CHAPTER 6

JOCHEN GLÄSER AND GRIT LAUDEL

EVALUATION WITHOUT EVALUATORS

The Impact of Funding Formulae on Australian University Research

THE ELUSIVE EFFECTS OF RESEARCH EVALUATION SYSTEMS

The Australian research evaluation system (RES) is unique in its exclusive reliance on a funding formula. For each university, statistics on income from competitive research grants, numbers of publications, numbers of current research students (Masters and PhD students), and timely completions of Masters and PhD studies are collected and used to calculate the allocation of state funds without any further consideration. The research component of university funding has developed into an allocation of three national competitive grants, including the Institutional Grants Scheme (IGS), Research Training Scheme (RTS), and Research Infrastructure Block Grant (RIBG), which use the indicators with different weightings as shown in table 1.

Table 1. Money distributed and indicators used in the three competitive grants in 2004
Source: Nelson 2005: 38, 75-76

Indicators used in funding formulae	*Competitive research block grants (Mio AU$) and weight of indicators*			*Share of research funding controlled by the indicator Mio AU$ (%)*
	RTS (552.153)	*IGS (290.591)*	*RIBG (182.982)*	
Research income from competitive grants	40%	60%	100%	547.774 (55.5)
Successful research student completions	50%			270.490 (27.4)
Number of higher degree research students places		30%		85.384 (8.7)
Research publications	10%	10%		82.559 (8.4)
Total amount of research block funding				986.207

R. Whitley and J. Gläser (eds.), The Changing Governance of the Sciences, 127–151.

The Australian system is a strong (standardised, public, transparent, and consequential) RES (see Whitley, this volume). It is highly standardised in that it is applied in exactly the same way to all sciences, social sciences, arts, and humanities. The same unified lists of grants that count as 'research income' and the same categorisation of 'research publications' (articles in refereed journals, books, book chapters and full refereed conference papers) are applied to all fields. The funding mechanism is also highly transparent because most of the information is on public record. The amount of money received by each university – and therefore the actual performance according to the measures – is on public record, too. Because of the formula, academics knew that each of their articles in a peer-reviewed journal in 2004 contributed about 2058 AU$ to their university's income, and that a book contributed five times as much. The consequences of the scheme for funding are significant. In 2004, the three research block grants amounted to 24% of the block funding for teaching and research allocated to universities.

This system has been in place, with variations and additions, for about 15 years.[1] Universities, university departments, and academics can be expected to have adapted to it, which inevitably raises the question about the effects of the system: has it achieved its purpose, namely increasing good performance by rewarding it and by automatically channelling money to the best performers? Has the adaptation of the affected actors produced non-intended side effects that are detrimental to the science system?

These questions are difficult to answer, and indeed have not been satisfyingly answered for any RES. While the political discussion about RES is laden with statements about their achievement of intended effects - improved quality - and about their negative side effects, none of these claims is backed by reliable empirical evidence. Attempts to establish positive or negative effects of RES face the two problems of identifying these effects and of causally attributing them to the RES. Identification is difficult because the intended and non-intended effects are changes in epistemic features of research processes such as quality, uncertainty, or interdisciplinarity, which poses serious measurement problems. Causal attribution is hindered by the overlap of RES by a multitude of other institutional influences on scientific research. Arguments that try to establish positive effects of RES can easily be countered by references to countries that show similar improvements without having any RES in place. Conversely, purported negative effects of RES can be ascribed to other conditions such as a general lack of money, decreasing success rates of grant funding, or government policies tying resource allocation to application-oriented research.

[1] Up to 2008. The formula-based RES will be replaced by a different procedure in the near future.

The aim of this chapter is to demonstrate that, in spite of the methodological problems, epistemic effects of RES can be identified and ascribed. We will use data from a current empirical study of Australian university research to demonstrate that the Australian RES has little direct steering effect in itself but does contribute to a general shortage of recurrent funding, and to a strong dependence on a small number of external sources, a situation that indeed does change research.[2]

APPROACH

Research Strategy – the Challenge of Causal Attribution

In order to solve the problem of causal ascription, we must identify the social mechanisms that link RES to changes in the conduct and content of research. Following Mayntz (2004: 241) we define a social mechanism as *a sequence of causally linked events that occur repeatedly in reality if certain conditions are given and link specified initial conditions to a specific outcome* (for similar but less precise definitions see Merton 1968: 42-43 and Hedström 2005: 11). Identifying social mechanisms means that we can demonstrate *how* a specific cause – an RES - produces changes in university research and thus causally attribute these changes to RES. The concept of mechanisms has first been introduced to science studies in Whitley's (1972) criticism of the Mertonian sociology of science, but has never been taken up.

The identification of the social mechanisms that link RES to changes in the production of scientific knowledge must bridge a rift that has opened in science studies during the last three decades. The initial conditions and specified outcomes of these mechanisms are investigated by different strands of science studies that have grown so far apart that today they seem almost incommensurable. Much science policy research has focused on changes in the governance of science, including funding policies (Braun 1993; Ruivo 1994; Guston 1996; van der Meulen 1998; Silvani, Sirilli, and Tuzi 2005). While political actor constellations and policies are identified as independent variables, the studies are less clear about the effects they investigate. For example, it is sometimes hypothesised that the changing role of funding councils will affect the cognitive content of science, but these effects are either not described at all or else only at a very general level without empirical backing (e.g. Rip 1994; Braun 1998). Mayntz and Schimank have argued that in order to understand the mechanisms that channel external expectations towards science, the "performance level of the science system" needs to be included in the analysis (Mayntz and Schimank 1998, p.753). So far, this has rarely been done (notable exceptions are Van der Meulen and Leydesdorff 1991; Morris 2000).

This disregard for changes in scientific knowledge by much work on science policy is complemented by a tendency to ignore the role of institutions by constructivist sociology of science. After its constructivist turn, the sociology of science developed a strong interest in scientific knowledge as a dependent variable and the

[2] Funding of this project by the German Federal Ministry of Education and Research in its programme 'science policy studies' and by the Australian Research Council is gratefully acknowledged.

micro-focus in this tradition produced many accounts of researchers' adaptations to local circumstances and of the consequences of these adaptations for the practices of knowledge production and the content of knowledge (e.g. Knorr-Cetina 1981; Lynch 1985; Latour and Woolgar 1986). However, the microscopic focus of these accounts favoured the production of individual single-case studies and hindered more comparative approaches. Additionally, the detail with which many single instances of knowledge production were studied resulted in the neglect of macro-structures and dominant institutions (Knorr-Cetina 1995: 160-163; Kleinman 1998: 285-291; Mayntz and Schimank 1998: 751).

