Higher Education (2006) 52: 375–403
DOI 10.1007/s10734-004-6414-5

The 'quality myth': Promoting and hindering conditions for acquiring research funds

GRIT LAUDEL
Research School of Social Sciences, Research Evaluation and Policy Project, Australian National University, Canberra, ACT 0200, Australia (Phone: +61 02 6125 3195: Fax: +61 2 6125 9767; E-mail: grit.laudel@anu.edu.au)

Abstract. Research funding has been undergoing a shift from recurrent, stable funding to competitive funding of projects. The system rests on the assumption that the best proposals or the best researchers receive the resources, i.e., that quality is not only necessary but also sufficient to win a grant. A comparative study of the conditions of fund acquisition was conducted to test this assumption. Qualitative interviews with 45 German and 21 Australian Experimental physicists were conducted. Although the quality of a proposal and the reputation of a researcher are important prerequisites for a successful acquisition of funds, the success of a funding proposal depends on several factors that are not linked to quality and cannot even be controlled by scientists. Scientists used adaptation strategies and universities applied institutional measures to increase their chances of external funding, but with limited success. Under the described conditions, grant acquisition is based on a Matthew Effect by rewarding the richly funded researchers and hindering entry or continuous funding for others. For these reasons it must also be doubted that external funding *per se* is a useful performance indicator.

Keywords: external project funding, Matthew Effect, performance indicators, research conditions, research evaluation, research funding

Introduction

Research funding has been undergoing a shift from recurrent, stable funding of research to competitive funding of projects. Researchers are receiving less and less of their funds via their organisations on a regular basis, and independent of specific projects. Instead, they must apply for external funding from funding agencies. This shift is the consequence of intentional science policy measures. The rationale behind it is the aim to use scarce resources most efficiently by giving them to the best researchers, because they will produce the best research possible with the available money.

The whole system rests on the assumption that the best proposals or the best researchers are winning in the competitive grant application game. This assumption implies that non-quality related conditions do not distort the quality-based distribution of funds, i.e., that quality is not only necessary but also sufficient to win a grant. We can define the rationale for competitive funding the 'quality-only assumption'.

The 'quality-only assumption' does not just guide the grant-distribution process. It is also present in some evaluation procedures, such as those that apply 'research income' as a measure of an organisation's, subunit's or researcher's quality. For example, research income is used as one component in the formula-based funding of Australia's universities, as criterion in the British Research Assessment Exercise, and as criterion in tenure-track decisions in the USA. Again, it is assumed that the amount of research income (or the number of grants) depends solely on quality because only in this case is it possible to treat research income as an indicator of quality without further qualification (as happens in most evaluations).

Given the political importance of the quality-only assumption it is surprising that it has never been tested. Most studies about peer-reviewed grant distribution investigated only the peer review process but not the conditions of the application process (e.g., Cole et al. 1978; Neidhardt 1988; Chubin and Hackett 1990; Wood 1992; Langfeldt 2001). A theoretical discussion by Hornbostel (2001) suggests that external fund acquisition is an appropriate research performance indicator only when:

- external fund acquisition is usual in the field (for example it is not common in law sciences);
- grant proposals are reviewed by qualified peers in a competitive system (this condition might not always be given but there is a lack of empirical data about distortions in the peer review process of grant proposals);
- there is a clear, but not disastrous competition for the limited funds;
- there is a mix of different sources; and
- an essential infrastructure is available that enables research.

Another theoretical discussion focused on the possibility of a positive feedback loop "in which those who receive grants in the past are more likely to be awarded them in the future" (Gillett 1991, p. 260). The author assumes that externally funded researchers are more likely to publish than non externally funded researchers, and that reviewers use an applicant's publication record as an assessment criterion. The existence of such a 'resource-mediated' Matthew effect was first proposed by Merton for research centres. "Thus, centers of demonstrated scientific excellence are allocated far larger resources for investigation than centers which have yet to make their mark''. (Merton 1968, p. 62). Merton concluded that this makes it extremely difficult to produce new scientific centres of excellence. With the increase of competitive project funding, such a Matthew Effect could occur at the individual level as well. This hypothesis is in accordance with Gillets' argument, and is partly supported by an empirical study at the department level in Flemish universities'. The 'rich' departments, i.e., departments that acquired most external funds, became even 'richer' in the following ten years. The allocation of basic allowances, as indicated by the distribution of scientific personnel, remained stable. Thus, a situation may emerge where the basic allowances are too small for externally funded research activities (Moed et al. 1998). This observation might be explained by the operation of a Matthew effect. However, no conclusion about causal mechanisms is possible because the conditions of research and research funding were not investigated.

Although there are several indications of factors affecting the grant distribution process that are not directly related to quality, no study has investigated the causal mechanisms that link conditions of fund acquisition to its success. The aim of this paper is to provide such an analysis and to demonstrate that the acquisition of external research funds significantly depends on factors that cannot be influenced by the applying researchers, and which are not related to the quality of their prior work or current proposal.

Analytical approach

To answer the question as to how individual research and research funding situations affect the success of grant applications, an analytical approach is necessary that supports multi-level analyses, analyses of the effects of macro-structures at the individual (i.e., micro-) level, and supports a synthesis of institutional and non-institutional factors.[1] I used a conceptual framework that is based on the neoinstitutionalist analytical approach of 'actor-centred institutionalism' (Mayntz and Scharpf 1995; Scharpf 1997).

Although there have been no studies of conditions of fund acquisition, some conclusions about factors that have to be considered can be drawn from ethnographic studies of scientific work (e.g., Knorr-Cetina 1981) and studies of the peer review process (e.g., Cole et al. 1978;

Travis and Collins 1991; Laudel 1999). Conditions of fund acquisition are related to the process of preparing a grant application, as well as to the decision process about a grant application.

Scientists' decisions about the acquisition of external funds can be assumed to depend on perceptions of both the need for external funds and the accessibility of such funds (See Figure 1). These perceptions are shaped by a variety of factors. The scientist's research trail (prior projects) and the ideas for new projects emerging from that prior research, field-specific characteristics such as the equipment needed, and the resources available from recurrent funding and other funding sources shape the perceived need for additional (external) funds.

