science often plays an important role in the decision-making process of whether and how to implement an internationally binding agreement. For example, science is to provide the knowledge about the characteristics and causes of environmental problems as well as, if possible, sound solutions. International technology regimes concern particularly security and safety issues related to the development or application of technologies such as military uses of nuclear, chemical and biological technologies on the one hand, or risks related to the trans-boundary movement of products or technologies on the other. Economic regimes, for example the WTO, may contain regulations on the environment and on technologies. At the same time, environmental and technology regimes are of economic importance by setting limiting or enabling conditions for economic activities (Barben/Behrens 2001). Similar to the configuration of politics at the national level, international regimes have to balance the highly valued norms of economic and scientific freedom with the protection of health and the environment across borders.

At the national level – Liberalization policies as well as environmental or technology policies at the international level were promoted by national governments, who also constitute the members of internationally binding agreements. Often domestic policy priorities shape national agendas in international politics. On the other hand, priorities set in international politics can help governments change, or circumvent, national policy agendas. For example, after the election victories of the conservative governments presided over by Margaret Thatcher in the UK and Ronald Reagan in the USA in 1979 and 1980, "free market" policies experienced a general upturn (King/Wood 1999). On the other hand, "globalization" was often referred to as a process that leaves no alternatives for national policies than adaptation to global economic developments. In this view, national policies are basically seen as forced to comply with the "free market" goals of deregulation and privatization. It has been a long-standing dispute in the public as well as in the social sciences as to what extent national governments are still able to exert sovereign power as set out in their constitutions. The extreme positions have been that national governments lost their ability to design policies according to a deliberate democratic will completely, or that they have not lost this ability at all. The policy areas considered particularly sensitive in this regard are those that concern economic competitiveness (Cerny 1997; Scharpf 1998; Rhodes 1998; Evans 1998). Competitiveness is usually evaluated in relation to national economies, particular economic sectors, or individual companies. Since the performance of economic sectors as well as of companies is also affected by conditions set by national regulatory frameworks and national infrastructures, business interest organizations and companies tend to exert power on governments in order to achieve more favourable conditions.

It had always been important to governments of capitalist democracies to support the "national industry," not least in order to improve the prospects of electoral success thanks to a prospering economy. Recently the tasks of national economic growth and employment have changed in meaning, though remaining as important as ever. A more liberal international framework and increasing transnational economic activities such as foreign investments by transnational companies brought about a power shift on behalf of these companies against the national governments (Crotty et al. 1998). Since transnational companies can always threaten to dislocate their activities or to leave a country completely, governments are pressured to improve the conditions for these companies that are the most powerful economic actors. Due to the increased significance of international competition in the global economy, governments as well as a variety of other actors stress the importance of various policy fields for improving or sustaining competitiveness (Cerny 2000; Mudambi 2003; Gamble/Wright 2004). Areas in which governments started competing against each other more and more have been taxation, labor market, welfare, infrastructure, environment, and science and technology policies. Often de- or re-regulation in favor of large corporations or start-up companies was a widespread response considered most promising for enhancing the economic performance of a nation, combined with efforts to strengthen the capabilities for market-oriented innovations and behavior. The policy instruments that were available to individual governments, and the significance and effects they would have, differed in principle depending on the type of political economic regime a particular country belongs to (Crouch/Streeck 1997; Hollingsworth/Boyer 1997; Kitschelt et al. 1999; Hall/Soskice 2001). For example, the debate on "varieties of capitalism" suggests that the "liberal market" and the "corporatist market" regimes differ with regard to the institutional degree to which associations or government agencies are regulating the markets.

As regards science and technology policy in particular, governments developed and combined a broad range of policy instruments in order to meet the overall goal. Of course, not all policy instruments were new, but even if not they were often given a particular emphasis. For example, governments continued to provide funding for basic research, but they were increasingly looking out for those areas that might be most up-and-coming and likely to have a broad economic impact. Since decisions about which areas should be granted funding were characterized by high degrees of uncertainty, governments would not only rely on the advice of science and engineering experts, but often follow the decisions made by the governments of the main competitors. The most significant policy changes took shape since the 1980s with respect to new modes of linking research to commercialization. To this end, institutional mechanisms have been created that would allow, encourage, or oblige researchers to engage in private commercial ventures or in market-oriented science and technology transfer. In addition, governments worked on improving the conditions for start-up companies or innovative small and medium-sized businesses. Generally, governments reorganized, and partly extended, their efforts in science and technology policy, although to a varying degree. For example, in the USA the Bayh-Dole Act of 1980 (Public Law 69-517), the Stevenson-Wydler Technology Innovation Act of 1980 (Public Law 96-480), the Technology Transfer Commercialization Act of 1980 (Public Law 106-144), the Trademark Clarification Act of 1984 (Public Law 98-620), the Federal Technology Transfer Act of 1986 (Public Law 99-502), the Omnibus Trade and Competitiveness Act of 1988 (Public Law 100-418), and the National Competitiveness and Technology Transfer Act of 1989 (Public Law 101-189) were landmark legislations that were to set standards for systematic commercially oriented science and technology policies in other countries. As a consequence, traditional institutional boundaries between the private and the public realms were shifted on behalf of the former, i.e. for example, by enabling and promoting private exploitation of publicly funded research. The debate about science and technology policy that has particularly been concerned with competitiveness (thus also touching on the importance of other policy fields) forms the context of innovation regime analysis (Nelson 1993; Lundvall 1992). So we find a partial overlap between the research on innovation regimes and that on "varieties of capitalism."

At the supranational level – Within the last fifty years, the process of European integration has brought increasingly fundamental changes for all member countries of the European Union (EU). Starting out with the Treaty establishing the European Coal and Steel Community in 1951, the European Community has been functionally expanded to the European Economic Community (EEC) and the European Atomic Community (Euratom) in 1957, to the Merger Treaty establishing a single Council, a single Commission, and a single operative budget in 1965, to the Single European Act as the first major reform of the Treaties in 1986, to the Maastricht Treaty in 1992 that institutionalized cooperation in the fields of foreign policy, defence, police and justice under one umbrella, the EU. This treaty also created the economic and monetary union, put in place new Community policies in the areas of education and culture, and increased the powers of the European Parliament. Since the mid-1980s, the goal of establishing the common market has served as the prime task for modernizing the European Community by eliminating internal barriers for the transfer of capital, goods, and work force. Although the common market has served as a driving force in the process of European integration by enhancing overall economic competitiveness, this process cannot be reduced to a mere free trade project. A number of policy areas the EU has increasingly engaged in, including environmental, social and employment policies, make it clear that the EU is much more than a common market enterprise. The rising number of policy areas, together with the strengthening of Community institutions as agreed upon in the Treaties of Amsterdam and Nice in 1997 and 2001, are indicative of a fundamental supranational transformation and reorganization of European politics. In consequence, government in the EU has become a complex multi-level configuration at the national and supranational levels (Grande/Jachtenfuchs 2000; Crouch 2000).

Science and technology policy already played a role in the treaties of the 1950s – with regard to the old industries of coal and steel and the new industry of nuclear energy – , although it was not a designated area of Community politics in the EEC treaty. The goal of the common market, in particular, brought up the idea of a European technological community. Since the late 1980s and early 90s, research and technology policy became part of legal agreements that were mainly intended to strengthen the scientific and technological basis of European industry (Sharp 1985; Peterson/Sharp 1998). Hereby, Research Framework Programmes have been of major importance for outlining and pursuing research and development priorities together with a broad variety of instruments. The current Sixth Framework Programme is oriented towards the creation of a "European research area." In addition to funding research and technology across Europe, Community activities are also involved in regulating environmental and health risks, patenting, and ethical issues. Thus science and technology policy became an integral part of the multi-level configuration of politics in the EU (Grande 2001; Dresner/Gilbert 2001).

In sum, I would like to draw three conclusions here. First, politics has become increasingly differentiated between the national, international, and supranational levels (and, not to forget, the regional and local levels) such that a complex multi-level configuration of politics has emerged. At the same time, the design, coordination, and implementation of policies at all levels has been confronted with a broad variety of problems and conflicts (see for example Sakamoto 1994). Second, within this configuration, international regimes – and, especially as regards Europe, supranational regimes – have gained importance against the nation-states. Because of the significance of "free market"-oriented international economic regimes, there has been a power shift to large transnational companies, and also an increasing transnational competition among nation-states in various policy fields, in particular in those policy fields that are considered important for economic competitiveness such as economic, financial and fiscal policies. However, the market-oriented transformations since the 1970s, including the dynamics of globalization since the 1990s, have not left national governments without any room for manoeuvre. Divergent options for government action have remained available – although in the different policy areas only to a greater or lesser extent. In addition, the nation-state is still the prime frame of reference for shaping political, social, and cultural identities and actions. Third, changing regimes of politics within the evolving global economy have rendered science and technology important not only for enhancing competitiveness, but also for assessing a broad variety of problems and for creating solutions in the policy areas concerned.

3. Recent changes in the configuration of science

The second half of the 20th century was characterized by an increasing number, and dynamic, of high-technology developments. As political change has influenced particular developments in science and technology, these developments have had an influence on the configuration of politics and policies. For example:

Nuclear technology – At the end of World War II nuclear technology was not only proven to be an immensely destructive technology for military purposes but was initially also considered a technology able to produce unlimited amounts of cheap and clean energy. Thus it would fulfil the constantly growing demand for electrical power in industry and – with a whole new set of appliances becoming available – in households. However, the development of nuclear energy turned out to be much more expensive than initially expected. It also demanded the active support and coordination of the state, without which nuclear energy would not have been developed – although, in later stages, the development of nuclear energy took different forms in different countries as regards the relationships between state and industry (Campbell 1988). In addition to government funding, government agencies also faced a variety of possibly serious hazards that required new institutional efforts in the area of safety and risk regulation. Safety and risk issues were in particular related to the construction of nuclear power plants, the operating procedures and the training of the work force, the nuclear fuel reprocessing, and the final storage of nuclear waste that would remain active in the environment for a very long time because of the particular half-time of nuclear material (OTA 1984b; Perrow 1984). The basic characteristics of nuclear energy, including its state-centred structure, made nuclear energy a prominent subject of long-lasting conflicts in many countries. While nation-state agencies have mainly been responsible for regulating nuclear energy, safety and risk management also required establishing an international regime. Due to the risks inherent to nuclear technology, safety standards for nuclear power plants had to be set and monitored. However, the worst-case accident of Chernobyl in 1986 could not be prevented, and its consequences would cross many national borders and affect many generations to come. Since nuclear material and technology could be used for military purposes, it was also an important, and internationally widely acknowledged, goal to prevent more and more nation-states from achieving the capacity to produce nuclear weapons. The International Atomic Energy Agency (IAEA), established in 1957 as part of the United Nations, serves as the world's most important intergovernmental organization in the area of nuclear technology. After the collapse of the Soviet regime in the late 1980s, nuclear proliferation became an even more dangerous issue. Now not only nation-states, but also criminal or terrorist groups could potentially try to sell or acquire nuclear material, making the monitoring and controlling of such unwanted activities much more difficult than before, if at all possible.

Information and communication technology – Microelectronics brought about a revolution in information and communication technologies. Though started already in the 1940s, it came to full fruition in the 1980s. Since then, hardly any area of modern life has been left untouched by microelectronics. It thus became a model for a most powerful key technology with the potential to become part of almost all economic sectors, and by virtue of innovation to open up and gain immense markets (OTA 1985; Nelson 1984; Brock 2003). Due to the overall decentralized, yet increasingly international, structure of information and communication technologies, the political challenges associated with them depend on the areas of application and modes of use, and on the institutions and actors involved (Rosenau/Singh 2002). For instance, the widespread electronic storage and use of personal information brings up privacy issues – as regards both corporate and government demand for, and use of, sensitive data. Or the extensive production and use of electronic devices such as microchips, computer monitors, or mobile phones may cause safety problems for human health in one way or another. An issue related to the particular "immaterial" quality of information technology has gained overall prominence and become subject of controversy and regime building, namely intellectual property rights (OTA 1986).

Since a great number of information and communication technology products can be easily copied and multiplied, inventors and innovators have feared the infringement of property rights. Industrial property rights, in particular patenting, had been created as an institutional form of protecting private inventions in the course of the industrial revolution in the mid and late 19th and early 20th centuries. At the same time, patenting required the publication of inventions so as to expose them to public scrutiny, and to make them available to further innovative activities by actors other than the initial inventors. It was the widespread diffusion of electronic information technology that inspired the conceptual extension of industrial property rights to intellectual property rights (Boyle 1996; Halbert 1999). Since information and communication technology had become a driving force of the rapidly globalizing economy as well as a significant element of everyday life around the world, the actual acknowledgment and protection of intellectual property rights became a crucial issue to those producing computer software, music or films, among other things. It is the agreement on TRIPS of the WTO that pays particular attention to this technological change in the international economy. The regime constituted by the TRIPS agreement provides powerful means for demanding from nation-states that they respect, and enforce, intellectual property rights (TRIPS 1994; Matthews 2002). For example, as a precondition of membership in the WTO, China was required to officially acknowledge and protect intellectual property rights both in international trade and at home. The underlying reason for this kind of international conflict is the disadvantaged position of developing and threshold countries in the global economy. While these countries often have strong aspirations to catch up and close technological (and thus economic) gaps, they usually lack the technological and financial capabilities to either produce or acquire high-technology in a legal manner. As the global economy is characterized by fundamental disparities of wealth and power, the issue of intellectual property rights has also an ethical dimension. This applies for the issue of the "digital divide" between the global North and South (an issue that goes beyond problems of intellectual property rights, and concerns also the people of developed countries, see Warschauer 2003) as well as, more specifically, for health care related pharmaceutical industry issues (see below). But intellectual property protection has also become a legal issue in the advanced industrial countries (including the EU). The Internet, for example, enabled people to easily exchange or download electronic information. Since this affects the interests of the software, music, and film industries, these branches lobbied for a strict enforcement of intellectual property rights against what they consider illegitimate commercial and private users. This issue has been controversial for quite some time not least because the position taken by industry denied a right that had been previously taken for granted, i.e., the right to make copies for non-commercial private use.

Biotechnology – With the advent of genetic engineering in the early 1970s, biotechnology started emerging as a new powerful key technology of the future. Based on the scientific breakthroughs and findings of a broad variety of disciplines, in particular molecular biology, which revolutionized both the scientific and popular understanding of life, biotechnology was to open up new horizons of technological innovation in a broad variety of economic sectors (Bull et al. 1982; OTA 1984a). While biotechnology was established as a new integrative field that extends our understanding of life and the potential to manipulate it according to an unlimited variety of purposes, the development of biotechnology took place in an uneven way and speed due to its nature as a cross-sectoral technology. Accordingly, the interests of public and private actors and the given or prospected markets have differed significantly in the sectors of medicine, agriculture and foods, environment, energy and raw materials production, among others. Although the multiple scientific and engineering disciplines that constitute biotechnology have contributed to an ever more sophisticated understanding of the unity of life, transfers of knowledge or methods between the different sectors often faced more difficulties than initially expected, as did the successful development of new products in general. In addition to intra-technological differences, differences between countries played a significant role in the development of biotechnology. Certain countries, in particular the USA and Great Britain, were better able to build the scientific and technological basis for biotechnology as well as to commercialize it than others, for example Germany. Various reasons contributed to this fact; however, they can be mainly attributed to the diverging performance of national innovation regimes (Jasanoff 1985; Casper 1999). Biotechnology had become a prime example for the crucial importance of close collaboration between academic research and corporate actors, in particular venture capital and transnational companies (Kenney 1986). This characteristic requirement of innovation in biotechnology could be better met by countries whose political, institutional, and cultural traditions belonged to the "liberal," as opposed to the "corporatist or negotiated" type of capitalist regime.

