Rationalization and the Utilization of Scientific Knowledge in German and U.S.-American Discourses

FRANK MEIER/ANDRE MÜLLER

1. Introduction

In political discourses scientific knowledge is seen as both a prerequisite for and a driving force of economic development and progress. However, while in more traditional concepts the utilization of scientific knowledge has been treated as a naturally evolving process it is now conceived of as the subject of intentional and planned action that facilitates the active transfer of technology between academia and the economy. Universities as core scientific institutions are increasingly expected to take an active role in this process.

Debates about a closer coupling between science and industry can be observed all over the globe (see, for example, Slaughter/Leslie 1997, Etzkowitz et al. 1998, Etzkowitz 2000, Slaughter/Rhoades 2004). Yet, higher education systems as well as national innovation systems differ in important ways. Comparing Germany and the U.S. this becomes obvious at first glance. It is not only the sizes or the heterogeneity of the systems, but also the internal governance structures and the role of non-university research that differ significantly. No less important are cultural traditions that shape the systems' disposition to social responsiveness. While "service" already became a legitimate mission for American universities in the second half of the 19th century, the German von-Humboldt-ideal favored social disembeddedness and remoteness.[1] Given these differences

1 Though an orientation towards the economy was not as alien to the German university system as it sometimes appears in retrospect. For some in-

one would expect only few similarities between the American and the German technology transfer discourses. In this article, however, we will present findings of a comparative research project[2] that suggest strikingly similar models in both countries' discourses. We assume that a general cultural trend of contemporary world society is underlying these models, a trend towards rationalization. In our view, thus, the case of science and technology transfer is a very instructive example of the discursive interplay between global trends on the one hand and national traditions on the other hand.

We will develop our main argument in three steps: First we suggest that discourses on science and technology transfer in Germany and the U.S. are embedded in a globalized cultural "project" that we, according the terminology of neo-institutionalist world polity studies, refer to as rationalization. Secondly, we argue that in both countries three distinct discursive models can be identified: the information and documentation model, the cooperation model and the blurring of boundaries model. Thirdly, we will discuss differences that exist despite all the similarities, and that they can be traced back to broader political cultures in both countries. Our concluding remarks will add some considerations on the very nature of rationalization.

2. Rationalization

Processes of rationalization in occidental culture have been most influentially analyzed by the classic works of Max Weber (1972). Very much inspired by Weber's work, sociological neo-institutionalism treats rationalization as a "project" profoundly transforming the institutional structure of modern society. In this view rationalization is closely linked to a comprehensive cultural framework that is increasingly globalized though Western in origin (Meyer 1994). According to this "western cultural account", nature (including the nature of society) is a disenchanted, lawful, orderly, and understandable interrelation between entities that are themselves lawful, orderly, and understandable. Rationalization, as a process, implies the inclusion of new objects into the sphere of rational-

sights into early cooperations between individual researchers and industry see (König 1990; Bertrams in this volume).

2 The results presented here are part of a larger comparative research project on technology transfer discourses and structures in Germany and the United States. This project was directed by Georg Krücken and made possible by a grant from the Deutsche Forschungsgemeinschaft (DFG Grant KR 2011).

ity and also the ongoing production of detailed rational knowledge and theories on all sorts of subjects. Moreover, rationalization results in the production and diffusion of structural elements that are perceived as rational. That is, they are seen as reasonable, effective and efficient means to attain legitimate ends. As a project, rationalization legitimizes the aim of complete disenchantment of nature and society and the pervasion of society with rationalized structures.