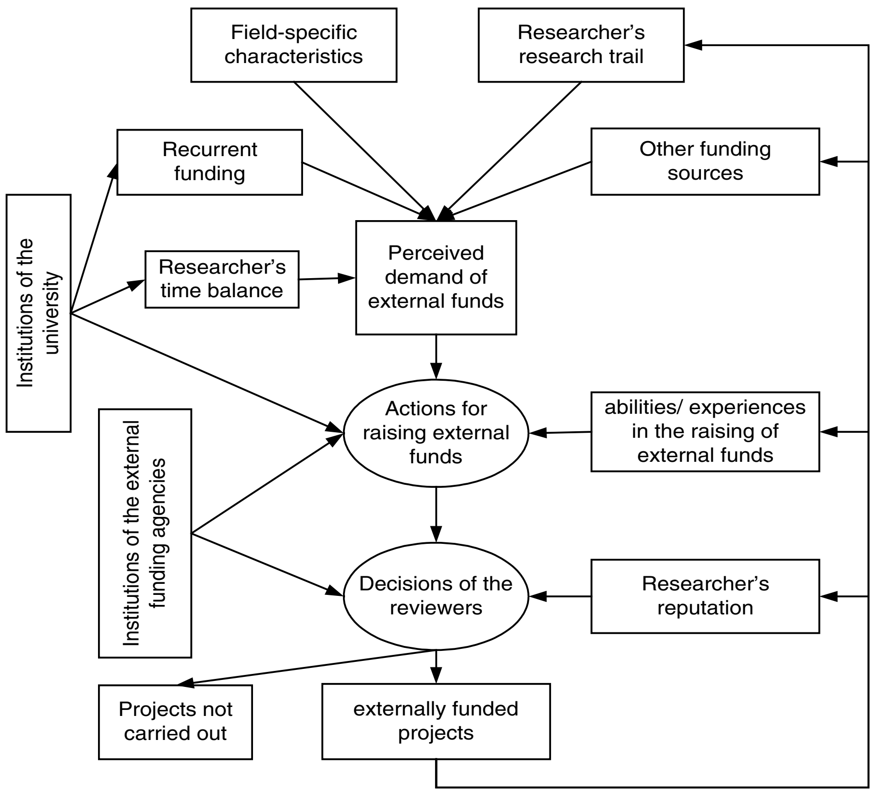

Figure 1. Acquisition of external funds – assumed variables and causal relationships.

Preparing grant applications is a part of a research process that requires time and resources. Therefore, the working conditions at the universities are important factors, especially the recurrent funding provided by the university. The latter depend on institutional rules set by the university or the university's funding body. The abilities and experiences of the scientist in fund-raising also influence the grant application.

The following process of deciding about the grant application is influenced by the quality of the grant application, the reputation of the scientist, and the decision behaviour of the reviewers. Both processes are influenced by institutional rules set by the funding agencies. Field-specific characteristics influence the demand for external funds and the relevance of different funding agencies.

Given the complexity of factors influencing fund acquisition the empirical study needed to be restricted. Therefore the review process itself (the decision about the proposal) was black-boxed in the study insofar as only researchers' perceptions of that process were taken into account.

Object of study: German and Australian University funding

The conditions of external fund acquisition were investigated in German and Australian universities. The study began with the analysis of the German system of external funding as part of a different project. A move to Australia made it possible to include the Australian system. However, any other developed country whose funding system would vary in some dimensions would have suited the purpose. The comparison of two different funding systems illuminates one research system through the lens of the other and thus identifies general features of funding systems independent of their nationally specific institutionalisation. Furthermore, the German and Australian research funding systems vary in some dimensions which turned out to be important conditions for the acquisition of research funds.

In both countries, most of basic research is conducted in universities on the basis of recurrent funding and external project funding. The systems differ in two main characteristics:

(1) The structure of research groups: Germany has a hierarchical system. Basic supplies including positions for junior researchers are assigned to university professors. Only university professors

are considered independent researchers. Scientists below this level are regarded as 'up and coming' scientists who are still in an educational phase, and whose research is therefore being directed by 'their' professor. The easiest way to make Germany's specific hierarchy internationally comparable is to regard German university professors as leaders of research groups of different sizes. Furthermore, there is a significant difference in the amount of basic supplies for "C4 professors" (chairs) and "C3 professors". The latter get significantly fewer resources. In contrast to the hierarchical German system, the Australian scientists usually don't dispose of scientific staff which they can utilise for realising their research projects. They might form a group of people who work together in a certain research field as equals but without 'owning' scientific staff like the German professors. It is also not generally the case in Australia that scientists or research groups have their own technical staff. The majority of the interviewed Australian scientists had access to centralised technical workshops.

(2) The number of external funding sources: While German university researchers have a variety of different sources, Australian researchers depend on very few sources.

In a comparative, qualitative[2] study I investigated promoting and hindering conditions of external fund acquisition of German and Australian university researchers in experimental physics. Experimental physics was chosen because research in this field requires significant resources, most of which have to be available locally in the research groups' laboratories. While some researchers also used centralised big science facilities, this was neither the common practise nor a sufficient substitute for a local laboratory. The restriction to one field limited the variance in some intervening variables like institutions of external funding and resource demand.

Data and methods

Semi-structured interviews with 45 German physicists were conducted in 2000, and interviews with 21 Australian physicists in 2002. Scientists were selected according to the following criteria:

(1) Variation of a scientist's basic supplies: It was assumed that the amount of basic supplies influences the ability to get external

funding. Therefore, professors at both the C3 and C4 level were selected. The Australian system does not have these distinctive hierarchies; thus only scientists from varying academic positions were selected.

(2) Variation of career stage: Scientists of all career stages, from young scientists at the start of their career to scientists at the end of their career, were included.

(3) Variation of the subfields: the physicists were chosen from different subfields of experimental physics in order to get information about the influence of epistemic conditions on the resource decisions. If possible, the Australian scientists were chosen within the same subfields as the German scientists.

(4) Variation of the universities: In order to get a broad picture of specific rules of resource attribution, German scientists were selected from 14 different universities and Australian scientists from 11 universities.

The interviews lasted on average one and a half hours. They covered the following topics:

- the scientists' research trails and their origins;
- current research projects and their funding sources;
- resource needs;
- funding opportunities and prerequisites for obtaining funds from the different sources;
- support measures provided by the universities;
- causes of the failure to get external funds; and
- adaptations of research to conditions of funding.

Additionally, data from a project on the effects of a special funding program on the development of research profiles at East German universities (Laudel and Valerius 2001) were used. Although conditions of fund acquisition were not the main topic of this project, they were addressed in the interviews. A secondary analysis of 41 interviews with research group leaders from various fields (biomedical research, physics, chemistry, engineering) was conducted.

The interviews were subjected to a qualitative content analysis. Moreover, I analysed publication and citation data for each scientist. These data served as an additional indicator for the reputation of a scientist.[3] The whole publication oeuvre of a scientist was retrieved. Citation data comprised a ten-year time span from 1990–1999 for the German scientists, and from 1993–2002 for the Australian scientists. The Web of Science was used as a data source, therefore only journal articles were included. However, this was considered to be a good indicator since this is the dominant publication type in experimental physics. The scientists were ranked according to their reputation in their scientific communities and to the number of citations they received. The top one third of this ranking are here regarded as 'top' scientists.

