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Forms of research organisation and their responsiveness to external goal setting

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Abstract

Notions such as 'post-normal science', 'mode 2' and 'triple helix' have been used to describe changing forms of work organisation in science. These notions have been acclaimed for their general scope yet criticised for their lack of empirical substantiation. This paper develops a theoretically informed but empirically applicable model for research into forms of work organisation in science and their responsiveness towards external goal setting. By means of empirical illustration, this model is applied to the organisation of university and non-university economic research in Germany. It is observed that it is not the epistemology of research that makes for its responsiveness towards external goal setting but rather its institutional organisation. In conclusion, the paper argues that the social accountability of research can be consciously designed in terms of the formal constitutions of publicly funded research organisations. This leaves an important task for national science policies. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

It has recently been argued that the organisation of scientific research in modern industrialised nations is undergoing rapid yet fundamental change exemplified by the emergence of new forms of research organisation. This phenomenon has been alternately described as the advent of 'post-normal science', characterised by a new and value-sensitive methodology (Funtowicz and Ravetz, 1993), as 'the new production of knowledge', replacing conventional forms of research organisation (Gibbons et al., 1994), and as the emergence of a 'triple helix' of intricate relations between university, industry and government (Etzkowitz and Leydesdorff, 1997). These notions differ in terms of their particular conceptual definitions and assumptions, but share an orientation towards innovative and application-oriented research in the interface between scientific, economic and political domains. As such, these ideas about fundamental changes in the organisation of the research process have been acclaimed for their general scope (Jacob, 1997), but have also been criticised for their lack of empirical substantiation (Weingart, 1997; Godin, 1998; Shinn, 1999).

This paper aims to contribute to current debates about changing forms of work organisation in science by developing a theoretically informed but empirically applicable model for research into the re-

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sponsiveness of research towards external goal setting. On the basis of the theoretical discussion in the first part of the paper, an analytical framework is sketched that allows for the specification of targeted questions about the institutional structures in which scientific research is embedded. Three ideal-typical research organisations are distinguished that differ in terms of their internal structures and external relations with actors in the economic and political sector. In the second part of the paper, this model is applied to the organisation of university and non-university economic research in Germany. In this empirical illustration, it is observed that knowledge production in German economics is of a hybrid nature, sometimes displaying characteristics of theoretically oriented disciplinary science and at times those of application oriented policy research. It is argued that differences in the intellectual orientations and outcomes of the research process can be explained in terms of the institutional structures of forms of work organisation in the field of German economics. Implied by this, attempts at external goal setting for economic research can necessarily follow only indirectly, their effectiveness being conditioned by the institutional structures in which research is embedded. The paper concludes that a differentiated understanding of forms of research organisation is of central importance to science policy decision-making. Such decision-making can only be goal-effective if it explicitly takes on its own bearing on the institutionally conditioned path-dependencies of the research process.

2. A new mode of knowledge production

The most widely debated of recent notions about changing forms of work organisation in science is that of the emergence of a new mode of knowledge production as put forth by Gibbons et al. (1994). These authors have postulated that a new mode of scientific research — referred to by them as mode 2 — is rapidly emerging in modern industrialised nations, essentially differentiating itself from traditional, disciplinary organised forms of knowledge production — referred to by Gibbons et al. as mode 1. Arguably, the new mode of knowledge production is distinctly applied in character, transdisciplinary in its fundamental research orientations, pursued by heterogeneous and transient research collectives, and both socially accountable and inherently reflexive in its contents and research methods. The new mode of knowledge production is typically observed in innovative research in fields such as new materials, biogenetics and information technology, but, according to Gibbons et al., can be seen to emerge in traditional areas of the humanities and social sciences as well and thus constitutes a truly general feature of modern science.

According to Gibbons et al., the emergence of the new form of knowledge production can largely be explained in terms of comprehensive social and economic changes, namely, the massification of higher education and scientific research on the one hand and the growing importance of knowledge as a production factor in innovative industries on the other. Thereby, the argument in favour of the emergence of a new mode of knowledge production underscores the ever growing significance of science and technology in post-industrial Western society (Stehr, 1994). The importance of knowledge and knowledge bearers for competitive industrial organisation in a globalising economy and for the political administration of changing welfare states also is being recognised by such influential organisations as the OECD and the European Commission (European Commission, 1998; Organisation for Economic Co-operation and Development, 1998). In this respect, debates about the emergence of new forms of work organisation in science not only are of theoretical meaning, but are of profoundly practical interest as well.

The idea of the emergence of an essentially new mode of knowledge production in science has, however, been challenged, one point of critique being that such a general observation may be convincing in itself, but needs be empirically substantiated for its analytical relevance to be fully appreciated (Godin, 1998; Shinn, 1999). One question, for instance, that must be empirically answered before the essential characteristics of the knowledge process in different scientific fields can be appropriately compared, concerns the way in which the institutional organisation of such fields entails differently constituted links to economic and political practice (Mayntz and Schimank, 1998). Another question that is important in this respect concerns the way in which such links represent mechanisms for the mediation of external

goals and priorities into scientific research (Weingart, 1997).

3. Resource dependency and external goal setting

Organised scientific research — as distinguished from R&D efforts in industry and in-house research in the public sector — is practically made possible by the financial and material means that are made available to science through formalised legal arrangements and financial decisions by funding agencies and influential client/user groups (Braun, 1998). Apart from its typical intellectual independence, organised research therefore is characterised by particular relations of resource dependency towards other social sectors, notably the private economy and government bureaucracy (Hasse and Krücke, 1996). By consequence, the development of theoretical insights and empirical knowledge follows relatively autonomously and results both from an inner-scientifically generated cognitive dynamic and from the mediation into the knowledge process of the external priorities that emerge from practical demands for applicable knowledge and insights.

The exact proportion of internal dynamics and external imperatives, however, varies between different fields and disciplines depending on their particular research traditions and methods, their accumulated knowledge and expertise, and their social status and professional standing (Whitley, 1984). Patterns in the distribution of the typical rewards for successful scientific research — professional reputation and research funding — vary across particular disciplines and precipitate in different forms of work organisation and in different communication habits within and across the boundaries of scientific fields. Empirical research into forms of work organisation in science, therefore, needs to distinguish analytically between different institutional contexts of research and has to take on differently constituted links between science and economic and political practice.