It has been argued that neo-institutionalists treat rationalization in organizational contexts only in terms of adaptation and diffusion (Hasselbladh/Kallinikos 2000). While studying diffusion of institutionalized cultural content is clearly very important to neo-institutionalist thinking, the concept of rationalization, as a project, goes far beyond this issue. It very quickly becomes clear that rationalization, in its very broad and abstract content, provides too little information to be prescriptive for organizational structures or action. Thus, there is plenty of room for local processes of selection and transformation. But maybe even this reasoning is linked too much to the idea of rationalization as a top down process, as an external force acting on social entities. In which case, it is more appropriate to define the project of rationalization as a generative structure that enables and legitimizes decentralized cultural production. This view highlights both the innovative potential of institutional structures and the active role of organizations and other local entities. These entities do not only generate rationalized structures for themselves, they feel increasingly entitled to give advice to others (Meyer/Jepperson 2000, Meier 2004). Rationalization thus leads to an increasingly dense net of dynamic cultural production, diffusion and transformation. Within this structure it is quite probable that global trends are interwoven with local cultural contents. The idea of a globalizing project of rationalization is then by no means inconsistent with the persistence of national traditions.

The rationalization of nature and society is closely related to the rise of science and scientific authority. Science is without any doubt a central piece of the net of rationalization (Drori 2003). This is not only due to the fact that huge amounts of law-like knowledge about nature are produced within processes of scientific inquiry. Rather, the concept of nature that is becoming dominant in modernity is an expression of a scientific outlook (Meyer/Jepperson 2000: 103). Moreover, specific claims on the nature of nature considerably gain authority when they are backed up with scientific knowledge. Who wants to justify her actions or omissions is well advised to rely on scientific or professional advice. Finally, science is not only seen as producing knowledge for its own sake (which is highly valued and legitimate) but also as contributing substantially to economic progress and public welfare, which are core values in rationalized world society.

However, while science is clearly an important driving force of rationalization, this does not imply that science itself is excluded from rationalization or cannot be disenchanted or further rationalized. Quite the contrary, we argue that science is increasingly becoming the subject of rationalizing forces. This holds particularly true with regard to its core institutions. University structures worldwide are currently experiencing dynamic rationalizing efforts (for some general tendencies see Krücken/ Meier 2006). Two examples will illustrate our claim.

One important aspect of the rationalization of universities is the introduction of evaluation procedures and standardized techniques of counting and accounting. Of course, since the advent of the research university, at the very latest, the idea of organized skepticism and collective criticism has been at the heart of academic culture. But this is quite remote from today's more rationalized approach. Traditionally, the output of universities (i.e., knowledge and educated people) was seen as distinct from the output of other organizations, and though it could and should be subject to scrutiny, the formal measurement of knowledge and education seemed to create insurmountable problems. These problems are not solved yet, nevertheless formal measurements, e.g. based on bibliometric data, are rapidly diffusing into academia. As Weingart (2004: 119) puts it:

> "[O]ne can now witness internationally a dramatic shift from the well founded scepticism to an uncritical embrace of bibliometric numbers. This change of mind is not limited to policy makers and administrators but has taken hold of deans, department chairmen, university presidents and officials in funding agencies and research councils as well, i.e., of representatives of the scientific community that were most strongly opposed to external evaluation of research by any means."

Another aspect is the transformation of university management into a profession. While university management was traditionally seen in many countries as the business of academics who were more or less managerial laypeople, higher education management is increasingly becoming the subject of academic teaching (with courses and degrees) and research (with specialized journals). As such, it is an understandable and learnable task just like any other kind of management.

In this article we will focus on different kinds of rationalization processes, those at the boundary of science and at the boundary of universities: that is rationalization with regard to the utilization of scientific knowledge. The outstanding relevance of this kind of knowledge for economic development is an idea that has become popular all over the world since World War II (Drori et al. 2003). In Germany as well as in the United States the emerging science policies concluded that it was of vital national interest that scientific capacities were expanded and that science was granted political priority (Bush 1945; BMwF 1965). Realizing science's utility was thus synonymous with advancing science, since it was clear that – metaphorically speaking – "nature has always given its fruits" (Stoltenberg 1969: 117). Implicit here was the idea of a cascade effect: basic knowledge would "spill-over" to more applied fields and eventually lead to innovations in the industrial domain. This implicit linear innovation model was consistent with a discursive emphasis on basic research. In the long run, it was believed, scientific excellence would lead to economic development; without the need for further investigation of the processes involved or specialized planning action. The paths eventually leading to the expected outcomes were not seen as problematic. Thus, the utilization of scientific knowledge was hardly rationalized at all.