For the causal mechanisms linking changes in state-science relationships to knowledge production to be identified, it is necessary to integrate science policy studies of RES as initial conditions with the constructivist studies of the conduct and content of research as specified outcomes. This synthesis can build on the constructivist insight that researchers opportunistically adapt their practices of knowledge production to their local situation, and the insight from science policy studies that the institutions of the national science system co-produce these situations by determining power relations and access to resources.

Systems of evaluation are specific institutions, i.e. systems of formal and informal rules that govern actions.[3] They merge political institutions (of analysing, reporting, and decision making) with institutions governing evaluative practices of scientific communities. The use of elements of the knowledge production process in RES links political actions to the conduct and content of research. Since the features of research that are used to measure quality are inextricably linked to other epistemic characteristics of that research, the adaptation of research strategies and approaches to the 'quality expectation' is likely to change more than research 'quality' as measured by the system. This is why unintended epistemic effects of RES are observed. In order to identify the social mechanisms that change the quality and other epistemic features of research, we must ascertain the impact of the Australian RES on the situations in which academics at Australian universities conduct research, the ways in which academics adapt to these situations, and the resulting changes in knowledge.

The main channel through which RES influence research is the money distributed to universities on the basis of performance measurements. This money makes RES an important element of the resource environment of universities. Universities can be expected to adapt to, as well as attempt to influence, their environments. While they respond not only to the RES but also to their whole environment, we can expect them to develop strategies for maximising their income from the RES by increasing performance as measured by the RES. This adaptation of universities to

[3] Contrary to the mainstream of the sociological 'new institutionalism' (Powell and DiMaggio 1991) we maintain that the concept 'institution' should not be extended to collective beliefs and frames, but is better reserved for systems of formal and informal rules (North 1990; Mayntz and Scharpf 1995; Scharpf 1997). This restricted concept has the theoretical advantage of enabling a separate treatment of qualitatively different social phenomena (rules and belief systems), thus supporting the distinction between systems of rules and actors' perceptions of these rules. The methodological advantage of a restricted concept is that it can be better linked to specific empirical strategies for investigating phenomena. The search for rules requires other empirical strategies than the search for belief systems.

RES is a first set of mechanisms that needs to be identified. The mechanisms of adaptation at the university level are 'remote' insofar they not affect research directly, but co-produce the situations of academics in the universities.

The direction and conduct of research are affected directly by a second set of mechanisms, namely the adaptation of researchers to their situation by making decisions on research. Laboratory studies have established that knowledge production consists of a stream of decisions in which researchers adapt to the local contingencies of their laboratories, rules and actor constellations in their organisation, funding opportunities, and societal expectations (e.g. Knorr-Cetina 1981). We may add that they also adapt to existing knowledge and to the dominant institutions of their scientific communities, a fact that is often neglected in constructivist studies. Some of the decisions of researchers are strategic in nature because they constrain further choices, thus creating a path dependency of research. The most important strategic decisions are the selection of research problems, objects and methods, and of partners for collaborations. They are often, but not always tied to explicit decisions on new projects or grant applications. The mechanisms that are at work in these strategic decisions are the 'proxy' mechanisms mediating the impact of RES on the conduct and content of research.

Thus, RES can be expected to influence research by triggering adaptive mechanisms at the university level, which in turn change the conditions for individual

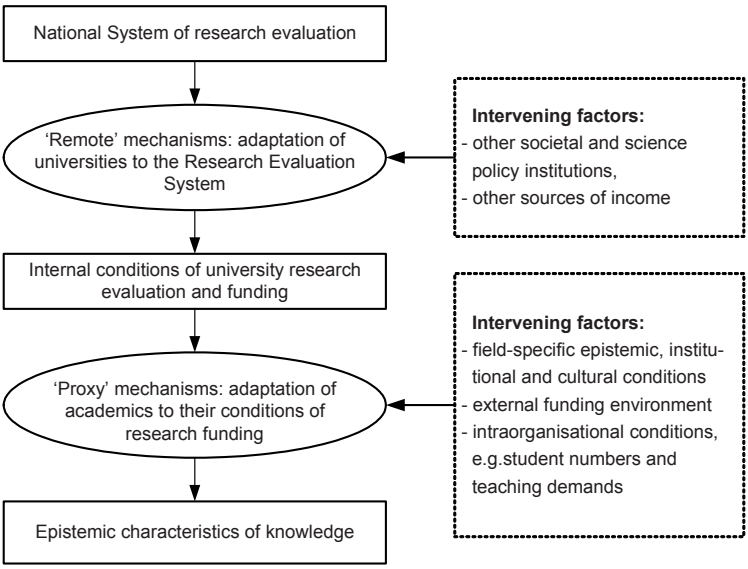

Figure 1. Assumptions about Causal Relationships between the National Research Evaluation System and Knowledge Production

academics and trigger adaptive behaviour at the individual level as summarised in figure 1. A second, more direct but simultaneously weaker impact of RES occurs because institutions may "bypass" the organisational level and directly affect members of the organisation (Scott 1991: 180-181). Academics perceive the performance expectations built into RES and interpret them as signals of what society values about their research. They may adapt to these perceptions regardless of changes in their material conditions for research.

Establishing the possible effects of these mechanisms is the most difficult part of the whole investigation because the sociology of science provides little theoretical guidance as to the nature of the key epistemic properties of research, and equally little methodological support for the empirical investigation of these properties. The following list of properties of research to be included derives from discussions of theory structures (Nagi and Corwin 1972; Whitley 1977; Rip 1982), theoretical attempts to conceptualise paradigmatic maturity (Böhme et al. 1973, 1983) or to apply the contingency approach of organisational sociology to science (Whitley 1984), and from the various warnings about negative effects of RES (Gläser et al. 2002):

- Type of research (for example, methodological, theoretical, experimental or field research) and its dominant orientation (basic, strategic, or applied);
- Relationship to the community's majority opinion (non-conformist versus mainstream);
- Time characteristics of research (long-term versus short-term processes);
- The degree of heterogeneity of knowledge combined in the research (usually referred to as 'interdisciplinarity');
- The degree of intellectual risk taken in the research; and
- Reliability of results.

Since the responses of academics to their institutional conditions of their work can be assumed to depend on characteristics of their field, epistemic properties are not only dependent variables but also intervene in the decisions of researchers. For example, the intention to conduct a project that requires long-term observations might affect the sources of funding addressed, and the fact that a certain line of research is capital-intensive might move researchers to look for collaborators.