Results: necessary, promoting and hindering conditions of external fund acquisition

Quality and funding

A first indication of unequal conditions of external fund acquisition is given if we compare the amount of external funds[4] of the top scientists against that of the non-top scientists. With the quality-only assumption one would expect that 'top' scientists have many funds while other scientists have significantly less funds. This assumption was tested by comparing the external funding of both 'top' and 'other' scientists (Tables 1 and 2). The data revealed no clear pattern.

Necessary conditions for external funding

In order to successfully acquire external funds, a researcher needs an appropriate funding source, enabling funds and a fundable proposal. If

Table 1. Reputation and funding of German scientists

	Amount of external funding	
	'Rich'	'Other'
'Top' scientists	8	7
'Other' scientists	7	23

Table 2. Reputation and funding of Australian scientists

	Amount of external funding	
	'Rich'	'Other'
'Top' scientists	3	4
'Other' scientists	4	10

we look at these seemingly trivial prerequisites more closely, we can see that they rest on a very sophisticated system of conditions. An *appropriate funding source* is one that funds research on the topic of the proposal, whose criteria of eligibility are met by the applicant, and whose terms of funding meet the funding needs of the project. *Enabling funds* are necessary because external funds usually do not cover all expenses. External project funding often excludes the applicant's salary, basic equipment, rooms, and technical support. For example, according to Germany's funding agency Deutsche Forschungsgemeinschaft (DFG), personnel and laboratory equipment should be provided "insofar as they usually belong in the respective research area to the respective research institution." (BLK 2001, my translation). The DFG finances technical staff only if they are needed for specific tasks in the project for which the grant is awarded. All other technical staff that are needed e.g., for running equipment that is part of the basic supplies belongs to the basic supplies themselves and therefore will not be funded by the DFG. Neither does it finance costs for servicing or repairing those devices. Thus, to conduct a project requires significant funds from sources other than the external agency which receives the grant proposal. Finally, a fundable, i.e., *acceptable proposal* has to meet certain requirements. One of them is, of course, the quality of the proposal. In many studies that dealt with the peer review processes of project funding it had been shown that the quality of the project proposal is always a criterion used by the reviewers. Quality is usually accompanied by criteria such as feasibility, and sometimes by criteria that refer to usefulness (of innovations). Another major criterion refers to the applicant, who has to demonstrate that she is able to successfully conduct the project. This can be proven by showing that the applicant has prepared the work for which money is sought by prior research on that topic (see also Hackett 1987, p. 144). Another variant is to demonstrate more generally that one is a successful researcher by providing a 'track record', i.e., references to one's prior research as documented in publications.

This short discussion clarifies that the necessary conditions – an appropriate funding source, enabling funds, and an acceptable proposal – are dependent on a very complex set of cognitive, social and institutional conditions whose overlap shapes a researcher's 'funding situation'. These conditions determine the opportunities for a researcher to actually acquire external funding, the amount of work and resources that must be invested in the creation of a funding proposal, and the likelihood that the proposal will be funded. In the following section, I will discuss these conditions as promoting and hindering fund acquisition. In this discussion I will focus on the extent to which conditions for fund acquisition depend on a researcher's 'quality'.

Promoting and hindering conditions and their dependence on quality

Factors affecting the availability of appropriate funding sources
The availability of funding sources is mainly shaped by the diversity of the funding landscape, the availability of collaborators, the epistemic room for manoeuvre, and the integration in the scientific community. A *diverse funding landscape* allows the scientist to approach different sources. The funding landscapes of Germany and Australia differed considerably in this respect. Germany has numerous funding sources an experimental physicist could access, while Australian physicists basically relied on one single funding source – the Australian Research Council (ARC). In addition, this funding source had a very low success rate and the number of ARC discovery grants – the most important funding scheme – is restricted to two per scientist.

Funding sources vary:

- in the amount of money they distribute. DFG grants were perceived as small in comparison with grants of other funding agencies that German physicists could access. ARC grants were also assessed as small;
- in the financial autonomy they grant. The DFG was perceived as very strict: it usually does not finance the position of the applicant, technicians, equipment, and consumables that are assigned as belonging to the basic supplies. Other funding agencies like the Federal Ministry of Education and Research (BMBF) granted far more financial autonomy; and
- in the topics of research that are funded. Many funding sources create programmes that offer funding for specified topics. This includes industry, in the sense that industrial enterprises are only interested in funding projects that have the potential to further their economic interests. Therefore, a researcher's chosen topic determines how many funding sources he or she can access, and what amount of money is provided.

Many funding schemes are aimed at promoting collaborative research. The *availability of collaborators* (who in some cases need to be industry partners) was a crucial precondition to access these schemes. Therefore, the availability of collaborators is an important promoting condition for fund acquisition. This availability is affected by a number of factors:

- Size and structure of the field: The availability of collaborators depends on the national size of their research field, i.e., how many research groups work in the field. Since scientific collaboration benefits from frequent personal interactions, scientists working in big cities sometimes had an advantage.
- Industry-relevance and existence of potential collaborators in industry: Many of the Australian physicists worked in fields with industrial relevance. But Australia lacks a high-tech industry with research and development capacities to absorb results from university research. Thus, scientists tried to get industry partners overseas, especially the United States. Although some were quite successful with that, they admitted that it is much more difficult to get access to overseas partners. In general, the location of a research group turned out to affect the availability of partners who are relevant for funding.

  I: Could you potentially contract with industry?
  Yes, [internationally] a lot of people in my area work with industry, ... it's specific to Australia, Australia doesn't have a semiconductor industry, so here we basically do academic work and we do have very little contact with industry ... Here in Australia we're funded 99% by the Australian Research Council which is a scientific body so I'm not funded by industry ... ('top' Australian scientist, 'rich')[5]

  Since there is hardly any industry nearby and least of all one needing high-technology, it is rather difficult to do such an BMBF project in this region here. (German scientist)

- Quality of work: Scientists try to collaborate with the best partners available. Trust in the partner's capabilities plays an important role in science. Therefore, good scientists can be assumed to be more successful in attracting collaborators, thus improving their chances of getting funded.
- Topic: The opportunities to collaborate depend on the topic on which a scientist is working. If collaborations are not necessary or feasible in a field (e.g., mathematical logic or history), collaborative projects do not make sense and do not have a chance of getting funded.

The opportunities for scientists to adapt their proposals' contents depends on their capabilities and on their *epistemic rooms of manoeuvre*. The epistemic room of manoeuvre describes the spectre of possible research a scientist can undertake with the objects and methods available. A large epistemic room of manoeuvre means that a greater variety of projects can be designed and thus provides a larger range of opportunities to apply for external funds. For example, some scientists used universal methods, i.e., methods that were applicable in a variety of fields. They could therefore access a larger number of different funding sources and they were often welcomed as collaborators in research networks.