However, since the 1950s processes of utilizing scientific knowledge have been increasingly becoming subject of theoretical reasoning. Here, the perception was expressed that transfer was less effective than it could be. "It has became apparent that the process of transfer in many cases does not run as smoothly and quickly, as desirable for the economy as a whole" (Wissenschaftsrat 1975: 137).

In this kind of theorizing – initially scholarly discussions, subsequently also political statements – science and technology transfer was seen as a process that is lawful, understandable and that can be intentionally organized. As more and more obstacles to the process were discovered, the alleged importance of science for economic development was strikingly hardly ever questioned, rather the perceived underutilization of this knowledge lead to demands for stronger efforts.

3. Transnational Models of Science and Technology Transfer

Over the decades the question of how to snatch the metaphorical fruit from nature in an effective and efficient way, and how to facilitate the intentional and planned utilization of scientific knowledge have been answered in different ways. We argue that these discourses on science and technology transfer, while being quite heterogeneous, display a fundamental order.[3] According to our analysis, three distinctive discursive models of transfer can be identified: the *information and documentation* model, the *cooperation model* and the *blurring of boundaries* model.[4]

Each model is accompanied by the production of theoretical knowledge on the one hand and the establishment of rationalized social structures (e.g. specialized agencies) on the other hand. We argue that in spite of remarkable differences between the national innovation systems these models are central in both countries' discourses. In Germany, the three models succeeded each other in a quite clear chronological order. Or to put it more precisely, one can observe a succession of dominant models, one at a time, though older models don't disappear completely and continue to leave their marks on transfer discourses. The American picture is even more strongly marked by overlapping models, in which subsequent steps are added in a piecemeal fashion.

While the picture drawn here is obviously not that of linear progression, this is not to be expected in processes of rationalization. Nevertheless, looking at the succession of the models one can observe two developments: First, the models are depicting the process of utilizing science in an increasingly complex way. Second, science is perceived as becoming increasingly involved in the process of utilization of scientific knowledge. Scientific institutions (esp. universities) are becoming actors in this process. Thus, science and universities, as its core institutions, are increasingly subject to rationalization.

The Information and Documentation (I & D) Model

According to the information and documentation (I & D) model, the key problem with utilizing scientific insights is the accelerating rate at which knowledge is produced. The solution to the problem of knowledge "superabundance" is the creation of information infrastructures that make knowledge available in a methodical, technologically advanced and modern way. Specifically, new infrastructures are supposed to ensure that targeted actors efficiently negotiate in an information-rich environment and receive timely and relevant information. In addition, new information infrastructures are expected to reduce the waste of time and resources that results from the reinvention of already-existing technologies.

3 Obviously and inevitably we offer a highly rationalized account of these discourses.

4 For a more comprehensive analysis of the three models see Krücken/Meier/Müller forthcoming.

Since the I & D model clearly focuses on technological solutions, it might appear to be an outcome of the computer age. Though it is probably true that the success of the model was connected to the possibilities and, even more, the promises of computer technologies, it is important to realize that institutionalized I & D efforts started, when the most advanced information and documentation technologies were based on file card systems.

The I & D model can be applied to all kinds of data, information and knowledge. Empirically it has sometimes been used as a very general concept: "In principle information from all fields of knowledge and all areas of life should be available to everyone who is interested" (Interministerial working group 1971: 17). Nevertheless, the utilization of science for economic purposes has been addressed specifically in the I & D model as well.

The I & D model of science-industry relations is *linear*: knowledge generation is followed by dissemination and then utilization. The transfer of existing knowledge across science-industry boundaries takes place without any transformation of that knowledge. At most, information is condensed, or when necessary, translated. Nevertheless, the I & D model is by no means *identical* with the linear innovation model in the sense that it is just a strange new label for what is known as the linear model. As mentioned above, even a less rationalized concept of the utilization of scientific knowledge displays an implicit linear innovation model and it will be shown that the cooperation model preserves residues of linearity. Additionally, the I & D model is very much connected to a special kind of professional practice and policy, both of which were historically known under the labels of information and documentation.