The a-priori possibility of making analytical distinctions between institutional contexts of research is however denied by recent developments in the sociology of science and technology (SST). The many theoretical contributions and detailed empirical case studies in SST over the last 10–20 years have demonstrated the essential contingencies that pervade actors' strategies at the level of actual research practice (Restivo, 1995). Constructivist approaches, in particular, have pointed out that scientific knowledge is being manufactured on the basis of practical and situational logics and not on the basis of the universal norms or institutional imperatives of science (Knorr-Cetina, 1981). The production of scientific knowledge at the level of actual research practice, therefore, does not distinguish itself analytically from the way in which shared meaning is realised outside science (Woolgar, 1988). Recognising differences between institutional contexts of research, then, must be understood as a political act that itself should be analysed in terms of reciprocal power relations and resource availability (Latour, 1987).

Basic tenets of constructivist approaches have been widely accepted, especially its actor-centered methodology and its capacity for analysing the contingencies inherent to actual research practice (Pickering, 1992). At the same time, however, sociological studies of scientific knowledge have made clear that scientists do not have unlimited freedom in constructing their knowledge claims (Barnes, 1990). Against the background of the organised character of research, the access to necessary resources is collectively organised and controlled by institutionally formalised rules and established procedures for transforming individual experience into public knowledge (Shapin, 1995). Research results constantly have to be integrated by researchers into existing schemes of recognised problems and accepted problem solutions. These schemes on their turn are the basis for the distribution of the resources that are necessary for the identification of relevant research problems and the production of new problem solutions (Allwood, 1997).

The strategic actions of individual scientists in the actual research process, then, only become possible through the collectively organised and institutionally patterned access to necessary resources. Scientists may for instance strive to maximise their scientific reputation and professional esteem through practical knowledge construction, but can necessarily only do so in particular settings in which the outcomes of their research efforts are stabilised or not (Stern, 1996). The structures of those settings, therefore, constrain what can be understood by maximum repu-

tation and esteem as well as they enable the identification of acceptable ways to acquire desired forms of professional recognition. Researchers will then develop varying cognitive preferences and professional interests which reflect basic characteristics of their particular fields of intellectual interest and concrete aspects of the organisation of their actual research practices (Hill, 1995). Such preferences and interests are based on shared ideas and beliefs, common cognitive and technical norms, and established procedural rules that prescribe how researchers can develop consistent strategies for effective action in the context of the constantly changing choice situations that comprise their actual work environments.

The observation that the institutional organisation of research structures the contingencies inherent to the knowledge process implies both that individual contributions to research underlie specific institutional constraints and that intellectual developments should therefore reveal particular path-dependencies, that is, follow typical patterns of stability and change (Schimank, 1995). It also means that the dynamics underlying the production of scientific knowledge should be investigated on the basis of a theoretical model which is both actor-centered — so as to accommodate basic constructivist insights — and able to explain patterns and regularities in processes of knowledge production (Hagendijk, 1990). The dynamics of cognitive change and intellectual innovation in science should therefore be investigated within an analytical framework in which the outcome of the research process in different fields and disciplines can be understood as institutionally conditioned by forms of research organisation. More in particular, such a framework should be able to generate researchable hypotheses as to how and why forms of research organisation in science structure the research process and condition its responsiveness towards external goal setting by economic and political actors.

4. Actor-centered institutionalism (ACI)

An applicable framework for research into the responsiveness of research towards external goal setting is provided by ACI as developed at the Max Planck Institute for the Study of Societies in Cologne, Germany. It provides an analytical framework for the specification of questions of the relation between the self-organising properties of social systems on the one hand and the political governance of such systems on the other (Mayntz and Scharpf, 1995). ACI concentrates its analysis on the intentional action of both individual and collective actors and relates the outcomes of interaction to the institutional settings in which these actors pursue their particular goals and interests. [1] As such, the framework of ACI has been successfully applied to the analysis of the organisation and functioning of scientific fields and disciplines (e.g., Hohn, 1998; Laudel, 1999). Also, the analytical usefulness of this framework for the study of technological development and innovation has been demonstrated (e.g., Schmidt and Werle, 1997; Werle, 1998).

In the framework of ACI, institutions are understood as particular sets of rules that demarcate actors' competencies and structure the possible uses of available resources for them to realise personal goals and objectives. The mutual and regulated relations between individual actors thus constitute more or less strongly integrated networks of interaction and communication. Actors may for instance individually control action resources and orient themselves almost exclusively towards personal goals and priorities. Alternatively, control over action resources may be collectively organised, forcing individual action to be oriented towards 'the joint effect of coordinated action' (Scharpf, 1997, p. 54). From an analytical point of view, networks of mutual relations between individuals may then form composite or collective actors. These may maintain relations among themselves, while being comprised by internal networks of interaction and communication.

Ready examples of collective actors are formal organisations. These are constituted by rules that specify their mission and which constrain the actions of their individual members towards organisational

[1] ACI recognises institutions as limiting constraints on the strategic choices of actors. These constraints, however, also enable actors to identify and rank remaining action options and thus to devise and evaluate goal-oriented strategies. Institutions, therefore, provide both positive and negative incentives for purposeful action. ACI contributes to the emergence of new institutionalist approaches in fields such as sociology, economics and political science (cf. Nee, 1998).

goals and priorities (Vanberg, 1994). The rules underlying the distribution of action resources within formally constituted organisations, however, differently enable them to co-ordinate and orient the actions of their individual members. Internal co-ordination mechanisms within organisations will vary, depending on the way they themselves depend on action resources controlled by other actors. This holds for instance for business firms that depend on the successful marketing of their products for acquiring the financial compensation for R&D costs and which therefore need to structure their internal organisation in accordance with the imperatives of the particular markets in which they operate (cf. Amendola and Gaffard, 1994). It also holds, to name another example, for the way in which the organisation of research funding agencies is geared to acquiring financial means from government and to maintaining the legitimation for allocating available funds within the scientific community (Rip, 1994).

These observations, then, enable the specification of researchable hypotheses concerning the relation between forms of work organisation in science and the responsiveness of research towards external demands for practical knowledge and applicable insights, that is, the extent to which economic and political actors can try and set goals for scientific research. The constitution of research organisations may be seen as the independent variable, to which the direction and outcomes of research — representing the dependent variable in these hypotheses — can be traced back (Fig. 1). Following this line of argument, the relations between research organisation and research practice are influenced by two intervening variables. Firstly, these are the relations with economic and political actors that are maintained by research organisations, through which external demands and expectations may be brought to bear on internal decision-making procedures. Secondly, these are the internal decision-making procedures within research organisations themselves, in which external imperatives may or may not be integrated into internal preferences as to the desired direction of research.