The notion of national innovation regime refers to the capability of academic organizations, companies, and government agencies of a country to generate innovations. Since the successful implementation and appropriation of innovations also depends on further societal factors, innovation regimes intersect with the institutions and practices regarding risk management, patenting, ethics, and acceptance politics. All these areas have contributed to the social configuration of biotechnology at the national level. Due to the broad resonance of biotechnology issues in society, claims for new forms of social accountability and consultation in science and technology affairs were raised. This led to the programmatic integration of research on ethical, legal, and social issues (ELSI) into the Human Genome Project. Actors related to new social movements or to a variety of NGOs often successfully argued for the implementation of participatory technology assessment procedures such as consensus conferences (Joss/Durant 1995; Abels/Bora 2004).

The issue areas of risk management, patenting, and ethics have also been important at the supranational and international levels (Barben/Abels 2000). For example, after risk management had been an intensely debated issue at the national and local levels, it also became part of supranational and international arenas. Safety and risk management have been integrated into the regulatory set-up of the EU dealing with the same issues as at the national level, but often in conflict with differences among the member states (Levidow et al. 1996). At the international level, risk management of biotechnology attained particular consideration with the Cartagena Protocol on Biosafety that had been negotiated as a multilateral environmental agreement under the Convention of Biological Diversity (Schomberg 2000). Since the Biosafety Protocol pays particular attention to the precautionary principle with reference to environmental and health risks, there is some tension with the WTO agreements, in particular the Agreement on SPS (Application of Sanitary and Phytosanitary Measures) and the Agreement on TBT (Technical Barriers to Trade), which state the clear priority of free trade and thus acknowledge risk issues only to the extent of definite scientific proof (Murphy/Chataway 2003). Within the EU biological patenting has proved a deeply contested issue both at the supranational level and between the European and the member state levels. While some areas of biotechnology had become subject to industrial property protection at the international level in accordance with the industrial development of microbiology or plant breeding earlier in the 20th century, the agreement on TRIPS enhanced the intellectual property protection in all areas of biotechnology. Despite the overall high importance of intellectual property protection for the WTO – expressing hereby the dominant position of the most advanced countries and industries – the agreement on TRIPS also embodies significant compromises negotiated between the fundamentally unequal WTO members. Dramatic health crises such as the one caused by AIDS in several countries helped developing and threshold countries like Brazil in their struggle to obtain exemptions from patent right protection at least with respect to the production and use of generic drugs (Art. 31 (b) TRIPS). However, such compromises help legitimate both the WTO and intellectual property rights. In all cases of conflict – biological safety, intellectual property rights for pharmaceuticals (and, very importantly, also for plants, animals, and genetic information) – transnational NGOs have played an important role. Ethics, unlike the other areas, has remained rather weakly institutionalized. The Convention on Human Rights and Biomedicine of the Council of Europe, which comprises more member states than the EU, has been widely considered very problematic, with the consequence that several countries, for example Germany, have been unwilling to sign it (COE 1997). The Declaration on the Human Genome and Human Rights of UNESCO is not legally binding at all, yet it provides a basis for normative accountability (UNESCO 1997). Finally, attempts within the UN to reach agreement on an international ban against human cloning failed in 2005, mainly because of national differences about how to deal with the so-called therapeutic or research cloning.

Nanotechnology – Nanotechnology is still in a very early stage of its development. The term nanotechnology generally refers to technologies at the nanometre scale (one nanometre equals one millionth of a millimetre), which implies fundamentally new prospects in the exploration of matter. The potentials of nanotechnology apply to a broad range of scientific and technological fields, which through the advent of nanotechnology will themselves become re-conceptualized and reorganized, at least to some extent. Nanotechnology, too, is a cross-sectoral technology relevant for materials science, manufacturing, energy production and storage, medicine, food, water and the environment, and the military, among others. Nanotechnology is expected to be particularly powerful because it will come along with what is called "converging technologies." Thus nanotechnology is not just the latest, in this case physical and chemical high-technology development, but it is also becoming increasingly connected to biotechnology, information technology, and cognitive science. Accordingly, nanotechnology has faced, or will face, issues relating to health and environmental safety, security and privacy, intellectual property rights, and ethics (National Science Foundation 2001). But it is too early to tell what kind of regimes will actually emerge.

To sum up, first, the major developments of science and technology within the last decades have led to ever closer connections between them; in other words, the recent high-technology developments have established the phenomenon of techno-sciences and science-based industries. The emergence and embedding of complex technologies in economic sectors as well as in society builds the context for technological regime analysis, i.e., put in slightly different terms, the analysis of the interdependency between the social shaping of technology and the technological shaping of society (Freeman 1993; Williams/Edge 1996). Second, those high-technologies that have emerged, or have experienced a breakthrough, in the 1970s and after, have been increasingly generated within regimes of innovation that incorporated extended or substantially new structures and practices oriented towards commercial applications. Transnational dynamics have not only been characteristic for competitive technology developments, but also for the controversies on environmental and health risks, intellectual property rights, and ethics. Not least important among the transnational repercussions have been claims for increased accountability of the science and engineering and business and science policy communities, together with claims for institutional, social and technological change toward sustainable development. Third, the particular qualities of the sciences and technologies concerned have brought about a broad spectrum of challenges to social institutions and politics (including policy fields and at times even polities) at various levels – often leading to institutional, political or, more generally, societal change (Jasanoff 1997; Sørensen/Williams 2002). Because of the perceived strategic importance of science and technology for economic competitiveness in the transformation process toward "knowledge societies," it is no surprise that universities have become increasingly subject to at times far-reaching organizational change. Consequently, universities are not only asked to pay more attention to marketable research, but also to become themselves more efficient organizations or to reorganize the traditional disciplinary structures into more problem-oriented research and teaching networks.

4. Conclusions and outlook: regime analysis of science and politics

The overview presented should not only broadly illustrate recent regime changes of science and politics, but also provide us with some insights about forms and factors of change in both domains and in their mutual relationship. As pointed out, regime analysis has contributed to the investigation and understanding of institutionalized structures and practices in various contexts – international regimes, national regimes of government, regimes of supranational integration, innovation regimes, technological regimes, etc. While regime analysis is often related to particular social science disciplines, there is no common understanding of regime analysis. Even more, the various approaches of regime analysis usually operate independently from each other, i.e. without discussion or without taking the concepts and methodologies developed in the neighbouring fields into account. On the one hand, this is due to the self-evident specialization of research topics and traditions, but on the other, it is also due to a certain ignorance that often comes along with disciplinary specialization. In substantive terms, the various approaches to regime analysis are limited by a confinement to a particular subject area or level of analysis. For example, the concepts of international regime analysis have been shaped by typical institutional and normative concerns of international relations, without connecting to other levels of politics. Or innovation regime analysis has mainly paid attention to those organizational and practical concerns that are more or less directly affecting innovativeness. In both cases the situatedness of international politics or of innovation are not framed as part of complex processes of social and technological change. In my view, it is not a useful task to try to develop a general regime theory (as a supposedly fancy update or modification of general social systems theory), but it would be helpful to achieve a framework of regime analysis that allows for theoretical generalizations. Not least, because there are various connections in reality between regimes of politics and those of science and technology – as demonstrated above.

Here, I cannot delve into a discussion of the various fields and traditions of regime analysis. Instead, I would like to translate the above overview into a set of comparative perspectives which, taken together, might help put together an integral framework for analyzing regimes of science and politics:

- Comparative analysis of the configuration of politics: politics at the national, local, regional, supranational, and international levels; actors, institutions, practices, and meanings of politics; politics, policies, and polities as dimensions of politics; politics and its relationship to science and technology, the economy, law, culture, and the environment.
- Comparative analysis of the configuration of cross-sectoral technologies: science and engineering disciplines, and fields of application, constituting cross-sectoral technologies; actors, institutions, practices, and meanings of science and technology; high-technology related innovation, property rights, risk management, and ethics; economic, political, legal, cultural, and environmental dimensions of science and technology.

The dimensions and aspects listed to specify the comparative perspectives of a regime analysis of politics and science are intended to outline ways of mapping and comprehending basic features of the configuration of politics and science. In addition, these perspectives are meant to support two methodological conclusions. First, the configuration of politics and science in today's world of rapid transition requires comparative perspectives because otherwise the social science investigation falls short of the complexity and empirical variety of reality. It also helps achieve more appropriate evaluations of hypotheses about new social phenomena. Second, transnational perspectives are needed because today's configuration of politics and science extends across various institutional levels that are not just differentiated but also connected with each other in multiple ways. Despite the prevalence of perspectives rooted in the nation-state, there have always been transnational perspectives in sociology, for example in the work of Max Weber. But now there is a clear demand for, and shift towards, such perspectives as the debates on globalization, world society, or "methodological nationalism" (Beck/Lau 2004; Zürn 2001) indicate. In other words, investigations focusing on changing regimes or shifting boundaries between science and politics are clearly limited if they do not take into account comparative or transnational perspectives (Jasanoff 2003). While I have tried to make clear that both perspectives are fundamentally important, two basic issues need further elaboration: first, the design of comparative analysis depending on the research subject and the questions asked; and second, the definition of transnationality as regards the forms of interdependency between the various levels and areas in the configuration of politics and science. At the same time, further clarification is needed of how to distinguish between transnationality, internationality, and globality. However, it would be misleading to neglect the importance of cross-national comparisons. Not only does transnationality presuppose "nationality," but diverging political, social and cultural institutions and traditions also account for different understandings of and responses to transnationality.

Given the numerous research topics and analytic traditions that require consideration, a common terminology is needed in order to better achieve epistemological coherence and communication. To this end, I would like to propose a generalized notion of regime that might contribute to a theoretical language and, ultimately, to an integral frame of regime analysis. First, it refers to the basic idea that social structures are the result of human actions as well as their precondition. It is the aspect of a two-way structuring that is basic in various accounts of both sociology and STS. Second, regimes are social structures mediated by practices that extend in time, i.e. are somewhat stable, though never fixed. Third, regimes are often characterized by relations of power, which may be hierarchical, or may take other forms. Fourth, regimes can be specified by particular institutional and organizational forms and elements, such as principles and norms, rules and procedures as they pertain to the various domains of society. Put briefly, instead of being a given or fixed structure, a regime is more or less constantly under construction – being built and stabilized, modified and reorganized, upheld or abolished. Since regime analysis is interested in the emergence, functioning, and transformation of social phenomena, distinguishing between the following dimensions seems essential in the context of science and politics: science and technology, institutions and organizations, discourses, and practices.[2]

[2] I indicated these dimensions as part of the two comparative perspectives above, but would now like to name a few reasons. Science and technology are of a specific nature themselves, but their particular social quality depends on the organizations and institutions that are in many ways concerned with their development and application; discourses work as a main form of shaping social meaning; and practices are not only indispensable for anything social to happen, but can also follow a logic of their own, since practices are not simply dictated by technologies or discourses, for instance.

What conclusions can be drawn from this overview for science and technology studies and science policy studies? All in all, both research traditions appear in the light of a clear epistemological deficit that needs to be overcome in each. Science and technology studies, by and large, need to fill the gaps in their analysis of institutions. Science policy studies, on the other hand, need to fill the gaps in their analysis of science and technology. While science and technology studies have mainly focused on the laboratory, they also need to acknowledge that other locations may be crucial for the generation and shaping of science and technology – for example international organizations. And while science policy studies have mainly concentrated on government institutions, they need to apprehend that science and technology are subjects of political significance, and that their particular qualities matter.

To come back to the beginning, to the question of what is new in the relationship between science and politics: As the brief above review of a few spotlights of modern history up to the post-World War II order has shown, it is not the connectivity of science and politics as such which has undergone change (these connections have long undermined the supposedly clear boundaries between them). The changes are more limited and concern, put briefly, the "vertical" differentiation and transnational extension and pervasion of politics and science, and the increasing significance of market-orientations as well as of social accountability in the relationship between science and politics. Since these trends do not account for a uniform mode of change, they rather point at tensions and contradictions. In consequence, this situation reconfirms the basic open-ended nature of social change, as well as the challenges to analyzing and understanding it.

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Meta-Innovation: The Optimum Role of the State in the Triple Helix

Henry Etzkowitz

Introduction

A new role for government has arisen in increasingly knowledge-based societies, transcending procurement of individual technologies and support of the science and technology base. Innovation is considered here as the process of developing an institutional infrastructure that helps create new industries and growth firms. Such "innovation in innovation" guides the specific process of generating new products or processes that traditionally goes under the heading of innovation. The state increasingly undertakes these tasks together with industry and university. We call this higher order of innovation, comprising bottom up, top down and lateral initiatives, from university, industry and government, individually and collectively, "meta-innovation," and inquire into the conditions under which it is produced.

The role of government in innovation in the classic sense is long-standing: to carry out traditional state functions, such as defence and enumeration of the population, as well as new tasks such as cure of diseases and industrial advance. Government has employed various means to induce innovation such as offering prizes for results, for example, a method to calculate longitude to improve navigation of ships and reduce the risk of shipwreck in 18th century Britain (Sobel, Dawa Longitude Penguin). Government has also established laboratories to achieve specific objectives such as improvement in weapons, sanitation and farming practices in 19th century U.S. (M. Rossiter, 1976). It has purchased equipment such as the Hollerith card sorter to speed analysis of census data in the early 20th century and, especially since the 2nd half of the 20th century, granted funds on a large scale to support basic research that scientists predict will have both theoretical and practical significance.

Different trajectories of meta-innovation can be identified depending upon the configuration of the triple helix and of governmental levels in relation to each other. The interaction between national and regional levels of government is a strategic research site to examine the emergence of meta- innovation. Conflict, as well as coordination, among the levels of government may be identified as a driving force of meta-innovation. A meta-innovation system has been created in the US, since the 2nd World War, and in Brazil since the downfall of the military regime in the 1980's. Welfare state societies, such as Sweden, and post -Socialist societies, such as Hungary, are moving in this direction. This paper analyzes the emergence of meta-innovation in societies moving toward a triple helix framework from various starting points.

1. The Triple Helix and Emergence of the Innovation State

The Innovation State attempts to regenerate the sources of productivity, through investments in science and technology, and by changing the rules of the game. Legal frameworks and administrative procedures may be changed to encourage the creation and growth of new firms. Government may partner with private capital to jump start a venture capital industry. Through these and other measures, government attempts to fill gaps in the innovation environment.

The Innovation State is the successor to the Capitalist, Keynsian and Welfare States, with their respective foci of assisting existing industry, promoting general economic advance and securing the basic conditions of a good life for all the population (B. Jessop, 2002). The Innovation State builds upon these various bases, incorporating elements of each of these models into a broader framework to support their realization under changed conditions of global competition. In the laissez faire model of separate institutional spheres, moving beyond Keynesian macro-economic policies arising from the 1930s depression, such as central bank adjustments of interest rates or money supply, was also a difficult transition.

