PLATTFORM fteval
Forschungs- und Technologieevaluierung

Profil, Leistung & Publikation

Nr. 32
Juni 2009

BUNDESMINISTERIUM FÜR WISSENSCHAFT UND FORSCHUNG
Minoritenplatz 5, A-1014 Wien
Mag. Irene Danler
irene.danler@bmwf.gv.at
Mag. Simone Mesner
simone.mesner@bmwf.gv.at

BUNDESMINISTERIUM FÜR VERKEHR, INNOVATION UND TECHNOLOGIE
Renngasse 5, A-1010 Wien
Dr. Rupert Pichler
rupert.pichler@bmvit.gv.at

BUNDESMINISTERIUM FÜR WIRTSCHAFT, FAMILIE UND JUGEND
Stubenring 1, A-1010 Wien
Mag. Sabine Pohoryles-Drexel
Sabine.Pohoryles-Drexel@bmwfj.gv.at

AQA – ÖSTERREICHISCHE QUALITÄTSSICHERUNGSAGENTUR
Wickenburggasse 26, A-1080 Wien
Mag. Alexander Kohler
alexander.kohler@aqa.ac.at

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY GMBH
Donaucitystraße 1, A-1220 Wien
Mag. Petra Wagner-Luptacik
petra.wagner@arcs.ac.at
Dr. Susanne Giesecke
susanne.giesecke@arcs.ac.at

AWS – AUSTRIA WIRTSCHAFTSSERVICE GESELLSCHAFT MBH
Ungargasse 37, A-1030 Wien
Dr. Sonja Hammerschmid
s.hammerschmid@awsg.at

CDG – CHRISTIAN DOPPLER FORSCHUNGSGESELLSCHAFT
(Haus der Forschung) Sensengasse 1, A-1090 Wien
DI Brigitte Müller
mueller@cdg.ac.at

FFG – ÖSTERREICHISCHE FORSCHUNGSFÖRDERUNGS-GESELLSCHAFT (Haus der Forschung)
Sensengasse 1, A-1090 Wien
Mag. Klaus Schnitzer klaus.schnitzer@ffg.at
Mag. Mariana Karepova mariana.karepova@ffg.at
Mag. Leonhard Jörg leonhard.joerg@ffg.at

FWF – FONDS ZUR FÖRDERUNG DER WISSENSCHAFTLICHEN FORSCHUNG (Haus der Forschung)
Sensengasse 1, A-1090 Wien
Dr. Rudolf Novak
novak@fwf.ac.at

JOANNEUM RESEARCH FORSCHUNGSGESELLSCHAFT MBH
Haus der Forschung, Sensengasse 1, A-1090 Wien
Mag. Wolfgang Polt
wolfgang.polt@joanneum.at
Mag. Michael Dinges
michael.dinges@joanneum.at

KMU FORSCHUNG AUSTRIA
Gusshausstraße 8, A-1040 Wien
Dr. Sonja Sheikh
s.sheikh@kmuforschung.ac.at

LUDWIG BOLTZMANN GESELLSCHAFT
Operngasse 6, A-1010 Wien
Mag. Claudia Lingner
c.lingner@ludwigboltzmanngesellschaft.at

RAT FÜR FORSCHUNG UND TECHNOLOGIEENTWICKLUNG
Pestalozzigasse 4/DG 1, A-1010 Wien
Mag. Peter Lindner
p.lindner@rat-fte.at

TECHNOPOLIS FORSCHUNGS– UND BERATUNGSGESELLSCHAFT MBH
Rudolfplatz 12/11, A-1010 Wien
Mag. Katharina Warta
warta@technopolis-group.at

WIFO – ÖSTERREICHISCHES INSTITUT FÜR WIRTSCHAFTSFORSCHUNG
Arsenal, Objekt 20, PF 91, A-1103 Wien
Dr. Rahel Falk
rahel.falk@wifo.ac.at

WWTF – WIENER WISSENSCHAFTS– FORSCHUNGS– UND TECHNOLOGIEFONDS
Währinger Straße 3/15a, A-1090 Wien
Dr. Michael Stampfer michael.stampfer@wwtf.at
Mag. Klaus Zinöcker klaus.zinoecker@wwtf.at

ZIT – ZENTRUM FÜR INNOVATION UND TECHNOLOGIE GMBH
Eberndorferstraße 4/DG 1, A-1010 Wien
Robert Mayer-Unterholzner
robert.mayer@zit.co.at

ZSI – ZENTRUM FÜR SOZIALE INNOVATION
Linke Wienzeile 246, A-1150 Wien
Dr. Klaus Schuch
schuch@zsi.at

Preface

Assuring quality in teaching and research is one of the prime objectives of higher education policy. Both internal and external quality assurance, valid evaluation systems, indicators and key figures are becoming increasingly important, and create the necessary transparency, not least of all within the framework of the accountability and statutory reporting obligations to Parliament and tax-payers regarding the use of public funds. Indicators and their interpretation are gaining importance, because they play a strategic role in the process of assessing performance.

In terms of the accountability research policy increasingly finds itself having to produce compelling, comparable and scientifically sound indicators in order to justify publicly funded research through results, be it in the form of publications, patents or other forms of utilisation. Greater emphasis will in future be given to output-oriented indicators. Scientifically sound bibliometric methods help us to describe complex connections; at the same time, however, a reflection upon these methods is required in order to show us the limits of their application.

During a one day workshop in October 2008 jointly hosted by the Platform Research and Technology Policy Evaluation and the Austrian Federal Ministry of Science and Research, several studies were presented, that discuss models which offer universities incentives to focus and strategically orientate their research through main focuses.

Prof. Jürgen Enders investigates matters of governance and incentive systems for universities and researchers, changing modes of governance in higher education and good practice in academic policy. In his article he reports about international trends in governance and financing of universities.

Alexander Kaufmann shows in a comparative analysis of three research fields (economics, botany and sustainability research) that significant differences in publication and dissemination behaviour within these three fields exist. He suggests how research evaluation could be modified and extended in order to assess the results of inter- and transdisciplinary research more adequately.

Brigitte Tiefenthaler und Katharina Warta present the documentation and evaluation of two university-related funding programmes, “Research Infrastructure I-III” and “Temporary Chairs I-II”. These funding programmes were developed by the Federal Ministry of Science and Research (BMWF) in order to support the development of competitive research profiles of Austrian universities.

Rudolf Novak comments in his article “Building University Profiles 2007/08 – Promotion of Priority Setting and Profile Development” the fourth call for applications under the BMWF’s (Federal Ministry of Science and Research) programme “Research Infrastructure and Temporary Chairs” for the years 2007/08.

Simone Mesner
Federal Ministry of Science and Research
Minoritenplatz 5, 1014 Wien
simone.mesner@bmwf.gv.at

Klaus Zinöcker
WWTF Vienna Science and Technology Fund
Währingerstr. 3/15a, 1090 Wien
Klaus.Zinoecker@wwtf.at

Jürgen Enders

Shifts in governance and higher education funding in the European Union

During the last few decades there have been shifts from traditional state-centred governing arrangements to alternative modes of governance. There is no doubt that these shifts – driven by economic, ideological and pragmatic motives (Kickert 1997; Pierre and Peters 2000; Pollitt and Bouckaert 2000) – have modified the forms and mechanisms of governance, the location of governance, governing capabilities and styles of governance (van Kersbergen and van Waarden 2004). Public sectors have experienced such change since the late 1970s. Over time, several large-scale reforms – focusing on privatization, deregulation and cutbacks – have been implemented, with varying success. As elsewhere, traditional modes of government steering, based on the notions of comprehensive planning, have been in retreat. In the 1980s and 1990s, new modes of governance, in the form of 'steering at a distance', new public management approaches, communicative planning and network approaches gained ground.

Higher education is one of the public sectors where such shifts in governance have been witnessed. One of the consequences of the introduction of new governance perspectives in higher education is that over the last two decades the university, as a 'corporate actor', has increasingly gained importance in processes of exercising collective coordination. As a consequence of the reshuffling of authority and responsibilities across the different levels in higher education, universities as organisations have become important foci of attention in the system's coordination.

A different but related development concerns considerable changes in the funding of higher education organisations. Funding is more than merely a mechanism to allocate financial resources to universities, academics and students. It is often the foundation of other governance instruments that enforce common goals set for higher education (e.g. access, efficiency), set incentives for certain behavior (e.g. competitive research grants), and attempt to maximize the desired output with limited resources. Governance issues and funding systems are therefore often two sides of the same coin. How much autonomy and monitoring universities need in order to meet societal expectations is an important funding issue when it comes to autonomy in internal resource allocation, but it is a larger governance issue in terms of the balance of responsibilities of the higher education organisation and state. Funding is therefore not an isolated topic but a set of instruments to achieve the goals of higher education.