Methodology and Methods – the Challenge of Empirical Identification

In order to identify causal mechanisms, variations of causes and effects need to be observed. In order to obtain such variations, we compare Australian universities that are subject to the same national RES but have implemented specific internal systems of evaluation and funding. The overlap of a uniform RES with varying intraorganisational institutions creates differences that can be used to analyse both variations in local conditions and commonalities of universities. The commonalities are likely to reveal national institutional conditions that 'reach through', i.e. affect academics regardless of university-specific adaptations.

The selection of cases for this study was prepared by a comparative analysis of Australian universities, which took into account their position in the highly stratified Australian university system, their research intensity, trends in publication behaviour, and the fields represented in the universities' research profiles. We followed Marginson's (2006: 11) distinction of five groups of universities as shown in table 2.[4]

Table 2. Stratification of Australian universities in terms of research (Source: Marginson 2006: 11 and own calculations based on Nelson 2005: 76-77)

Segment	*Number of universities*	*Share in research block grants in 2005 (%)*
'Sandstones' or 'Group of 8'	8	63.6
'Gumtrees'	11	21.2
'Unitechs'	5	8.3
'New Universities'	12	6.4
Other	3	0.5

A total of seven universities were selected, three from the 'Group of 8' and two each from the 'Gumtrees' and 'Unitechs'. The universities from the other groups did not show a sufficient amount of research and lacked too many of the fields included in our investigation to enable comparisons.

In a second step, the Australian RES will be compared to the German system, which is only now introducing evaluations and therefore can still be regarded as representing the 'ground state' of research that is not influenced by RES (see Lange, this volume). The case of the German state of Lower Saxony, which has conducted peer reviews of all of its university research (Schiene and Schimank, this volume), is an exception in the German context.

The expectation that the impact of RES varies with field specific needs for funding, time characteristics of research, publication practices, etc. (see Whitley, this volume) suggests epistemic differences between scientific fields as a second dimension for comparison. The selection of fields was more difficult because no empirically confirmed systematic description of fields by epistemic characteristics exists. In order to achieve sufficient variation of key epistemic properties listed above, we selected four fields from the natural sciences and one each from the social sciences and humanities. The fields investigated in our study are mathematics; biochemistry; physics; geology; history; and political science.

In this paper we report on the preliminary analysis of data comparing changes in research direction and conduct in two research-intensive universities (U1 and U2)

[4] The 'Sandstones', or 'Group of 8' are most of the older foundations except the Universities of Tasmania and New England. The 'Gumtrees' include all other universities established in each state prior to the higher education reforms that began in 1987. 'Unitechs' are former Institutes of Technology that became Universities in the higher education reform of 1987. The 'New Universities' were created from 'Colleges of Advanced Education' in the same reform. Others include private universities and a few small higher education providers. See Marginson and Considine (2000: 175-232) for a discussion of the segments.

and five fields, namely history, political science, biochemistry, mathematics, and geology. Our data collection combined analysis of documents and internet sites, bibliometric analyses, and qualitative interviews as the core method of case studies. Interviews with university managers were conducted in order to collect data on the perception of funding conditions by universities and their responses. The interviews focused on:

- managers' perception of the funding conditions for their university,
- the research funding schemes currently in place within the university,
- the impact of the RES and internal funding schemes on the core functions of the university (teaching and research), and
- university strategies for the internal governance of research, with special emphasis on performance evaluation schemes for organisational units and academic staff that are currently in place.

We prepared for the interviews with analyses of financial data and strategies of universities, and of internal funding schemes for research, which could be downloaded from the internet.

The interviews with academics were designed to produce information on the interviewees' perceptions of their research biographies and plans as well as their working conditions, with a particular emphasis on resources for research and on performance evaluation. We conducted detailed bibliometric analyses of the interviewees' publications in order to identify topical changes, trends in publication behaviour, and the researchers' international visibility. 'Bibliometric research trails', such as those portrayed in figure 2, were constructed and presented as a basis for discussion in the interview. In the fields with insufficient coverage of publications by the databases of Thomson Scientific (see Gläser and Laudel in this volume on bibliometrics), publication lists were retrieved by internet search, and the network was constructed on the basis of similarities in title keywords.

Based on this reconstruction of previous research, the first part of an interview covered the following main aspects of the research and its epistemic characteristics:

- Research projects conducted since the interviewee joined the university (the researchers' research trails, Chubin and Connolly 1982) and their epistemic characteristics;
- Reasons for abandoning certain topics and following others, especially the extent to which this behaviour is triggered by funding considerations;
- National versus international character of the subject area; and
- Practices of national and international collaboration.
- Publication strategies, especially audiences that are targeted by publications and criteria for selection of journals.

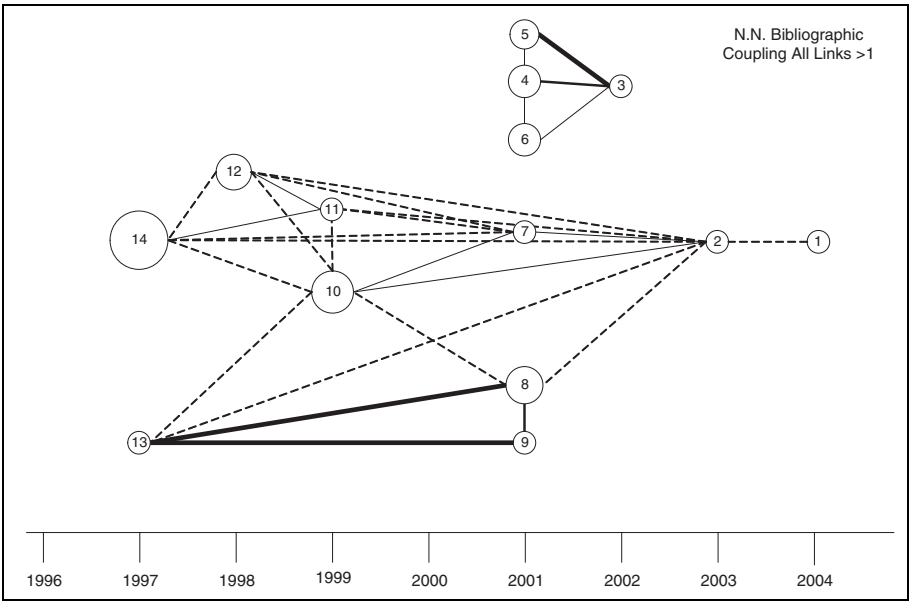

Figure 2. Example of a bibliometric research trail (strength of lines indicates topical proximity, size of circles indicates numbers of citations)

In a second part of the interview, one project that had recently been started was selected for a more detailed analysis. In this part, questions about strategic decisions were asked, namely about the selection of the problem, object, methods, collaborators, and communication channels, and about the reasons for making these selections. A further set of questions referred to funding needs and the way in which funding was obtained for this project including application procedures and selection criteria applied to the researcher's proposals. A third part of the interview was devoted to the interviewee's working conditions. We explored the availability of time for research, teaching loads, performance evaluations, the general degree of autonomy, and external pressures perceived by the researcher.