The triple helix of innovation is emerging in widely different societies, with previous traditions of strong and weak levels of state activity. In statist societies, the relaxation of the total state, based upon central planning, to a more modest role of incentivizing innovation, without going all the way to inaction, was also a difficult transition. A triple helix coordinated entirely by the state only provides a limited source of ideas and initiatives. Under these circumstances government may take initiatives without consulting others; indeed it may subsume the other institutional spheres and direct their activities. Although large projects may be accomplished it is not the most productive form of triple helix relationships since ideas are coming only one source, the central government.

Of course, top-down models have been highly successful in organizing large military and space projects in both socialist and capitalist regimes and in promoting economic development in authoritarian regimes. The Singapore government organized the transition to high-tech manufacturing and then to knowledge based economic development. However, too strong human capital focus on formation of employees for manufacturing enterprises left a relatively narrow base to draw upon when it became apparent that transition to a knowledge economy was indicated.

Conceptualizing the role of the state in innovation thus should take into account multiple levels of state activity, from the local to the multi-national. If the role of the state in innovation is presumed to be primarily at the national level, policies may be to broad to deal with local or regional needs. Too great focus on the national level also may result in policies and practices targeted at large national firms rather than start-ups which typically have local origins. Most importantly, encouraging different levels of state activity has the advantage of allowing various sources of program experimentation to arise.

Interaction among university-industry-government, as relatively independent, yet inter-dependent, institutional spheres is the key to improving the conditions for innovation in a knowledge-based society. The change in the role of the state from public partner in dual relationships, with either industry or university, to one of three participants in triple helix relationships increases government involvement in innovation issues, irrespective of political system or development level. For the triple helix to operate fully there must also be initiatives arising bottom up and from the other institutional spheres.

2. Statist transition

In countries with a planning system, people from research and production units who knew each other sometimes made informal exceptions to the rule of centralized control. Although research and production were formally linked by intermediary organizations, industry's focus was on quantity production, not qualitative innovation and local technology transfer. Bureaucratic controls were an obstacle to introduction of inventions but the more fundamental barrier to innovation was the disincentive to systemic change.

In the post-socialist era, in countries such as` Hungry, top down co-ordination was removed and each element in the former system was left to fend for itself, with sharply reduced funds from the state. Some research institutes obtained contracts from abroad; others tried to transform themselves into incubators and science parks. Many scientists and technologists left the country for positions abroad or stayed and tried their hand at new tasks, often in unrelated business areas to their former employment.

A few tried to start high-tech firms based on their knowledge and competency, often with the support of their Institutes. Occasionally, multi-nationals, like General Electric that invested in former state firms such as Tungsram, to take advantage of skilled labor, also found pools of un-utilized innovation that they could build upon. Nevertheless, the abrupt re-configuration from a statist to laissez-faire regime left a gap where the state had formerly played a leading role.

Science and technology policy had formerly been the centerpiece of regimes legitimated by a thesis of a 'scientific-technological revolution.' Given the discrediting of government it was difficult to justify more than a minimalist state, confined to basic security and welfare activities. Science and technology policy was barely a legitimate activity, no longer a priority. If the state is absent from the innovation picture: coordination, regulation and funding necessary to encourage improvements may be insufficient. There is a need to bring the state back into the innovation picture but in a more modest role than in previous regimes. Such a re-transition is currently under way across the former socialist bloc, often coupled with participation in EU innovation programs.

3. Devolution of the Center

The changing role of the state in innovation is most clearly apparent in countries such as Mexico, where state sponsored industry sector associations and university consultative councils coordinate these spheres. However, the predominance of national government centralized research resources in the capital, leaving other parts of the country bereft. In recent years, this problem of over-centralization has been addressed by relocating some national research institutes outside of the capital and by state governments becoming active in promotion of innovation.

There has also been a significant devolution of powers in recent years in countries, such as Great Britain, France and Sweden, lacking a strong regional level of governance (L. Greyson, 2002). Formerly central government operated through regional levels that mandated common polices and was a mechanism for carrying out these polices. Increasingly it is seen that it is necessary to have policies specific to the competencies and capacities of different areas. Moreover, it is difficult for a central government to mandate appropriate strategies from a distance. In Sweden some regions have been given a broader authority to develop their own regional development initiatives as an experiment.

Sweden is ambiguous case of conflicting policies in the context of relatively high R&D budgets. There was a substitution effect when a series of foundations, established with the proceeds from the "Wage Earners Funds" to promote innovation, replaced funds cut from Research Council budgets. Sweden already had a high level of research funding and there was a feeling that there was inadequate take-up from existing research resources, so why spend more money?

Even though more money wasn't made available, there was a change in the way it was spent. The foundations encouraged a shift from disciplinary to interdisciplinary research; from small research groups to larger research teams, and to collaborative university-industry projects. There was also a dual dynamic of centralization and decentralization: concentrating resources at leading universities and spreading funds around to build up research at the regional colleges and new universities.

Sweden uses the triple helix framework to knit together different initiatives at the national, regional and local levels that might otherwise be at odds with each other. The model provides a rationale to cooperate and aggregate resources to a common end and reduce friction among what otherwise might be a set of small competitive initiatives. Different government agencies and foundations have established many innovation initiatives such as "university holding companies" and regional foundations to assist technology transfer.

The central question in Swedish innovation policy is how to moderate the effect of centrifugal forces and increase the strength of centripetal forces.[1] One clue to the trajectory for the emergence of the Swedish triple helix can be seen in the transfer of CONNECT, a local level networking format from San Diego to Sweden (M. Walshok, 1995). An initial attempt made by members of the local biotechnology association in Skane did not succeed, lacking sufficient support from the region and the university. A later effort undertaken by the prestigious Academy of Engineering in Stockholm attracted support from regional officials and universities across Sweden and several CONNECT networks, linking entrepreneurs, business advice providers, patent lawyers, accountants and angels, were successfully established. The cultural carryover of a top down tradition of initiative was decisive.

4. Direct Innovation Policy

Perhaps ironically, the state was assuming a greater role in innovation in other countries at virtually the same time as it withdrew from the scene in the former Socialist countries. Concurrent with the Nokia success, which gave Finland appearance of a country as an appendage of a corporation; government increased its role in innovation, making it a direct responsibility of the Prime Minister's office. Finland was a much less technologically developed country in the early 1990's than most of its Nordic peers when the decision was taken to concentrate resources on science and technology in a few selected fields of IT and biotechnology (M. Benner, 2003).

The monies gained from the privatization of public enterprises were utilized to sharply raise the level of public R&D funding. In a relatively few years, the Helsinki region has become second only to Stockholm as a center of biomedical research in Scandinavia. Tampere which had at most a few dozen IT researchers in the early 90's is now home to 3,000. The Finnish case suggests that the original premise of the linear model, concentrated R&D pump priming, is still valid. In statist societies direct

[1] Region Skane is an example of a regional authority utilizing the triple helix model to stimulate collaborative projects. VINNOVA, the National Agency for Innovation, uses the triple helix model, coupled with financial incentives, to encourage collaboration but is itself only a relatively modestly funded agency. Its resources appear to be sufficient for the purpose in smaller regions but centrifugal forces can still inhibit collaborations in larger regions. See VINNOVA 2001. Forskning och innovation for hallbar tillvaxt.

intervention is expected while, under laissez-faire conditions, only indirect approaches may be possible.

5. Indirect Innovation Policy

An assisted linear model of organizational mechanisms to assist technology transfer and development, based on intellectual property protection has replaced the passive linear model of simply relying on dissemination of research through publication. Nevertheless, given strenuous opposition, there is reluctance to recognize that a plethora of specific policies and programs accumulated over more than a century constitutes a U.S. innovation policy. Given the resistance to government action at the federal level, when intervention is decided upon it is typically occurs as a joint initiative of the federal and state governments, utilizing universities as an interface between government and industry. In response to ideological constraints, the trajectory of immanent industrial policy formation creates networks and initiatives that cut across the institutional spheres.

Given the resistance to an enhanced role for the federal government, when intervention is decided upon it is typically carried out indirectly. The university was the institution of choice in three key instances: agriculture (mid 19th century), the military (World War II) and industry (1970's).Higher education is not a direct federal responsibility in the US with a few notable exceptions of the military academies, Galaudet University for the Deaf and Howard University in Washington D.C, an historically black university. Nevertheless, the federal government has had a significant influence on university development by supporting the so-called Agricultural and Mechanical Universities, the "land grant" schools oriented to practical subjects, with one-time subventions of federal lands as an endowment.

The funds provided for research pre-dated the Second World War but since they were primarily for agricultural they only affected a special sector of academia. Broad-based government funding of the universities was institutionalized in the aftermath of the Second World War, a conflict that had demonstrated the utility of universities as research providers and coordinators. Whereas the academic contribution during the First World War had been largely limited to turning campuses into training facilities and providing researchers to work in government laboratories, the Second World War involved the universities more directly with the state.

6. The War-time Triple Helix

Despite barriers, a de facto innovation policy is created through pressures on government to act in crises. The World War II Office of Scientific Research and Development (OSRD), originated at the initiative of academic scientists, was active across the spectrum of research areas of potential military use. Under wartime conditions R&D, testing, manufacturing and customer demand were integrated into "a seamless web," ignoring traditional boundaries.

During the 2nd World War the U.S. Office of Scientific Research and Development (OSRD) spent significant sums at universities to support advanced weapons development, often on projects proposed by academics. Government negotiated R&D contracts with universities, accepting their argument that it should contribute to the infrastructural costs of the project. In the post war, practices of academic initiative and subsidization of the university were generalized into a metaphorical "Contract" in which government assumed responsibility for support of science with public funds.

The linear model of an automatic transmission belt from science to society was thus invented. Although, a quid pro quo of public benefit was part of the "contract;" few research results were actually translated into useful innovations, even given an extended time-frame. Two evaluation studies, carried out in the late 1960's, produced contradictory findings but the overall assessment was that a more structured approach would produce greater outcomes.

Direct links among university, industry and government, helped produce weapons from science during the 2nd World war. Moreover, academics having put aside their basic research interest to work as engineers on military projects soon found that they had ideas for basic research that they would pursue after the war. This rediscovery of the interconnection between the practical and theoretical, and the experience of working with virtually unlimited resources at their disposal, transformed academic scientists' anti-government attitudes that had led them to refuse support in the depth of the depression.

7. The Emergence of a Peace-time Triple Helix

The wartime experience of working closely with industry and government through innovative linkages also brought basic scientists out of the self imposed isolation in which they had placed themselves from the late 19th century in order to assure the autonomy of science. With the return of peace, universities and companies returned to their previous boundaries, with an important difference, the heritage of their wartime experience of cooperation. Pre-war opposition to government funding of research at the universities was reversed as universities sought government funds. In addition to the precedent of ad-hoc appropriations, a more systematic approach was sought.

The question of how to access externally supported projects to meet government's needs, maintained their own research programs, thereby solving the knowledge flow problem through internal capacities. The military also solved the problem of obtaining useful results through close monitoring of projects supported in academia, while maintaining a long-term perspective of what might be useful to the military in supporting research on computers and artificial intelligence. Although practical results from basic research were only expected in the long term; such results were the premise for the funding flow.

8. Government-Industry Relations Via the University

A change in economic circumstances called for renewed attention to innovation. During the economic downturn of the 1970's, there were proposals for government to become directly involved in aiding existing industries and building up new ones, but these were quickly defeated. Instead, government went through the universities to reach industry. The patent system was reorganized to give intellectual property rights from federally funded research to the universities, with the condition that they had to take steps to put them to use. After 1980 technology transfer mechanisms, that had only been utilized by a relatively few universities, were diffused throughout the research university system (H. Etzkowitz, 2002).

Relatively little of the expenditures put into research were actually being translated into products, even given an extended time-frame. To resolve this problem, the US created a public venture capital system as an extension of basic research at that time (H. Etzkowitz, M. Gulbrandsen and J. Levitt, 2001). It could not be called public venture capital but the NSF program officers who founded the Small Business Innovation Research (SBIR) program recognized that a neutral terminology of stages and phases had to be utilized.

Reinterpretation of the missions of these and other research agencies has allowed an assisted linear model to be partially re-constructed in recent decades, in response to increased international economic competition. In addition to creative extensions of the basic research model at the federal level e.g. the Small Business Innovation Research Program (SBIR) that serves as public venture capital, the most far reaching developments have occurred, bottom-up at the state and local levels through policies typically developed as the outcome of triple helix interactions.

9. Transforming the Role of Government in Innovation

Technology transfer from academia developed in several stages in the U.S. Founded in 1912 as an external linkage mechanism, the Research Corporation provided technology transfer services to a range of universities. Alternatively, the University of Wisconsin developed its own technology transfer office through a foundation controlled by the university. As research expanded during the post-war additional universities established their own offices. A permanent presence on campus allowed closer interaction with the faculty and also encouraged attention to the local region.

Perhaps the most important event, and the necessary bases for subsequent developments, was the creation of a well-funded system of federally supported research in the universities. During the post-war period, high overhead payments became a method of funding the major research universities directly from the federal government, without explicitly accepting it as an explicit policy as is commonplace in Europe. These universities clustered in a relatively few parts of the country, on the east and west coasts, with a few in the mid-west. This was not a major issue as long as academic institutions were primarily seen in their traditional role as educational and research institutions.

As new industrial areas arose from an academic research base in molecular biology and computer science in a few locations, other parts of the country became aware of the significance of universities as engines of economic development and wished to follow this model; first in North Carolina in the 1950's. In addition to creating their own S&T programs, states have become active proponents, along with their universities for increases in federal R&D budgets. Indeed the salience of R&D spending to future economic development has spilled over from the budgets of the research agencies to so-called "porkbarell" methods for funding local improvements through attachments made to other bills.

Given the realization of the connection between the location of research and the future location of industry arising from that research; pressure has increased on the federal government to increase research spending and to distribute it more broadly, eschewing peer review mechanisms instituted in the early post war to focus federally funded research at a relatively small group of schools. Now that the connection of science and technology to economic growth is apparent, regions with low levels of federal R&D spending are unwilling to depend upon modest set asides, instituted to reduce pressures for equalization, or slowly building up their capabilities with local funds.

A science and technology policy has been developed that works the same way as appropriations for roads or bridges or any local improvement that a Senator or Congressperson wants for their district or state. A legislator typically attaches a provision for a research center for a local university to a funding bill for an agency with a related purpose, the so-called "earmark." The regular level of funding of these special bills is such that earmarks should be considered as a regular feature of S&T policy, despite objections to the method.

Universities that have been outside of the research system but want to increase their research strength have also been active in seeking these funds. Typically as this new group of research universities enhances their capabilities, through such targeted measures, they then begin to compete successfully for peer reviewed funds through the normal research funding channels. It is this increase in competition from universities across the country that have given the older research universities the feeling, indeed it is a reality, that competition for research funds has increased even as federal research budgets have risen significantly, especially in health and security.

10. Science Policy and States Rights

As an alternative to traditional programs to attract existing industries and firms to relocate, knowledge-based development focuses on creating new industries and firms represents a new departure for most for state governments, beyond a relative few like Massachusetts that have been active for some decades. Virtually every state now has an S&T agency and at least one, and usually more than one, program that attempts to raise the level of S&T in the state and attract researchers from elsewhere. Taken together, these programs represent approximately 3 billion dollars of spending per annum (H. Etzkowitz, 1998).