The transformation of the university as a corporate actor

Since the 1980s, one can observe a trend to challenge traditional characteristics of the university. Alternative models for universities as organisations appeared in policy-making, as well as in the study of higher education organisations such as the corporate model of universities (Bleiklie 1994); the entrepreneurial model (Clark 1998) or enterprise model (Marginson and Considine 2000). These alternative models contrast strongly with traditional models, which include the collegial organisation (Goodman 1962; Millett 1962); the professional bureaucracy (Mintzberg 1979); the organized anarchy (Cohen et al. 1972); and the loosely coupled organisation (Weick 1976), which all stress the peculiarities of universities as organisations. They are 'bottom-heavy' with low potency for collective action (Clark 1983). Organisational leadership is weak compared with other organisations. Organisational change takes place mainly through continuous local adjustments, while major change is difficult to achieve; central policies are often weak and interventions on this basis may have only minor, local effects (Weick 1982). It is the academic professionals who act, rather than the university as an organisation. Why, then, were the relevant actors – policy-makers or university leaders – convinced that this loosely coupled organisation (or an arena in which academics act) should be or should become a more 'complete' organisation (Brunsson and Sahlin-Andersson 2000)? How does this relate to the overall shifts in the governance of universities?

First, on a very general level, it can be argued that the construction of universities as 'complete' organisations is consistent with the overall tendencies in public sector reforms (Enders 2002). Top-down regulation and control have lost acceptance and legitimacy in public sectors. Guidance by the government, its intermediate bodies and other stakeholders is seen as more effective, efficient and democratic. But the provision of guidance assumes that there is an addressee who is enabled to receive advice and to act on it. The model of the university as a more autonomous and 'complete' organisation certainly fits this purpose better than the traditional model of the university characterized by a high degree of internal fragmentation and academic 'multi-vocalism'. In other words, the government's attempt to steer this sector call for having an addressee.

Second, devolving authorities to the organisational level forms is an integral part of new public management approaches that stimulated Dutch higher education reform to a certain extent. In this context, the limitations of the central government to 'run' public sectors and the advantages of devolving authorities through local 'corporate actors' are stressed. Universities are thus supposed to act as social entities that possess a certain degree of independence and sovereignty, with partly autonomous and self-interested goals as well as with rational means, commanding independent resources and visible boundaries (Meyer et al. 1983; de Boer 2003). As corporate actors, they can make statements and develop and implement strategic actions. Since they can choose and control (part of) their own action, they also become responsible for them (Brunsson 1989). This makes the concept of 'organisation' interesting for policy-makers and reformers, who are in search of new procedural arrangements to govern a public service sector that is growing in complexity, such as higher education. From such a perspective it may be wise to share responsibility – as well as problems – with others, for instance, with the organisations and their management. The emerging prominence of evaluations and audits also supports this argument. More formal and open accounts and justifications have to be made to the variety of bodies, which claim the right to judge the performance of universities and their professionals. In universities, this kind of accountability forms the other side of enhanced autonomy.

Third, a related factor that supported the rise of the organisation concept in higher education is due to the idea of introducing market-like mechanisms and conditions (as in some other public sectors). A side-effect of this was to stimulate the rise of the university as an organisation. Markets need actors, individuals and organisations, that can buy and sell, produce and consume. At the organisational level, universities have in the past not been perceived as producers competing for costumers. Scholarly competition for resources and reputation was the 'name of the game', while substantial state-funded growth in higher education dampened any need for organisational competition among universities. Thus the capacity of most organisations to compete was limited in practical terms, even if they might have wished to extend their territory (Dill and Sporn 1995). Models such as the service university or the entrepreneurial university signal changes in the beliefs about the role of the university in the market place. This goes along with the rise of the consumer concept in higher education and the commodification of teaching and research. In this context the transformation of the university into a 'corporate actor' is thought of as a necessity in order to stimulate market mechanisms. In summary, a number of elements of the new governance philosophy coincide with arguments towards the transformation of the university as a corporate actor in the coordination of higher education.

Shifts in funding for universities and colleges

In the last two decades most European countries have revised their higher education funding systems. The extent to which the reforms have been implemented varies considerably, but no country has been able to ignore the debate on higher education funding entirely. There are many common characteristics in the reforms. In general terms, there is a tendency towards increasing spending autonomy leading to full freedom in the internal allocation of resources of higher education organisations; there is a development towards greater transparency and simplicity in the funding mechanisms; and there is a move towards cost-sharing (Kaiser et al., 2002; Strehl et al., 2006; CEGES, 2007; Lepori et al., 2007a). More specifically the new developments are:

- shift towards formula based funding,
- change from open-end funding to closed budgets for higher education
- shift from input-based to output-based funding,

- change towards linking basic funding to objectives through performance indicators
- increasing the share of funding allocated through competition,
- increasing the share of private contract funds
- introduction and increase of tuition fees
- increasing reliance on student loans instead of grants.

Focusing more narrowly on the funding of research, recent studies show that project funding both from public and private sources has become more important. Lepori et al. (2007a) recently published a comparative analysis of the European network of excellence PRIME into the evolution of national research policies with a special focus on the changes of public project funding schemes during the past three decades in six European countries (Austria, Italy, France, Netherlands, Norway and Switzerland). Given quite some variation between countries, they found three interesting commonalities or patterns:

- a strong increase in the volume of project funding;
- a differentiation of funding instruments (centres of excellence, large programmes within the fields of information technology, genetics, nano-tech and so on);
- and a general shift towards instruments oriented to thematic priorities.

The interrelationships between funding systems and overall higher education policies vary greatly between countries as is shown in an OECD study by Strehl et al. (2006). Nevertheless, looking at changes in funding policies, mechanisms and instruments an important question is how these influence organisational strategies and behavior. How do organisations react to contingencies and frameworks? The economic assumption is that all organisations aim at optimizing strategy and activities within the given structure. The recent OECD study by Strehl et al. (2006) concludes that funding systems are major influencing factors on organisational strategies. The study found a general tendency for universities to increasingly develop strategies including explicit goals and objectives, processes of monitoring and control as well as to strengthen organisational leadership and management in response to changing funding systems. The strategies primarily focus on core outputs, scientific and administrative staff, and organisation structures and processes as new funding regimes increasingly reflect resource scarcity which increases the awareness of efficiency, performance and effectiveness. An additional important trend concerns increased emphasis on outside funding rather than remaining dependent on state resources. Often there is a particular focus on areas such as high technology, business administration, economics, and consulting in various other fields.

Another strategy dimension is increasing attention to marketing, public relations and profiling. In many countries, the number of students and graduates determines important portions of the budget. Consequently, strategies are developed aimed at increasing of the number of students per academic year. There is a risk, however, that some of these strategies might reduce the quality of teaching by reducing the level of aspiration, encouraging lenient grading as well as allowing students to increase the time to complete their studies.

The autonomy of universities in the use of public funding has increased considerably in the last decade or two. Unlike earlier, almost all countries receive public funds as a block grant. In some countries, especially in Central and Eastern Europe, public authorities still confirm the budget of a university (Eurydice 2008). Universities in all countries put effort into attracting private funding. The majority of countries have implemented at least some type of incentive to encourage universities to obtain private funding. A recent study by the CHINC (Changing incomes of universities) research consortium explored for a set of 100 universities, colleges and other higher education organisations in 11 European countries developments in organisations' internal resource allocation models in the 1994-2003 period (Slipsæter et al., 2006; Lepori et al., 2007b; Jongbloed, 2008). The CHINC project found that, partly as a result of the increased performance-orientation, the individual universities' resource allocation mechanisms and their revenue structures were affected over the years. Universities have implemented policies to encourage income generation and research concentration to build competitive strengths. Thus, developments in the national funding environment are mirrored by developments inside the universities – although performance based funding remains a contentious issue. An interesting finding was that tuition revenues have remained relatively unimportant and that, contrary to expectations, resources per student have not really diminished over the 1994-2003 period (in constant prices).

However, there are substantial differences between organisations and countries but there was a less dramatic pattern of change in higher education funding than normally assumed. All in all, throughout the world, governments remain the primary funding source for higher education organisations. It is not surprising then that they wield considerable power in shaping the regulatory framework and incentive structures to make higher education organisations perform as they see fit.