The interviews took sixty to ninety minutes in the case of researchers and around sixty minutes in the case of managers. With few exceptions, they were tape-recorded and subsequently transcribed. This paper is based on 32 interviews with academics from the five fields and 21 interviews with managers from all levels of the university hierarchy. Data was analysed by computer-guided qualitative content analysis (Gläser and Laudel 2006) that used the variables described in the previous section to extract information from the interview transcription.

ADAPTATIONS TO A STRONG RESEARCH EVALUATION SYSTEM

The Situation of Universities

Australian universities are formally autonomous. They have authority over the content and conduct of teaching and research, their internal structure and internal allocation of money. Creating positions and filling them is at the discretion of the university. Salaries are regulated by local workplace bargaining between the university and the union, and can be topped up by universities in individual cases.

The internal governance of Australian universities is characterised by strong hierarchies. Principal strategic decisions on the academic development of the university are made by the senate, which includes major stakeholders from industry and the community, and is headed by the university chancellor. The vice chancellor is the university's chief executive officer and responsible for university governance. He usually has several Deputy Vice Chancellors (DVCs), one of whom is responsible for all of the research of the university. The major subunits of the bigger universities are faculties and schools within faculties. The hierarchy is complemented by a system of committees that support decision making on all major issues within the university – the academic board advising the vice chancellor, research committees at university, faculty, and school levels, central and faculty promotion committees, and so on. Some of these committees are granted control over funds (e.g. over research grants, see below). The degree of academic self-governance is quite limited. Faculty meetings and staff meetings of schools still take place, but their influence on decisions of managers depends on the discretion of the latter.

The autonomy of Australian universities is limited by the fact that they financially depend on the federal government, whose financial support does not match increases in student numbers.[5] Therefore, universities have little choice but to access all existing sources of funding. Exploiting this dependence, the federal government offers additional funding for universities that fulfil specific demands. For example, the provision of an increase in the operating grants of 5% in 2006 and 7.5% in later years depends on universities' compliance with the "Higher Education Workplace Requirements", which mainly prescribe the offer of individual workplace agreements beside the collective agreements with unions (DEST 2005b). Thus the visible hand 'cannot let go' in Australia either (see Engwall and Nybom, this volume, for the case of Sweden) and interferes with internal matters of universities.

The Australian research funding environment is neither rich nor diverse and does not provide significant alternative funding sources for universities. A major problem is the structure of the Australian economy, especially the weakness of science-based industries; accordingly contributions by industry to the funding of research are low. In 2002, for instance, the share of business in the gross domestic expenditure for research and development was only 51.2% (compared to 64.3% for the EU-15 and 67.8% for the OECD, DEST 2005a: 25). Many researchers cannot find industry

[5] The share of federal government funding of higher education decreased from 57% in 1996 to 41% in 2004. The absolute amount of funding increased by 16% (in actual prices, AVCC 2005), while the number of domestic students rose by 23% in the same period (Nelson 2005: 18).

partners in Australia in fields where this would be possible in most industrialised countries. Furthermore, support from the states is limited to ad hoc-funding in designated fields.

Consequently, the national research councils are the only significant sources of research funding for many fields. These are the National Health and Medical Research Council (NHMRC) that funds health science, biomedical, and clinical research; and the Australian Research Council (ARC) that funds research in all other fields including basic biosciences. Both agencies administer several funding programmes for individual projects in the responsive mode, for collaborative research with industry or between research groups, and for international collaboration.

The chances of getting a grant from a research council significantly vary between funding schemes. In 2005, 'Discovery grants' (individual project grants funded by the ARC in the responsive mode) had a success rate of about 30%, while 'Linkage grants' (collaborative projects with industry) had a success rate of 46% (ARC 2005). In decisions about discovery grants the applicant's track record is the single most important criterion and is weighted at 40%. Hence the applicant's publication list and record of prior grants are decisive for the success of an application. In some fields, applicants are expected to submit numbers of citations or the impact factors of journals in which they publish as additional information on the 'track record' (see Gläser and Laudel, this volume, on the use of these measures).

The project funding in the responsive mode is inflexible because there is only one round of decisions each year, and it takes nine months from the application to the start of funding. If they get an idea for a project at the wrong time, researchers have to wait up to one and a half years for funding. In some funding schemes, the councils provide only part of the necessary money, and industry partners or universities must co-fund projects or equipment.

The ARC and NHMRC are subordinated to the Ministry of Education, Science and Training and to the Ministry of Health, respectively and ministers need to approve the funding decisions made by the councils. The Minister of education, science and training recently exercised this right by preventing several projects that had passed the ARC's peer review from being funded. Apart from this direct political intervention, there are several ways in which a political direction of research is implemented through funding by research councils. An orientation towards applied research is achieved by the significantly higher success rate of collaborative grants with industry partners. Discovery grants do not depend on collaborations with industry but still require applicants to describe the 'national benefit' of the research, which is weighted 10% in the evaluation process. The government has also defined 'national research priorities' and expects the research councils to give grant applications in these areas priority. At a more subtle level, there is a widespread perception that government and research councils prefer applied and 'hot' topics. This perception has been voiced by researchers from all five disciplines. It cannot be dismissed as a rationalisation of failure because holders of grants and scientists who worked as reviewers held the same view.[6]

[6] For a more extensive discussion of the Australian grant funding system, see Laudel (2006).

Adaptation to the Research Funding Environment

The universities respond to their conditions of research funding by trying to maximise their income from the funding formula in general and from external grants in particular. We could identify three mechanisms at the university level.

A first mechanism is *mimesis*. As in all other Australian universities, the two universities analysed here allocate a significant amount of the resources according to an internal formula that mirrors the formula according to which teaching and research resources are allocated to universities by the government. This was first observed by Marginson and Considine (2000: 149) for the 17 universities in their sample. The analysis of documents from all universities conducted by us as part of the case selection process confirmed this observation. Mirroring the research funding formula internally can thus be considered a "standard operating procedure" (March and Olsen 1984) of Australian universities.