The I & D model does not assume personal contact between scientists and industry. A scientist's primary role is that of knowledge producer, although he may be asked to avoid "unnecessary" or redundant publications and to provide titles and abstracts that may be easily understood by others[5]. Even here, specialized agencies and archival journals, rather than the scientists themselves, are expected to undertake the bulk of the required work. Thus, the rationalizing process involved in I & D only marginally affected science in its institutional structure. The rationalized structures that were introduced were only loosely coupled (Weick 1976) to scientist's usual every day work. The I and D model can be illustrated by the following quotation from the US case:

5 This was, for example, postulated in the Weinberg report (President's Advisory Committee 1963), which was therefore much more demanding than other I & D papers (cp. Bundesrechnungshof 1962: 2).

"[The federal government] has an obligation to develop a workable system of utilizing this enormous reservoir of scientific information so that its benefits can be transmitted to business both large and small in order to provide the ingredients necessary for an accelerated growth in our civilian economy." (Eugene Foley cited in Rosenbloom 1965: 6)

Although I & D efforts go back in time beyond our scope, with documentation technologies adapting to the respective technical standard of a given era, it bloomed, both in Germany and the US, in the late 1950s and early 1960s. While international efforts to establish information policies can be observed, especially in the early 1970s (e.g. OECD 1971, UNESCO 1971), it was in the late 1970s that the following model took precedence. The information policy nevertheless continued to exist into the 1990s when it was transformed into an information and communication policy.

The Cooperation Model

The idea that research outcomes more or less automatically "fall-out" or "spill-over" from the academic to the industrial domain when a sufficent I & D infrastructure exists has been met with increasing skepticism. The fact that potential users have access to documented knowledge seemed to be, in itself, not enough to stimulate innovation based on this knowledge. Taking this consideration into account, the cooperation model emphasizes that science and technology transfer can only be successful if scientists and practitioners actively exchange their ideas through immediate personal contact. This may be achieved informally or formally, for example, through personnel exchanges between research institutions and industrial partners. Mediators (like technology transfer offices, the most obvious rationalized structures introduced under this model) shall help establish contacts and to clear up misunderstandings. Thus, in this model, actual or perceived "cultural gaps" between science and the economy are seen as the key problem. These gaps can only be bridged by personal trust.

In contrast to the I & D model, which clearly implies a linear and hierarchical process of transmitting existing knowledge, the cooperation model understands "transfer" as a *dialogue* among partners from different institutional backgrounds. Transfer is no longer conceptualized as a one way street. Rather, scientists engage in cooperation, learn about the technological needs of their (industry) partners and redraw their research agenda accordingly. Thus, the cooperation model introduces an element of feedback even though scientists are still seen as the primary knowledge producers in the exchange. Here, a quote from a report by a German transfer office is quite revealing:

"It is the expert's task to mediate between research and industry in both directions. On the one hand results from applied research are transmitted to industry, where they are developed further into marketable products and procedures. On the other hand problems from industry are reported to universities in order to make them the subject of research. Technology transfer is thus ongoing communication between research and industry, which aims to dismantle prejudices and to enable mutual reflection. As a result, science is opening up to a stronger industry-orientation and industry is gaining understanding of scientific methods of operation." (Allesch 1979: 21)

This quotation casts some doubt on the character of dialogue in the cooperation model. Indeed, at least in this case, the contributions of the two parties involved seem to be asymmetrical. Science on the one hand provides the demanded knowledge, industry on the other hand is just informing scientists about problems, raising the hope that they can be solved. This asymmetry is expressed precisely when, in respect to the American situation, Bozeman concludes (2000: 633): "The logic is simple: universities and government labs make, industry takes." Despite the element of feedback, the cooperation model does not necessarily transcend the linear innovation model in all its facets.