Three ideal-typical research organisations, which differ in terms of their internal structures and external relations, may then be distinguished, namely, *knowledge seekers*, *research contractors* and *service providers*.

Knowledge seekers are organised on the basis of a constitution that guarantees their access to necessary action resources and warrants their independence in identifying organisational goals and priorities. Organisations of this type are not dependent upon maintaining direct external relations with economic and political practise for acquiring necessary action resources such as basic research funding. By consequence, there are no strong incentives for these

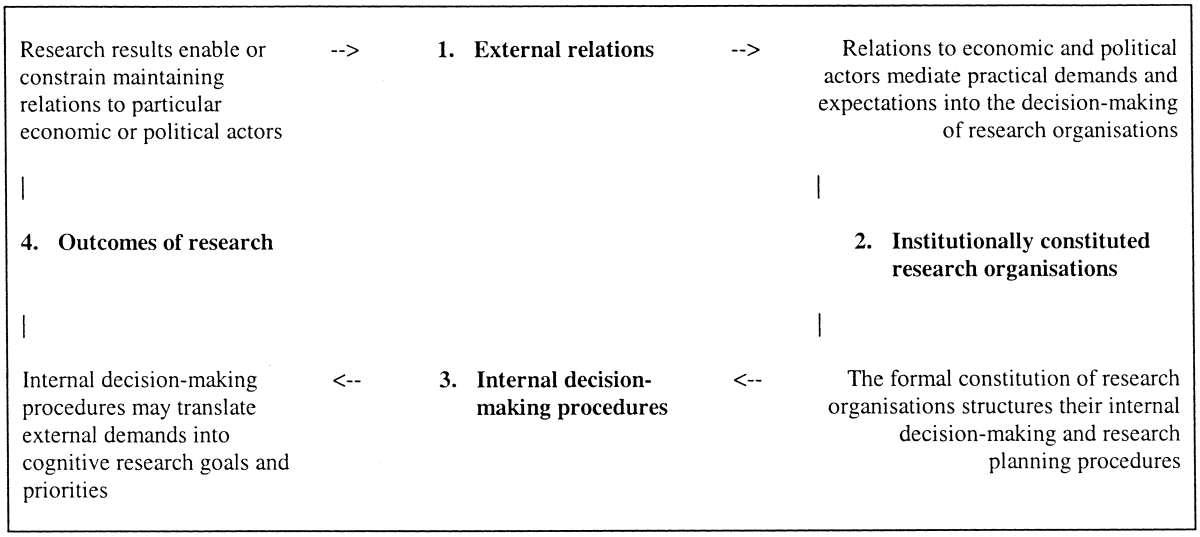

Fig. 1. The mediation of external influences on research.

organisations to accommodate their internal decision-making procedures to direct external demands and expectations. The collective orientation of action in this type of organisation therefore is likely to consist of allowing individual members to pursue personal goals and objectives. In the academic context, such goals and objectives typically involve acquiring individualised scientific reputation through the publication of theoretically or methodologically advanced contributions to the international literature. This is the conventional model for the organisation of university departments and academic research institutes, which generally are financed on the basis of fixed agreements and therefore able to orient their research towards inner-scientifically generated goals and priorities in stead of the imperatives deriving from external demands for applicable knowledge and insights (Stichweh, 1994).

Research contractors, on the other hand, typically are organisations constituted by formalised and externally acknowledged autonomy, yet dependent upon the successful marketing of research results for gaining full access to necessary action resources. Their constitution thus provides concrete incentives for these organisations to structure their internal decision-making procedures in such a way that the research efforts of individual members are adequately constrained towards organisational goals and priorities. In organisations of this type, research practice will be structured by specific forms of research management and planning in order to secure access to action resources controlled by economic and political actors. The relative resource dependency of organisations of this type will therefore constrain the intellectual orientations of the work of their individual members towards externally valued research outcomes. Clients and financiers may then influence the general direction of the research of these organisations through their financial appreciation of particular forms of knowledge and expertise. [2] This organisational model applies, for instance, to independent, but application-oriented research institutes outside traditional university structures (Mayntz, 1985).

Service providers, finally, typically lack a constitution that warrants their institutional autonomy. These organisations strongly depend on funding decisions by their principals in order to gain access to necessary action resources and can do so to such an extent that it may be difficult to still recognise them as independent research facilities. The goals and objectives of the research of organisations of this type, therefore, are more or less directly determined through the influence that external actors can exert on internal decision-making procedures, that is, the extent to which such procedures are replaced by hierarchical directives in the actual practice of research. The internal structures and external relations of this type of organisation, then, are likely to leave their individual members with comparatively little room for orienting their research efforts towards personal goals and objectives that would diverge too much from organisational priorities. This holds for instance for R&D divisions in industry and for in-house research divisions of government bodies, central banks and large financial institutions, where researchers generally are not encouraged to orient their intellectual work towards acquiring individualised scientific reputation.

The institutional constitutions of these three ideal-typical forms of research organisation entail different links to economic and political practice. Their constitution thus structures the extent to which the external relations that these organisation maintain, are linking mechanisms, that is, mechanisms through which practical demands and expectations can be mediated into the intellectual orientation and outcomes of their research. Since the proportion between internal dynamics and external imperatives that underlie the research of these three types of organisations is structurally different, their intellectual work is likely to show diminishing characteristics of disciplinary oriented science and increasing characteristics of application oriented research. Different forms of research organisation will therefore go together with particular forms of research management. Differently constituted research organisations will then produce varying forms of research outcomes which, on their turn, will enable contacts

[2] The extent to which the internal decision-making of this type of organisation is geared to external imperatives partly depends on market structures, that is, the number of clients that these research organisations are confronted with, the possibility of building strategic coalitions with some or all of these, the degree of specialisation and exclusiveness of their research expertise, and so on.

with some economic and political actors and constrain contacts with others.