University managers told us that although they do not like the funding formula because it does not appropriately measure research quality, the same formula is applied internally because the universities want to maximise their income. The management believe that income maximisation can be best achieved by adopting the external funding criteria and thus rewarding faculties and schools for contributing to the university's income. This mechanism is well known to organisational sociology as "mimetic isomorphism" (DiMaggio and Powell 1991). In our cases, organisations adopt institutional structures applied to them by powerful external actors rather than copying successful organisations, as has been described by DiMaggio and Powell (ibid.: 151-52). However, they clearly respond to the uncertainties of the environment and the poorly understood relationship between internal conditions and research output.

While the internal formulae use the same indicators as the government formulae, the weighting of the indicators is modified. According to the university managers we spoke to, this is necessary because the disciplines differ significantly in their reliance on external grants, on which the most consequential indicator is based. Assigning the same weight to this indicator as in the external formulae would seriously disadvantage the social sciences and humanities, in which research can be conducted with smaller grants or even without grants. To accommodate these disciplines, the weight assigned to external funding was reduced in both universities. U1 increased the weight assigned to research students, while U2 increased the weight assigned to publications.

A second mechanism is *strategic investment in grant acquisition*. The two universities reported on here specifically responded to the importance of external grants for both their income from the funding formula and their researchers' opportunities to conduct research at all by investing the money they had strategically in order to obtain as many external grants as possible. Strategic investment at the individual level was practiced by both universities in similar ways. Specifically, internal grants are made available to academics:

- whose external application nearly succeeded, in order to bridge the year to the next application round and to provide them with the means to further strengthen their application by conducting additional research ('near miss' grants);

- who need seed money for preparing an application, e.g. for beginning new collaborations with industry partners; or
- who have yet to build a track record that can win them grants (newly appointed staff and early career researchers).

Most internal grants in Australian universities are competitive in that academics need to apply for them and may fail. The criteria are similar to those of the funding councils, i.e. quality of the proposal, track record etc. However, no specific weighting is assigned to the criteria. Success rates have been described to us as being 'much higher' than those of the research councils.

All these grants have the sole purpose of improving an academic's chance to win external funding. In addition to this strategic investment at the individual level, U1 employed a mechanism of *strategic investment in critical mass*. At each level of the hierarchy from the Vice Chancellor to the Heads of Schools, 3-4% of the operating grant is allocated to strategic funds that are at the discretion of the respective manager. Additionally, a significant proportion of the RIBG is used to build a strategic fund at the discretion of the DVC (Research). The strategic funds are used to improve the conditions for research in selected areas by providing advanced equipment and time for research (via teaching relief and research-only personnel). The dominant organisational forms of these initiatives are research centres at the school, faculty, or university levels. Decision-making on centres and other strategic investments is hierarchical and applies a leverage principle. Managers at each level of the hierarchy must contribute some of their strategic funds for higher-level managers to contribute some of theirs. Thus, managers at several levels of the hierarchy must agree to a strategic investment at the faculty or university levels.

The centres are created in priority areas (i.e. areas which either are already seen as research strengths of the university or will be developed as such). Establishing a centre requires a pre-existing critical mass of research in that area (see Schiene and Schimank in this volume for similar recommendations of German assessors of university research). This creates problems for the social sciences and humanities whose research is more diverse and individualistic. Centres are expected to employ the competitive advantage created by the strategic investment to secure external grant funding. The grant funding must make centres self-sufficient after three to five years because the strategic investment ceases after that time regardless of the quality of the centre's research.

The role of the priority areas was interpreted differently by the managers at different levels of the hierarchy. A manager at the university level emphasised that belonging to a priority area does not affect strategic funding within the university, which would be allocated on the basis of scientific quality alone. Some of the Deans and Heads of Schools said that proposals from non-priority areas had to be at least slightly better in order to get funded. Academics were under the clear impression that priority areas receive more funding. Not surprisingly, the priority areas largely mirrored national research priorities because obtaining external grants was considered easier in these areas.

While U1 uses all of its research money strategically, U2 also uses a mechanism of *selective grant funding* that resembled the responsive mode rather than the hierarchical decision-making of U1's strategic investment in critical masses. Academics can apply for small research grants (for one year, up to 20.000 AU$), which are administered by faculties. These grants are used to compensate for lack of external funding. One school had introduced a rule according to which academics who have more than 100,000 Dollars in external grants are not eligible for internal grants. Decisions are made by faculty committees. One faculty has further devolved the decision process by letting the schools decide and just confirming these decisions.

A final mechanism that is applied by both universities on various occasions is *individual performance evaluation*. While the yearly performance appraisals are conducted rather informally within the schools and are inconsequential even where salary increments are concerned, evaluations of individual research performance inform decisions about promotions (along the ladder from lecturer to senior lecturer, associate professor, and full professor). Since U1 hires its academic staff on a tenure-track basis, i.e. beginning with five-year fixed term appointments and a decision about tenure after that period, evaluations of individual research performance are also conducted in the contexts of those decisions.

Decisions about promotion and tenure at U1 and about promotion at U2 are made by central university committees. Schools and faculties try to discourage weak applications but routinely agree to applications by 'their' staff, which leaves the actual decision to the university committees. Evaluations are based on the presupposition that each academic should be active in teaching, research, and administration. The higher the level an academic applies for, the more emphasis is laid on research. Interviewees commented that excellent teachers with little research could not become full professor, while excellent researchers who are bad teachers could. Decision criteria include indicators used in the funding formula, i.e. the committees take into account the numbers of publications, external grants awarded, and research student supervision. The procedures at U1 include an additional strong element of quality assessment because applicants for both promotion and tenure are asked to submit three research publications, which are externally assessed.

Another context in which individual research performance is assessed is the allocation of workloads. Academics report on all their activities in the areas of teaching, research, and administration in the previous year. Teaching loads for the next year are assigned on the basis of prior activities. While all academics except the 'research only' staff are expected to contribute to teaching, the teaching load can slightly vary depending on the amount of research points an academic gets for the previous year. However, the distribution of teaching loads is essentially egalitarian.