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Author:

Jürgen Enders

Center for Higher Education Policy Studies (CHEPS)

University of Twente

P.O. 217, 7500AE Enschede, The Netherlands

j.enders@utwente.nl

Alexander Kaufmann

Differences in publication practices and the need for a more diversified research evaluation

Modern science has become a highly diversified social system. Its diversity is not only attributable to the multitude of specialized subjects but also to different research styles. Disciplinary, interdisciplinary and transdisciplinary research coexist side by side. Interdisciplinary research integrates methods of several research fields. Transdisciplinary research integrates non-scientists in the research process. Both styles have certainly become a very important part of modern science. Nevertheless, much of the actual research evaluation practice is still based on the standards and customs of traditional disciplinary science. A comparative analysis of three research fields – economics and botany, representing disciplinary science, and sustainability research, representing a more transdisciplinarily oriented field – shows that there do exist significant differences in publication and dissemination practices. From these facts some conclusions can be drawn how research evaluation should be modified and extended in order to be able to assess the results of inter- and transdisciplinary research adequately.

The complexity of modern science results in diversity of publication and dissemination practices

It is well known that publication and dissemination practices and standards differ significantly between disciplines and research fields. Major causes are the different research objects and the resulting need for specific methods to formulate theories and to produce evidence to support or reject them. But methodological differences due to research content are not the whole story. There are also more general differences regarding the basic research style:

1. Disciplinary (intradisciplinary) research remains within the thematic and organizational boundaries of established scientific disciplines. Each discipline usually applies a specific set of analytical methods which characterizes it often more clearly than its research objects (e.g. sociology versus economics). Communication within each disciplinary community is highly standardized and needs specific knowledge to be able to participate. Accordingly, exchange between disciplines is limited, especially between disciplines from different fields of science. The processes of knowledge production follow predominantly well established paths and according to widely accepted quality criteria. As a consequence, they tend to be rather conservative, favouring incremental and hampering more radical progress.

2. Interdisciplinary research combines the specific methods of several mutually independent disciplines in order to deal with a joint research problem. Each contributing discipline sticks to its specific methods and standards, but they are integrated in a common analytical framework. In this respect, interdisciplinary research goes beyond multidisciplinary research, because the former integrates the discipline-specific methods while the latter restricts collaboration to the exchange of data and results and the deduction of joint interpretations.

3. Transdisciplinary research involves people from outside the scientific community in the research process. This is a sharp contrast to both disciplinary and interdisciplinary research, both staying within the scientific community. Transdisciplinary research combines scientific and practical knowledge. Accordingly, it always deals with research problems which are also problems of the society or parts of the society and which are defined by the scientific as well as other communities. The integration of non-scientists requires a participatory research process, the establishment of non-scientific communication practices and the translation between contributions of scientists and non-scientists. The results of transdisciplinary research projects can be judged only partly according to the traditional criteria of the scientific community. Partly it has also to be judged in the "real-world" context.

In recent years, is has been more and more claimed that a new paradigm – transdisciplinarity – would become the rule in modern science. Gibbons *et al* (1994) claim that science would enter a new so-called "mode 2", displacing the traditional "mode 1-science". This "new" kind of science would be characterized by transdisciplinarity as a rule, problem-orientation instead of academic structures, temporary project- and network-organization instead of hierarchical organization and evaluation based on the capability to solve real-world problems instead of academic peer review (Frederichs, 1999). Nowotny (1999) stresses the changed role of science in society and refers to three processes which are primarily causing this transformation: First, science is increasingly called upon by policy and business for contributing to solve problems the society is confronted with and to stimulate or enable innovation in order to strengthen the competitiveness of the economy. Second, the autonomy of science is increasingly disputed. Science faces more pressure from other parts of society to legitimate its activities. Third, the authority of science is dwindling. It is increasingly criticized from outside the scientific community how scientific knowledge is produced, what counts as scientific knowledge and how it is put into practice. Nowotny concludes that these processes require more social responsibility and embeddedness of science than in the past.

It is hardly contested that important changes in the way science is done are actually taking place. However, at present it cannot be observed that this has led to a basically new kind of science with a fundamentally new role in society. And it is also not a necessary conclusion that the changes observable today will lead to such a new role in the future. The production of scientific knowledge outside the academic sector, integrating non-scientific knowledge is not a new phenomenon. The claim that transdisciplinary research is much more important today than in the past is not substantiated by reliable empirical evidence.

Contrary to the claims of the mode 2 theorists modern science is characterized by a multitude of methodologies and research styles. It is not the substitution of one kind of science for another one that can be observed, but rather a complex mix of fields of science with more and less involvement of the society beyond the scientific community. Furthermore it is hardly possible to distinguish between interdisciplinary, transdisciplinary and disciplinary fields of science along traditional boundaries defined primarily by the research object. All research styles can be found in almost all fields of science.

The complexity of modern science regarding disciplinary, inter- and transdisciplinary research methodologies poses a challenge to research evaluation. Each methodological approach requires specific means of communication during the research process and channels for publishing and disseminating its research results. In the case of transdisciplinarity, participants and the audience reach beyond the scientific community, further adding to the diversity of communication, information and dissemination. As a consequence, serious evaluation has to consider a wide range of types of research output depending on the basic methodological characteristics of the research fields under scrutiny.

The empirical case of economics, botany and sustainability research

For being able to give an answer to the question whether and how research fields and styles differ with respect to publication and dissemination practices, three fields of research have been analysed: on the one hand economics and botany, representing traditional disciplinary research, and, on the other hand, sustainability research, representing a field with a strong focus on transdisciplinary research. Data was collected by means of an online-survey in 2007, addressing respective scientists working at universities as well as all other kinds of research organizations in Austria, Germany and Switzerland. The addresses were collected from specific scientific conferences, internet-resources and journals. The sample comprised all levels of scientists, from PhD-students to professors and heads of research departments. Almost 2,500 people were invited via e-mail to fill in the questionnaire. Overall, 229 persons responded. After the elimination of failed addresses and people who deemed the survey irrelevant for them, this is equivalent to a response rate of about 11%. According to the self-description of the respondents, 100 are economists, 83 botanists and 72 sustainability researchers. The three fields of research are not mutually exclusive, there are several scientists who are both active in sustainability research on the one hand and economics or botany on the other (13 persons each).

The sample is predominantly male (77%), less than a quarter is female (23%). Regarding age, most respondents are in their thirties (37%) and forties (31%). Older persons being 50 or more are still quite numerous (23%) whereas only few are younger than 30 (10%). Accordingly, most respondents are senior scientists (36%), followed by those in a leading position (e.g. head of department) (28%) and junior researchers (25%). Persons at the beginning of their scientific career (PhD-students) make up for the smallest group (11%). Since the survey addressed only scientists working at institutions in Austria, Germany and Switzerland, most respondents come from these three countries: 57% Germans, 32% Austrians and 8% Swiss. Only 3% are from non-German-speaking countries (Italy, France, Spain and the UK). The distribution of affiliations is similar: 49% in Germany, 36% in Austria and 13% in Switzerland.

Differences concerning publication and dissemination practices between research fields

The core of the questionnaire focused on the relative importance of publication and dissemination channels as indicated by the respondents (on a scale from "1" = "very important" to "5" = "not important"). In table 1 the average of the importance of each channel assessed by the respondents is presented, differentiated by the respective research fields of the respondents.

Table 1: Mean importance of publication and dissemination channels by research field

1 = very important ... 5 = not important	Economics	Botany	Sustainability research
Scientific journal	1.32	1.17	1.94
Working paper	1.72	3.86	2.79
Newspaper, magazine	3.49	3.63	2.77
Monograph	3.13	2.70	2.45
Contribution to an anthology	3.04	2.54	2.24
Conference-proceedings	3.33	2.46	2.44
Presentation on a scientific conference	1.78	1.61	1.97
Presentation outside the scientific community	3.34	3.31	2.49
Research project website	3.68	2.92	2.78
Database	4.04	3.03	3.52
Consultancy	3.26	3.87	2.40
Expert or information system	4.33	3.87	3.46
Academic teaching	2.80	2.01	2.37
Non-academic training	4.13	3.54	3.31

Source: ARC systems research survey 2007.