5. Organisations for economic research in Germany

The empirical applicability of the theoretical considerations of the previous paragraphs can be demonstrated by a brief sketch of different forms of research organisation in the field of economic science in Germany. This overview is based on a series of extensive interviews held with German economists working in the university and non-university sector (see Wilts, 1999). Interviews were held with economists working in publicly funded research organisations — either universities or non-university research institutes. Those organisations can be expected to have sufficient institutional autonomy to be able to independently specify goals and priorities for their research work, thereby adjusting internal research priorities and external demands for particular forms of knowledge and expertise. The broader question of how responsive economic research is towards external goal setting was further restricted to the question of the extent to which research is oriented towards issues of economic policy decision-making. For that reason, no interviews were held with economists working in the fields of business economics and econometrics.

The first group of interviewees consisted of 23 senior researchers at seven publicly funded non-university institutes for applied economic research in Germany. These were heads of research divisions on such terrains as 'economic trends', 'industrial economics' or 'international financial markets'. The second group of interviewees consisted of 17 university professors in macroeconomic fields such as 'general economic theory', 'economic policy', and 'financial economics' at the universities of Bonn, Cologne, Freiburg, Kiel and Munich. Expert interviews with these two groups of economists are a suitable method for gaining insight into institutional aspects of research organisation on the hand and the intellectual orientations and practical considerations underlying actual research on the other. [3] Although the results of those interviews as such cannot be generalised to cover the knowledge process in an entire discipline or national sub-field, they provide a good basis for the specification of hypotheses and tentative questions for further research into external goal setting in science.

5.1. Non-university economic research

Characteristic of the German research system is a large non-university sector of publicly funded research (Hohn and Schimank, 1990). This sector is comprised by a heterogeneous collection of research organisations whose intellectual work ranges from the basic research of the institutes of the Max Planck Society to the distinctly applied research of the institutes of the Fraunhofer Society (Meyer-Krahmer, 1990). Within the non-university sector, there are seven publicly funded institutes for applied economic research. Six of these institutes receive their basic funding from both federal and state governments. These institutes are the Institute for Economic Research in Munich (IFO), the Hamburg Institute for Economic Research (HWWA), The German Institute for Economic Research in Berlin (DIW), the Rhine-Westphalia Institute for Economic Research in Essen (RWI), the Kiel Institute of World Economics (IFW), and the Institute for Economic Research in Halle (IWH). [4] The seventh institute, the Center for European Economic Research in Mannheim (ZEW), does

[3] The two groups of economists were asked the same set of questions. These concerned (1) the organisation of strategic research planning, that is, the structure of decision-making processes and the actors involved in those processes; (2) the financial organisation of research, that is, the dependence of research planning on the agreement of representatives of financiers, clients or other relevant actors; (3) the intellectual orientation of research, that is, the question of the relative weight of theoretical and practical priorities in strategic research planning.

[4] The first five of these institutes recently were subjected to an official research assessment procedure, which resulted in the evaluating body to advice financial cut-backs and reorganisations of the institutes in Munich and Hamburg (Wissenschaftsrat, 1998). These recommendations sparked off debate about the criteria that should be applied to assessing the quality of extra-academic research and about the extent to which such research should be oriented towards fundamental scientific or, alternatively, applied and practical priorities.

not receive basic funding from the federal government, but is financially supported by the state of Baden-Württemberg.

Although publicly funded, these institutes only are partly financed by federal and state governments and need to realise substantial parts of their annual budgets from other sources, mainly from contract research (Table 1). On average, the institutes realise about a third of their annual budgets through other sources of income than institutional funding (Wissenschaftsrat, 1998, p. 35).

As far as the research portfolios and particular research traditions of the various institutes are concerned, there exist both differences and similarities. The institute in Munich, to name an example, distinguishes itself because of its comparatively large number of contract projects for clients in the private sector whereas the institute in Kiel for instance is formally attached to the local university and accepts contract research from clients in the public sector only. The latter institute, moreover, is known for its comparatively theoretical research orientation, favouring a neo-classical, supply-side approach to questions of economic development and economic policy (Wissenschaftsrat, 1998). In contrast, the German Institute for Economic Research in Berlin generally is associated with a more traditional, Keynesian approach to such questions. Such general intellectual differences mainly reflect varying research traditions.

In addition, differences between the research orientations of the various institutes can partly be traced back to their particular location. The institute in Essen, located in the *Ruhr* area, has for instance build up extensive expertise in the economics of the energy and steel sector, whereas the institute in Halle, in the former GDR, has focused much of its research since its founding in 1992 on economic aspects of German unification and the economic difficulties in Eastern Europe.

The seven non-university institutes for economic research do, however, have in common that they pursue applied research, thereby use empirical research methods and mainly focus on questions of economic development and economic policy. The results of their research, therefore, at times are highly visible in the media and in the public debate. An example is the joint publication by the institutes — with the exception of the institute in Mannheim — of economic prognoses and growth expectations of the German economy in the spring and fall of each year. These biannual publications often lead to debate about the economic policies of the German government and greatly contribute to the reputation of the institutes as being facilities for applied economic research.

Focusing on applied topics, the seven non-university institutes pursue their research relatively independently from the theoretical discourse in the discipline of economics (Gerlach, 1993). Instead, themes and topics of publicly funded economic research outside academia are strongly oriented towards the practical priorities emerging from political decision-making (Wissenschaftsrat, 1998). The three main research topics of the non-university institutes in recent years, for instance, concerned German unification, European economic integration and economic aspects of environmental problems. Concrete priorities for research on these terrains largely are mediated into the work of the non-university institutes through contract research for important clients in the government bureaucracy, the federal ministry of eco-

Table 1
Budgets in million Dm and staff of the non-university institutes in 1995 (Wissenschaftsrat, 1998, p. 35)

Institute	Total budget	Institutional funding	Additional funding	Number of staff	Of which research staff
IFO, Munich	34.2	15.4	18.8	245	141
DIW, Berlin	30.8	16.8	14.0	209	97
HWWA, Hamburg	22.7	21.4	1.3	220	72
ZEW, Mannheim	19.5	13.9	5.6	n.d.	n.d.
IFW, Kiel	16.1	12.9	3.2	164	66
RWI, Essen	9.9	7.5	2.4	75	46
IWH, Halle	n.d.	n.d.	n.d.	66	37

nomic affairs in Bonn in particular. Research for such clients is a vital source of income for the seven non-university institutes which, after all, are only partly financed out of public means and greatly rely on contracts from the public sector for successfully marketing their macroeconomic research expertise.