Consequences for Academics

The emphasis on research affects the teaching-research relationship. In U1, the general perception of academics and many managers was that teaching is of lower priority for the university than research. The investment in research only staff, the reduction of teaching loads for academics who were perceived as key researchers,

and the provision of key infrastructure for research centres was perceived to be cross-subsidised from teaching funds. A very high proportion of the academic staff at U1 is in 'research only' positions. Naturally, the teaching loads of the academics in standard 'teaching and research' positions increase. Grants from the ARC contribute to the separation of teaching from research because academics can apply for teaching relief, i.e. for funds for substitute teachers. Because of the growing teaching loads, this opportunity is used by an increasing number of academics, in particular from the social sciences, arts and humanities. Thus a vicious circle is emerging because the increasing teaching loads force academics to 'buy out' of teaching with their external grants, which in turn increases teaching loads for their colleagues.

Academics in U2 must also cope with increasing teaching loads because of the general scarcity of funding. Heads of School and academics observed the disappearance of the funds for casual teaching, a process that refers a large proportion of teaching back to the academics themselves. Apart from insufficient government funding of teaching, the necessary cross-subsidisation of research by teaching funds (which is due to the insufficient government funding for research) was mentioned as the cause for increasing teaching loads.

However, U2 is different in that teaching is still clearly regarded as the major task of the university. While concerns about increasing teaching loads and the decreasing quality of teaching have been voiced, none of the interviewees questioned the priority of teaching. The proportion of 'research only' staff and the student-to-teacher ratio of U2 are significantly lower than those of U1.

While the two universities applied partly different strategies in their allocations of resources for research, no significant differences in the financial situation of the academics could be observed. At the time of the interviews, only the academics from one School at U1 received recurrent funding for research (a few thousand dollars), which was possible because of their School's exceptionally high income from teaching. The other School budgets in U1 covered salaries and only the most basic infrastructure. Some 'travel grants' for conference attendance were allocated on the basis of applications and selection at school levels. The situation of members of strategically funded centres was somewhat better. However, strategic funding was tied to the creation of centres and to collaboration between faculties or at least schools. This requirement was not equally easily met by all disciplines. Historians and geologists complained that they either had to warp their research to make it fit the centre or would not get strategic funds. But even if they got 'centre money', academics still lacked research funding. The investments concentrated on key equipment and staff rather than money needed to conduct research projects. Centres had more researchers, research time and advanced equipment, but no basic supplies.

Although U2 allocates less money to strategic funds and more to faculties and schools, it is not able to provide recurrent funding for research to all academics. Interviewees reported that some recurrent funding was available in previous years when there was a surplus in the school budget. Nowadays there is not enough money to fund basic supplies.

Thus, research funding in both universities is intermittent, short-term funding that does not cover all costs of research, and is available only to a limited number of

selected academics. Whenever significant funding is required, the only way of obtaining it is to apply for external grants. Most of our interviewees were holding grants from one of the research councils at the time of the interview.[7] One mathematician from U1 and two political scientists from U2 reported that they had no money for research at all. Several academics from both Universities had only internal grants. Others supplemented their grant income by consultancies and other industry-funded projects.

Adaptation by Academics

The academics responded to three elements of their situations, namely to the individual performance evaluations, to the difficulties in obtaining research funding, and to insufficient amounts of resources available for their research. Three mechanisms that operated under these conditions could be observed.

Academics responded to both the individual performance evaluations and the conditions for getting grants by *adapting to indicators*. Academics were conscious of the need to have an impressive publication record and external grants in order to become promoted. Five interviewees reported that they changed their publication strategy by publishing more, publishing alone, and publishing in higher reputed (international) journals. A historian, a political scientist and a geologist named the promotion criteria as causing the changes, while two biochemists stated that they need to boost their track record in order to be successful with their grant applications. None of them reported changes in the content of research resulting from the changed publication behaviour. The descriptions gave the impression that these adaptations occurred ex post in decisions about how to publish finished research. However, changes in later research resulting from the new publication strategies cannot be excluded beyond doubt. A historian who did not need external funding (the expensive part of the project was completed) applied for an ARC discovery grant because having grants was a promotion criterion:

> You are encouraged to apply for grants. The university actually measures the input, not the output, in a sense, so that they reward you - they want to see grant money coming in. [...] I could, probably for the rest of my career, publish material from the files which I already have. I don't really need to ever get any more research material. No need. I have enough. But that's not how universities work. And that's quite distasteful really. I mean, they are pushing us along to apply for money to do new things rather than to say, "Well, for the next 20 years I'm perfectly happy using the files that I have amassed to write more work". They don't want you to do that. They press you to go and get more money.
>
> (Historian, Associate Professor)

An adaptation to indicators by a biochemist significantly affected his research. He was asked by an industry partner to conduct a research project outside his main

[7] This should not lead to the conclusion that most university academics hold external grants. The universities and academics analysed here are not 'representative' because (a) we present results from two research intensive universities, and (b) we selected academics who visibly conducted research because we are interested in the adaptation of research to funding conditions.

research interest and agreed in order to enhance his publication record, which he deemed necessary for securing ARC funding in the future.

A second mechanism is *accommodating patrons*. This mechanism is very widespread because all research we investigated depends on decisions about grants, which are made by university committees and managers (about internal grants or centres) or by funding agencies. Academics are convinced that they need to anticipate and accommodate the interests of the decision-makers, and interpret both success and failure in obtaining funding in these categories. The adaptation mechanism operated at two different levels. At the level of the 'research portfolio' of an academic who followed several lines of research simultaneously, lines of research that were deemed 'unfundable' because they are 'basic' or 'not hot' were given up. Several of our interviewees ended whole lines of research for this reason.

> And then I […] came here [from the US] and ran into a wall and just absolutely could not continue that. And the wall was two things actually: one, there's less of a focus here on basic science, whereas in the US there would be just no question that that would be fundable science. Here it had trouble passing the "significance" test. […] And here, you have to convince the particular reviewer that gets your proposal that this is significant. And that reviewer might work on something quite unrelated to what you're working on, and they might just think, "This is absurd". […] And that caused a lot of problems, yeah. So that was just impossible to continue.
>
> (Biochemist, Senior Lecturer)

Applied or fashionable lines were continued and enhanced when they already existed, or were created. In its stronger version, this move included the search for industry partners and applications for linkage grants. Application-oriented and otherwise fashionable topics were also selected for discovery grant applications. This happened across all five fields.