> With our equipment we can work at very different ranges of topics of interface analysis. And then it is relatively easy to jump on a certain topic and to say, we'll conduct such and such investigations for that topic. (German scientist)

The availability of funding sources is also linked to the basic or applied character of research. Many funding agencies are directed towards applied and industry-related research. Therefore scientists who conducted applied research could access a larger variety of funding sources. Basic researchers complained about not being able to choose between different agencies. With few exceptions, in Germany basic research is only funded by the DFG. In Australia, it is only funded by the ARC. Thus, the diversity of the funding landscape is rather low for basic research.

Factors affecting the availability of enabling funds

Enabling funds can come from two different sources. The most important source is *recurrent funding*. In Germany, a university professor becomes a research group leader with his or her appointment. The professor receives funding for a number of positions for scientific and technical staff, laboratory space, and research equipment as 'first supplies'. The amount of funding depends on the level at which the appointment is made (which can be seen as dependent on the candidate's quality) and on the wealth of the federal state that funds the university.

In Australia scientists receive 'first supplies' in the form of research equipment with their appointment. This happens on an individual basis, which means that the funds are smaller. Funding for maintenance and consumables is limited. A university-internal grant system exists for small one-year grants that cover these items and small equipment.

The scientists' basic supplies varied considerably: I found in both countries, Australia and Germany, relatively 'wealthy' research groups and relatively 'poor' research groups. For example, on the one end of the spectrum were German scientists with 6 full-time research positions, and on the other end scientists with only one doctoral student position. The same was found for the technical staff: German scientists had up to eight technicians or had not a single technician working for their group.[6] Research equipment that was originally acquired by external funds usually becomes part of the basic supplies after the project is completed. Thus, scientists who raised funds containing research equipment could improve their equipment basis.

The basic supplies of a research group directly influenced the amount of external funding it was able to acquire. None of the research groups with poor basic supplies were able to get a large number and amount of external funding while groups with large basic supplies were often the most successful groups in getting external funds.

> This stainless steel tube in this arrangement exists perhaps two or three times in the whole world. With it we are able to work in completely new areas of surface physics. Thus, we can also tell our industry partners: we have the latest research equipment in the world available. (German scientist)

> That's why I can't see how the initial situation of basic supplies for research ... will turn to good account. That will reduce my chances to get external funding; that's for sure. If I must write into my funding proposal I have a DSC down there (the device which I told you is needed because it is so central) which is ten years old, then the DFG, the reviewer will say: How do you intend to do reasonable experiments with it? That's quite impossible. ('top' German scientist)

Both German and Australian physicists assessed their basic supplies as insufficient and many of them experienced a considerable deterioration of it. In the last decades, German universities experienced a decrease of their recurrent funding that made them unable to finance personnel, equipment and material that are standard for a research group in the field (Schimank 1995, Wissenschaftsrat 2000, p. 11). The recent funding situation is similar or even worse for Australian university physicists. Thus, supplementing external funds by recurrent funds becomes more difficult for all scientists.

German scientists could increase their basic supplies by applying at other universities and use their success in these applications as an asset in negotiations with their home university. By negotiating appointments with other universities and threatening to leave their current university, they could demand more basic supplies. But only the few scientists who actually applied elsewhere and were successful could use this strategy.

Apart from recurrent funding, scientists used *external funding from other projects* to finance basic supplies. That is, they 'rearranged' money from other externally funded projects to supplement funds.

> This is a doctoral thesis, just about to be finished. . . . well, you need a certain basic substance of publications as basis for externally funded projects. Thus, the idea was to start this way and then to convert it into a DFG project. . . . Well, a doctoral thesis you can just offer and you finance it from any other project but you do something completely different with [that project money]. (German scientist, 'rich')

The availability of such 'free' money depends on several factors. The two main factors are the number of externally funded projects and the restrictions posed by the funding agency on how the money can be spent. The restrictions on funding depend entirely on the funding agency that provides the money. Projects that grant high financial autonomy in spending the money were especially valuable, this was often the case with industry projects. The number of externally funded projects is influenced by a scientist's quality but also depends on other factors as we have seen already so far.

To sum up, access to enabling funds is influenced by:

- available funds of a university: They affect what can be offered as first and continuing basic supplies to a scientist;
- the number of externally funded projects which is influenced by quality and by non-quality-related factors; and
- quality of work: good researchers might get better offers of basic supplies than mediocre researchers but this is highly restricted by the funding opportunities of the research institution. The quality also has an influence on the number of externally funded projects.

These factors create the possibility of a Matthew effect. The conditions of fund acquisition partly depend on a researcher's prior success in that very activity. However, the general situation is characterised by a mix of quality-related and non-quality-related factors. Furthermore, it is important to note that not all of the factors can actually be influenced by the researcher.

Factors affecting the acceptability of funding proposals

An acceptable proposal has to be of high quality, it must describe a feasible project, and it must be written according to the formal and informal standards of the scientific community and of the funding agency. Additionally, the acceptance of a proposal is affected by a scientist's reputation. These factors are interwoven and are treated by funding agencies in different ways. The most important features of a proposal are the characteristics of the project itself, i.e., *quality and feasibility*. While a high quality of a proposed project is generally required, 'normal' projects generally have better chances than exceptional ones. As peer review studies have shown, it is preferably mainstream, low-risk, and disciplinary research that passes the peer review process of funding agencies (e.g., Chubin and Hackett 1990, p. 69; Horrobin 1996; Travis and Collins 1991, p. 336).

> For completely new things, new ideas you hardly get money. ... The DFG is, I think, a very good funding instrument but it has its flaws. It is conservative. The reviewers are conservative. For new ideas it is difficult to succeed, especially if they are between the areas. I mentioned before the example of the implants – this is a typical example where the funding programme doesn't fit. If you intend to start something new there, you need to do some research to show that it works. The reviewers of the DFG are very reluctant to give you the freedom just to try something. ('top' German scientist, 'rich')

> Some years ago the ARC decided that it had to support multidisciplinary research and we tried to put in a grant, physics/biology grant. ... [what] happened was they would send the grant to a biologist who would be critical of a physicist's rendition of the biology and to a physicist who would be very critical of the biologist's rendition of the physics and if the ARC were serious about promoting interdisciplinary research, they needed to take into account that people that were putting in grants crossing over a boundary were coming out of their comfort zone. ... So if you really do want to promote a new area, you have to be prepared to take some risks in terms of the funding. And I suppose our argument was we were experienced researchers, we have complementary expertises and you should trust us. But they wouldn't. ('top' Australian scientist, 'rich', referring to his unsuccessful grant application)

It was also easier to get funding for 'cheap' research, i.e., for research that requires less than average amounts of funding. This led to certain adaptation strategies by the scientists which will be discussed later.

Most German funding agencies assess the feasibility of a project by requesting a description of the applicant's prior work on the topic. For the applying scientists it is important to demonstrate that they have either worked on the topic of the proposed project for some time or (at least) that they have prepared the project by some empirical work. An applicant's amount of prior work is increased by a continuous research trail, that is research projects in the same area which are connected to each other.