State S&T policy is typically tailored to the industrial background and research intensity of the state. States with technology industries attempt to upgrade these industries by supporting local universities to work more closely with key firms, typically by supporting a research center that address some of the longer range problems of these firms. Conversely, states without significant technology industries, attempt to build research capacities related to a local natural resource in order to create a knowledge base that will enable them to take the next steps in firm formation. Such a strategy may involve luring scholars with significant relevant research activity in these areas to the state by providing them with research funds and other resources.

Enhancing an academic focus at a local university with possible future relevance to local economic development is now viewed as similar to traditional physical infrastructure development. States view these intellectual capacity building efforts as akin to building highway and bridges to improve transportation and encourage business. In the past state S&T efforts were typically funded through regular legislative appropriations, making them subject to cuts and even closure in an economic downturn. This is especially the case due to requirements that states, in contrast to the federal government, maintain a balanced budget.

On the premise that intellectual infrastructure is now as secure an investment as physical infrastructure, California has taken a new departure in state S&T policy with proposition 71, an initiative placed on the ballot and passed in the 2004 election. The measure will provide 3 billion in debt financing through a bond issue. The funds will go to support stem cell research at the state's public and private universities and to investments in biotechnology firms that are expected to realize the fruits of that research as marketable products.

Federal opposition making stem cell research extremely difficult to carry out led to the state initiative in California. A coalition of patient support groups focused on a cure for diabetes, joined with scientists who wished to pursue stem cell research and venture capitalists interested in the next wave of commericiable technology. The scientists also wanted to find solutions to the gaps in transnational research that made it difficult to move findings "from the lab to the patient." An attorney, whose child suffered from diabetes and whose previous career involved the innovative use of public bonds to support the development of low cost housing, led the campaign.

The campaign utilized the method of direct democracy introduced into the Constitution of the state of California by radical groups in the early twentieth century to enable a law to be passed by a vote of the electorate rather than going through the processes of representative democracy. In recent years, however, conservative political groups had largely used the proposition mechanism to reduce taxes as in the proposition 13 that put a limit on school taxes, emasculating public education in California. Proposition 71 took the proposition mechanism back to the intentions of its founders, to introduce path breaking measures that legislatures might not consider.

The California Institute for Regenerative Medicine, currently in formation, will distribute funds to academic researchers, for research projects to universities to build laboratories to house stem cell research separately from federally funded grants and may also make investments in firms to commercialize the research results. The proposition is still controversial. Conservative groups intend to challenge it in Court and some politicians even seek to change the state Constitution in order to stop the Institute. Nevertheless, the project is expected to proceed in the interim, while court challenges are addressed through philanthropic donations.

It is expected that the borrowed monies will be paid back in the future out of the proceeds from intellectual property created from academic research and the equity generated in biotechnology firms. Federal programs that provide money to researchers and firms expect payback to government, only indirectly and in the long term through increased tax revenues and job creation. The California initiative creates a direct link and feedback loop between university, industry and government, seeking to create a virtuous circle of science-based economic development-- Silicon Valley's next wave-- based on public credit.

Returns from Intellectual Property are expected to creating a self generating model of S&T infrastructure support derived from procedures to build public infrastructure such as roads and bridges. This initiative is the latest in a series of efforts to address downturns in Silicon Valley and other technology conurbations that appear to be solely "private" entities in the upturn but whose concomitant "public" character is revealed in the downturn when laissez-faire models are deemed inadequate.[2]

11. Implications for the Federal Science "Contract"

The Bush administration's limit on stem cell research to stem cells created before August 9 2001, created a crisis in the collaborative relationship with science established at the advent of the Second World War. At that time leading academic scientists, such as Presidents Conant of Harvard and Compton of MIT convinced President Roosevelt to create an agency to support research for the war effort in which scientists would define the terms of the research taking military needs into account. This relationship in which scientists had control of their own agency allowed them to put forward advanced ideas, drawing upon basic research. The origins of the Manhattan bomb project, drawing upon the fission findings that been arrived at only a few years earlier by Meitner and Hahn in the Institute of Physical Chemistry in Berlin, extrapolated by Leo Szilard and communicated by Albert Einstein in a letter delivered to the President by a Wall Street friend, exemplified the new influential relationship of scientists to the state. This relationship was basically continued during the post war.

The rejection of the superconducting supercollider physics project was an early warning of change in the relationship. However, the reason for cancellation did not go into the scientific content of the project. The reasons for rejection rested on the escalating costs of this basic research project. In the case of stem cells, objections from religious and conservative political groups go to the heart of the scientific content of the project, arguing that "human life" is destroyed when cells at the earliest developmental stages are experimented on. One bill before Congress would make such research punishable by a one million dollar fine plus a jail term.

A proposed federal law would go well beyond simply not funding stem cell research by making its conduct punishable by a one million dollar fine plus jail term. At present the law has passed the House but is bottled up in the Senate. However, if anti- filibustering legislation is passed, a simple majority would likely allow its passage. At this point, if it occurred a confrontation between states rights and federal prerogatives could ensue on a scale not seen in the us since just prior to the Civil war when issues of what was reserved to the states as a field of action eventuated in that confrontation. Science is once again at the center of national politics in a way it has not been since the Second World War when it became a central part of the war effort.

[2] See www.jointventure.org/ for the 1990's response: Joint Venture Silicon Valley.

However, whereas science was viewed positively by virtually everyone in that era; in the current situation with respect to stem cells, opinion is sharply divided. Some would shut an area of science down, prompting some scientists to recall Stalin's prohibition of genetics research in the Soviet Union when he supported Lamarckism, the theory of inheritance of acquired characteristics. In that case the dispute was between two scientific theories, with the power of the state put behind one to the disservice of the other. The current situation if it escalates to stage of criminal legal action against scientists could reprise of the Church's confrontation with Galileo.

The metaphor of a science contract could well be replaced by one of "science wrangle", in the case of stem cells, denoting a dispute that is increasingly irreconcilable as it becomes subsumed in the controversy over abortion. Nevertheless, the California initiative has inspired other states, such as New Jersey, to begin their own stem cell programs through the more traditional routes of legislative appropriations. When government initiatives have not been forthcoming, philanthropic foundations have taken the lead in supporting stem cell research in New York City. The controversy over stem cells has arguably led to more initiatives and a higher level of resources fm a greater variety of sources, than if the normal NIH funding process had prevailed.

A similar result can be seen with the Human Genome initiative, which was the outcome of a conflict between government agencies, the Department of Energy and NIH over leadership of the program. This was followed by conflict between the government program and a private firm that was established to compete with the government initiative. Competition speeded the genome mapping process. In a similar manner competition among different internal projects to purify uranium in the Manhattan project speeded the development process. Different paths could be intercalated with each other even as the public and private genome efforts eventually negotiated a cooperative arrangement.

Given the intersection of science-based economic development with other political issues, as in the stem cell instance, the path is not expected to be smooth. Conflicts and coalitions in welfare state, post socialist and laissez faire societies over the role of science in society are an indicator that science is no longer a minor area requiring special protection but well able to fend for itself in the political arena.

12. Civil Society and the Triple Helix

Beyond the question of activation of multiple levels of government is the issue of the societal base to support innovation. Civil society is the foundation stone of the triple helix and the relationship between science policy and democracy. Although a limited triple helix can exist under authoritarian conditions, a full triple helix occurs in a democratic society where initiatives can be freely formulated.

As the state incentivizes university and industry to enhance their technology transfer and firm formation capabilities, it does not necessarily imply that the government increases its control over these spheres. Indeed precisely the opposite course of action may be indicated in societies where government has dominated the industrial and academic spheres. On the other hand, in societies where government has been relatively inactive; it may mean playing a greater role in society. The ideal triple helix configuration is one in which the three spheres interact and take the role of the other, with initiatives arising sideways as well as bottom up and top down.

A flourishing civil society of individuals and groups freely organizing, debating and taking initiatives, encourages diverse sources of innovation. The basis for a triple helix including bottom up as well as top down initiatives can be seen most clearly in countries that are just emerging from military dictatorships. The first academic revolution, the incorporation of research as a broad university mission, took place in Brazil in the 1970's, expanding the role of the university in society from a traditional support structure to one directly linked to national priorities. This transformation took place under a military regime where the university had relative autonomy. University discussion groups became a place where some internal opposition was tolerated even as many other academics were removed from their jobs and forced out of the country.

When the military gave up control in the early 1980's, a space opened up for university science and technology researchers to introduce the concept of the incubator from the U.S. At the same time a financial crisis led large scale technology programs to be downsized, making smaller scale initiatives, such as incubators to encourage the creation of start-ups, a necessity. At a later point, the national government built upon these programs and made them national policy. However, it was not until the re-creation of civil society that these local initiatives became possible. In succeeding years, various levels of government as well as industry and civil associations took up the incubator concept and spread it throughout Brazilian society, applying to a variety of problems from raising the level of low tech industry to creating jobs for the poor (H. Etzkowitz, J. Mello and M. Almeida, 2005).

13. Conclusion: Towards a Meta-Innovation System

What is the optimum role of government in innovation? The triple helix is an analytical and normative concept derived from the changing role of government in different societies in relation to academia and industry. There is no single answer to finding an appropriate balance between intervention and non-intervention. However, the previous history of the role of the state in society will set some bounds and also determine whether it is most useful for the state to intervene directly or indirectly, acting through other institutional spheres.

The linear model of translating university-based science into weapons systems and medical advances during the 2nd World War relied heavily on university, industry and government cooperation. However, the "mixed public/private innovation system," instituted by conservatives like Vannevar Bush in wartime, was anathema to these same persons in peacetime. Thus, they deconstructed the triple helix model constructed in wartime during the immediate post-war. The Office of Scientific Research and Development was closed in 1945 and the US does not have a Department of Science and Technology to this date. However, a National Science Foundation was founded in 1952 and the National Institutes of Health greatly expanded. Nevertheless, an assisted linear model, utilizing the university as an interface, was invented to spur innovation.

The development of university technology transfer capability served as an indirect industrial policy in a country precluded by laissez faire ideology from taking an activist stance, in contrast to more direct approaches taken in Japan and Europe. However, the added value of bringing academia into closer contiguity to industry, through the creation of new firms from academic research, has drawn increased attention to this unintended consequence of academic technology transfer. Indeed, Europe and Japan, Latin America and Eastern Europe, increasingly hope to attain similar results from their universities by changing the rules of academic practice and offering incentives to academics to engage in activities that formerly would have been beyond the scope of the professor as "civil servant".

Thus, one path to the Innovation State is from a top down model of bureaucratic control, with the state devolving its authority to various degrees. The other is from a standpoint of modest participation by central government in which case the pathway is to increased activity. The two different starting points intersect at some mid-point, where government, industry and university assume relatively equal status as interdependent institutional spheres.

Government is either taking a more or less active role in knowledge-based economic development, as the case may be. Direct and indirect innovation polices are formulated in former statist and laissez-faire regimes, utilizing the university as an intermediary between government and industry. In countries that followed a linear model, there has been a shift to an assisted linear model, with intermediate mechanisms introduced to move research into use. An indirect and decentralized innovation policy, across the institutional spheres, may be more effective than traditional direct approaches since it is better able to take regional differences into account and incorporate bottom up initiatives.

If the regional and local levels are active and with input from universities and industry as well, there is a much broader base to develop creative ideas for innovation as well as better base for implementation, especially at the regional and local level. The resulting dynamic of initiatives from different levels of government and from joint initiatives among the institutional spheres is the hallmark of an innovative society.

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Das Ritual der Evaluierung und die Verführung der Zahlen[1]

Peter Weingart

1. Rituale der Selbstgeißelung

Als sei die Gesellschaft von einer kollektiven Psychose befallen: ein allgemeiner Vertrauensverlust in die großen gesellschaftlichen Institutionen hat sie erfasst. Das politische System mit den Organisationen der Regierung, den Parteien, und den Politikern, die Medien, und schließlich auch die Wissenschaft. Allenthalben hat sich eine Sprache der Kontrolle und der Rechenschaftslegung gegenüber der Öffentlichkeit etabliert. Die neoliberale Semantik hat in der Wirtschaft ihren Anfang genommen. Transparenz, Konkurrenz, Effizienz, Exzellenz, Gerechtigkeit durch die Herstellung von Märkten, Freiheit durch selbstbestimmte Leistung sind die markanten Werte dieser neuen Verheißung. Sie postuliert u.a. die präzise Zuschreibung von Kosten und Ertrag auf die Aktivitäten, auf die zumindest in erster Näherung eine solche Zuschreibung möglich ist. Ziel ist die Identifizierung von Leistung und individueller Verantwortlichkeit, die Fokussierung von Anreizen, die Steigerung von Effizienz. Nach der untergegangenen Tristesse der kollektiven Solidarität des letzten Reichs der Freiheit erscheint die Eigenverantwortlichkeit als heller Leitstern, der den Weg in das neue Reich der Freiheit weist. So muss man sich wohl erklären, wie es zu dem nahezu totalen Erfolg einer Ideologie gekommen ist, die eine moderne Form der Selbstgeißelungen darstellt, wie sie sonst eher religiösen Sekten zugeschrieben wird.

In der Politik geht es um die Kontrolle der gewählten Repräsentanten. Sie reagieren auf das allgemeine Misstrauen in ihre Fähigkeit, eine komplexe Gesellschaft noch angemessen zu steuern, indem sie fortlaufend von allen anderen öffentliche Rechenschaft einklagen. Die Forderung, gegenüber dem Souverän über die Verwendung öffentlicher Ressourcen der Berichtspflicht nachzukommen, entspricht guter alter demokratischer Tradition. Sie droht jedoch zu einer rein symbolischen rituellen Handlung zu degenerieren, wenn die Rechenschaftslegung zum Selbstzweck entartet oder gar für andere politische Interessen instrumentalisiert wird. Wenn die Erfüllung der Berichtspflicht mehr materiellen Aufwand erfordert und höhere symbolische

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Kosten erzeugt, als sich durch die Bewertungs- und Kontrollübungen erwirtschaften lässt, ist die Grenze zum bloßen Ritual überschritten.

Die Wissenschaft ist eines der Hauptziele des politischen Rechenschaftsrituals. Obgleich sie als Institution das vergleichsweise höchste Vertrauen in der Gesellschaft genießt, obgleich ihr in den Sonntagsreden der Politiker die größte Bedeutung für den Wohlstand und die Entwicklung der Gesellschaft zuerkannt wird, wird keine andere Institution derartig der Pflicht zur Rechtfertigung ihrer Leistungen unterworfen. Das mag ein Reflex darauf sein, dass sie – ebenfalls wie keine andere Institution – Vertrauen in ihre Operationen verlangt. Sie verschließt sich notgedrungen dem Einblick von außen. Ihre Sprache und ihre Methoden sind für die Öffentlichkeit unverständlich. Ihre Ergebnisse lassen oft keinen unmittelbaren Nutzen erkennen. Die Beziehung zwischen Aufwendungen und Erträgen sind zumeist indirekt, und vor allem liegen in den meisten Forschungsbereichen lange Zeiträume zwischen ihnen. Die in politische Kalküle übersetzten Orientierungen des ‚shareholder value' lassen sich in der Wissenschaftspolitik eben nicht bruchlos umsetzen. Es wirkt deshalb auch nachgerade komisch, wenn sich Politiker den Nobelpreis zurechnen, den der Geehrte angeblich aufgrund großzügiger Förderung während der laufenden Legislaturperiode errungen hat.