Notably, although the cooperation model stresses the institutional integrity of science (and of economy as well), it implies an important change in the role of science in the utilization of scientific knowledge. Scientists, as transfer partners, and scientific institutions, as mediators, are expected to get *actively* involved in the process of science and technology transfer. Scientists and scientific institutions are no longer simply rationalizing forces, they become subject to rationalization. The cooperation model can be illustrated by this quotation from the German case:

"Technology-transfer requires mutual trust between the partners involved. A fruitful process of exchange can only develop this way. Scientists, who want to cooperate with small and medium sized enterprises, have to be willing to show understanding for their problems and their ways of thinking and have to partly put aside the criteria of their usual work. Entrepreneurs for their part have to show understanding for scientific work." (Research Council Baden-Württemberg 1983: 24)

While the cooperation model in Germany and its successor, the BoB model, can be distinguished in time, this is not the case in the U.S. In the 1980s, both models were simultaneously supported. Nevertheless, we suggest that efforts conforming to either of the models can be distinguished analytically.[6]

The Blurring of Boundaries (BoB) Model

While the cooperation model takes clear institutional boundaries between science and the economy for granted, and even emphasizes them, the blurring of boundaries (BoB) model assumes that these boundaries are becoming increasingly permeable, diffuse and, in some cases, "blurred".

Analytically, this model has two variants. The first focuses on the emerging entrepreneurial activity of the university, which is understood as an *economic* actor in its own right, engaging in licensing activities and/or fostering spin-offs. In becoming entrepreneurial the university transcends its institutional identity and undermines traditional boundaries. This variant is more important in the American case, where the famous Bayh-Dole Act of 1980 serves as a *symbolic* point of reference.[7]

The entrepreneurial variant highlights the proliferation of university licensing offices as probably the most visible rationalized structures. In the U.S. extensive professionalization efforts can be observed in this field, which have been greatly fostered by the Association of Technology Managers (AUTM) and have begun to expand beyond the American borders in recent years.

The second variant emphasizes the embeddedness of academic knowledge production in a comprehensive innovation process, which is regarded as highly complex and is often described with metaphors of systems or networks. This model highlights, for example, the interaction of the systems' components or feedback loops. Formalized networks are advocated as the most appropriate structures in innovation contexts.

6 Two pieces of legislation, both of which were passed in 1980 can be identified as the most visible examples of the two models: The Stevenson Wydler Act (as the embodiment of the cooperation model), and the Bayh-Dole Act (as most prominently displaying the entrepreneurial BoB model).

7 The Bayh-Dole Act permits universities to retain title to inventions developed using federal funding. Before the act, universities needed special approval to secure patents on inventions developed with federal research monies. Slaughter and Leslie conclude: "In a very real sense the Bayh-Dole Act encouraged academic capitalism." (Slaughter/Leslie 1997: 46). Yet, some authors suggest that the Act has had little real effect on university patenting and licensing, and that it was only one among other factors contributing to the corresponding increase in the 1980s and 1990s (see, for example, Mowery et al. 2001).

These network features clearly contrast with the cooperation model's more simple and linear structure. The cooperation model focuses on a mediated and straightforward (usually) dyadic relation between scientists and practitioners. In contrast, the more complex network model makes it harder or even impossible to differentiate a well-defined academic role from an economic one. As a result, as in the network variant of the BoB model, the institutional boundaries of the economy and of academia are blurred.

This variant is very prominent in the German discourses of the 1990s, as the following quotation from the Federal Ministry of Research illustrates:

"Making the existing borders between public research and the economy permeable is one of the main issues of shaping the future direction of research. Where it is relevant to the economy, research must […] be able to smoothly move from the public sector to the economy." (BMBF 2000: 28)

4. Synopsis: The Development of the Science and Technology Transfer Discourses in Germany and the U.S.

Given the differences between the German and the American higher education and innovation systems, it is quite remarkable that all three models – in their specific instances – shaped the transfer discourses in both countries.