> Moreover they look at, that's how the reviewers proceed, how many publications they have in this area. There we have relatively few because these were the first animal experiments. Furthermore, this is a relatively new area. And then it is always difficult, especially at the DFG, to get a project through. If you have already ten publications or a long list related to this topic, then it is most simple. (German scientist)

Since prior work is a condition for getting funded, it is difficult to begin work in a new area by applying for external funding. The necessary prior work can be conducted with either recurrent funding or external funding from other projects. These two sources of money affect a scientist's opportunity to do the prior work and to build up a track record. Scientists with small amounts of basic supplies and limited external funding needed a long time to conduct prior research in preparation for a grant proposal.

> I thought that I could produce a good set of prior work with the basic supplies and then apply for grants. But the problem is, the basic supplies are gone and we only now have a really good set of prior work. Well, it took us about three years until this was properly set up, worked and produced proper results. And before this, it is difficult. I mean this is the chicken-and-egg problem. (German scientist)

The continuity of a research trail was generally influenced by a scientist's success in fund-raising. Since none of the interviewed scientists was able to conduct a research project solely from his or her basic supplies, failures in fund-raising led to break-downs of specific topics and endangered the continuity of research trails.

A second effect of a scientist's prior work is that it contributes to his or her *track record* and general *reputation*, which are important factors affecting a proposal's success. It is not only the quality of the project that is assessed, but the whole of a scientist's former research. Therefore, scientists who are well-known in their community for their (good) research and who are integrated into informal networks and into decision-making processes have an advantage in getting funds.

> One [project] is submitted to the BMBF, another to a DFG Priority programme, a third to another Priority programme, and a fourth – there I got a phone call yesterday, we should take part at any case – again a BMBF project with industry participation. If you have some experience and you bear a name, then you sometimes can't save yourself from all the requests you get. ('top' German scientist, 'rich')

The main factor in building a reputation is of course research. Scientists needed to conduct projects that led to publications. This, in turn, depended on funding. Scientists who had small basic supplies and who were not successful in fund-raising quickly got in a vicious circle of not being able to conduct the necessary prior work and maintain a sufficient publication record. This situation was particularly evident within the Australian science systems with its small basic supplies and lack of diversity in funding sources.

As a result of shrinking success rates, it becomes even more important to *know how to 'play the game'*. This includes knowledge about which funding programmes are available, what the formal rules of each funding scheme are and general knowledge about how to write a grant proposal. The latter is usually part of a scientist's socialisation process. East German scientists who had missed this kind of socialisation due to the lack of an external funding system in the GDR, claimed that they had difficulties writing grant proposals immediately after German unification. Scientists who came from other countries to Australia or Germany had similar difficulties. An extreme case is the highly bureaucratic EU funding programmes where scientists often were not able to obtain the required knowledge but had to 'outsource' the application process to specialised companies (De Strooper 2004).

A general promoting condition for external funding was the *availability of time*. Time is necessary for the preparation of the grant proposal as well as for reporting activities. The preparation of a grant proposal requires prior research, conceptual work, the coordination with collaborators, and writing the application according to the formal rules of the agency. The amount of time for preparing a proposal very much depends on the funding rules. EU proposals were considered as extremely time-consuming by the German physicists. Collaborative research networks are very time-consuming to coordinate.[7] The amount of time a researcher had for grant applications and reporting depended on the amount of time he or she had to spend on non-research activities like teaching and administrative duties at the university. The scientists' conditions differed considerably in this respect. In general, the teaching load of Australian scientists was higher than that of German scientists. They also usually had no research group members with whom they could share teaching and other duties while some German scientists could delegate part of these activities to members of the research group, including grant-writing. The amount of time that could be spent for research activities did not systematically depend on a researcher's 'quality'. Teaching loads and other duties were influenced by a variety of idiosyncratic factors such as the histories of departments and universities.

Adaptation strategies

As a result of the strong dependence of scientists on external funds, both scientists and their universities attempted to influence the conditions of external funding. Scientists responded by developing strategies for increasing the likelihood of getting funded. The adaptation strategies targeted either the resource base or the content of the research proposals. I will mention these strategies briefly; for a more detailed discussion see Laudel (2006).

Australian and German scientists used a *money-laundering* strategy to supplement funds of external grants by rearranging money from other externally funded projects. Australian scientists particularly had to cope with severe grant cuts for which they tried to compensate. Money-laundering played an important role in doing prior work for new grants. To tap additional sources of money, scientists *commercialised* their research results or sold *services* (e.g., routine analyses) to customers, mainly to industry. German scientists who could choose between several funding sources often used as many different ones as possible by *targeting all sources*. Others selected *easy sources*, that is sources they were familiar with and which took the least amount of time to write, compared to the size of the grant.

Scientists also adapted their research to the funding landscape by *selecting externally predetermined topics*. Since many of the topics defined by science policy had an applied character, this strategy could preferably be used by scientists who conducted applied research. German scientists *diversified their research* by including additional research topics and objects in their research. In this way, they increased the number of external projects, because every new project must be sufficiently different from other already externally funded projects. All scientists usually *avoided risky research* because new ideas where one is unsure if it will work cannot be included in a grant proposal. Finally, scientists *selected 'cheap' research* in anticipation of what is likely to be funded by adapting research methods and objects (by choosing inexpensive methods, reducing the number of different methods applied, etc.).

In light of the shrinking recurrent funding, universities need their scientists to be successful in the acquisition of external funds. Therefore, they set up a variety of measures in order to support and to reward the fund acquisition. All universities had specialised administrative units for supporting fund acquisition. Since each university developed its own support system, it would go beyond the scope of this article to analyse them all. The discussion is confined to all those measures and their perception by the scientists that were actually mentioned in the interviews.

Several German universities provided *funds for the preparation of grant proposals*. These funds generally aimed at the acquisition of larger grants, e.g., for collaborative networks. They were as scarce as external project grants. The interviewed scientists reported a high rejection rate for these internal proposals. Australia had a university-internal grant system where small amounts of money could be raised. These funds served the exploration of new areas, the improvement of ARC proposals that had been submitted and narrowly missed being funded, and the formation of larger collaborative proposals. Nevertheless, they were regarded as insufficient. Australian universities were often not able to provide any travel grants for the formation of networks. In general, Australian scientists experienced a deterioration of all these internal funding sources.

Australian Early Career funding schemes existed which targeted a special group of applicants, namely scientists at the beginning of their research career. The aim was to get them into the system despite their lack of a track record and inexperience in grant-writing. The interviewed scientists had not applied for these schemes; hence these schemes' usefulness cannot be reported.

German universities usually had a centralised advisory service that collected *knowledge about all possible funding sources*. Scientists could get information there about funding opportunities, about formal requirements of the schemes, and their proposals were checked for formal correctness. The extent to which scientists appreciated these services depended on their experiences in fund-raising, access to other information sources, the competence of the advisers, and the design of the information system. German scientists valued the check of formal correctness of applications by university administrators.