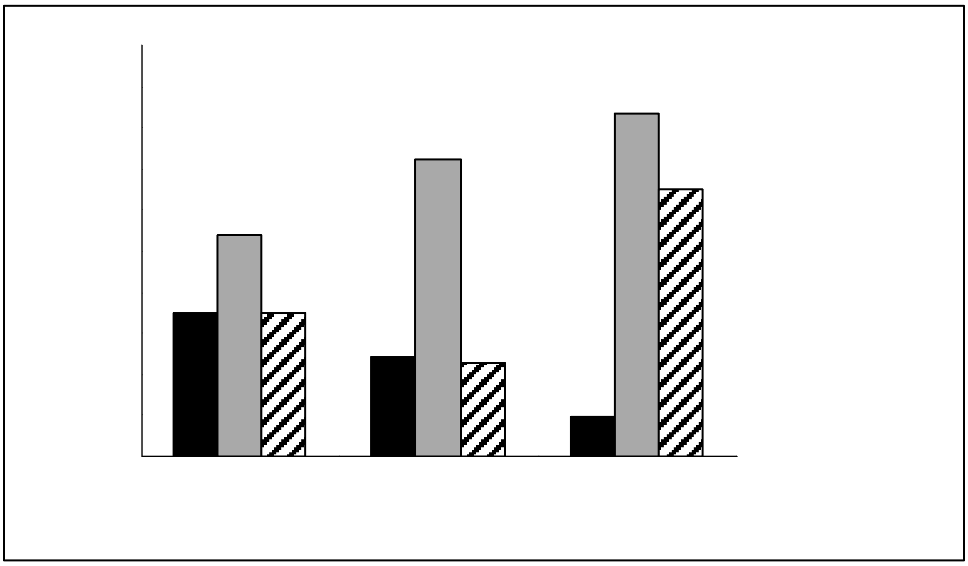
In all three research fields scientific journals and conferences are the most important ways to publish the research results. Economists appreciate also working papers which are less important in botany and sustainability research. In economics and botany as well as in sustainability research, research results are predominantly disseminated within the scientific community. However, there is a significant difference regarding the relative importance of dissemination beyond the scientific community: Publication addressing non-scientists – newspapers, magazines, public presentations, policy and business consultancy – is much more important in sustainability research than in economics and botany.

Differences by research style – disciplinary, inter- and transdisciplinary

The importance of research styles differ between the analysed research fields. In order to identify the research orientation of the respondents, four questions on methodological preferences were included in the questionnaire. Two features of their research work were taken to describe interdisciplinary orientation: "frequent exchange of data and results with other disciplines" and "integration of methods of other disciplines into the own research work". The two features to describe transdisciplinary orientation were "involvement of persons from outside the scientific community in defining the research problem" and "involvement of persons from outside the scientific community in the actual research work". In case they indicated a value of "1" or "2" (on a scale from "1" = "applies completely" to "5" = "does not apply at all") to at least one of the relevant features, they were considered to have a significant interdisciplinary or transdisciplinary research orientation. According to these criteria, 152 scientists (66%) could be classified as "interdisciplinary", 88 scientists (38%) as "transdisciplinary" and 59 (26%) as "disciplinary", working primarily within their own field of research without relevant relations with other fields or beyond the scientific community. Inter- and transdisciplinarity are strongly overlapping. In total 71 persons (31%) qualify for both labels. This is no surprise, considering the huge importance of interdisciplinary work in transdisciplinary research. Our classification does not mean, however, that inter- or transdisciplinary orientation excludes disciplinary work. It only means that inter- and transdisciplinary work is important for the respective scientist while he or she may still be engaged in disciplinary research too.

According to these criteria, the relative importance of research styles in the three research fields analysed could be estimated (see figure 1):

Figure 1: Differences regarding research style between economics, botany and sustainability research



Source: ARC systems research survey 2007.

As expected, sustainability research is the research field where transdisciplinarity is most frequent. It is also the field where interdisciplinary research is most widespread. Actually, there are only 7 respondents (from 72 sustainability researchers) whose research activities do not reach beyond their own field. Interdisciplinary research is also very important in botany which reflects its strong interrelations with other fields like chemistry, medicine and agricultural and forestry sciences. In comparison, economics is the most disciplinarily oriented research field. The share of researchers who work in transdisciplinary projects is much lower here than in sustainability research, surprisingly low for a social science discipline.

Are there similar differences in publication and dissemination practices between research styles like those between research fields? The results presented in table 2 show that considerable differences indeed exist:

Table 2: Mean importance of publication and dissemination channels by research style

1 = very important ... 5 = not important	Disciplinary	Interdisciplinary	Transdisciplinary
Scientific journal	1.25	1.43	1.80
Working paper	2.35	2.69	2.46
Newspaper, magazine	3.73	3.20	2.95
Monograph	3.33	2.64	2.39
Contribution to an anthology	3.00	2.53	2.34
Conference-proceedings	3.26	2.64	2.48
Presentation on a scientific conference	1.86	1.70	1.69
Presentation outside the scientific community	3.75	2.95	2.38
Research project website	3.69	3.01	2.90
Database	3.72	3.50	3.62
Consultancy	4.00	2.98	2.46
Expert or information system	4.31	3.87	3.70
Academic teaching	2.75	2.26	2.33
Non-academic training	4.12	3.56	3.27

Source: ARC systems research survey 2007.

Not surprisingly, it is the transdisciplinary research style where dissemination beyond the scientific community has received the relatively highest importance ratings on average. Because of the fact that non-scientists are involved in such research projects by definition, this result could be expected. More interesting is the similarly high importance of non-science dissemination in interdisciplinary research, where it is not as compelling as in transdisciplinary research. Nevertheless, both in transdisciplinary and interdisciplinary research, communication within the scientific community remains of top importance. The mean importance of the scientific journal in these two research styles is only slightly less than in disciplinary research.

Differences regarding the intra-science publication practices

Looking at the traditional way of scientific publication via articles in scientific journals in more detail, the survey leads to some additional interesting results. The publications of all respondents being at least junior researchers (192 overall) which are listed in the Web of Science between 2000 and 2007 have been analysed. All three indices of the Institute for Scientific Information (ISI) or Thomson Scientific, respectively – Science Citation Index (SCI), Social Sciences Citation Index (SSCI) and Arts and Humanities Citation Index (AHCI) – have been used. No distinction has been made whether a respondent was single author, corresponding author or co-author. Furthermore, only the publications of a respondent in his or her time working at the present affiliation have been considered, earlier publications at other affiliations could not be considered. Three indicators have been analysed:

1. Number of each respondent's publications covered by SCI, SSCI or AHCI between 2000 and 2007.

2. Average number of citations per publication of each respondent: Total number of the citations to all publications of a respondent divided by the number of his or her publications.

3. Average "personal impact factor" of each respondent: Total of Impact Factors (in the year 2006) of the journals in which a respondent has published divided by the number of his or her publications.

As far as the number of publications is concerned (see figure 2a), botany shows much higher numbers than the two other research fields. More than a quarter (28%) of botanists have more than 15 publications. In economics the respective share is only 3%, in sustainability research 11%. The maximum number of 109 publications has also been achieved by a botanist. The differences regarding breadth and frequency of publications between natural and social sciences is remarkable, supporting an already well-known fact. Sustainability research has an intermediate position between these two fields of science. If the scientific background of a sustainability researcher is natural sciences, the number tends to be higher, if it is social sciences, lower. The transdisciplinary character of much of sustainability research leads also to a comparatively high number of researchers without any publication in one of the ISI-indices. As expected, the number of publications of those researchers who concentrate on the scientific community is higher. Within this group interdisciplinarily oriented scientists tend to publish slightly more frequently than disciplinarily oriented.

Figure 2a: Number of publications (covered by ISI) by research fields and styles

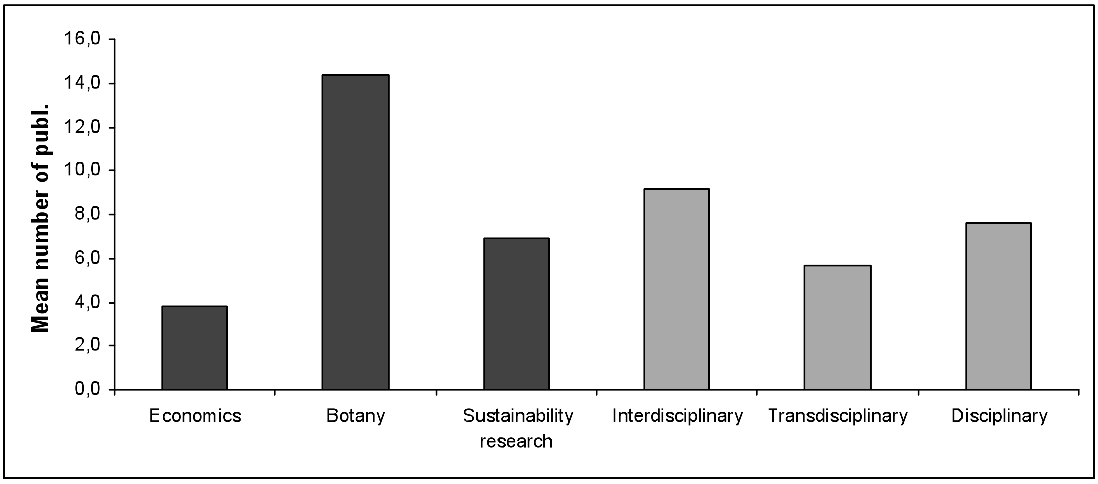


Figure 2b: Citations per publication (covered by ISI) by research fields and styles