> So we became interested in it because we were working in [that] area […]. And to be quite frank about it, we developed the project because we knew that that was the sort of thing that could be attractive to the funding agencies, to the ARC. So, you know, the ARC has priority areas of what they consider special priorities. So we thought, well, okay, let's try to develop a project that fits into their priorities for funding. That's how it came about.
>
> (Mathematician, Research Fellow)

The mechanism of accommodating patrons occurred not only at the level of lines of research and research portfolios. It was also applied in the fine-tuning of projects, where applied or fashionable aspects of the research were emphasised and enhanced. For example, one of the historians switched to "politically relevant history" in order to improve the chances of his project proposal.

> I think it's true too at the ARC Discovery level that - I say this because I've recently applied for [a grant] and I'm very conscious of the topic - the research that I'm going to do and the project that I'm going to put up is one that I think is going to be sellable as a humanities person with some sense of national interest. Even though it's in the [earlier] centuries, it's got to have some 21st century bite. So that's going to drive the content of my research in a particular direction rather than another. I'm not going to spend my time whipping up [a grant] on, say, ghosts, fairies, goblins and elves in [earlier period]. It would be a good topic, a great topic. But it's not going to sell to the ARC.
>
> (Historian, Associate Professor)

A third mechanism that could be identified is *opportunistic fundraising*. Under special circumstances, academics conducted scientifically uninteresting projects or consultancies in order to get funding for their research. This mechanism operates if the need for money cannot be satisfied by other sources and an industry partner with matching needs exist. Opportunistic fundraising was practised even by holders of ARC grants because not all necessary expenses can be funded with these grants.

> But you do things that are unrelated. One of the ways we funded the lab is, I do consultancy for [a government agency] […] I did it partly because it was interesting, but more because of money, you know, very well paid work. And I mean […] technically, it's quite interesting, it's quite satisfying technically, but it's not in any sense related to my core research interests, and we basically do it so we've got money for the lab.
>
> (Geologist, Associate Professor)

Having obtained research funding, academics need to match their research projects to the actually available amount of money. This is obviously necessary for academics who are forced to fund their research exclusively by the small internal grants. Interestingly, many of their colleagues who received external grants experienced significant cuts of their budgets and thus faced discrepancies between project design and available funding. All these academics responded by *downsizing or stretching* their projects.

Downsizing occurred with respect to all major features of the project. In mathematics there is no empirical research that could be downsized. Therefore, the only available strategy was narrowing the problem by limiting the range of topics that were addressed in a project. The empirical disciplines could go further by narrowing the research object by either reducing the number of objects investigated (reduce the number of sites for fieldwork, reduce time spent in archives) or using less suitable objects (e.g. sites for fieldwork closer to the university). Similarly, academics could narrow the methodology by reducing the variety of methods used to investigate an object or applying 'cheaper' methods that used less expensive equipment.

> Under ideal conditions the project would look very differently because of two things really. One, I would have an extended stay in B. [...] If you can come down for six weeks it is much more benefit than if you were jetting in for two weeks or ten days or something like that. Because of the connections you have to make and sometimes it takes time to do things. Two ways it would look different, one; under ideal funding conditions it would have enabled me, to spend an extended period of time in B. And I think that would be very relevant and necessary to what I'm trying to do with the project. And secondly, I would have had funds to attend a couple of [certain] meetings and have access to delegates.
>
> Interviewer: You would just interview more people in B.?
>
> Yes, I would interview more people in B. .. and also when you go to these [political events] you sit on the edge of things as well. But sitting on the edge of things you learn quite a lot about what outside of the [event happens] - just by observation and talking to people ... So, ideal conditions really in a sense would get me closer to the source of what I'm trying to understand and write about.
>
> (Political Scientist, Professor)

Another mechanism – stretching the project – is not linked to any strategic design of the project but is rather passive. It occurs when academics do as much as is possible at the time and do less if there is less funding. One historian and two mathematicians told us that their research slowed down due to a lack of funding.

While situations of insufficient funding occurred frequently across all disciplines and triggered the described adaptive behaviour, there were also academics who did not report any adaptations. Ten of our 32 interviewees described no adaptations whatsoever. With one exception (a geologist whose entire work was industry-related), all academics who did not report adaptations work in fields that are not resource-intensive (four in mathematics, three in political science, two in history).

Having described the mechanisms at the individual level, we would like to draw the reader's attention to two mechanisms that we expected to occur but didn't find. Firstly, academics did not adapt to the external or internal funding formulae for the simple reason that they did not receive any money according to this formula. The 'research money' distributed to faculties and schools covered part of the salaries and basic infrastructure. The few remaining funds were used for internal grants and to support some travel. None of this money was distributed according to any formula. The academics at the two universities did not perceive the funding formulae as consequential for their research conditions.

Secondly, an adaptation process that could have been expected under conditions where only the very best research gets external funding is the attempt to improve the quality of one's own research by turning to central problems of the field and achieving solutions that can be published in leading journals. This mechanism – the *improvement of research by choosing important problems at the research frontier* - is one that the various performance-based funding procedures are supposed to trigger. However, we observed no attempts by academics to turn their research into 'world-class research', which is one of the stated aims of the RES (Kemp 1999: 6). The academics we interviewed did not extend the space in which they sought research problems but rather adapted within the limits of that space according to the chances of funding they perceived.

Changes in Knowledge Production

The adaptation of universities to the formula-based funding of their research resulted in an increased emphasis on and better support of research. As a result of the formula-based funding, there is more research in these universities than there has been before. However, this is not a result of the specific procedure applied in the Australian RES. Any strong RES is likely to increase the emphasis on research because it turns research into a source of income for the university. As long as teaching activities are funded without taking their quality into account, the observed shifts in the relationship between teaching and research are also likely to occur under any strong RES.

Apart from this general redistribution of attention and resources from teaching to research, mechanisms at the university level had two major consequences. Strategic investment in critical mass (as observed in U1) provides a competitive advantage to collaborative, interdisciplinary research. By strategically investing in grant applications,

universities significantly provided a competitive advantage to research that is likely to be approved by external sources of funding, thus reinforcing the latters' thematic preferences.

While the epistemic consequences of the mechanism 'adaptation to indicators' are difficult to assess, the other mechanisms at the individual levels can be unambiguously linked to changes in the content of research. As a result of the described adaptive behaviour, research becomes more applied, approximates the mainstream, narrows, and its results become less reliable (less rigorously tested). The increasing orientation towards applications is produced by the internal priority setting of universities and better chances of grant funding for such research. Even the responsive mode of ARC grant funding that is supposed to be thematically neutral is biased in favour of applied topics. The same holds for 'hot' topics that represent the current focus of international scientific communities.