Like the German universities, Australian universities provide information about available funding sources. Since, there were only a few funding schemes for Australian physicists, this information played a minor role. The scientists mentioned workshops for learning grant-writing but did not find them necessary (which might be different for early career researchers). University administrators checked proposals for formal correctness. These services were assessed very differently: as very helpful, as not so important, not very supportive or even hindering.

Thus, university support for the application process was perceived as being of limited value in both countries. Due to the lack of funds, universities concentrated on reshifting the available funds to the successful scientists (see below) and on formal administrative support. It is not surprising that the general interview question "Do you get any special support from the university for the raising of funds?" was usually answered by the interviewees with "No, I didn't get any support". The services described above were mentioned only as a response to further questioning.

Both Australian and German universities used funds for *rewarding scientists for successful grant applications*. In Australia, a considerable proportion of the recurrent government funding depends on the research income of a university. The internal distribution of recurrent funding to the departments and units partly takes into account these units' (and ultimately, their scientists') success in acquiring external grants. Whether this reward system had any effect on increasing the research money for the scientists who actually received the grants depends on the internal distribution rules of the university, the department etc. The two following comments by Australian scientists on the funding procedures show that the system can distort the rewarding effect:

> Our department has a formula which I have never understood because the amount of money that usually comes back to me is usually quite small and each time I try to get an explanation for exactly what happens, I get an explanation that I never understand because it doesn't seem to, in a sense, work right because, I mean, we do actually publish a lot, but we do also bring in a fair bit of money and so where does it all go? (Australian scientist)

> So, the more successful I am in getting new grants, the more income the university gets.
> I: There's no money that goes back to you?
> There is, but I don't know where the money goes. It doesn't come to me. It goes somewhere in the college, probably, which is two levels above the schools, and it's the Rio Grande. [...] It starts in the mountain and then it gets a very big river. Flows into the desert and it dries up eventually and it never reaches the sea. We're living near the sea, so we never see it. ('top' Australian scientist, 'rich')

In Germany, eight of the fourteen investigated universities had introduced bonus systems to reward research groups for external fund acquisition. Although this money was distributed directly to the group of a professor, the amount of this bonus was usually so small that the majority of the German physicists thought of it as having only a symbolic value. In general, neither of the reward systems could fulfil a role of enabling funds because the funds were too small.

Some funding schemes such as collaborative networks had a rule implemented that the university must *directly match the external funding* by providing basic supplies (especially equipment). This meant reshifting the scarce recurrent funds towards the areas and topics that were selected by the funding agencies. Under the conditions of already underfunded research at universities, other problems emerged:

> That is, you submit a project with 300,000 Marks investment costs, and the reviewers say: "He needs it but it has to be provided by the basic supplies." In the end, this is taken from my colleagues here, and I can't walk down the corridor because I've cut their budget dramatically. ('top' German scientist, 'rich')

> The reason why we have no funds from the university for our research is partly because the university is required to put them into centres, or with the Federation Fellow[ship grant]. The Federation Fellow is very demanding on the university. The university has to provide money towards their salary and towards their set up costs. ... It's not feeding the grass, so that the lawn grows. It's planting a big tree in the middle, and having a desert everywhere else ... ('top' Australian scientist, 'rich')

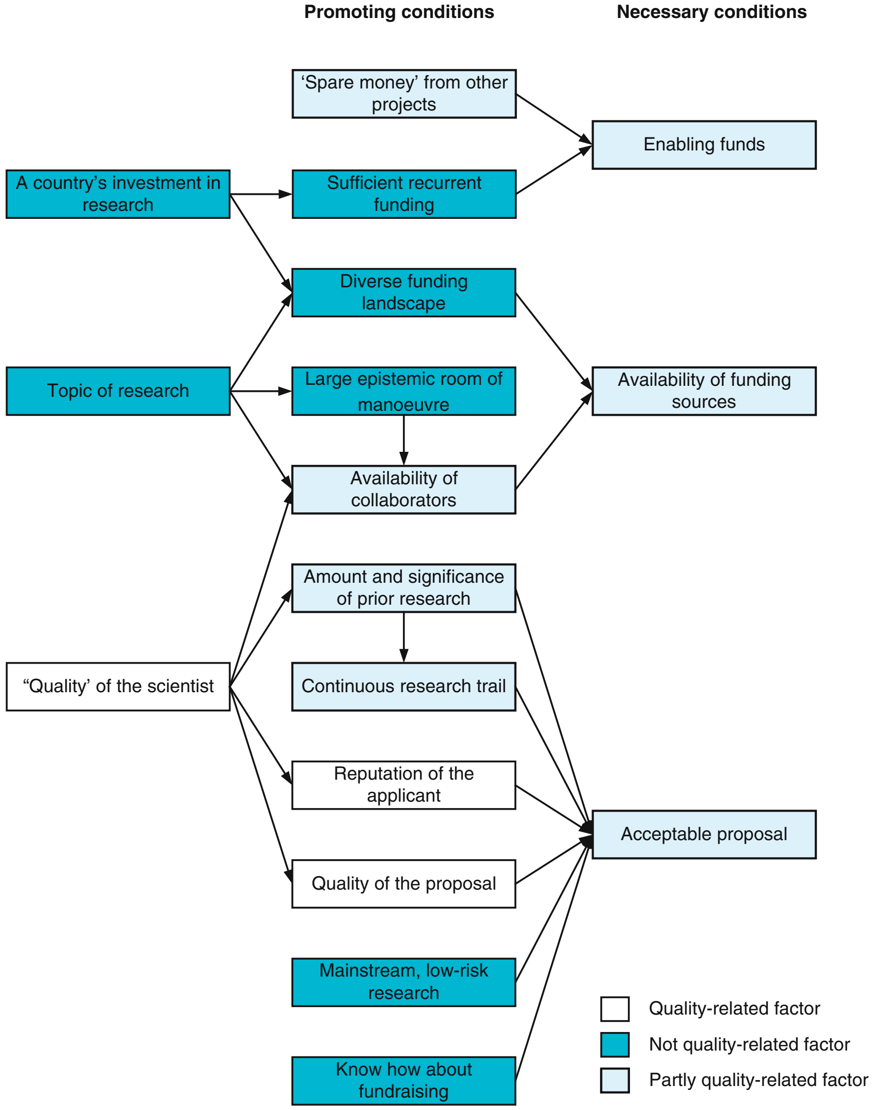

Figure 2. Necessary and promoting conditions of fund acquisition.