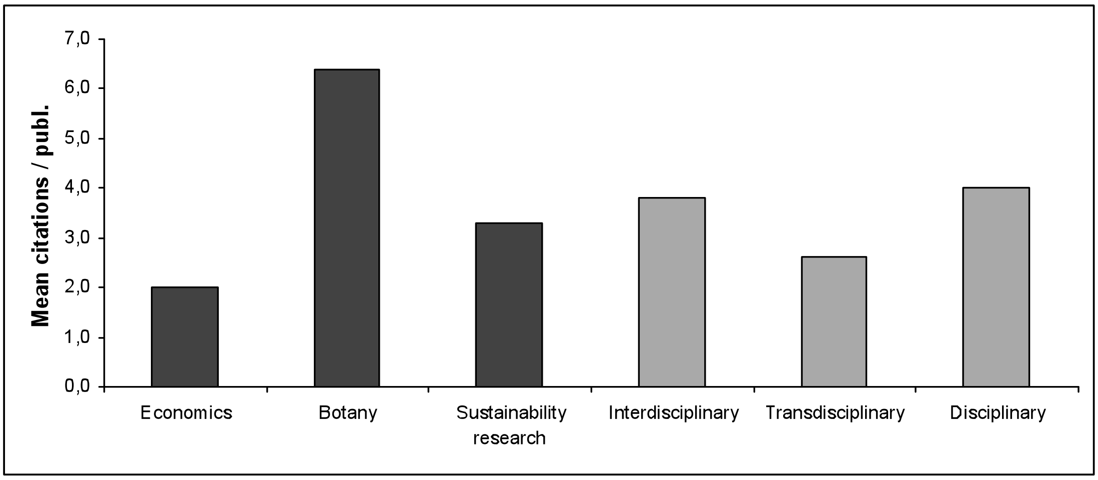
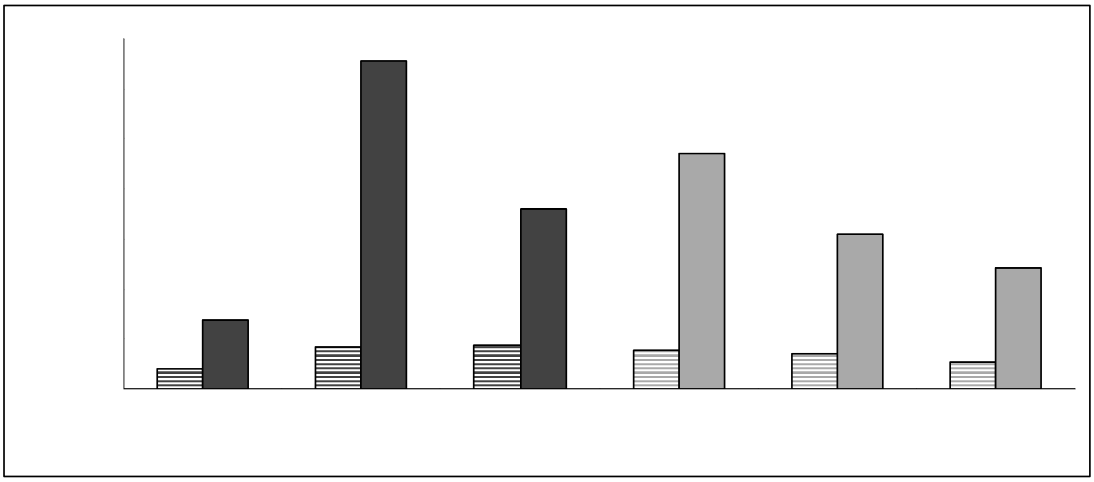


Figure 2c: Impact Factor of journals where articles have been published by research fields and styles: left = lowest, right = highest Impact Factor



Source: Thomson Scientific 2007.

Counting publications is rather simple, a better indicator of research impact, however, is counting citations. Applying this indicator leads to rather similar results regarding research fields (see figure 2b). Regarding research styles, transdisciplinarily oriented researchers still have the lowest count on average, but disciplinarily oriented researchers have caught up with those working more often in an interdisciplinary way. It seems that interdisciplinary research results in more publications, while disciplinary research seems to be more at the core of many scientific disciplines and therefore is more often cited.

Often it is not the citations a specific publication receives that is used to assess its quality but the Impact Factor of the journal it is published in. The Impact Factors differ significantly between the research fields (see figure 2c). Those of economics journals are much lower than those of botany journals. Journals in which the respondents from sustainability research have published are somewhere between. Furthermore, Impact Factors are highest in journals where researchers with interdisciplinary orientation are publishing. This seems plausible considering the broader range of researchers that will be interested in interdisciplinary publications. More disciplinary-focused publications, on the contrary, address only the "home" community. Accordingly, the Impact Factors are lower. Using Impact Factors to assess the quality of individual research output may be more convenient than analysing citations, but it might well be misleading. This is due to the fact that the Impact Factor does not measure the specific impact of a certain publication on the scientific community. Instead it is assumed that the average impact of all publications of a certain journal also applies to each of them which is, obviously, generally not true.

The results presented in figure 2 are summary data concerning groups of respondents. At this general level, all three indicators lead to rather consistent results. Does this also apply to the assessment of the research output of individual persons? Comparing the rankings of the survey respondents based on each indicator shows that the rankings do not produce coherent results. The ranking of most persons changes depending on the indicator used. Furthermore, the variation of individual rankings can be extreme. The biggest change in the ranking between two indicators was 143 positions under 176 persons ranked overall! This means that relying on one indicator only can be dangerously misleading in individual cases.

Consequences for research evaluation

From the survey of economists', botanists' and sustainability researchers' publication and dissemination practices the following conclusions can be drawn:

1. Benchmarks regarding the publication in scientific journals should be more differentiated according to the specific practices of research fields and styles – disciplinary, interdisciplinary or transdisciplinary. Individual indicators like the number of publications and the citations per publication should be preferred over proxies like the Impact Factor of a journal. The number of citations is a better indicator of research impact than the publication per se and should be used

more often. Nevertheless, it should be avoided to rely on a single criterion only when assessing the research quality of individual scientists or research organizations.

2. Research evaluation should also comprehend additional intra-science publication channels, especially books but also conference presentations, proceedings, working papers and research-oriented education. In some research fields (e.g. social sciences, humanities) they can be of similar or even higher importance than articles in scientific journals. Similar bibliometric indicators as in the case of journal articles would be desirable. The importance of specific publication media varies between research fields and styles, they should therefore be weighted differently.

3. According to the degree of transdisciplinarity, dissemination addressing the non-scientific community should be considered in addition to intra-science publication more than it is usual today. The degree of transdisciplinarity varies between research fields, but also between research organizations and individual scientists. As a consequence, extra-science dissemination should receive a higher weight in research fields where transdisciplinary work is more common (e.g. sustainability research) or when transdisciplinarity is a stated objective of respective research organizations and programmes.

Modern science is a complex mix of research fields and styles with numerous, sometimes quite different publication and dissemination practices. Accordingly, it seems reasonable that research evaluation should apply a more diversified set of benchmarks as well as a more extended set of assessment criteria than it is mostly usual today in order to come up to the complexity of the science system.

Acknowledgment

The research project has been funded by the Austrian Federal Ministry of Science and Research.

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Author:

Alexander Kaufmann

Austrian Research Centers GmbH - ARC, systems research

Tech Gate Vienna, Donau-City-Straße 1, 1220 Vienna, Austria

Brigitte Tiefenthaler, Katharina Warta

New Tools for Competitive Funding of Universities in Austria

Documentation and Evaluation of Two University-related Funding Programmes: 'Research Infrastructure' I-III and Temporary Chairs I-II'

(2001 – 2006)[1]

Introduction

'Research Infrastructure' (short: RI) and Temporary Chairs (short: TC, German 'Vorziehprofessuren') are two funding programmes developed by the Federal Ministry for Science and Research (BMWF) in order to support the development of competitive research profiles at Austrian public universities. The two programmes are in fact independent funding measures, but trebly linked: (i) they are the first and only (competitive) funding programmes launched by the BMWF's University Department so far, (ii) both addressed the 21 public universities exclusively and (iii) they were planned and implemented at the same time. Therefore, the BMWF has commissioned us with the documentation and evaluation of both programmes. The study covers the period between 2001 and 2006; the volume of funding granted in this phase was €140.6 mill. for research infrastructure and €21.8 mill. for chairs. The objectives of the study were (i) to trace and document the development and implementation of the programmes against the background of the structural changes in the national research system taking place at the same time, (ii) to analyse and assess the results, and (iii) to draw conclusions for future activities. The study primarily served as an internal evaluation for BMWF to close the first period of these new instruments. Compared to 'normal' evaluations the documentation part of this study was high, especially for the Research Infrastructure Programme due to the unusual history of the programme. The study is based on several sources: on written material provided by the ministry, on a survey among the rector's offices of all universities participating, on interviews with people involved in the programmes' design and implementation, and on interviews at four universities with different specialisation (general, technical, medical, arts).