5.2. University economic research

Apart from the applied research of the extra-academic institutes, work in German economics is organised in the university sector of the German research system. There are faculties and departments for economics at almost 70 of the 83 German universities (Kirman and Dahl, 1996). Generally, teaching and research in economics is organised in two main sectors, namely business economics and general or macroeconomics, the latter often including econometrics. University research on macroeconomic terrain, in particular, shares potential relevance to economic policy decision-making with the work of the seven non-university institutes.

The practical relevance of macroeconomic university research is exemplified by the professional activities of academic economists. Individual economics professors at times occupy influential positions outside academia, either as acknowledged experts on specific policy issues or as members of advisory bodies to the German government. The prime example of such a body is the Council of Experts on Economic Development (*Sachverständigenrat*) established by law in 1963 and consisting of five members who generally are distinguished economics professors. The annual economic reports and policy recommendations of the Council receive widespread attention in the media, contributing to the public perception of the scientific nature of economic analysis.

It is through the professional activities of academic economists and through the contacts these maintain across the boundaries of their discipline that theoretical insights can touch upon the concrete questions of economic and political decision-making. This does not necessarily mean, however, that the work of these economists directly mediates external priorities into the knowledge process within the discipline. Only if external demands and expectations can be translated into accepted schemes of theoretically recognised research problems can practical concerns be integrated into contributions to the advancement of disciplinary goals and priorities (Breslau, 1993). For that reason, the practical relevance of academic research often is of an indirect nature. An example of academic research with a practically relevant yet relatively specialised and esoteric character is work in experimental economics. Such research ultimately is meant to yield insights into actual decision-making processes but, for analytical reasons, abstracts from empirical reality considerably by creating and modelling artificial choice situations. The practical relevance of such research, then, does not lie in its direct bearing on economic questions and political debates so much. Rather, its practical relevance is more likely to consist of fundamental conceptualisations of the outlines of such questions and debates.

5.3. Structural differences between sectors

Apart from general differences in terms of the intellectual orientation of research, work in the university and non-university sectors is organised in differently constituted organisations. Non-university economic research is done by large organisations that need to structure their internal decision-making procedures in such a way that they can realise their institutional goals and secure their future existence by gaining access to resources that are controlled by their major clients in the private economy and government bureaucracy. The need for the seven non-university institutes to secure access to additional research funding therefore has its institutional correlate in their internal organisation and the way in which their research planning is organised.

All seven institutes annually draw up written research programmes, consisting of longer-term research plans and concrete short-term research priorities. These research programmes generally materialise as the result of the interplay between bottom-up initiatives and top-down sanctioning within the various organisations. External representatives do play a role in this process, for instance as trustees or as members of scientific advisory boards. Such external actors, however, are only involved in internal decision-making processes within the institutes at a general organisational level while the actual selection of themes and topics for research, and their integration into existing research interests and ambi-

tions, often takes place at the level of research practice within individual research divisions. External influences on the formulation of research programmes, therefore, can only follow indirectly and at some distance to the actual research process.

The relation between research practice and research management is very much different in the university sector. When compared to research outside academia, decisions as to the direction and methodological orientation of research are made by university researchers in Germany with great autonomy. University research, moreover, is pursued either by individual economists or by very small research groups, consisting of a single professor and a limited number of assistants. The latter can be PhD students pursuing more practically oriented research in order to prepare themselves for a career outside academia. Often, however, staff and assistants of university professors pursue their research interests to further qualify themselves as academic scientists through theoretically advanced and methodologically articulated publications in the international literature. The personal goals and professional interests of this group of economists, in particular, therefore, involve a comparatively strong inner-scientific orientation, precipitating in work on specialised and relatively esoteric research topics.

Competition and co-operation in the context of university economic research, then, are primarily oriented towards acquiring the traditional reward for contributions to the advancement of disciplinary goals and priorities. That is, towards the scientific reputation which is a necessary asset for achieving an established position in the social structure of academically organised fields. Relations of competition and co-operation between academic economists in Germany thus contribute to reproducing an inner-scientific dynamic of cognitive change and intellectual innovation in which external considerations of empirical applicability necessarily can be of secondary importance only. This is stimulated by the institutional organisation of work in academia. In the university sector, competition is between individual researchers and predominantly is for institutional resources in stead of contract funding. Such resources are largely associated to positions in the disciplinary hierarchy such as professorships and the membership of funding agencies.

University researchers, moreover, often have the liberty as well as the concrete possibilities to orient their intellectual work towards inner-scientifically generated goals and priorities since basic funding is given largely unconditionally. Only when acquiring additional funding do external considerations necessarily play a role in the research orientations of academic economists. Such funds, however, often are dispersed through funding agencies — such as the *Deutsche Forschungsgemeinschaft* in Germany — and are more or less directly controlled by the scientific community itself (Hartmann, 1990).

Competition and co-operation between the seven economic research institutes in the non-university sector, in contrast, particularly involves the integration of external demands and expectations into internal research goals and priorities. Competition between the institutes results from the tension between the need for them to maintain an individual research profile so as to occupy a particular market niche and attract external funding and, on the other hand, the need for them to join forces so as to secure the continuity of basic government funding and the external acknowledgement of their competence to dispose of available resources.

The network relations between the non-university organisations thus reproduce the applied character of their research since it is only through established and recurrent contacts with economic and political clients that research competence can be demonstrated and the availability of additional resources secured. The communication with these clients cannot be too abstract but needs to address practical questions in stead. For that reason, the work of the institutes cannot be too theoretically oriented and methodologically articulated. Yet, the work of the institutes has to be based on disciplinary insights of economic science in order to distinguish itself from the work of typical service providers such as in-house research divisions in government ministries and large financial institutions.

The non-university institutes, then, operate as typical research contractors. Their individual members depend upon the continuing existence of the organisation for realising their personal preferences and interests. Therefore, individual research efforts within these larger organisations are likely to be in line with the central themes and research priorities identified

in the institutes' internal decision-making procedures and laid down in formal research programmes. The formal constitution of the non-university institutes include sanction mechanisms that endorse compliance with organisational goals and denounce deviation from them. This is normatively and hierarchically achieved at the level of research practice in that researchers are employees without enjoying the intellectual autonomy and professional benefits of academic tenure. This does not imply, however, that researchers within the non-university institutes need be passive recipients of organisational directives. Rather, by doing research and by realising research outcomes they produce the cognitive basis — as well as the intellectual justification — for extensions and alterations of existing research programmes. The personal interests and objectives of individual researchers will therefore overlap but not fully coincide with organisational goals and priorities and this possible tension, arguably, provides incentives for innovative research at the level of actual research practice. For this reason, also, are the relations between the institutional structures and intellectual orientations of research organisations analytically comparable yet empirically differentiated.