Discussion: The dependence of success on quality

Figure 2 summarises the conditions discussed and shows how they depend on the quality of a researcher or a research proposal. The discussion in the previous section has shown that the quality of a proposal and the reputation of a researcher are important prerequisites for a successful acquisition of funds. However, I have also shown that a funding proposal's success depends on several factors that are not linked to quality and cannot even be controlled by scientists. An often neglected factor is a country's general investment in research. The extent to which a quality-based fund distribution can work at all depends on the willingness of science policy to provide a sufficient material basis for applicants. If recurrent funding is insufficient to prepare grant applications, or if grants are so scarce that even excellent projects must be rejected, the mechanism cannot work properly.

Another major factor that is not related to a proposal's or its author's quality is the research field in which a scientist is working. Fields significantly differ in the amount of grant money that is available. For example, fields that do not have any promise of applicability for industrial innovation will be funded neither by industry nor by agencies that are devoted to the promotion of industrial innovation. Basic research fields differ in the extent to which they can attract collaborators, in the amount of money that is needed for basic supplies, in the speeds with which their basic equipment needs to be replaced, in the epistemic room of manoeuvre they provide etc. None of these factors can be changed by the researcher. A few excellent researchers could partially compensate for the hindering conditions, but none of the interviewed scientists could overcome all of them.

A third important factor, which is only partly dependent on quality, is the availability of 'free' money to prepare project proposals, start new lines of research etc. All interviewed researchers regarded this money as insufficient. Its amount depends partly on quality because by and large better researchers can be assumed to get posts at more prestigious and richer organisations, they will be able to demand more basic supplies, and will have more 'spare money' from other projects. However, the limitations of recurrent funding cannot be completely overcome.

A fourth main factor, which also only partly depends on quality is the continuity of the research trail. The emphasis on track record and prior work on a topic is prone to Matthew Effects that channels the money to the previously successful researchers. This is not wrong because prior success depends on quality. However, it is not right either because prior success only depends on quality to a certain extent. Thus, for certain scientists it is difficult to get external funding, e.g., those who are at the start of their research career; those who begin new lines of research; those who have interruptions in their careers.

This is not to say that a researcher's excellence or the quality of a proposal are unimportant. The quality of a proposal remains the most important criterion for a proposal's acceptance, and a researcher's track record and reputation are similarly important. However, the empirical investigation has revealed a variety of non-quality-related 'competitive disadvantages' researchers can experience without being able to affect them.

The empirical findings demonstrate that a scientist's successful acquisition of competitive grants is influenced by a variety of factors such as a country's general investment in research, a scientist's research field, the availability of enabling funds, and the continuity of the research trail. These factors depend either partly or not at all on a scientist's or a proposal's quality. Nor can they be changed by scientists. Thus, scientists' actions for improving their funding success are limited as well. There is only limited room for adaptations of the research content because scientists usually cannot shift easily from basic to applied research to target application-oriented funding programmes, jump on a new topic announced by science policy, and choose universally applicable methods and so on. To do so, would make them leave their area of competence and therefore not fulfil other necessary criteria for funding success. Strategies targeting the resource base presuppose conditions such as the diversity of the funding landscape, which also cannot be influenced by the scientists. Despite these limitations, many of the interviewed scientists tried to improve their conditions of funding success. These individual adaptations are an unintended consequence of competitive funding schemes whose consequences are not yet fully understood, but imply a danger of seriously limiting the variety of approaches to research problems and the number of nonconforming, risky attempts to solve problems (Laudel 2006).

The efforts of universities to improve their scientists' external funding situations were also of limited success because their scope of action is even smaller than that of the scientists. The three ways in which universities can try to increase fund acquisition are providing seed money, providing administrative support, and rewarding successful scientists. By rewarding those who brought in most external funding, the universities contribute to a Matthew effect by which successful scientists can further improve their chances of success in subsequent grant applications.

Both the funding criteria related to prior work respectively 'track record' and the resource shift to the successful scientist strengthen the Matthew effect. Scientists who do not win enough grants can get in a vicious circle where they do not have enough funding to prepare grant proposals and cannot get grants because they have not done prior work or achieved a sufficient track record. This is particularly a danger in resource-intensive fields like experimental physics and other experimental sciences. At the same time, it becomes increasingly difficult for early career researchers to enter the grant game.

Science policy has introduced some rules that seem to counteract this process. A mechanism that might slow down the Matthew effect of external fund distribution is the restricting rule of the funding agencies: the ARC has a two-grant rule and the DFG an informal three-grant rule for their most important funding schemes, respectively; it prevents the situation where all the money would go to the 'rich' scientists. This might have had a more serious effect in Australia, whereas in Germany with its variety of funding sources, the situation essentially would not change.

Conclusions

The aim of this article was to find out which conditions influence a researcher's success in fund acquisition and if they are related to the quality of the researcher's prior work or current proposal. Most of the causal relationships hypothesised by Gillet (1991), Hornbostel (2001) and Moed et al. (1998) could be confirmed: sufficient recurrent funding as enabling funds, a diverse funding landscape, and a scientist's track record have an important influence on the funding success. These and other factors were examined for their quality-dependence. Although the quality of a researcher and the researcher's proposal were found to be important conditions for external funding success, other factors were only partly quality-related or independent from the quality at all. The 'quality myth' that dominates recent science policy was proven wrong.

If the quality-only assumption is wrong, the question arises as to how many good scientists and how much good research is crowded out by the system. Therefore, it would make sense to have counter-mechanisms to keep scientists in the system and to counteract the pressures of external funding towards mainstream, low-risk, application-oriented research. The most important countermeasure would of course be to provide sufficient money for basic supplies and for the funding of all research that is regarded as excellent. Any strategic actions by universities require a financial basis that enables the conduct of additional research projects that are not otherwise funded. The recent scarcity of recurrent funding for Australian and for many German universities does not provide such a basis. Mechanisms should be established for directing money to areas that are not well-supported by external funding. Furthermore, universities should direct money to scientists who (just) missed out on external funding to ensure the continuity of research trails.

Rejecting the quality-only assumption, casts doubt on external funding *per se* as a useful performance indicator. It seems especially problematic to use it in a comparative manner or to aggregate it because the field in which researchers work has a major influence on opportunities, success and amount of money that can be acquired via the 'grant game'.

The results presented here suggest three lines of further research. While the argument for the existence of a Matthew effect at the individual level could be strengthened, it is difficult to gather conclusive evidence by synchronic investigations. It would be necessary and fruitful to investigate research biographies, i.e., researchers' funding histories over the course of their careers, and to look for 'lock in' – and 'lock out' effects. If these transitions to stable funding respectively non-funding situations can be identified, the conditions that trigger these transitions could be identified as well.

A second question concerns the work of researchers who are locked out from funding cycles. While one respondent in my study had no external funding at all, the interview was too problematic to enable any conclusions about this type of situation. According to the general results of my study, researchers without external funding should not be able to conduct research at all. Do these researchers exist, and if so, how do they manage? Without answering this question, our picture of the funding situation remains incomplete.