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[1] This article is based on a previously unreleased Technopolis report to the Federal Ministry of Science and Research. A summary has also been published in the latest university report (*Universitätsbericht 2008*, p. 61ff;

http://www.bmwf.gv.at/submenue/publikationen_und_materialien/wissenschaft/universitaetswesen/hochschul_und_universitaetsberichte/2008/).

The Programmes' Background

Both programmes have been initiated, designed and implemented during a period of fundamental changes in the Austrian research system:

- General political conditions: The European Stability and Growth Pact of 1997 obliged Austrian governments to cut public expenditure in general. Consequently, between 2000 and 2004 the annual budgets available for universities' research infrastructure (excluding related staff and buildings) within the General University Fund were reduced by up to 48% compared to €94.1 m in 1999 – a cut considered drastic by both, the BMWF and the universities. Hence, initially the RI programme was mainly an attempt by the University Department at the BMWF to partly compensate these cuts in the institutional funding for universities by taping into new sources of R&D funding (see next point), while the competitive aspect of programme funding stepped in only later.

- Research policy making: The Austrian Council for Research and Technology Development was established in 2000 as an advisory body to the government, giving recommendations related to all fields of R&D policy. Moreover (and despite the budget cuts mentioned) the Austrian Government provided additional funds for R&D in pursuit of the Lisbon and Barcelona objectives and it committed itself to spending these funds according to the recommendations given by the Austrian Council. In 2001, the Austrian Council actually approved budgets for the first calls of the two measures proposed by BMWF on the condition that the reform of the university act was completed.

- Reform of university-related legislation: The University Act 2002 granted far-reaching autonomy to Austrian public universities. Since 2004, government funding is allocated by the BMWF to each university on the basis of a three-year contract. This reform completely changed the roles of and the relationship between the ministry as the principal and the universities as the agents. Persons involved on both sides had to reinvent themselves and their work to a certain extent – not an easy task after a heated and emotional debate during the preparation of the Act. The two programmes were also intended to support the acceptance and implementation of these reforms.

- Change in research funding: Beginning in the 1990ies, additional public research funding was increasingly allocated through new competitive programmes with thematic and / or structural priorities, and the budgetary recommendations of the Austrian Council fuelled this trend. The changing 'state of the art' in research funding also changed the roles of ministries which became less involved in programme implementation and increasingly concentrated on programme ownership with strategic responsibility, and, vice versa, the funding institutions had to grow into their new agency role – a learning process still not completed on either side. The University Department at BMWF has experienced these changes in the course of the two programmes. While all programme activities were performed in-house during the period investigated in this study, the programme management has finally been handed over to the Austrian Science Fund FWF in 2007.

- Organisational change in the BMWF: The most demanding (and still ongoing) change is the growing into the new role after the reform of the university act already mentioned. Moreover, retirements at senior management levels and a new division of labour between ministries have altered the face of the ministry, especially of the University Department.

The Research Infrastructure (RI) Programme

Programme design and implementation

The main objectives of the Research Infrastructure Programme were to increase the attractiveness of universities as research partners for industry and non-university research institutions, to safeguard existing and to facilitate new research co-operations at national and international level, and to support the universities in the development of competitive research profiles. These objectives were to be achieved through the improvement of research infrastructure, i.e. the acquisition of new as well as the replacement of outdated measuring and testing instruments, laboratory equipment and other infrastructures according to the needs of the respective area of research, e.g. hard- and software, databases, archives, studio equipment, excluding associated costs for labour and buildings, as well as infrastructure needed for teaching purposes only.

Universities were invited to submit projects in three calls for proposals, ranked according to their internal priority. Projects were not evaluated by peers but selected by a jury, mainly based on the internal prioritisation and their compliance with the universities development plans. In the second and third call, projects in thematic priority fields recommended by the Austrian Council were preferred, especially in the nanotechnologies, information and communication technologies and the life sciences. The jury comprised decision makers from the BMWF, 1-2 distinguished scientists experienced in university funding, and the chairman and deputy chairman of the Austrian Council.

In the beginning, the ministry actually did not intend to launch a multi-annual programme but rather considered it a one-off measure in compensation of the budgetary restrictions outlined above. Therefore, the first call for proposals was organised in a rather ad-hoc manner without clearly predefined procedures, which was considerably improved in the second and third call, although no consistent monitoring and reporting system has been set up during the period investigate in this study and communication between the various ministerial units involved in the implementation was insufficient. The measure was developed towards a competitive funding programme, but also during the second and third call competition was limited as the jury selected projects largely along universities' prioritisation.

The Austrian Council evidently had a strong influence on the Research Infrastructure Programme, stronger than on other new programmes initiated during the same period. First, its recommendations had been decisive for the implementation of a programme rather than of some kind of institutional funding. Moreover, the Austrian Council held two seats in the jury and thus had a strong influence on the selection of projects. This has to be considered a mistaken perception of the Austrian Council's role, because its task is to provide strategic R&D policy advice and not the active implementation of policy measures, even less at the project level.

Allocation and effects of funding

Table 1 provides an overview of the funding data of the Research Infrastructure Programme. 254 projects were selected in three calls (2002, 2004, and 2005) and funded with a total of € 140.6 mill. of which €3,15 mill. were granted as (small) equal shares of a basic allowance at the free disposal of the universities in the second and third call. Success rates were higher in terms of funding granted than in terms of project numbers which implies that larger projects were preferred by the jury, not least because of the universities' own ranking. This indicates that the programme has in fact helped to support the development of specialisations, at least in areas with a high demand for infrastructure.

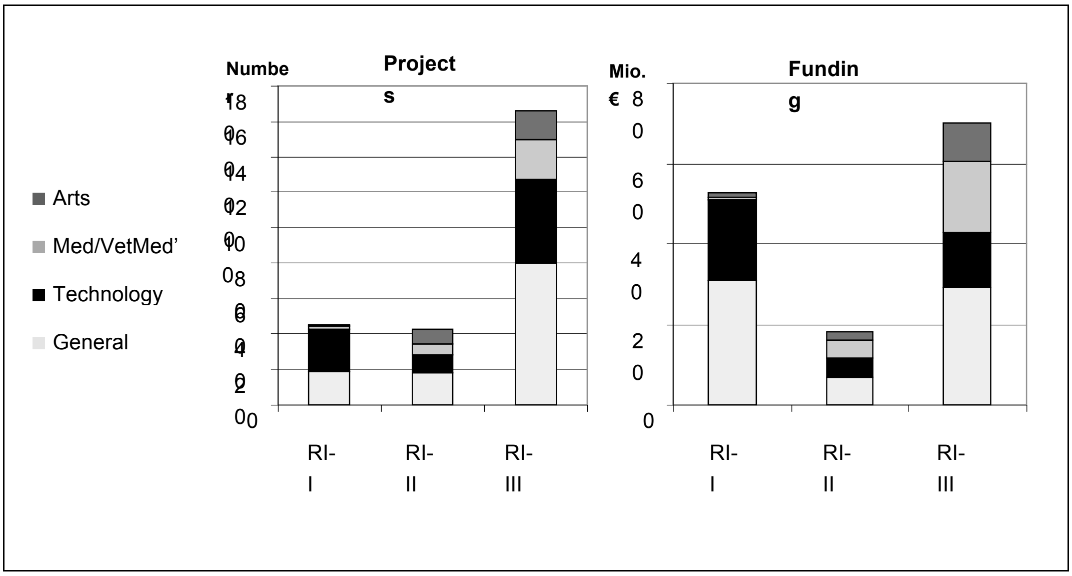
Table 1: Funding Data for the Research Infrastructure Programme

Information	RI I	RI II	RI III	Total
Funding requested [€]	130,810,000	70,402,827	111,882,685	182,285,512
Volume of funding [€]	52,613,000	18,000,000	70,000,000	140,613,000
Basic allowance per university / per call [€]	0	50,000 / 1,050,000	100,000 / 2,100,000	150,000/ 3,150,000
Number of projects submitted	173	286	333	792
Number of projects realized	45	43	166	254

Source: BMWF, Technopolis research

As displayed in Figure 1, 47% of the funding were allocated to the seven 'general' universities, approx. one quarter to the four universities of technology, one sixth to the three medical and one veterinary universities (Med/VedMed), and approx. 9% to the six universities of arts. The average funding per project decreased in the course of the programme: While initially many projects comprised the more or less complete endowment of entire working groups, the second and third call rather funded single infrastructures, e.g. instruments plus auxiliary equipment. Across all three calls the average project size was the largest in Med/VetMed group (€ 770.000), followed by those at general universities (€ 570.000), technical universities (€ 477.000) and the universities of the arts (€ 470.000).