In contrast, organisations within the German university sector, such as institutes, chairs and research departments are not forced to market their research results so as to secure access to necessary action resources. These organisations can therefore operate as prototypical knowledge seekers. The relations they maintain among themselves do not display the kind of network characteristics that structure the contacts between the various institutes for applied research outside academia. Organisational goals and priorities in that case are more or less identical to the multitude of personal interests and objectives of individual researchers. Research styles in academic economic research in Germany consequently are often of an outspoken individual nature and display sometimes widely diverging professional preferences. Much work in academic economic research therefore escapes the attention of non-specialists, that is, those in a position to articulate a societal demand for applicable knowledge and insights.

The academic organisation of German economic science, then, restricts the contacts that researcher can maintain across the boundaries of their discipline. Thereby, the institutional organisation of academic research shields the knowledge process in the field off from direct external goal setting and thus partly reproduces the abstract and comparatively esoteric character of its theories and research methods. Despite the often large empirical differences between the local work environments of academic economists, the institutional contexts in which they pursue their research, therefore, are structurally similar, allowing for analytical comparison with differently organised non-academic research.

Institutional variation between German economists' work environments, that is, variation in terms of the rules that structure the distribution of action resources among and within different research organisations, leads to different forms of competition and co-operation between them. These forms of competition and co-operation, on their turn, structure the intellectual orientations that underlie their particular research efforts and constrain the personal interests of their individual members towards organisational objectives. The dynamics of knowledge production in German economics — and by implication the intellectual orientation of the knowledge produced within the field — therefore, are largely conditioned by the institutional structures and financial arrangements different work environments of economists. These structures and arrangements provide both incentives and constraints for economists to work on the goals and priorities of theoretically oriented disciplinary science or, alternatively, those of application-oriented policy research.

6. Policy implications

It is not the epistemology of research in terms of its disciplinary or applied orientations, then, that makes for its responsiveness towards external goal setting. Rather, it is the *organisation* of research that conditions to what extent external imperatives can be integrated into intellectual orientations at the level of actual research practice. The availability of action resources and the distribution of the competence to dispose of those resources within formally constituted organisations structure the way in which external demands and expectations can be mediated into research. Institutional variation in terms of the for-

mal organisation of the research process thus partly determines the extent to which its outcomes can be 'socially accountable and reflexive' (Gibbons et al., 1994, p. 3).

This general conclusion is of relevance to the empirical analysis of changing forms of research organisation and, therefore, to science policy decision-making. Publicly funded research more and more is confronted with budget cuts and forms of conditional financing. This increasingly forces research organisations, in particular, universities, to behave as research contractors in stead of ideal-typical knowledge seekers (cf. Etzkowitz and Leydesdorff, 1997). Changes in funding arrangements and in the organisation of research, also are taking place in the German research system. Under the pressure of economic difficulties, which intensified after German unification in 1990, German research policy in recent years has changed and become more sensitive towards the return of government expenditure on scientific research (Schimank, 1996). This particularly concerns the benefits of publicly funded research in terms of knowledge transfer to the private sector (Beise and Stahl, 1999).

The changing attitude towards state support of science and R&D also concerns the organisation of research in the university sector which, in the context of German federal politics, has long been characterised by its 'structural incapability of reform' (Mittelstraß, 1996, p. 103). Under the pressure of growing internal problems and contextual changes, notably the Europeanisation of science and technology policies, the organisation of scientific research at German universities is now slowly starting to change (Künzel, 1996). Education and research tasks are beginning to be more clearly separated and public funding increasingly is distributed through channels other than regular university budgets (Schimank and Winnes, 1999). In addition, the growing importance of European science and technology policies have also led to closer co-operation between German research organisations and to common interest representation by these organisations vis-à-vis European and national decision-makers (Fabisch, 1996).

Primary changes in the organisation of the German research system are in line with the observation of recent accounts of the emergence of new forms of research organisation, namely, that scientific research increasingly is subject to market forces and local forms of governance as opposed to traditional academic autonomy and national science policies. This development, however, is not altogether unproblematic. Economic pressures and practical incentives favour the production of particularistic forms of knowledge, that is, those forms of knowledge which correspond most closely to specific demands by economic and political actors. Those pressures, therefore, can seriously undermine science's capacity to produce intellectual innovations which do not have immediate practical relevance or which are not perceived as such (Kazancigil, 1998; also see Shinn, 1999).

The solution to the problem of balancing this development does not lie in extending established forms of peer review as a means of distributing funding and additional resources within existing academic structures. Research evaluation on the basis of standardised criteria of inner-scientific quality — such as the regular Research Assessment Exercise in the UK — provides strong incentives for researchers to orient their work to the priorities of established disciplinary research interests. This, on its turn, can greatly enforce the stability of disciplinary boundaries thereby discouraging work on controversial but potentially innovative research topics, as illustrated for the case of economics at UK universities (Harley and Lee, 1997). Increasing resource allocation through existing funding arrangements would thus lead to a growing distance between academic, disciplinary science on the one hand and practically oriented and applied research outside traditional academic structures on the other.

The question, then, is how 'mediating institutions' can be designed (Mayntz and Schimank, 1998, p. 753). That is, horizontal structures that link relative autonomous research to societal demands and expectations but which do not rely on bureaucratic forms of centralised control of the research process. This question essentially is a political one. The dynamic of co-operation and competition within existing academic structures — that is, the dynamic of the academic labour market — is such that an increase of resource allocation through peer review is not likely to provide incentives for work which transgresses established disciplinary boundaries. The dynamics of the private market, on the other hand, will

not easily allow the production of knowledge, which does not have immediate practical relevance. This, then, leaves and important task for informed and well-designed science and technology policies (cf. Hicks and Katz, 1996).

Such policies, however, can only be goal-effective when they take on their own bearing on the institutionally conditioned path-dependencies of the research process. Transnational European policies, for instance, further active interest representation by research organisations and stimulate them to seek co-operation across the traditional boundaries of national academic disciplines. European regulations thereby are an ever growing factor in the emergence of new forms of research organisation.