Die neoliberale Manie hat schließlich auch den Widerstand der Wissenschaft gebrochen. Über lange Zeit hat sie sich den simplifizierenden Maßen widersetzt. Als Anfang der 1980er Jahre die ersten Bibliometrie basierten Evaluierungen von Forschungseinrichtungen durchgeführt wurden, bestritten die betroffenen Wissenschaftler die Möglichkeit eines solchen Unterfangens aus methodologischen Gründen. Sie drohten damit, die Urheber der Untersuchungen vor ein Gericht zu bringen, weil sie fürchteten, dass die Ergebnisse dem Ruf ihrer Institution schaden würden (Weingart 2001, 316). Diese Reaktion war vorhersehbar, weil bereits der bloße Versuch, die Forschungsleistung durch ‚Außenseiter', d.h. Laien in dem entsprechenden Gebiet, messen zu lassen, der vorherrschenden Überzeugung widersprach, dass nur die Experten selbst in der Lage seien, die Qualität und die Relevanz der Forschung zu beurteilen und dass der geeignete Mechanismus, dies zu erreichen, nämlich die ‚peer review', zufriedenstellend funktioniere. Ein zweiter Grund für ihre Skepsis wenn nicht gar vollständige Ablehnung war die Methode der Evaluierung. Bibliometrische Maße, obgleich quantitativ und daher anscheinend objektiv, erschienen theoretisch unbegründet, empirisch krude und abhängig von Daten, die bekanntlich ungenau waren. Die Ablehnung bibliometrischer Indikatoren seitens der Wissenschaftler wurde zu jener Zeit von den (Wissenschafts-) Politikern und Verwaltungsbeamten in den einschlägigen Ministerien sogar noch unterstützt, wenngleich zumeist aus Desinteresse.

Seither haben sich die Zeiten in verschiedener Hinsicht geändert. Da die Budgets für die Forschung nicht mehr die gewohnten Zuwachsraten zu verzeichnen haben und Prioritätenentscheidungen über die Umverteilung vorhandener Mittel statt über die Verteilung zusätzlicher Mittel befinden, hat der Druck, diese Entscheidungen zu legitimieren, das Interesse auf Maße gelenkt, die die Politiker nicht mehr in Argumente mit den Wissenschaftlern verwickeln, denen sie nicht gewachsen sind.[2] Obgleich die Forschungsindikatoren seit Beginn der 1970er Jahre entwickelt wurden, dauerte ihre Implementierung bis zu dem Zeitpunkt, da die Bewertung von Departments bzw. Fakultäten, einzelner Wissenschaftler und das ‚Ranking' von Universitäten ein wichtiges Instrument für die kompetitive Verteilung von Mitteln wurde, die an die Stelle der wegen ihrer angeblichen Ineffizienz in Verruf geratenen institutionellen Förderung getreten ist.

Indikatoren der Forschungsqualität sind noch nicht allgemein akzeptiert. Die amerikanische Regierung verwendet sie trotz ihrer Neigung zu Leistungsindikatoren für die Rationalisierung von Budgetentscheidungen noch nicht (Roessner 2002; Feller 2002).[3] In der EU ist die Situation uneinheitlich. Unter den unterschiedlichen Formen der Institutionalisierung von bibliometrischen Indikatoren bildet Finnland wahrscheinlich das Extrem. Es ist das einzige Land, in dem der ‚Impact – Faktor' für wissenschaftliche Fachzeitschriften zum Gesetz eines Landes kanonisiert wurde. Das impliziert dort, dass die Veröffentlichung nur eines Artikels in einer Zeitschrift mit hohem ‚Impact – Faktor' das Budget einer Universitätsklinik um ungefähr 7000$ erhöhen kann (Adam 2002, 727).

Die Verführungskraft der quantitativen Maße scheint zunehmend auch auf andere Regierungen zu wirken. Sei es durch das Kopieren anderer Beispiele, sei es durch äußeren Druck durch die sich ausbreitende Kultur der Rechenschaftslegung und durch die wechselseitige Beobachtung anderer Akteure kann man inzwischen eine geradezu enthusiastische Übernahme bibliometrischer Zahlen beobachten. Dieser Sinneswandel beschränkt sich nicht etwa auf Politiker und Verwalter, sondern er hat inzwischen die Dekane und ‚Chairs' von Departments, Universitätspräsidenten, die Referenten in Förderorganisationen sowie schließlich auch die Wissenschaftler selbst erfasst, die ursprünglich die schärfsten Gegner der Forschungsevaluierung von außen waren. Sie haben sich den Zwängen der ‚accounting society' mit ihren Leistungsindikatoren ergeben und nehmen nun bereitwillig an den durch sie bewirkten Ritualen der Selbstgeißelung teil. Der Logik dieser Rituale folgend begeben sie sich in

[2] Ein Vorläufer dieser Entwicklung in der deutschen Diskussion über den tertiären Bildungssektor war die Regulierung der Lehrbelastungen und der Studentenströme durch numerische Formeln, die in den 1970er Jahren implementiert wurden. Dieser Fall ist hier nicht von Interesse außer als historisches Beispiel dafür, dass damit zum ersten Mal demonstriert wurde, dass die scheinbar komplexe Welt der Lehre mit ihren unterschiedlichen Gegenstandsbereichen, Unterrichtstypen und Qualifizierungsebenen durch die Anwendung einiger weniger kruder Zahlen reguliert werden konnte. In diesem Fall war das Ziel, die durch die Demokratisierung der Universitätsausbildung stark steigende Zahl der Studenten mit den Lehrkapazitäten abzustimmen und damit die Kontrolle über die Kosten des Lehrpersonals zu erlangen.

[3] Private Einschätzung von S. Cozzens. Roessners und Fellers Artikel geben einen Überblick der Indikatoren für die Evaluation von S&T Programmen in den USA.

eine sich ständig selbst steigernde Konkurrenz, und wo es ihnen möglich ist, umgehen oder unterlaufen sie die Erfolgskontrollen mit dem Erfolg, dass deren ursprüngliche Ziele in ihr Gegenteil verkehrt werden.

2. Wer kontrolliert die Kontrolleure?

Die neue Nachfrage nach Zahlen verdankt sich der Verheißung, dass sie die Geheimnisse der Welt der Forschung und der internen Verteilung von Reputation und Belohnungen lüften und es Außenseitern erlauben, einen direkten Blick auf die internationale Stellung oder die provinzielle Isolierung ihrer lokalen Wissenschaftler zu werfen und ihnen so die Macht geben, unberechtigte Ansprüche auf Ruhm zu entlarven. Plötzlich werden viele Spieler auf diesen rapide wachsenden Markt der Forschungsevaluierung und speziell der bibliometrischen Analysen gelockt. Verschiedene Länder haben eigene Organisationen gegründet, die mit der Sammlung und Verarbeitung von Daten über die Forschungsleistung ihrer eigenen Forschungseinrichtungen befasst sind. Andere bedienen sich einer der unabhängigen, entweder universitären oder kommerziellen Institute und Forschungsgruppen, die auf bibliometrische Analysen spezialisiert sind, um besondere Untersuchungen für sie durchzuführen. In den USA veröffentlicht die National Science Board der National Science Foundation seit den 1970er Jahren ihren ‚Science Indicators Report'. Frankreich hat sein ‚Observatoire des Sciences et des Techniques' (OST) und ähnlich die Niederlande (NOWT). Der Schweizerische und der Deutsche Wissenschaftsrat verwenden bibliometrische Indikatoren in ihren Analysen. Der Fokus der Berichte dieser Organisationen sind primär die jeweiligen nationalen Wissenschaftssysteme. Soweit ist folgerichtig, dass die Bewertung und Kontrolle der mit öffentlichen Mitteln geförderten Wissenschaft durch Einrichtungen erfolgt, die ihrerseits öffentlich legitimierte (und finanzierte) Einrichtungen sind, von denen unterstellt werden kann, dass sie nach dem Stand des Wissens operieren.

Die Sache hat jedoch einen Haken. Alle diese Organisationen sind nämlich bis jetzt und in absehbare Zukunft von einem einzigen Datenlieferanten abhängig, dem Institute of Scientific Information (ISI), dem Produzenten der einzigen multidisziplinären Datenbank wissenschaftlicher Literatur, die Zitationen enthält und folglich die Erstellung von Zitationsanalysen und Impact – Faktoren für wissenschaftliche Zeitschriften ermöglicht. Ursprünglich war sie als Literaturdatenbank konzipiert. Sie ermöglichte es den Forschern, den Gebrauch ihrer Ergebnisse durch andere Forscher zu verfolgen ebenso wie Forschernetzwerke zu identifizieren. Bald jedoch erwies sich die Datenbank von ISI, der ‚Science Citation Index' (SCI), als wertvolles Instrument für die Evaluierung von Forschungseinrichtungen und sogar einzelner Wissenschaftler. Nach vielen Jahren einer eher zögerlichen Reaktion auf diesen randständigen Gebrauch seiner Produkte hat ISI nun die wachsende Bedeutung der

Nachfrage nach bibliometrischen Indikatoren erkannt und begonnen, maßgeschneiderte Evaluationsinstrumente wie *ISI Essential Science Indicators* und *ISI Highly Cited Com* zu liefern. Dies sind machtvolle Instrumente, die es jedem mit einem Internet-Zugang zu einer Universitätsbibliothek erlauben, die hochzitierten Wissenschaftler ihrer örtlichen Universität, den Rangplatz dieser Universität oder eines bestimmten Fachbereichs im Vergleich zu anderen national oder international zu ermitteln. Diese Instrumente werden inzwischen aktiv vermarktet, und eine wachsende Nachfrage treibt ihre Preise. Der neue Eigentümer von ISI, die Thomson Company in Toronto, vertreibt sie aggressiv und fördert damit ihren direkten Gebrauch durch jeden, der bereit ist, die Gebühren zu zahlen.

Die Produktion der Indikatoren, auf die sich Entscheidungen der Mittelzuweisung an Universitäten und Forschungseinrichtungen sowie mitunter der Rekrutierung und Besoldung von Wissenschaftlern stützen, liegt also in den Händen einer kommerziellen Firma, die praktisch über ein Weltmonopol für sie verfügt. Ob bewusst oder nicht prägt sie durch das Profil und die Qualität der Daten die politischen Entscheidungen mit, die die Forschungssysteme überall in der Welt betreffen. Die Evaluation der Forschung, soweit sie sich auf bibliometrische Daten stützt, ist damit praktisch in die Hände einer privaten Firma mit kommerziellen Interessen gelegt worden. [4]

Dies ist umso problematischer, wenn man bedenkt, dass die Daten keineswegs über alle Kritik erhaben sind. Bislang haben intermediäre Forschungsgruppen die kruden ISI Daten gesäubert und für spezifische Analysen zubereitet. Sie besitzen spezifische Kompetenzen für die Interpretation der Daten, so insbesondere Kenntnisse über die Namen der Institutionen im Land sowie ihrer Reputation. Darüber hinaus arbeiten sie fortlaufend daran, die Indikatoren durch Forschung über ihre Anwendungen in Evaluierungsverfahren zu verfeinern. Diese Gruppen drohen jetzt aus dem Markt gedrängt zu werden. Dies geschieht aufgrund einer kombinierten Verantwortungslosigkeit: ISI produziert und vertreibt ‚Evaluationsprodukte-per-Druckknopf', Politiker lassen sich auf diese Produkte ein, weil sie schnell und billig anzuwenden sind.[5] Wenn dies geschehen sein wird, werden auch die speziellen Fähigkeiten dieser Gruppen verloren gehen. Schließlich wird der Eindruck übrig bleiben, die Daten seien korrekt und bedürften nicht kostspieliger ‚Reinigungsverfahren'. Die leichte Verfügbarkeit der scheinbar exakten Indikatoren suggeriert vielmehr, dass jeder Laie die Wissenschaftler und ihre Produkte bewerten kann. Tatsächlich sind die methodologischen und operationalen Grundlagen dem Endnutzer jedoch verborgen,

[4] Es gibt augenblicklich keine ernsthaften Anstrengungen, die Position von ISI in Frage zu stellen. S. NATURE, 415, 14. Feb., 2002, 728. Eine Implikation des Status von Thomson als einer privaten Firma ist möglicherweise, dass der Druck, die Daten zu früh zu vermarkten, zunimmt, die Qualität der Daten damit abnimmt. Vgl. zu einem solchen Kommentar S. Müller, Das Monopol, Deutsche Universitätszeitschrift (DUZ), 21, 2003, 10-11.

[5] Van Raan will nur Letzteres als Problem sehen. Verantwortungsloser Gebrauch von methodisch fragwürdigen Evaluationsmaßen ist aber nur möglich, wenn es sie gibt (van Raan 2004).

der aufgrund dessen nicht in der Lage ist, die theoretischen Annahmen kritisch zu beurteilen, die ihrer Konstruktion zugrunde liegen. Dies hat bereits zu einer wachsenden Zahl von Fällen geführt, in denen Ministerialbeamte der Wissenschaftspolitik oder Mitglieder der Hochschulverwaltungen sich auf diese Daten beziehen, wenn sie Haushaltsentscheidungen treffen, oder in denen Dekane sie für ihre Berufungs- und Gehaltsverhandlungen zugrunde legen. Im gleichen Maß, in dem der Diskurs über die Rechenschaftspflicht der Wissenschaft an Intensität zunimmt und die Evaluierungen von Forschungseinrichtungen häufiger werden, steigt die Nachfrage nach den gebrauchsfertigen ISI – Indikatorenpaketen. Eine Folge unter anderen ist, dass Rankingverfahren, die auf diesen Daten beruhen, eine große Aufmerksamkeitswirkung erlangen, denen sich die Rektoren und Präsidenten von Universitäten nicht mehr entziehen zu können glauben, obwohl ihre methodischen Unzulänglichkeiten bekannt sind. Das inzwischen berühmt-berüchtigte Shanghai – Ranking der führenden Universitäten in der Welt erzeugt Sogwirkungen, weil es international ‚sichtbar' ist, obwohl es einer methodischen Prüfung nicht standhalten kann.[6] Die gesunde Skepsis, gepaart mit Vorsicht, wie sie noch vor ein paar Jahren verbreitet war, ist einem unkritischen und zuweilen sogar verantwortungslosen Gebrauch der bibliometrischen Maße gewichen.

Die Implikationen dieser Entwicklungen sind beunruhigend. Der Evaluationsprozess, der bislang eine wissenschaftsinterne Angelegenheit war, ist ‚externalisiert' worden, d.h. einer Laienöffentlichkeit über Zahlen zugänglich gemacht, die die quantitativen Aspekte des Kommunikationsprozesses in der Wissenschaft repräsentieren. Das ist gewollt und entspricht der Forderung nach Transparenz, die wiederum die Voraussetzung für die Kontrolle und die Bildung von Vertrauen ist. Die Zahlen, die zur Grundlage von Budgetentscheidungen werden und den Forschungsprozess sowie die Verfahrensweisen von Universitäten, Kliniken und anderen Forschungseinrichtungen direkt beeinflussen, sind jedoch voraussetzungsreich, interpretationsbedürftig und nicht uneingeschränkt verlässlich. Anders gesagt: Der Politik und der Öffentlichkeit, d.h. den Medien werden Instrumente der Steuerung der Wissenschaft in die Hand gegeben, die sie nicht in angemessener Weise bedienen können, deren unsachgemäße Anwendung aber möglicherweise großen Schaden anrichtet.