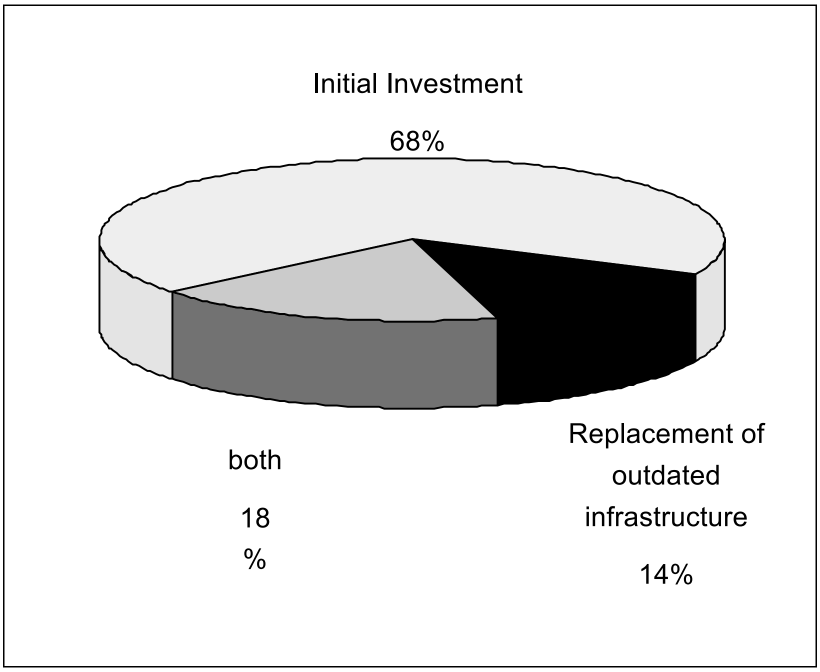
Figure 1: Research Infrastructure-Type of University, Number of Projects, and Funding



Source: BMWF, Technopolis survey

More than two thirds of the funding was spent as initial investments in entirely new infrastructures; 14% of the funding was used to replace outdated infrastructures and 18% were both, typically in cases of complex, multi-part equipment (see Figure 2). Thus, despite the option explicitly offered in the calls, to fund re-investments and replacements, universities mainly used the programme to finance new infrastructure. At the time of our survey, 96% of all infrastructures were in use; in the remaining cases procurement had not yet been completed.

Figure 2: Research Infrastructure – Type of Investment



Source: Technopolis survey

Universities' perception

Nearly all university representatives interviewed pointed at financial shortages and the difficulty of financing adequate research infrastructure, not only for new acquisitions but also for maintenance and repairs as well as for qualified personnel for the operation of the infrastructure. It would go beyond the scope of this study to comment on university funding in general, but we consider it important to take such hints seriously.

Even though the Research Infrastructure Programme's budget was small in comparison to the total university budget, its effects were disproportionately high, because the lion's share of the general public university funding is tied to medium- to long-term commitments (mainly personnel and built infrastructure) and hence the programme funding made a substantial contribution to the at the flexible disposal of universities. In absolute terms the programme did not fully compensate for the budget cuts outlined above, but through the different mode of allocation these funds helped the universities to select priorities and to invest in comparatively larger projects.

Several universities used the money for the endowment of newly appointed professors ('Vorziehprofessors' in some cases). Moreover, 40 infrastructure investments were jointly implemented by two or more universities; these co-operative projects built on and intensified mainly existing ties as the timing of the calls did not allow for the development of new links.

All in all the universities perception of the Research Infrastructure programme is ambivalent: on the one hand it was seen as a drop in the ocean but on the other hand the funding was considered helpful for the development of research profiles in selected areas.

Temporary Chairs Programme ('Vorziehprofessuren')

Programme design and implementation

The programme's objectives were (i) to develop internationally competitive competences in teaching and research, (ii) to support the development of research specialisations ('profiles') at universities, and (iii) to create new career options for highly qualified young researchers. In order to achieve these goals, the BMWF funded the personnel costs for professorships in (newly defined) research areas of strategic importance to the university. Funding was granted for a maximum duration of three years (hence "temporary") while the university provided for an adequate endowment with personal and material resources. There were two major conditions for funding: the planned chair had to be evaluated positively in the context of the university's development plan and the university had to continue financing the professor after the end of the programme funding, normally by re-allocating budgets from a discontinued professorship. Thus the programme funding enabled the university to fill a new chair up to three years before resources from a phased-out professorship would become available (e.g. after a retirement), hence the German programme title "Vorziehprofessur" (vorziehen = to bring forward in time).

All proposals submitted during two calls in 2002 and 2003 were evaluated and selected by an international jury of distinguished scientists. The selection criteria had been defined in advance and were then communicated to the universities.

Other than Research Infrastructure, the Temporary Chairs Programme has been designed as a multiannual programme from the very beginning. It was planned, implemented and monitored by the BMWF in house and all in all met the basic requirements of an up-to-date funding programme in terms of clarity, transparency and timing, albeit less so in the practicalities of the monitoring and reporting system.

Allocation and effects of funding

Table 2 provides an overview of the funding data for the Temporary Chairs Programme. Of 217 proposals submitted in total, 77 were selected for funding with an average funding per chair of €243,614 across both calls. 35 of the chairs are at general universities and 22 at technical universities, 16 at Med/VetMed and only 4 chairs at the six universities of the arts, three of which had not even participated in the calls. The main reason for this low participation was that the universities of the arts are relatively small and had only few possibilities to bring forward chairs during the limited duration of the calls. Moreover, career models at universities of the art differ from those at 'traditional' scientific universities: other than university based scientist, most professors teaching arts pursue their artistic career outside the university and there are only few opportunities for art careers within these universities.

Table 2: Funding Data for the Temporary Chairs Programme

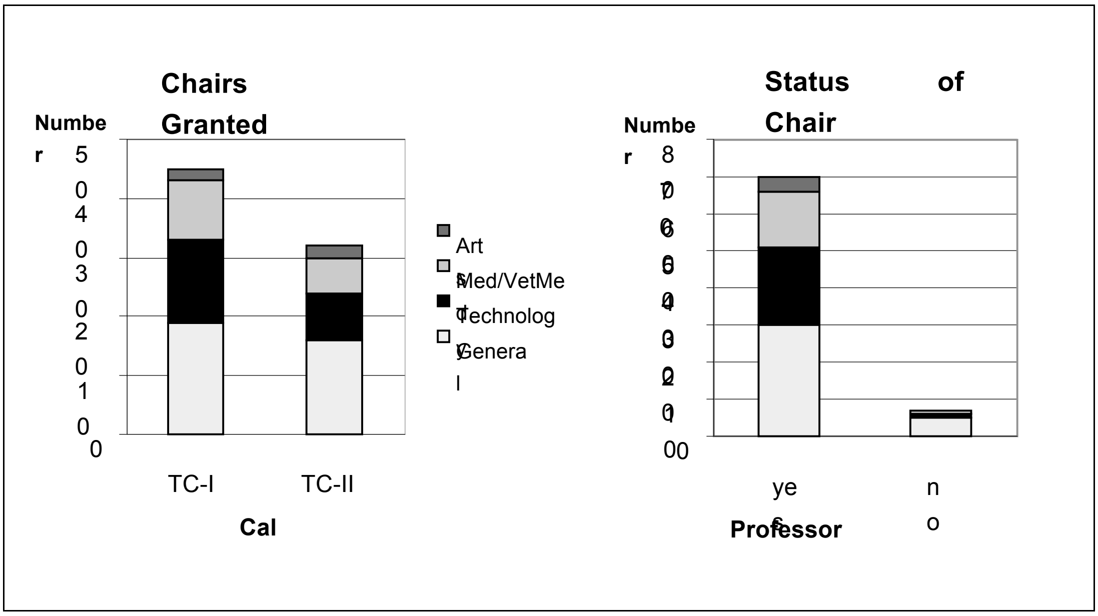
Information	TC I	TC II	Total
Funding granted [€]	10,155,622	8,602,664	18,758,286
Number of chairs submitted	145	72	217
Number of chairs funded	45	32	77
Number of universities participating (out of 21[2])	18	18	18
Number of universities funded (out of 21)	13	16	17
Average funding per chair [€]	222,681	268,833	243,614

Source: BMWF

At the time of our survey in summer 2008, 70 of the 77 chairs were implemented (see Figure 3). The remaining 7 positions were vacant for different reasons. There are some indications that during the first years of their autonomy, universities did not have the budgetary flexibility necessary to allocate adequate resources for the 'Temporary Chairs' which might have deterred qualified candidates. On the positive side, universities have already taken over a number of chairs funded under the first call into their regular budget, well in line with the intentions and rules of the programme.