Implied by this, is that national science and technology policies are necessary, aimed at finding a balance between established disciplinary science and new forms of practically oriented research. Since funding alone cannot be an effective instrument in the context of existing academic structures, such policies should entail legal and administrative reorganisations of research contexts (Becher, 1995). That is, those policies should be aimed at designing institutional arrangements, which allow scientists to organise themselves and to operate as research contractors, partly located outside traditional academic structures but variably linked to existing universities.

The theoretical and empirical observations of the previous paragraphs thus lead to a number of straightforward questions that are of importance to science policy decision-making and which can be the basis for further and comparative research into forms of work organisation in science: Under what locally differentiated, but analytically comparable institutional circumstances is actual research practice responsive towards external goal setting while retaining sufficient intellectual independence? How can research practices in that case be classified and how can such a classification be effectively used as a policy device when identifying opportunities and limitations for the design of mediating institutions which link established disciplinary science and new forms of research organisation? On the basis of empirical answers to these and similar questions, then, can such challenging notions as the development of a new mode of knowledge production or the emergence of post-normal science be substantiated and used productively in pragmatic science policy decision-making.

7. Conclusion

In this paper, a theoretically informed but empirically applicable model for research into forms of work organisation in science has been developed. This model is actor-centered and therefore able to accommodate basic insights from constructivist approaches in the Sociology of Science and Technology. Thereby, the many contingencies that pervade actual research practice can be understood as essential degrees of freedom when analysing the nature and organisation of the research process. At the same time, the model that was discussed differentiates between institutional structures in which research is embedded. Therefore, it is able to explain path-dependencies in processes of knowledge production in terms broad enough to address general differences between national and disciplinary contexts of research yet sufficiently concrete to account for empirical variation in local forms of work organisation in science.

By means of illustration, this actor-centered institutionalist model was applied to the analysis of the relations between forms of research organisation and intellectual orientations in economic science in Germany. It was observed that knowledge production in German economics is of a hybrid nature, sometimes displaying characteristics of theoretically oriented disciplinary science and at times those of application oriented policy research. It was argued that the institutional structures in which research is embedded are the main factors explaining these differences. It are these structures which condition the responsiveness of economic research towards external goal setting by economic and political actors.

Two conclusions, then, can be specified that bear on current debates about changing forms of research organisation and which are particularly relevant to science policy decision-making. Firstly, given the organised character of the research process, external goal setting through deliberate policy intervention can only be indirect and contextual. In the decision-making procedures within formally constituted research organisations, only certain external impera-

tives are integrated into internal preferences as to the desired direction and outcomes of research. Secondly, the social accountability of relatively autonomous research can be institutionally organised. That is, the scientific and practical relevance of such research can be consciously designed in terms of the formal constitutions of publicly funded research organisations. In the face of current changes in the organisation of the research process, this leaves an important task for national science policies.

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References

Allwood, C.M., 1997. The function and handling of research problems in the social sciences. Science Studies 10, 50–73.

Amendola, M., Gaffard, J.-L., 1994. Markets and organizations as coherent systems of innovation. Research Policy 23, 627–635.

Barnes, B., 1990. Sociological theories of scientific knowledge. In: Olby, R.C., et al. (Eds.), Companion to the History of Modern Science. Routledge, London, pp. 60–76.

Becher, G., 1995. Regulation and Innovation, Some prospects of science and technology policy in the Federal republic of Germany. In: Becher, G., Kuhlmann, S. (Eds.), Evaluation of Technology Policy Programmes in Germany. Kluwer Academic Publishers, Dordrecht, pp. 331–360.

Beise, M., Stahl, H., 1999. Public research and industrial innovations in Germany. Research Policy 28, 397–422.

Braun, D., 1998. The role of funding agencies in the cognitive development of science. Research Policy 27, 807–821.

Breslau, D., 1993. Contract shop epistemology, credibility and problem construction in applied social sciences. Social Studies of Science 27, 363–394.

Etzkowitz, H., Leydesdorff, L., 1997. A triple helix of university–industry–government relations. In: Etkowitz, H., Leydesdorff, L. (Eds.), Universities and the Global Economy, A Triple Helix of University–Industry–Government Relations. Pinter, London, pp. 155–162.

European Commission, 1998. Society, The Endless Frontier, A European Vision of Research and Innovation Policies for the 21st Century. EC, Brussels.

Fabisch, G., 1996. The impact of the European research and development policy on the German research system. In: Sturm, R. (Ed.), Europäische Forschungs- und Technologiepolitik und die Anforderungen des Subsidiaritätsprinzips. Nomos, Baden-Baden, pp. 125–130.

Funtowicz, S.O., Ravetz, J.R., 1993. The emergence of post-normal science. In: von Schomberg, R. (Ed.), Science, Politics and Morality, Scientific Uncertainty and Decision Making. Kluwer, Dordrecht, pp. 85–126.

Gerlach, K., 1993. Anreizstruktur und Forschungsaktivitäten in wirtschaftwissenschaftlichen Fachbereichen. In: Schmidt-Schönbein, T. (Ed.), Die ökonomische Wissenschaft und ihr Betrieb. Campus, Frankfurt am Main, pp. 245–268.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzmann, S., Scott, P., Trow, M., 1994. The New Production of Knowledge, The Dynamics of Science and Research in Contemporary Societies. Sage, London.

Godin, B., 1998. Writing performative history: the new Atlantis? Social Studies of Science 28, 465–483, Review of Gibbons, M., et al., 1994, The New Production of Knowledge.

Hagendijk, R.P., 1990. Structuration theory, constructivism and scientific change. In: Cozzens, S., Gieryn, T. (Eds.), Theories of Science in Society. Indiana University Press, Bloomington, pp. 43–66.

Harley, S., Lee, F.S., 1997. Research selectivity, managerialism, and the academic labor process: the future of nonmainstream economics in UK universities. Human Relations 50, 1427–1460.

Hartmann, I., 1990. Begutachtung in der Forschungsförderung, Die Argumente der Gutachter in der Deutschen Forschungsgemeinschaft. Fischer, Frankfurt am Main.