In Germany there has been a more or less a clear succession of the three models. The issue of science technology transfer has been addressed as a problem of I & D activities – with and without using the term – in political papers since the 1960s (Bundesrechnungshof 1962) and in scholarly discussions, at least since the 1950s. Yet, the first German program on I & D was not introduced until the mid seventies (BMFT 1975), after several international organizations had begun to promote information policy. Trust and dialog based cooperation became the focal issue in the late 70s and the 80s, when transfer offices were seen as contributing considerably to university-industry interaction. In the 1990s, most notably, the federal government postulated the BoB model. Unlike the U.S.-case, the model appeared predominantly in its network-variant. This may be due to an emphasis, in German political culture, on interest mediation and the inclusion of heterogeneous actors. This tendency has been further fueled by the European Union, which also heavily promotes the network idea through a variety of programs and by making the participation of different institutions from different member states obligatory for European research funding. The very idea of the European Union as a multinational entity is probably ideologically supportive of boundary spanning networks that are integrating heterogeneous and self-confidant participants. Though there is also a call for entrepreneurial universities in Germany, this demand is rather hesitant in comparison to that in America.

The I & D model preceded the other models in the U.S. too. Triggered by the sputnik shock information policy was established considerably earlier than in Germany. But, unlike in Germany the American discourse as been characterized by an incisive discontinuity since the beginning 1980s. Marked by legislative innovations like the Stevenson-Wydler Act (which displayed the cooperation model) or the Bayh-Dole Act (which became the epitome of entrepreneurial activity) – and a series of other pieces of legislation – both trust-based cooperation and entrepreneurial elements simultaneously became central aspects of the discourse. In addition, the Bayh-Dole Act served as a focal discursive event for all relevant actors dealing with university-industry relations. Such a central reference point is missing in the German discourse.

In accordance with differences in broader political cultures, the American discourse displays a different version of the BoB model. The strongly individualist American polity is probably more in line with the emphasis on the entrepreneurial university and the entrepreneurial researcher than the German corporatist polity. In return, though heavily discussed and promoted in academic discourses, innovation networks are significantly less visible in political discourse, related programs, and legislation.

Interpreting the succession of the models in chronological order – which is appropriate for the American case only to a limited degree – a development towards increasing involvement of scientists and scientific institutions in the process of utilizing science can be observed. In the BoB model – in its network variant as well as in the idea of the entrepreneurial university – even the institutional boundaries of science and the economy seem to be getting blurred. In this development, the process of rationalization is increasingly affecting the institutional core of science and the university.

5. Concluding Remarks

In this article we have described rationalization as an all-embracing process that is increasingly affecting science itself. Some concluding remarks on the very nature of this process are called for.

While rationalization is disenchanting in nature, it does not expel myths from society. Quite the contrary, neo-institutionalists have provided detailed descriptions of the *myths of rationality* prevailing in contemporary world society (Meyer/Rowan 1977; Dobbin 1994; Brunsson/Olsen 1993). Thus, arguing that processes of rationalization can be observed, we certainly do not claim that discursive models of science and technology transfer are increasingly infused with the spirit of reason. Of course, we do not deny that there has been some theoretical progress but, as has been shown, even variants of contemporary models display the existence of myths in the "innovation society" (Krücken/Meier 2003).

For example, the common belief that networks are to be seen as superior social structures in the context of innovation, as expressed in the network variant of the BoB model, is clearly a myth. Though many studies point to the advantages of networks, these are not always and not in every respect superior. While the institutional economics of Oliver Williamson (1990) points to the fact that the choice of network structures is only rational under certain conditions, other authors warn against "lock in"-effects (Grabher 1993). My own studies suggest that networks, in the context of science and technology transfer offices at German Universities, are costly (in terms of invested time), fragile, difficult to establish and difficult to sustain, while the benefits are difficult to measure.

Nevertheless, maybe it is the network myth that leads to beneficial outcomes in some cases. In such cases it would be the unshakable belief in the superiority of network structures that allows networks to establish and to grow, in spite of all difficulties. The idea of superiority would then contribute to its own realization. More generally speaking, the myths of rationality, like all myths, enable action despite uncertainty. From this perspective, the production of "appropriate" myths is one of the most important social functions of the project of rationalization.

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