2 The three Medical Universities became independent on January 1st, 2004. However, in anticipation of this independence, the BMWF invited their predecessors, i.e. the three Departments of Medicine like independent universities to participate in this programme. Therefore they are counted as universities in this overview.

Figure 3: Temporary Chairs: Grants and Status

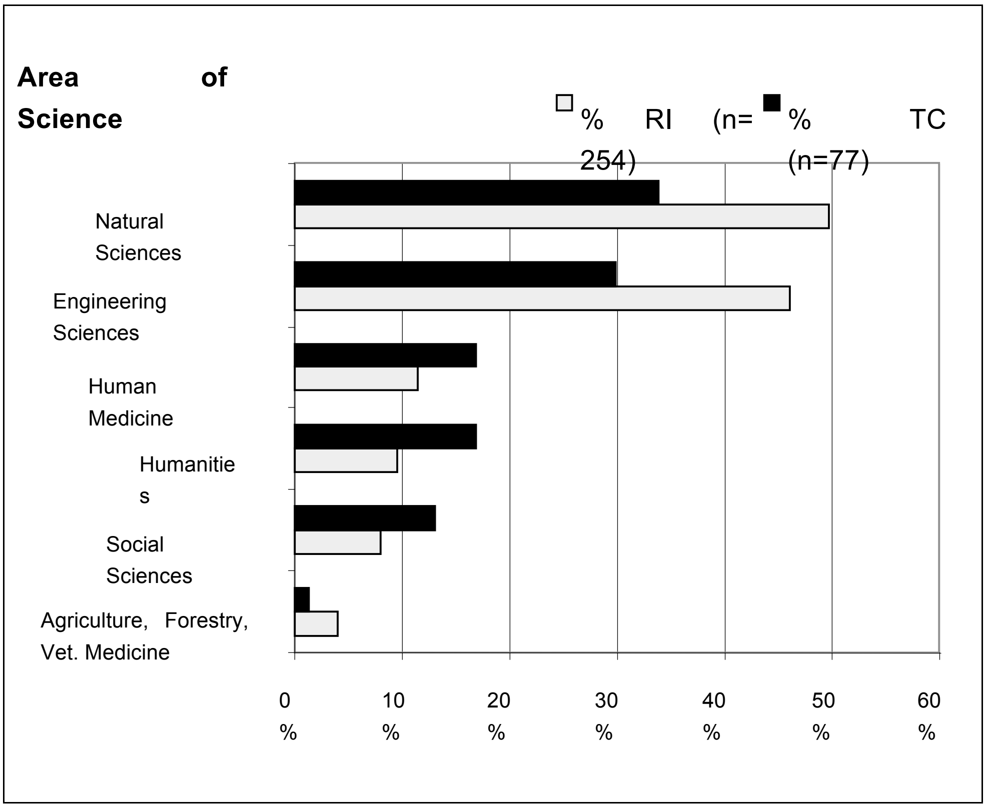


Source: BMWF, Technopolis survey

Thematic classification of both programmes

Figure 4 shows the classification of the projects funded in both programmes according to the system currently used for the follow-up programmes already in place at the time of the survey. The largest part of research infrastructures have been funded in the natural and technical sciences. This is not only due to the generally larger demand of expensive equipment in the respective disciplines but also a result of the research policy priorities recommended by the Austrian Council. Projects within these priorities were generally preferred during the selection procedure although they exclude large fields of sciences covered by Austrian universities. The topic proposed for each Temporary Chair, on the other hand, was mainly assessed against the respective university's development plan and consequently the selected projects are more evenly distributed across the thematic fields.

Figure 4: Subject Areas of RI and TC Projects



Source: Technopolis survey

Conclusions and Recommendations

The evaluation has shown that universities have spent the funding systematically and in line with the programmes' objectives. Although, especially in the case of 'Research Infrastructure', some considered the funding a mere drop in the ocean, this programme enabled the university management to realise comparably larger and more complex projects in some selected areas. The additional flexibility for the timely appointment of new professors was appreciated, although some universities evidently struggled with the task of endowing these professors sufficiently.

The management and implementation of both programmes became increasingly professional over the years, and the rules for participation as well as selection criteria and procedures gained transparency. The recent transfer of the programme management to the Austrian Science Funds completed this development.

We recommend continuing both programmes. Their key elements should remain the funding of research infrastructure in support of competitive research specialisations and the funding of professorships for the more flexible timing of appointments. However, we also recommend some revisions on the basis of the experience made to date.

Research Infrastructure

Being aware of the reforms already made for the Research Infrastructure Programme in 2007 we recommend the following points for future calls:

Clear orientation on university profiles and needs: We recommend that next to outstanding high-tech infrastructures the programme should be open to less spectacular infrastructures provided that its need for the development of a strategically important field of research is justified and convincingly argued by the university. The programme should avoid a bias towards a merely technical or physical understanding of infrastructure and remain open to other material and non-material prerequisites for research, e.g. archives, collections, databases, and it should take operation and maintenance into account as indispensible components of research infrastructure. Inter-university or inter-departmental projects should be encouraged.

Endowment of professorships: The Research Infrastructure Programme aims at supporting the development of competitive research profiles at Austrian universities. As the strategic appointment of new chairs is one of the most effective ways towards the same goal we propose to allow for the endowment of professorships through this programme. In such cases, proposals with a clear profile of the professorship and a less detailed specification of the infrastructure could be conditionally awarded, with payments depending on the actual appointment of the planned professorship.

Clear positioning of the programme between open competition or prioritisation by universities: During the first three calls, the jury selecting the projects largely followed the prioritisation of projects submitted by each university, which limited competition but it increased planning security for the universities. The most recent call involved an external jury of experts and was a step towards more competition between all proposals, while the internal prioritisation made by the universities played no role in the selection procedure which undid the related previous efforts. We therefore recommend to lay down and communicate the selection procedures clearly and unmistakably.

There is obviously no easy answer to the question, what the infrastructure resource needs of an internationally competitive university are and how much of it is financed from public sources, and to a certain extent these issues will always remain subject to negotiation and expression of political commitment. In any case a profound consideration of all funding sources for research infrastructure as well as a comprehensive understanding of research infrastructure should be the basis for the future programme design.

Temporary Chairs

The main asset for universities participating in this programme is the increased flexibility in appointing professors, which is one key measure for the development of universities' profile. The programme could support this more effectively by providing more planning security than in the past. We recommend that instead of the irregular and temporary calls the programme should be permanently open for the submission of proposals with regular cut-off dates for evaluation and selection, e.g. semi-yearly. This would also facilitate the participation for small universities which have less room for manoeuvring due to their smaller number of professors.

Procedures and selection criteria should remain basically the same, with more attention to the university's plans for the endowment of the professorship. A Temporary Chair should be an attractive career opportunity, not least because it has to be situated in a field of strategic importance for the development of the university.

Beyond the programmes

A university that receives funding in one of these programmes always has to commit substantial matching funds for the respective projects in order to strengthen the selected priority areas, which was perceived difficult due to lacking funds by many people interviewed, while others considered this a mere matter of proper decision making and management. Both 'parties' addressed the issue of university funding as a whole, expressing opposite views on the financial situation and leeway of universities. Our final recommendation therefore goes beyond the programmes evaluated, however, we consider it a necessary prerequisite for a rational debate and decision making about the future public funding of universities: to strive for an analysis of the financial situation of Austrian universities based on evidence and transparency.

Authors:

Brigitte Tiefenthaler

Katharina Warta

Technopolis Forschungs- und Beratungsgesellschaft mbH

A-1010 Wien, Rudolfsplatz 12/11

T +43 1 503 95 92 19

brigitte.tiefenthaler@technopolis-group.com

warta@technopolis-group.com

INFORMATION
Der Newsletter der Plattform Forschungs– und Technologieevaluierung ist ein unregelmäßig erscheinendes offenes Forum zur Diskussion methodischer und inhaltlicher Evaluierungsfragen in der Forschungs- und Technologiepolitik.

© Wien 2009 ZVR-Zahl: 937261837 ISSN-Nr.: 1726-6629

IMPRESSUM
Herausgabe und Versand: Dr. Rupert Pichler, Dr. Sonja Sheikh, Mag. Klaus Zinöcker, Mag. Leonhard Jörg
Plattform Forschungs– und Technologieevaluierung, Währinger Straße 3/15a, A-1090 Wien, office@fteval.at
Gestaltung: to-pixelate, A-1170 Wien, carmen@to-pixelate.org
Druck: Remaprint, Neulerchenfelderstrasse 35, 1160 Wien

FÜR DEN INHALT DIESER AUSGABE VERANTWORTLICH
Plattform Forschungs– und Technologieevaluierung: Mag. Klaus Zinöcker

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Plattform Forschungs– und Technologieevaluierung
Währingerstraße 3/15a, A-1090 Wien

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