Das macht die kritische Betrachtung der Validität und Verlässlichkeit der Daten von ISI, der auf ihnen beruhenden Anwendungen durch die Wissenschaftspolitik und vor allem der *unbeabsichtigten Steuerungseffekte* dieser Anwendungen zu einer vorrangigen Aufgabe – sowohl im Interesse der ‚scientific community' als auch der Regierungen und Wissenschaftsverwaltungen.

[6] Der Vice – Chancellor einer erstrangigen Universität Süd-Afrikas berichtete, Studenten hätten vor einer Entscheidung für die Einschreibung gefragt, warum die Universität nicht im Shanghai – Ranking aufgeführt sei. Er sah sich aufgrund dieser Erfahrung veranlasst, das Ranking ernst zu nehmen. Zu den methodischen Problemen des Shanghai – Rankings siehe van Raan 2004.

3. Validität und Verlässlichkeit bibliometrischer Indikatoren in der Evaluierung von Institutionen und Wissenschaftlern

Seit den frühesten Tagen ihrer Entwicklung haben Forscher Fragen der Validität und Verlässlichkeit bibliometrischer Indikatoren behandelt. Diese zunächst akademischen Fragen haben jedoch in dem Augenblick eine dringliche politische Qualität angenommen, in dem die Indikatoren mit Finanzentscheidungen verknüpft werden. Dann kommt es nämlich darauf an, dass sie valide und verlässlich sind, d.h. sie müssen die Sachverhalte messen bzw. ‚indizieren', die sie messen sollen, und sie müssen Anfechtungen standhalten, da es sich um politisierte Daten handelt, an die sich materielle Interessen knüpfen. Tatsächlich sind die Indikatoren aber nicht über jeden Zweifel an ihrer Verlässlichkeit erhaben. Mängel der Datenverarbeitung, grundsätzliche methodische Probleme, Begrenzungen der Datenbanken sowie Einschränkungen der Anwendung der Indikatoren sind unter den mit ihnen vertrauten ‚Insidern' bekannt. Wenige markante Beispiele sollen diese Probleme illustrieren.

Da die Indikatoren zumeist (und vorzugsweise) auf einer großen Zahl von kumulativen Daten beruhen, enthalten sie Fehler der Datenverarbeitung. Ein inhärentes Problem sind Überschneidungen bei häufigen Nachnamen und falsch geschriebene Namen von Personen und Institutionen. Korrekturen dieser Fehler sind meistens nur aufgrund lokaler und sprachlicher Kenntnisse zu leisten, und sie sind aufwendig.

Die ISI-Datenbank ist gegenüber der Gesamtheit der Fachzeitschriften stark selektiv und repräsentiert nur einen Ausschnitt des gesamten Kommunikationsprozess. Abhängig von der Datenbank können die Indikatoren zum Teil erhebliche Verzerrungen gegenüber Ländern, Disziplinen und Zeitschriften enthalten (Braun et al. 2000, Zitt et al. 2003). Die Ingenieurswissenschaften, die Sozial- und Verhaltenswissenschaften sowie die Geisteswissenschaften sind unterrepräsentiert.

Ein weiteres Problem ist die Definition der Gebiete. In bestimmten Fällen werden Publikationen aus der Betrachtung (und damit aus der Bewertung!) ausgeschlossen, weil die Definition eines Forschungsgebiets in der Datenbank, das auf einem bestimmten Satz an Fachzeitschriften beruht, unvollständig ist oder sich mit anderen Definitionen überschneidet. Vor allem interdisziplinäre Gebiete entziehen sich einer angemessenen Kategorisierung. Derartige Probleme der Gebietsabgrenzungen können letztlich zu fehlerhaften Zitationszählungen führen.

Des Weiteren ist viel zu wenig über den Akt des Zitierens im wissenschaftlichen Kommunikationsprozess bekannt, seien die Zitationen negativ, positiv oder eher rituell (Case & Higgins 2000, Cronin 2000). Bis auf weiteres muss die Anwendung von Zitationsindikatoren auf die Überzeugung gestützt werden, dass sich die unterschiedlichen Motive, einen Artikel zu zitieren, gegenseitig neutralisieren. Das allen gemeinsame Ergebnis ist die Aufmerksamkeit für den zitierten Artikel. Wir wissen auch, dass verschiedene Disziplinen sehr unterschiedliche Kulturen des Zitierens entwickelt haben. Artikel in der biomedizinischen Grundlagenforschung werden sechsmal so oft zitiert wie Artikel in der Mathematik. Derartige Regelmäßigkeiten müssen berücksichtigt werden, wenn Vergleiche zwischen Institutionen über die Grenzen von Disziplinen hinweg vorgenommen werden. Eine akzeptierte Theorie der Zitationsentscheidungen, auf die sich eine besser informierte Verwendung bibliometrischer Indikatoren stützen könnte, gibt es jedoch nicht, und wird es nie geben (van Raan 1998, Small 1998).

Ein letztes Problem ergibt sich schließlich aus statistischer Perspektive. In vielen Evaluationen, die auf Zitaten beruhen, sind die Zahlen klein. Kleine Differenzen der Zitationszahlen sind möglicherweise auf das gewählte Zeitfenster zurückzuführen, d.h. auf die Zeit, die einem Artikel zur Verfügung stand, zitiert zu werden und können sich folglich rasch verändern. In institutionellen Evaluationen und Rangordnungen kann die relativ kleine Zahl involvierter Zitationen zu ‚extremen' Fällen führen wie etwa dem, dass ein hoch zitierter Artikel die relative Stellung einer entsprechenden Institution bestimmt, unabhängig von der ‚Qualitätsverteilung' in der Gesamtheit ihrer Mitarbeiter im Vergleich zu anderen. Der betreffende Autor mag vielleicht schon vor längerer Zeit die Institution verlassen haben, während sie den durch ihn bewirkten Rangplatz nach wie vor einnimmt. Kleine Unterschiede oder Unterschiede, die auf einer kleinen Anzahl von Fällen beruhen, können keine Haushalts- und Einkommensentscheidungen rechtfertigen, weil sie keine gehaltvollen Unterschiede kompetitiver Anstrengungen, der Produktivität und Innovativität und noch weniger der Qualität einer Institution oder von Individuen indizieren. Die Schlussfolgerung, die die im Umgang mit bibliometrischen Maßen erfahrenen Evaluatoren daraus ziehen: Sie können nur auf einer hohen Aggregationsebene angewandt werden, sie müssen sorgfältig im Hinblick auf präzise Fragen konstruiert werden, und sie müssen mit ebenso großer Sorgfalt und mit Blick auf die technischen und methodischen Probleme interpretiert werden. Evaluationen mit Sanktionsfolgen sind zu ernst, als dass sie mit kommerziellen Knopfdruckprodukten wie *ISI Highly Cited Com* zu leisten wären.

4. Bibliometrische Indikatoren – besser als 'peer review'?

Ein Grund für die neue Popularität der quantitativen bibliometrischen Indikatoren unter den Wissenschaftspolitikern ist die wachsende Skepsis, wenn nicht die Enttäuschung gegenüber der 'peer review', d.h. dem internen Qualitätsprüfverfahren der Wissenschaft. Anfängliche Zweifel über die Offenheit des Verfahrens, die in den USA schon in den 1970er Jahren geäußert wurden und Vorwürfe der Vetternwirtschaft ausgelöst haben sind neuerlich durch eine Anzahl von Betrugsskandalen genährt worden, die bis weit in die Eliten der Biomedizin und der Physik hineinreichen. Aufgrund der Kritik an den Selbstkontrollmechanismen der 'scientific community' und des politischen Drucks, die Forschungsmittel auf der Basis umfassender Evaluationen neu zu verteilen, werden die leicht verfügbaren und praktikablen numerischen Indikatoren mit ihrem Versprechen von Transparenz und Objektivität für Politiker unwiderstehlich attraktiv. Das Vertrauen, das den 'peer review' – Mechanismen entzogen wird, wird auf die numerischen Indikatoren verlagert. Das kommt einem Autonomieverlust der Wissenschaft und einer stärkeren Mitwirkung der politischen Öffentlichkeit in ihren Angelegenheiten gleich.

Der 'peer review' – Prozess, besonders die Verlässlichkeit und Konsistenz der Beurteilungen, sind Gegenstand vieler empirischer Untersuchungen gewesen. [7] Die Ergebnisse dieser Untersuchungen erscheinen auf den ersten Blick in der Tat nicht ermutigend. Die Urteile divergieren, sie widersprechen sich zum Teil sogar, und sie sind über einen gegebenen Zeitraum hinweg nicht konsistent. Bei näherer Betrachtung erweisen sich diese Ergebnisse angesichts der Natur des wissenschaftlichen Kommunikationsprozess allerdings als wenig überraschend. Dieser Prozess ist nämlich offen, kontrovers und unabgeschlossen. Meinungsunterschiede sind von zentraler Bedeutung für seine Produktivität und Innovativität sowie dafür, dass keine Meinung eine unberechtigte Dominanz erhält. Einigkeit wäre die Ausnahme und ist folglich selten zu finden bis eine gegebene Forschungsfrage als beantwortet gilt und die Aufmerksamkeit der Forscher sich anderen Themen zuwendet. Die Erwartung übereinstimmender Beurteilungen entstammt einem ‚enttäuschten Szientismus' in Verbindung mit Gerechtigkeitsvorstellungen (Hirschauer 2002). Als Basis für die unterschiedlichen Kritiken an der ‚peer review' im Allgemeinen und zur Rechtfertigung der Anwendung bibliometrischer Indikatoren im Besonderen bilden diese Erwartungen den falschen Bezugsrahmen.

Warum ist dies für bibliometrisch begründete Evaluierungen relevant? Zunächst einmal gilt, dass die ‚peer review' den Standard bildet, an dem die Validität aller anderen Typen von Forschungsbewertung gemessen wird (Roessner 2002, 86). Letztlich kann es keine andere Instanz der Überprüfung wissenschaftlichen Wissens und der Qualität der Forschung geben, als die Wissenschaft selbst. Soweit die Einführung der Maße durch das Misstrauen gegenüber der ‚peer review' motiviert ist, unterliegt sie deshalb auch zwei Fehlannahmen: Erstens unterstellt sie die Unabhängigkeit der Maße vom ‚peer review' – Prozess. Zweitens nimmt sie an, dass die Maße exakter sind als die ‚peer review' weil sie quantitativ und damit objektiver erscheinen.

Tatsächlich sind Publikations- und Zitationsmaße Repräsentationen des Kommunikationsprozess, wie er sich in den Veröffentlichungen in Fachzeitschriften entfaltet. Sie verkörpern also auch die ‚peer review' – Bewertungen, die zu den Publika-

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[7] Siehe u.a. Cichetti 1991; Bakanic et al. 1989; Cole et al. 1981. Die aktivsten Disziplinen in der Untersuchung der Funktionsweise ihrer eigenen 'peer review' sind die Medizin und die Psychologie. Die führende medizinische Fachzeitschrift in den USA, JAMA, hat in den 1990er Jahren vier internationale Konferenzen zur peer review in den Medizinwissenschaften durchgeführt. Nebenbei: es ist eine interessante Frage, warum gerade dieser Disziplinen besonders über ihre peer review Mechanismen besorgt zu sein scheinen.

tionen geführt haben. Aus diesem Grund können sie nicht exakter oder objektiver sein, als diese selbst.

Die wirklichen Vorteile der bibliometrischen Maße liegen auf einer anderen Ebene. 1. Diese Maße sind (vermeintlich) ‚nicht reaktiv', d.h. die Ergebnisse beruhen in der Regel auf einer großen Zahl von Ereignissen (Publikationen und Zitierungen, die die Entscheidungen der Gutachter involvieren). Die entsprechenden Entscheidungen sind nicht dadurch motiviert, dass sie für die Zwecke von Evaluierungen gezählt werden. 2. Die Verwendung von Bibliometrie kann in verschiedenen Hinsichten einen günstigen Effekt auf den ‚peer review' – Prozess haben. Die Maße umfassen üblicher Weise eine sehr viel größere Zahl solcher ‚Ereignisse', als sie in einem begrenzten Begutachtungsprozess anfallen. Sie bieten deshalb eine sehr viel breitere Perspektive, so dass Vorurteile, die auf den Beschränkungen persönlicher Kenntnisse beruhen mit einer größeren Wahrscheinlichkeit eliminiert werden. Weil die bibliometrischen Maße auf Massendaten basieren lassen sie Makromuster im Kommunikationsprozess erkennen, die aus der eng begrenzten und selektiven Perspektive des individuellen Forschers nicht gesehen werden können. Die Bibliometrie kann zum Beispiel die unerwarteten Beziehungen zwischen Forschungsfeldern aufdecken, die institutionell noch nicht miteinander verbunden sind. Der einzigartige Beitrag der Bibliometrie zum kollektiven Kommunikationsprozess und ihr größter Wert sowohl für die Wissenschaft als auch für die Wissenschaftspolitik und die Öffentlichkeit besteht darin, dass sie dieses ‚größere Bild' zu liefern vermag. Die bibliometrische Analyse und die sich auf sie stützende Evaluation ersetzen jedoch nicht die ‚peer review': Die Interpretation der Muster sowie unerwarteter Widersprüche der Ergebnisse zur allgemeinen Überzeugung der ‚scientific community' oder anderer Unregelmäßigkeiten muss den Experten in den entsprechenden Gebieten überlassen bleiben oder zumindest von ihnen unterstützt werden.

Die wichtige, vielleicht sogar die wichtigste Funktion der Bibliometrie besteht also darin, die ‚peer review' zu ‚kontrollieren' und zu stärken. Peer review Urteile (besonders solche in politikbezogenen evaluativen Kontexten), die durch bibliometrische Studien ‚geprüft' worden sind, sind besser gegen die Wirkungsweise von ‚old boys networks' geschützt. Der schnelle Niedergang der Aufmerksamkeit für ein Forschungsfeld, das zuvor eine prominente Position einnahm und dessen institutionelle Dominanz seine vergangene Bedeutung verlängert, kann dem ‚review' – Prozess aufgrund seiner inhärenten Selektivität und /oder der involvierten Interessen leicht entgehen. Die Kontrollen dieser Art stärken letztlich die Glaubwürdigkeit dieses Mechanismus und rechtfertigen in allererster Linie die Verwendung bibliometrischer Indikatoren.

5. Beabsichtigte und nicht beabsichtigte Steuerungseffekte der bibliometrischen Maße

Zusätzlich zu diesen traditionellen Fragen, die mit der Konstruktion jedes politikrelevanten Indikators verbunden sind, stellt sich eine weitere: Was sind die unbeabsichtigten Effekte der Anwendung dieser Indikatoren? Das letztlich entscheidende Problem ist, ob sie ihre Ziele als Instrument der Politik erreichen. Reagieren Individuen und Institutionen in der Weise, wie es mit der Anwendung der Maße beabsichtigt ist, oder entziehen sie sich diesen Zielen bzw. umgehen sie sie? Entgegen der ursprünglichen Annahme, bibliometrische Indikatoren seien ‚nicht-reaktive' Maße, gibt es Anzeichen dafür, dass diese Annahme falsch war.