Hasse, R., Krücke, G., 1996. Was Leistet der organisationssoziologischen Neo-Institutionalismus? Eine theoretische Auseinandersetzung mit besonderer Berücksichtigung des wissenschaftlichen Wandels. Soziale Systeme 2, 91–112.

Hicks, D.M., Katz, J.S., 1996. Where is science going? Science, Technology and Human Values 21, 379–406.

Hill, S.C., 1995. The formation of the identity as a scientist. Science Studies 8, 53–72.

Hohn, H.-W., 1998. Kognitive Strukturen und Steuerungsprobleme der Forschung, Kernphysik und Informatik im Vergleich. Campus, Frankfurt am Main.

Hohn, H.-W., Schimank, U., 1990. Konflikte und Gleichgewichte im Forschungssystem, Akteurkonstellationen und Entwicklungspfade in der staatlich finanzierten außeruniversitären Forschung. Campus, Frankfurt am Main.

Jacob, M., 1997. Life in the triple helix: the contract researcher, the university and the knowledge society. Science Studies 10, 35–49.

Kazancigil, A., 1998. Governance and science: market-like modes of managing society and producing knowledge. International Social Science Journal 50, 69–79.

Kirman, A., Dahl, M., 1996. Economic research in Europe. EUI Monographs in Economics, European University Institute, Florence.

Knorr-Cetina, K.D., 1981. The Manufacture of Knowledge, An Essay on the Constructivist and Contextual Nature of Science. Pergamon, Oxford.

Künzel, R., 1996. Political control and funding, the future of state support. In: Ash, M.G. (Ed.), German Universities, Past and

Future, Crisis or Renewal? Berghahn, Providence, pp. 164–175.
Latour, B., 1987. Science in Action, How to Follow Scientists and Engineers through Society. Harvard Univ. Press, Cambridge.
Laudel, G., 1999. Interdisziplinäre Forschungskooperation, Erfolgsbedingungen der Institution ›Sonderforschungsbereich‹. Edition Sigma, Berlin.
Mayntz, R., 1985. Forschungsmanagement, Steuerungsversuche zwischen Scilla und Charybdis, Probleme der Organisation und Leitung von hochschulfreien, öffentlich finanzierten Forschungsinstituten. Westdeutscher Verlag, Opladen.
Mayntz, R., Scharpf, F.W., 1995. Der Ansatz des akteurzentrierten Institutionalismus. In: Mayntz, R., Scharpf, F.W. (Eds.), Gesellschaftliche Selbstregelung und politische Steuerung. Campus, Frankfurt am Main, pp. 39–72.
Mayntz, R., Schimank, U., 1998. Linking theory and practice, introduction. Research Policy 27, 747–755.
Meyer-Krahmer, F., 1990. Science and Technology in the Federal Republic of Germany. Longman, Harlow.
Mittelstraß, J., 1996. Coping with crisis — the German universities: their future role in teaching and research. In: Krull, W., Meyer-Krahmer, F. (Eds.), Science and Technology in Germany. Cartermill, London, pp. 101–109.
Nee, V., 1998. Sources of the new institutionalism. In: Brinton, M.C., Nee, V. (Eds.), The New Institutionalism in Sociology. Russell Sage Foundation, New York, pp. 1–16.
Organisation for Economic Co-operation and Development, 1998. Internationalisation of Industrial R&D: Patterns and Trends. OECD, Paris.
Pickering, A., 1992. From science as knowledge to science as practice. In: Pickering, A. (Ed.), Science as Practice and Culture. University of Chicago Press, Chicago, pp. 1–26.
Restivo, S., 1995. The theory landscape in science studies, sociological traditions. In: Jasanoff, S., et al. (Eds.), Handbook of Science and Technology Studies. Sage, Thousand Oaks, pp. 95–110.
Rip, A., 1994. The republic of science in the 1990s. Higher Education 28, 3–23.
Scharpf, F.W., 1997. Games Real Actors Play, Actor-Centered Institutionalism in Policy Research. Westview Press, Boulder.
Schimank, U., 1995. Für eine Erneuerung der institutionalistischen Wissenschaftssoziologie. Zeitschrift für Soziologie 24, 42–57.
Schimank, U., 1996. Universities and extra-university research institutes, tensions within stable institutional structures. In: Krull, W., Meyer-Krahmer, F. (Eds.), Science and Technology in Germany. Cartermill, London, pp. 111–124.
Schmidt, S.K., Werle, R., 1997. Coordinating Technology, Studies in the International Standardization of Telecommunications. MIT Press, Cambridge.
Schimank, U., Winnes, M., 1999. National Report: Federal Republic of Germany, European Comparison of Public Research Systems. TSER Project No. SOE1-CT96-1036. Max Planck Institute for the Study of Societies, Cologne.
Shapin, S., 1995. Here and everywhere: sociology of scientific knowledge. Annual Review of Sociology 21, 289–321.
Shinn, T., 1999. Change or mutation? Reflections on the foundations of contemporary science. Social Science Information 38, 149–176.
Stehr, N., 1994. The Knowledge Society. Sage, London.
Stern, P., 1996. Prisoners of the Crystal Palace, Mapping and Understanding the Social and Cognitive Organization of Scientific Research Fields. Boréa, Umeå.
Stichweh, R., 1994. Wissenschaft, Universität, Professionen, Soziologische Analysen. Suhrkamp, Frankfurt am Main.
Vanberg, V., 1994. Organizations as constitutional systems. In: Vanberg, V. (Ed.), Rules and Choice in Economics. Routledge, London, pp. 125–143.
Weingart, P., 1997. From 'finalization' to 'mode 2': old wine in new bottles? Social Science Information 36, 591–613.
Werle, R., 1998. An institutional approach to technology. Science Studies 11, 3–18.
Whitley, R., 1984. The Intellectual and Social Organization of the Sciences. Clarendon Press, Oxford.
Wilts, A.S., 1999. Institutionelle Vermittlungsmechanismen zwischen Wissenschaft und Praxis, am Beispiel der außeruniversitären und universitären Wirtschaftsforschung in Deutschland. Research Report, Max Planck Institute for the Study of Societies, Cologne.
Wissenschaftsrat, 1998. Stellungnahme zu den Wirtschaftsforschungsinstituten der Blauen Liste in den alten Ländern. Drs. 3320/98. Wissenschaftsrat, Berlin.
Woolgar, S., 1988. Science: The Very Idea. Ellis Horwood, Chichester.