The most important question to be answered concerns the content of research that is being produced under the described conditions: Do the conditions of recurrent and external funding lead to research that is different with regard to its content? Is different knowledge being produced under the conditions of heavy dependence on external funding, conditions which are only partly connected to quality and are prone to the occurrence of Matthew effects? If this is the case, the push towards more competition in fund acquisition might well have serious non-intended consequences that will surface only after some time. To answer this question requires comparative analyses of scientific knowledge, which remains the biggest challenge for the sociology of science.

Acknowledgements

This paper is based on a project that was partly funded by the Deutsche Forschungsgemeinschaft. I thank Jochen Gläser from the Australian

National University, and two unknown reviewers for their critical comments to the manuscript.

Notes

1. Studies that remain at the macro-level are unable to identify causal mechanisms that relate conditions of fund acquisition to outcomes. For example, Geuna linked the success of EU project applications to attributes of applicants' universities because no data were available at lower levels of aggregations. This effectively means that his study had to ignore all data that were specific for individual projects which makes it impossible to establish any causal relationships, let alone causal mechanisms. (Geuna 1998).
2. Purely quantitative approaches (e.g., Bazeley 1998; Viner et al. 2004) found correlations between factors influencing the grant success but can only speculate about rather than explain the causes why peer review panel membership, departmental affiliation or gender promote or hinder the grant success.
3. For the scientist's reputation in his or her scientific community I used the following indicators: if and how often he or she reviews journal articles and/or grant proposals, their work on editorial boards, their work on committees of international conferences, invited talks at the international level, and visiting fellowships.
4. As a rough indicator I used only the number of externally funded researchers (rather than the whole amount of funding) as this is usually the most expensive part of a grant. This enabled me to make comparisons over different subfields of experimental physics. I defined German scientists who had seven and more externally funded research positions as 'rich'. Australian scientists were defined as 'rich' if they had five and more research positions.
5. 'Top' specifies the reputation of the quoted scientist, and 'rich' specifies his or her amount of funding (see Tables 1 and 2). If these categories are not mentioned, the scientists belong to the group of 'others' ('other' scientists, 'other' amount of funding)
6. How the scientists assessed their need for technical support was influenced by the resource demand of their research area. For example, in semiconductor research large equipment is used, such as epitaxy systems, that needs to be permanently supervised by trained technicians.
7. The interviewed scientists deplored the increasing number of funding schemes for collaborative networks. These networks were often assessed as highly artificial entities which did not promote collaborations and instead required a substantial amount of time for coordination.

References

Bazeley, P. (1998). 'Peer review and panel decisions in the assessment of Australian Research Council project grant applicants: What counts in a highly competitive context?', *Higher Education* 35, 435–452.

(BLK), Bund-Länder-Kommission für Bidlungsplanung und Forschungsförderung (2001). Ausführungsvereinbarung DFG (AV-DFG) - vom 28. Oktober/17. Dezember 1976, zuletzt geändert am 20. März 2001.

Chubin, D.E. and Hackett, E.J. (1990). *Peerless Science: Peer Review and U.S. Science Policy*. Albany, NY: State University of New York Press.

Cole, S., Rubin L., and Cole J.R. (1978). *Peer Review in the National Science Foundation. Phase One of a Study*. Washington: National Academy of Sciences.

De Strooper, B. (2004). *The EC Framework Programme - time for a radical rethink*. (ELSO Gazette, Issue 18, February 2004).

Geuna, A. (1998). 'Determinants of university participation in EU-funded R & D co-operative projects', *Research Policy* 26, 677–687.

Gillett, R. (1991). 'Pitfalls in assessing research performance by grant income', *Scientometrics* 22, 253–263.

Hackett, E.J. (1987). 'Funding and academic research in the life sciences: Results of an exploratory study', *Science & Technology Studies* 5, 134–147.

Hornbostel, S. (2001). 'Third party funding of German universities. An indicator of research activity?', *Scientometrics* 50, 523–537.

Horrobin, D.F. (1996). 'Peer review of grant applications: A harbinger for mediocrity in clinical research?', *Lancet* 348, 1293–1295.

Knorr-Cetina, K. (1981). *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science*. Oxford: Pergamon Press.

Langfeldt, L. (2001). 'The decision-making constraints and processes of grant peer review, and their effects on the review outcome', *Social Studies of Science* 31, 820–841.

Laudel, G. (1999). *Interdisziplinäre Forschungskooperation: Erfolgsbedingungen der Institution 'Sonderforschungsbereich'*. Berlin: Edition Sigma.

Laudel, G. (2006). 'The art of getting funded: How scientists adapt to their funding conditions', (submitted).

Laudel, G. and Valerius, G. (2001). *Innovationskollegs als "Korrekturinstitutionen" im Institutionentransfer? Abschlussbericht zum DFG-Projekt Innovationskollegs als Instrument der Umgestaltung der unviversitären Forschung im ostdeutschen Transformationsprozess - Akteure, Strukturen und Effekte'*. FIT Arbeitsberichte. Frankfurt (Oder): Europa-Universität Frankfurt, Frankfurter Institut für Transformationsforschung.

Mayntz, R. and Scharpf F.W. (1995). 'Der Ansatz des akteurzentrierten Institutionalismus', in Mayntz R. and Scharpf F.W. (eds.), *Gesellschaftliche Selbstregelung und politische Steuerung*. Frankfurt a. M.: Campus, pp. 39–72.

Merton, R.K. (1968). 'The Matthew Effect in Science', *Science* 159, 56–63.

Moed, H.F., Luwel, M., Houben, J.A., Spruyt, E. and Van den Berghe H. (1998). 'The effects of changes in the funding structure of the Flemish universities on their research capacity, productivity and impact during the 1980's and early 1990's', *Scientometrics* 43, 231–255.

Neidhardt, F. (1988). *Selbsteuerung in der Forschungsförderung*. Opladen: Westdeutscher Verlag.

Scharpf, F.W. (1997). *Games Real Actors Play. Actor-Centered Institutionalism in Policy Research*. Boulder: Westview Press.

Schimank, U. (1995). 'Probleme der westdeutschen Hochschulforschung seit den siebziger Jahren', *Leviathan* 23, 56–77.

Travis, G.D.L. and Collins H.M. (1991). 'New light on old boys: Cognitive and institutional particularism in the peer review system', *Science, Technology, and Human Values* 16, 322–341.

Viner, N., Powell P., and Green, R. (2004). 'Institutionalized biases in the award of research grants: a preliminary analysis revisiting the principle of accumulative advantage', *Research Policy* 33, 443–454.

Wissenschaftsrat (2000). *Drittmittel und Grundmittel der Hochschulen 1993 bis 1998*. Köln: Wissenschaftsrat.

Wood, F.Q. (1992). 'The Commercialisation of university research in Australia: issues and problems', *Comparative Education* 28, 293–313.