Wenn Menschen betroffen sind, reagieren sie auf die Anwendung bewertender Maße durch die Veränderung ihres Verhaltens. Verhaltensänderungen sind durchaus beabsichtigt. Die Verknüpfung von Zitationsmaßen und der Mittelzuweisung soll zum Beispiel die Forscher dazu veranlassen, sich kompetitiver in ihren Veröffentlichungsroutinen zu verhalten, d.h. mehr Artikel zu schreiben und diese in Zeitschriften mit einem höheren ‚Impact' – Faktor zu publizieren. In der Regel werden die Mittelzuweisungen an mehr als einen Indikator gebunden, z. B. werden bibliometrische Maße mit eingeworbenen Drittmitteln als Indikator kombiniert. Letzterer soll die Forscher veranlassen, externe Forschungsmittel zu beantragen und sich in die Konkurrenz um sie zu begeben. Ein anderer Indikator für die Forschungsqualität ist die Zahl der beaufsichtigten Doktoranden. Hier geht es um die Intensivierung der Betreuung. Sir Gareth Roberts, der Präsident des Wolfson College, Oxford, meint, die Reform des 'British Research Assessment Exercise' müsse genau in diese Richtung verlaufen. „Zahlen wie die Anzahl der produzierten Doktoranden, der Drittmittel und der Anzahl der produzierten Artikel können als Indikatoren der Forschungsqualität benutzt werden, um herauszuarbeiten, wie viel Forschungsmittel eine Universität erhalten sollte" (Roberts 2003).

Jeder dieser Indikatoren beruht auf der Annahme einer eindimensionalen Reaktion, der sogen. Anreizkompatibilität, aber diese Annahme ist eine Illusion. Forscher können – und sind bekannt dafür – die Zahl ihrer Publikationen dadurch erhöhen, dass sie ihre Arbeiten zu ‚kleinsten publizierbaren Einheiten' aufteilen. Sie können relativ konservative aber sichere Forschungsprojekte vorschlagen, und sie können die Standards ihrer Doktoranden absenken. Dies sind nur Beispiele dafür, wie einzelne Personen die Indikatoren manipulieren oder den beabsichtigten Steuerungseffekten ausweichen können. In einem Kommentar in der Zeitschrift *Nature* hieß es: „Wissenschaftler streben zunehmend danach, in wenigen Spitzenjournalen zu publizieren und vergeuden ihre Zeit und Energie damit, ihre Manuskripte zu manipulieren und die Herausgeber zu umwerben. Das Resultat ist, dass die objektive Darstellung der Arbeit, die Zugänglichkeit der Artikel und die Qualität der Forschung selbst kompromittiert werden" (Lawrence 2003a, 259).

Was für Individuen gilt, gilt in diesem Fall auch für Organisationen. Sie können in derselben Weise handeln. Offensichtlich beruht die Effektivität der Forschungspolitik, die sich der bewertenden Indikatoren bedient, auf der soliden theoretischen Basis der Indikatoren und dem entsprechenden Wissen über die Reaktionen, die sie seitens der Personen und Organisationen auslösen, deren Verhalten sie allererst verändern sollen.

Bislang sind nur wenige Untersuchungen durchgeführt worden, die die Effektivität und die unbeabsichtigten Reaktionen auf diese Art der bibliometrischen Maße sowie die sekundären Folgen für die Universität oder den wissenschaftlichen Kommunikationsprozess als ganzen untersuchen. Wissenschaftssoziologische und ethnographische Studien zeigen, dass Wissenschaftler in der Tat auf politisch-administrative Einflüsse reagieren (Gläser et al., 2002, 16). Eine australische Untersuchung zeigt, dass die Zahl der Veröffentlichungen tatsächlich nach der Einführung der auf Formeln gegründeten Förderung (‚formula based funding'), d.h. in diesem Fall der Verknüpfung der Zahl der Publikationen in ‚peer reviewed' Zeitschriften mit der Zuweisung von Finanzmitteln, gestiegen ist. Freilich ist die Qualität, gemessen in Zitationen, nicht mit angewachsen. Ohne einen Versuch, bei der Mittelzuweisung zwischen Qualität, Sichtbarkeit oder dem ‚Impact' der verschiedenen Zeitschriften zu differenzieren, gibt es wenig Anreiz, die Veröffentlichung in einem angesehenen Journal anzustreben (Butler 2003, 41). Der offenkundig eindimensionale Anreiz, der durch die Politik gesetzt wurde, hat zu voraussehbaren und kontraproduktiven Reaktionen geführt. Die Spanische Nationale Kommission für die Evaluierung der Forschung (CNEAI) belohnt Forscher mit Einkommenserhöhungen, wenn sie in renommierten Zeitschriften publizieren. Eine Untersuchung kommt zu dem plausiblen Ergebnis, dass die Wissenschaftler darauf mit einer Erhöhung ihres Forschungsoutputs reagiert haben (Jiménez-Contreras 2003, 133, 138). In einem Vergleich der australischen mit der spanischen Erfahrung erklärt Butler, dass die spanische CNEAI „ihr erklärtes Ziel, die Produktivität und die Internationalisierung der spanischen Forschung zu erhöhen, erreicht hat. Im Gegensatz dazu sollten die australischen Finanzierungsformeln die Qualität belohnen, tatsächlich belohnen sie jedoch Quantität" (Butler 2003, 44). Schlimmer noch, Australien ist hinter fast alle OECD Länder zurückgefallen.

Ein Vergleich zwischen zwei australischen Universitäten (Queensland und Western Australia) „liefert weitere Unterstützung für die Annahme, dass die Verknüpfung steigender Quantität und abnehmender Qualität auf die Einführung quantitätsbasierter Finanzierungsformeln zurückgeht" (Gläser et al. 2002, 14). Die Universität ‚Western Australia' (UWA) führte eine Formel ein, die auf eine derartige quantitätsorientierte Mittelzuweisung abstellte. Die University von Queensland (UQ) versuchte demgegenüber ihre Position im nationalen Ranking durch die Rekrutierung intelligenter junger Forscher zu verbessern. Während sich die Position der UWA im Hinblick auf ihren relativen Zitationsimpakt (RCI) verschlechterte, konnte UQ ihren RCI sogar signifikant verbessern (Gläser et al. 2002, 14).

Eine andere Untersuchung über Veränderungen in den Universitäten zeigt, dass es inzwischen eine Bevorzugung der Forschungsquantität gegenüber der Qualität gibt, ebenso zugunsten der kurzfristigen Leistung, nicht aber der langfristigen Forschungskapazität, und dass es schließlich eine Bevorzugung konventioneller Forschungsansätze gibt (Marginson, Considine 2000, 17 zitiert in Gläser et al. 2002,12). Unter einem Regime der evaluationsbasierten Finanzierung, so hat sich gezeigt, publizieren Wissenschaftler mehr aber weniger riskante, ‚mainstream' Artikel, und sie versuchen sie in Zeitschriften von geringerer Qualität unterzubringen, solange diese im ISI Zeitschriften Index enthalten sind. Unter solchen Bedingungen ist das Publizieren zu einem Zweck geworden, um die Publikationszahlen zu erhöhen und Finanzmittel zu erhalten, eine legitime aber unbeabsichtigte Reaktion. Im australischen Fall zum Beispiel, können Publikationen mit Preisschildern versehen werden: A$ 3000 für einen Artikel in einer Zeitschrift mit ‚peer review'. A$ 15000 für ein Buch (Butler 2003, 40).

Da detaillierte Zitationsanalysen kostspielig und zeitraubend sind, haben viele Evaluationsagenturen Abkürzungen gewählt. Sie „betrachten die Publikationslisten von Wissenschaftlern und bewerten die Qualität ihrer Produktion über die Impaktfaktoren der Zeitschriften, in denen sie erscheinen – Zahlen, die leicht verfügbar sind (Adam 2002, 727). Impaktfaktoren von Zeitschriften sind die „Zitationsanalyse des armen Mannes" (van Raan). Sie sind aufgrund der unterschiedlichen Zitierpraktiken als Qualitätsindikatoren problematisch, wenn sie für Vergleiche zwischen Gebieten angewandt werden. Sie sind auch unzuverlässig, weil die Verteilung der Zitationen in einem gegebenen Journal sehr uneinheitlich sein kann, so dass ein Artikel in einer Zeitschrift mit hohem Impaktfaktor erscheint, aber selbst weniger häufig zitiert wird, als andere Artikel in einem weniger berühmten Journal. Per Seglen bemerkt, „dass es eine allgemeine Korrelation zwischen den Zitationszahlen von Artikeln und dem Zeitschriftenimpakt gibt, aber dies ist eine einseitige Beziehung. Die Zeitschrift hilft nicht dem Artikel, es ist umgekehrt" (Adam 2002, 727). Impaktfaktoren sind in ihrer undifferenzierten Form überholt und sollten überhaupt in keinem Evaluierungskontext verwendet werden. Dennoch sind sie wahrscheinlich die populärsten bibliometrischen Maße überhaupt. Sie sind es so sehr, dass die Zeitschrift Nature einen Werbeprospekt mit ihrem neuesten Impaktfaktor in großen Lettern versieht und dazu den Slogan: ‘No Nature, no impact’. [8]

Auf einer anekdotischen Ebene wird der Redaktionspolitik wissenschaftlicher Zeitschriften vorgeworfen, dass sie von Impaktfaktoren beeinflusst sei. Die Zunahme von Artikeln mit einem Bezug zur Medizin in biologischen Spitzenjournalen wird auf deren „günstigen Effekt auf den Impaktfaktor statt auf ihre wissenschaftli-

[8] Auf der Macmillan News Website reiht sich das angesehene Journal in die von ISI gestellten ‘impact factor’ Rankings u..a. mit der Feststellung ein:" Nature's Impact Factor makes it the second-highest cited primary journal in any field – a remarkable feat for a multidisciplinary journal - and puts it more than 4 points above the closest multidisciplinary journal, Science. The figure of 30.432 also puts Nature more than 3 points above Cell." http://www.macmillan.com/newsarchive/NPG1.asp .

che Qualität" zurückgeführt. Das gleiche gilt für die Veröffentlichung von sog. ‚Review-Artikeln' in spezialisierten Journalen, da diese häufiger zitiert werden, als Forschungsartikel (Lawrence 2003b, 836). Es ist folglich nicht überraschend, dass die Verleger wissenschaftlicher Zeitschriften darauf erpicht sind, günstige Impaktfaktoren als Werbung für ihre Produkte einzusetzen. Dies hat ein bekanntes Journal im Bereich der Notfallmedizin (*Shock*) zu dem nahezu absurden Versuch verleitet, den Kommunikationsprozess zu manipulieren. Der vorläufigen Annahme eines Artikels für den Druck fügte der stellvertretende Redakteur die Aufforderung hinzu, dass das Journal „darum bitte, dass mehrere Zitate von in *Shock* erschienenen Artikeln in die Literaturliste aufgenommen werden". Nachdem das Manuskript mit den von den Gutachtern geforderten Veränderungen zurückgesandt worden war, insistierte der Redakteur, dass es sehr begrüßt werden würde, „wenn Sie 4-6 Zitate geeignete Artikel, die in *Shock* publiziert sind, in Ihr überarbeitetes Manuskript aufnehmen könnten. Dies wäre… für die Zeitschrift eine enorme Hilfe". Es geht sogar noch weiter: Als der Artikel erschien, wurde der Autor gebeten, Kopien an Kollegen zu schicken und sie aufzufordern, ihn zu zitieren.[9] *Shock* ist keineswegs die einzige Zeitschrift, die versucht, durch sanften Druck auf ihre Autoren ihren Impaktfaktor in die Höhe zu treiben. Die Zeitschrift *Leukemia* ist wegen der gleichen Redaktionspolitik sogar der Manipulation bezichtigt worden. Eugene Garfield, der Gründer des ‚Science Citation Index' und damit der Basis für die Berechnung von Impaktfaktoren, kam zu ihrer Verteidigung, vielleicht weil er sich um dessen Zukunft sorgt. Aber sein Argument, die Herausgeber seien „berechtigt, Autoren darum zu bitten, äquivalente Referenzen aus demselben Journal zu zitieren, um dem ‚Matthäus-Effekt' zu begegnen, kann kaum überzeugen (Smith 1997, Garfield 1997).

Unabhängig davon, wie erfolgreich und wie verbreitet diese Praxis ist, demonstriert sie, dass nicht nur das Verhalten einzelner Wissenschaftler, sondern auch das von Organisationen durch bibliometrische Maße auf eine Weise beeinflusst wird, die ganz eindeutig unbeabsichtigt ist. Lange bevor sie die Größenordnung struktureller Effekte erreicht hat handelt es sich um Warnsignale. Im Fall des Impaktfaktors ist dies deutlicher als bei anderen Indikatoren: „Er hat sich zu einem Selbstzweck entwickelt – die Triebkraft für Wissenschaftler, ihren Ruf zu verbessern oder eine Stellung zu bekommen, und er erzeugt eine schädliche Konkurrenz zwischen Zeitschriften" (Lawrence 2003b, 836).

Diese Einsicht hat inzwischen auch Wissenschaftspolitiker und –administratoren erreicht. Sir Robert May, der Präsident der Royal Society und vormalige Wissenschaftsberater Tony Blairs, bekannt für seine offenen Worte, kritisierte im May 2004 die Auswirkungen des britischen Evaluierungssystems. Die Veröffentlichung in den reputierten Zeitschriften Nature und Science nehme eine allzu wichtige Rolle in der Bewertung von Wissenschaftlern und Universitätsdepartments ein. „Wir brauchen eine fundamentale Überprüfung...Es gibt eine sehr schädliche Veränderung in der

[9] Kopien der Briefe sind im Besitz des Autors.

(Wissenschafts-)Kultur. Unsere Aufmerksamkeit sollte sich auf die Ideen und ihren Wert richten, nicht darauf, wo sie publiziert worden sind“ (Curtis 2004).

In Verbindung mit der wachsenden Erkenntnis der unbeabsichtigten Anpassungseffekte des britischen Research Assessment Exercise durch einige Untersuchungen sind dies dringende Gründe, die Anpassungsprozesse in Reaktion auf evaluationsbasierte Finanzierungssysteme im Allgemeinen und auf die Verwendung bibliometrischer Maße im Besonderen sorgfältiger zu erforschen. Welche Auswirkungen haben sie auf den Inhalt des Wissens, auf die Fragen, die gestellt werden, die Methoden, die verwendet werden, die Verlässlichkeit der Ergebnisse? Welche Effekte haben sie auf den Kommunikationsprozess der Wissenschaft, auf die Mechanismen des organisierten Skeptizismus, auf die Zuweisung von Exzellenz und Reputation? In einigen jüngeren Fällen von Betrug und verfrühter Publikation wurden bibliometrische Maße und der durch sie erzeugte Druck, zu publizieren, als Ursachen dieses Verhaltens ausgemacht. Würde diese Verbindung nachgewiesen, wäre dies der endgültige Beleg dafür, dass die unbedachte Flucht in die evaluationsbasierte Mittelzuweisung mehr Schaden anrichtet als sie Nutzen bringt. Es würde letztlich bedeuten, dass die akademische Kultur, in der die Wissensproduktion auf der einzigartigen Kombination von Konkurrenz, wechselseitigem Vertrauen und kollegialer Kritik beruht, zerstört wird. Ob das, was an ihre Stelle treten wird, leichter zu kontrollieren und weniger kostspielig zu unterhalten sein wird, ist eine völlig offene Frage.