By following these fashions, the Australian grant funding system favours the mainstream against nonconformist perspectives. Researchers drop lines of research that are 'too basic' or 'unfashionable' and advance the remaining research lines towards more applied and 'hot' topics. This implies that their research trails also narrow, i.e. academics investigate fewer topics and observe a narrower field of knowledge production. Since the recombination of knowledge and the creation of links between different fields is a major mechanism of innovation in the production of scientific knowledge (Gläser 2006), the narrowing of research trails reduces the potential for such innovations. It also limits the potential for collaborative research because narrower research trails provide fewer 'docking points' for researchers from other fields. A systematic trend towards narrower research trails could also lead to a reduced diversity at the level of scientific fields in Australia. However, we cannot identify this effect with the methods used in this project.

The reduced scope and reliability of research is caused by the necessity to adapt the project design to the funding that is actually available. Fewer empirical objects, less suitable empirical objects, fewer experiments, measurements, or methods all mean that the knowledge claims offered to the scientific community in publications are less well grounded then they could be. Since these features are directly linked to the quality standards of the scientific communities, we can say that reduced scope and reliability also mean reduced quality of research.

INTENDED AND UNINTENDED EFFECTS OF STRONG RES

When we compare the results of our analysis with Whitley's sketch of effects of strong RES (Whitley, this volume), some differences become apparent. The Australian RES affects the stratification of disciplines only insofar as disciplines that rely heavily on external grants are more important for the universities. Changes in the social structures of disciplines or practices of knowledge production cannot be ascribed to the RES. The reason for this is that the formula-based RES relies on the most basic indicators of academic behaviour and is therefore 'egalitarian'.

Although egalitarian with regard to individual contributions, the Australian RES achieves a highly skewed distribution of research funds, with eight universities

receiving about 64% of the funding. Its effects are limited because in its attempts to economise the government has weakened the steering instrument, i.e. the amount of money. Major effects of the RES are an increasing general support for research and attempts to concentrate resources on the best performers at the expense of others. The content of research is changing mainly because academics respond to the meagre and biased funding environment, of which the RES is the least important part.

The strong pressure of the funding environment has been the most significant influence that has forced most of the interviewed academics to adapt their research strategies. As a result of this adaptation, their research is becoming less diverse, less fundamental, and less reliable. We did not observe moves towards 'better' research by addressing more fundamental problems and providing surprising solutions to them. Except for the abandonment of whole lines of research, changes were topical and incremental.

There might be a deeper reason why academics do not simply 'improve' their research in spite of the mounting pressure. The collective production of knowledge by scientific communities applies a self-selection of tasks because only the scientists themselves are able to formulate tasks they can solve (Polanyi 1962; Benkler 2002; Gläser 2006). If formulating a task that makes sense to the academic is a necessary prerequisite of successful research, than RES can change neither the way in which tasks are selected nor the tasks themselves. At the current stage of our investigation, we would hypothesise that the adaptive behaviour follows a bell curve that is produced by the overlap of two exponential curves (figure 3). The ability to adapt to external conditions highly depends on the capabilities of an academic. Only excellent scientists are able to move across a wide problem area and are able to move between minor and fundamental problems. This ability decreases when we move to the majority. However, the pressure to actually change their research is highest for the academics who are least successful. The overlap of these two characteristics leads to the bell curve which means that significant adaptation will be found only in the middle field where a recognisable pressure towards adaptation coincides with limited capabilities to adapt.

If our hypothesis is correct and many researchers are unable to adapt, then RES in this context can only lead to either increasing discrepancies between institutionalised expectations about the 'right' research and the practices of task definition or to a redistribution of funds to researchers whose practices of tasks definition meet the demands of RES. Thus, in order to improve their research performance, universities should hire better researchers rather than 'work on' the ones they currently have. However, this strategy has already been in place for a long time and cannot significantly change the income of a university because all its competitors are doing the same. Whatever strategy will be applied, will be another case of 'running as fast as you can in order to stay where you are'.

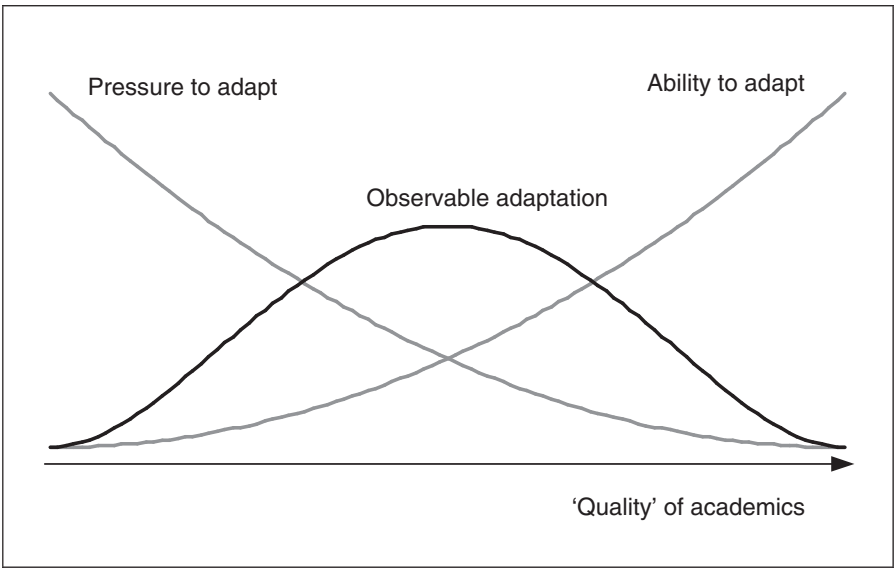

Figure 3. Observable adaptive behaviours resulting from the interaction of pressure and abilities to adapt

Our study has also revealed an important limitation in studying the impact of RES on the content of research. A possibly significant cognitive change is occurring because certain kinds of research are no longer conducted. While we could identify the reasons why certain lines of research are discontinued, we were unable to ascertain features of research that might be systematically suppressed by the research funding system. To obtain these features, we would need to investigate research that has not been conducted, which is obviously impossible.

This dilemma leads us to two methodological conclusions. Firstly, we need to attempt an even more detailed investigation of research processes, namely comparative participant observations of different research settings. With such an approach, a more systematic comparison of conducted and abandoned research processes would become possible. Secondly, it might well be the case that these changes cannot be observed at the micro-level of individual research processes at all. An approach to the measurement of cognitive changes at the meso-level of scientific fields might be necessary. Such an approach could include comparisons of epistemic features of national scientific fields that are subject to different RES. We will try to develop such an approach in further projects (Schmidt et al. 2006).

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