6. Die Öffentlichkeiten der bibliometrischen Indikatoren

Ein Teil der zukünftigen Kultur der Wissensproduktion wird an den Rändern der wissenschaftlichen Welt und der Welt der Informations- und Datenproduktion sowie der Verlagsindustrie und der Medien schon sichtbar. Um zu verstehen, was passiert, muss man sich vergegenwärtigen, dass die Evaluierungsindustrie, die geschaffen worden ist, mehreren Öffentlichkeiten dient. Eine von ihnen sind die Politiker, die diese Industrie ins Leben gerufen haben und für ihr Wachstum verantwortlich sind, indem sie sie als Instrument zur Ausübung von Kontrolle über Universitäten und Forschungsinstitutionen im Namen des öffentlichen Interesses benutzen. Ihre Motive sind durch den Bezug auf das öffentliche Interesse legitimiert, dass Steuergelder für die Forschung effizient und umsichtig mit Blick auf die Bedürfnisse und Interessen dieser Öffentlichkeit ausgegeben werden. Eine andere Öffentlichkeit sind die Medien, die sich ihrerseits auf das öffentliche Interesse berufen, dass die Arbeitsweisen der Forschungsinstitutionen, ihre relative Stellung und Qualität, dem Laienpublikum transparent gemacht werden soll.

Die legitimatorische Kraft dieser Öffentlichkeiten wird am besten durch die Rhetorik der öffentlichen Repräsentation von Evaluierungsdaten durch die Produzenten dieser Daten und die Medien demonstriert. Die unangemessene Vereinfachung ist nur eins der Probleme, die auftreten, wenn zum Beispiel kumulative Publikationsdaten und Daten der Forschungsmittel ohne die entsprechende Gewichtung etwa durch die Größe der Institution präsentiert werden. Die daraus abgeleiteten Rangordnungen sind sinnlos und irreführend, sie kommen aber offenbar dem Bedürfnis der Medien nach Dramatisierung entgegen. ISI bietet Universitätsrankings unter ihrem Produkt ScienceWatch mit reißerischen Titeln wie "Harvard runs high in latest 'Top Ten' Research Roundup" an. Die Metapher des ‚roundup', des Viehauftriebs also, verlegt die einst als ‚Elfenbeinturm' mystifizierten akademischen Anstalten in die Welt muhender Rinderherden. Das Ranking beruht auf den kumulierten Zitationen – pro – Artikel, dem sog. Impact jeder Universität in 21 Wissenschaftsgebieten für den Zeitraum 1997 – 2001. Die entsprechenden Zahlenwerte wurden sodann mit einem Weltdurchschnitt für die jeweiligen Gebiete verglichen. Daraus ergeben sich dann relative Impactwerte in der Form von Prozentzahlen. Zuweilen basieren die Rankings auf einer hundertstel Dezimalstelle. Die dadurch suggerierte Exaktheit der Werte mag ein Werbetrick für die ISI-Produkte sein. Politiker werden auf diese Weise jedoch mit eindimensionalen Rankings konfrontiert, die in Wirklichkeit mehrdimensional sind. Jeder oberflächliche Versuch, diese Rankings ohne die Hilfe von Experten zu interpretieren, die wissen, wie diese Zahlen allererst zustande kommen und was sie repräsentieren, ist im Kontext politischer Entscheidungen irreführend, sinnlos und unverantwortlich. Man kann sogar so weit gehen, sie für unethisch zu halten, wenn man dabei an die Kombination von unvermeidlicher Beschränkung der Beurteilungskompetenz seitens der Entscheider und ihrer gleichzeitigen Beobachtung durch die Medien denkt.

Ein anderes Beispiel für die Verwendung der Sprache des Medienhypes durch ISI findet sich im Ranking von Personen. In der Schlagzeile von Science Watch im Januar/Februar 2003 war zu lesen: "Astrophysicist Andrew Fabian on Rocketing to Prominence". Die Einschätzung von ISI beruhte auf 6000 Zitationen über das vergangene Jahrzehnt. Hier wird offenkundig, dass die Sprache der sensationalisierten Konkurrenz auch in die bisher auf sich selbst beschränkten Diskurse der ‚peer review' eingedrungen ist. Das heißt selbstverständlich nicht, dass die Wissenschaft nicht schon vor den Tagen bibliometrischer Indikatoren Konkurrenz gekannt hat.[10] Ganz im Gegenteil. Aber nur selten, wenn überhaupt, hatte sie ein äußeres Publikum und Kommentatoren, die sich der Sprache von Sportwettkämpfen bedienten.

Man kann über die Rückwirkungen dieser Entwicklung spekulieren. Es erscheint höchst wahrscheinlich, dass die Orientierung an Medienprominenz, die auch in anderen Kontexten erkennbar ist, stärker werden wird. Kurzfristige Erfolge wie die Spitzenposition in einem Ranking, die beobachtet und kommentiert werden wie die nationale Fußball – Liga und die Auslöser für benevolente Entscheidungen der Förderorganisationen sein mögen, werden wahrscheinlich die Oberhand über nachhaltigere, längerfristig angelegte Strategien gewinnen. Ist die Metapher wirklich zu weit herge-

[10] Das prominenteste Beispiel war die Watson/Crick Geschichte über die Entdeckung der Doppel-Helix, wie sie Watson erzählt hat.

holt? Die Zeitschrift Science kommentierte schon 1997, dass die „Taktiken von Fußballmanagern die Welt der Hochschulen erfasst hat". Der Einschätzung des Journals zufolge hätten die Ergebnisse der britischen Forschungsevaluation desselben Jahres gezeigt, "how soccer style transfers of researchers and other tactics aimed at improving department's rating are now part of British academic life" (Williams 1997, 18). Dieser Kontrollverlust über die eigene systemspezifische Zeitspanne und Art der Evaluierung wird voraussichtlich einen tiefgreifenden Einfluss auf die Wissensproduktion haben. Unglücklicherweise wird dies nie im Einzelnen bekannt sein, da die Vergleichsmöglichkeit fehlt.

Das Plädoyer richtet sich nicht gegen die Anwendung von Evaluationsverfahren in der Wissenschaft, die auf Indikatoren beruhen und geeignet sind, die unkontrollierbaren Äußerungen einflussreicher Persönlichkeiten einer unabhängigen Kontrolle zu unterwerfen. Gerade die Wissenschaft mit ihren für die Öffentlichkeit undurchschaubaren Verfahren (dem ‚peer review – Prozess) bedarf derartiger Kontrollen, um nach außen Transparenz zu erzeugen und dadurch Vertrauen zu schaffen. Aber Technologien können klug oder unverantwortlich eingesetzt werden. Bibliometrische Indikatoren sind eine forschungsbasierte Sozialtechnologie, und da sie Politikern und Medien Wissen über einen sonst unzugänglichen Prozess liefern, sind sie anfällig dafür, für alle möglichen wissenschaftspolitischen Interessen instrumentalisiert zu werden. Das bedeutet, dass Fragen der Validität und Verlässlichkeit, der theoretischen Begründung und der Qualität der Daten eine politische Rolle einnehmen. Die Datenproduzenten und die Bibliometriker haben eine Verantwortung für die Qualität ihrer Instrumente. Politiker haben eine Verantwortung für ihren Gebrauch. Die oben beschriebenen Tendenzen verweisen jedoch auf eine andere Realität. Die Warnung richtet sich gegen das kommerzialisierte Marketing generalisierender Produkte, deren Qualität fragwürdig ist, gegen die unkritische Verwendung bibliometrischer oder anderer Indikatoren unabhängig vom ‚peer – review' Prozess und gegen deren Verwendung ohne Beachtung ihrer Rückwirkungen auf Individuen und Institutionen. Bibliometrische Indikatoren sind ein derart mächtiges Instrument im Kontext der Wissenschaftspolitik geworden, dass ihre potentiell irreführende und destruktive Verwendung bedacht werden muss. Gerade ihre Wirkmächtigkeit verlangt einen Kodex professioneller Ethik für ihre Anwendung.

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Shifting Boundaries between Science and Politics
New Research Perspectives in Science Studies

Programme of a two day conference at the
Social Science Research Center Berlin (WZB)
25/26 June 2004

Conference theme

The two day conference "Shifting Boundaries between Science and Politics – New Research Perspectives in Science Studies" explores the intersections between science policy studies and science studies. In recent years, the boundaries between science and politics have blurred so that both domains seem to be linked more closely to each other. The 'blind delegation' of authority from the political to the scientific system that marked the decades after the Second World War is no longer seen as a valid principle of science policy. New forms of the 'governance of science' have emerged, both for the self-regulation of scientific institutions and in science and technology policy. The aim of the conference is to assess recent tendencies in science and technology policy, focusing on the case of Germany and contextualizing it within a European and transatlantic perspective.

The conference focuses on recent developments in the political domain. Two theses will be of particular interest: first the changing regimes of science policy and second the new forms of expert decision-making in science policy.

a) Changing regimes of science policy: trends and paradoxes
There is evidence to suggest that the regimes of science policy, traditionally based upon the delegation from political to scientific and intermediary institutions, are being fundamentally transformed. New forms of governance and new mechanisms of accountability have been introduced by different actors in recent years. Governments for example, in order to foster capacities for socio-economic and technological innovation, are demanding more flexible and effective forms of scientific self-regulation. As a consequence, new and more detailed instruments of quality assurance, such as program based funding, evaluations, or cost-benefit-analyses, are becoming prevalent in universities and research institutions. Intermediary institutions like the German Wissenschaftsrat are calling for a realignment of the scientific system by demanding more complementary cooperation between scientific institutions – a call at least partly motivated by the expectation of synergy effects and the ambition to economise the academic system. Also, to support processes of knowledge and technology transfer, universities and research institutions are actively strengthening links between science and industry, for example by supporting spin-offs and start-ups.

However, the variety of actors and steering principles implicates that the changing regimes in science policy remain contested, their common direction unclear and their effects sometimes paradoxical. The conference tries to assess the changing science policy regimes, for example by asking in what direction the boundaries between science and policy have recently shifted. Also, the conference discusses the question whether these trends are really a fundamental transformation of the previous relation between policy and science or just a more specified continuation of the traditional delegation principle.

b) New forms of expert decision-making in science policy: potentials and limitations
In the controversies over environmental and technological risks in recent years, the procedures of expert-based decision-making in science policy, particularly the dominance of economic expertise, have repeatedly been criticised. Critics have demanded that expert-based deliberation become more transparent or that the public be more actively involved in expert decision-making. It has also been suggested that in order to avoid the dead-ends of technological 'entrapments' and 'lock-in', participation in science and technology policy should become more diversified, thus producing plural and conditional advice. Parallel to these criticisms, science and technology has itself changed its relation to political decision-making by becoming actively engaged in the shaping of policy agendas. Increasingly, scientific expertise is entangled with political decision-making already in the beginning, not only at the end, of decision processes – giving rise to a new status of expertise that has also been called 'anticipatory science and technology'. The conference assesses the potentials and limitations of transparent and participatory forms of decision-making in different areas of science policy.

The changing regimes of science policy will be discussed from an internationally comparative perspective. The conference discusses whether recent trends in science policy reflect the specific circumstances of particular countries (like the Humboldtian heritage in Germany) or whether they represent more general trends. Also, the conference addresses the role of the European Union for science policy debates on the national level. Are recent developments of national science policies just reflecting earlier or superordinate trends on the European level?

The conference is hosted by president of the WZB, Prof. Jürgen Kocka. It is initiated and organized by Dr. Dagmar Simon and Dr. Martin Lengwiler, in collaboration with Prof. Sheila Jasanoff who joined the WZB as Karl W. Deutsch Professor in summer 2004.

Conference program

Friday 25 June

11:00 hrs	Jürgen Kocka (WZB, Berlin): opening address
11:10 hrs	Dagmar Simon (WZB, Berlin): Shifting Boundaries between Science and Politics (introduction)
11:30 hrs	Sheila Jasanoff (Harvard, USA/WZB, Berlin): The New Social Contract: Democratic Challenges to Science and Technology Policy (opening lecture) Comment: Helga Nowotny (ETH Zurich / Wissenschaftskolleg zu Berlin)
12:15 hrs	Discussion
12:45 hrs	Lunch break

Session I: Changing regimes of science policy

(papers: 25 min; comments: 5 min; 15 min discussion)

14:00 hrs	Ulrich Wengenroth (TU München, Germany): Changing regimes of science policy: historical perspectives Commentator: Joerg Potthast (TU Berlin, Germany)
14:45 hrs	Dietmar Braun (University of Lausanne, Switzerland): New Policy Rationales in the Funding of Research Commentator: Raymund Werle (Max-Planck-Institute, Cologne, Germany)
15:30 hrs	Coffee break (30 min)
16:00 hrs	Andrew Stirling (SPRU, Sussex, UK): Opening Up and Closing Down? Justification, precaution and pluralism in science and technology policy Commentator: Willem Halffman (Public Administration, Twente University)
16:45 hrs	Clark Miller (University of Wisconsin, Madison, USA): Constituting Reason, Securing Legitimacy: Scientific Institutions as Proto-Democratic Experiments in International Governance Commentator: Katie Vann (Royal Netherlands Academy of Arts and Science)

Session II: New forms of accountability in science policy

(papers: 25 min; comments: 5 min; 15 min discussion)

14:00 hrs	Brian Wynne (University of Lancaster, UK): The Reflexive Character of Science in Policy - the new mood of Dialogue with Publics Commentator: Ragna Zeiss (Free University, Amsterdam, Netherlands)
14:45 hrs	Michel Callon (CSI, Ecole des Mines, Paris): Do some patients organizations usher in a new regime of science policy, and, if yes, which one? Some lessons from the French Association of people suffering from neuromuscular diseases Commentator: Malte Schophaus (University of Bielefeld, Germany)
15:30 hrs	Coffee break (30 min)

16:00 hrs Christophe Bonneuil (Centre Alexandre Koyré, Paris, France): The effect of the French public controversy on genetically modified organisms on research orientations
Commentator: Astrid Epp (University of Bielefeld, Germany)

17:30 hrs Reception

19:00 hrs Conference dinner for speakers and commentators

Saturday 26 June

Session III: New forms of steering science

(each paper: 25 min; comments: 5 min; 15 min discussion)

09:00 hrs Henry Etzkowitz (State University, New York, USA): The role of the state in the Triple Helix: Toward a meta-innovation system Commentator: Niki Vermeulen (Maastricht University, Netherlands)

09:45 hrs Arie Rip (University of Twente, Netherlands): New and emerging governance arrangements for science Commentator: Katy Whitelegg (ARC Systems Research GmbH, Austria)

10:30 hrs Coffee break (30 min)

11:00 hrs Peter Weingart (University of Bielefeld, Germany): Impact of Bibliometrics upon the Science System: Inadvertent Consequences? Commentator: Stefan Sperling (Harvard University, Cambridge MA, USA)

11:45 hrs Dominique Pestre (EHESS, Paris; Wissenschaftskolleg zu Berlin): For a critical broadening of STS questions on Science, finance and the political: which regulations? which accountabilities?
Commentator: Bruno Strasser (University of Geneva, Switzerland)

12:30 hrs Martin Lengwiler (WZB): Conclusions for a future research agenda

13:00 hrs Round table and final discussion (chair: Sheila Jasanoff, Harvard/WZB): open questions, research lacunae (discussants: Daniel Barben, University of Bielefeld, and others)

14:00 hrs End of second day