Effectiveness of National Research Systems

Discussion paper for the 2013 ERAC mutual learning seminar on research and innovation policies

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Background Paper on Effectiveness of National Research Systems

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Introduction

This background paper supports a session in the 2013 ERAC Mutual Learning Seminar on the theme of the effectiveness of national research systems. Within the wider context of Europe 2020 the aim of the Seminar is to support the monitoring of the implementation of the twelve Country Specific Recommendations related to research and innovation. The specific objective of the session is grounded in the priority for the European Research Area (ERA):

> *"More effective national research systems – including increased competition within national borders and sustained or greater investment in research."*[1]

The ERA Communication argues that open national-level competition is necessary to improve the effectiveness of the national research systems and thus contribute to deriving maximum value from public money invested in research and innovation. Best practice in this respect is stated to involve:

> "*Allocating funding through open calls for proposals, evaluated by panels of leading independent domestic and non-domestic experts (peer review) - this incites researchers to reach internationally-competitive levels of performance; and*
>
> *Assessing the quality of research-performing organisations and teams and their outputs as a basis for institutional funding decisions - peer review can form a part of such assessment and, in the long-term, lead to organisational change*."[2]

The expectation is that Member States should introduce, or enhance competitive funding through calls for proposals or institutional assessments, introducing legislative reforms if necessary. Public bodies responsible for allocating research funds are expected to apply 'the core principles of international peer review'.

The annual cycle of economic policy coordination, the European Semester, results in Country-Specific Recommendations (CSRs). In the final versions approved by the Council in 2012 several Member States (Czech Republic, Estonia, Latvia and Sweden) had recommendations in relation to increasing the effectiveness of their research systems,

Following the adoption of the 2012 ERA Communication and Council Conclusions thereafter , this session of the Mutual Learning Workshop will focus on these issues. The aim is to explore how different approaches lead to different results across the EU; and to identify best practices and

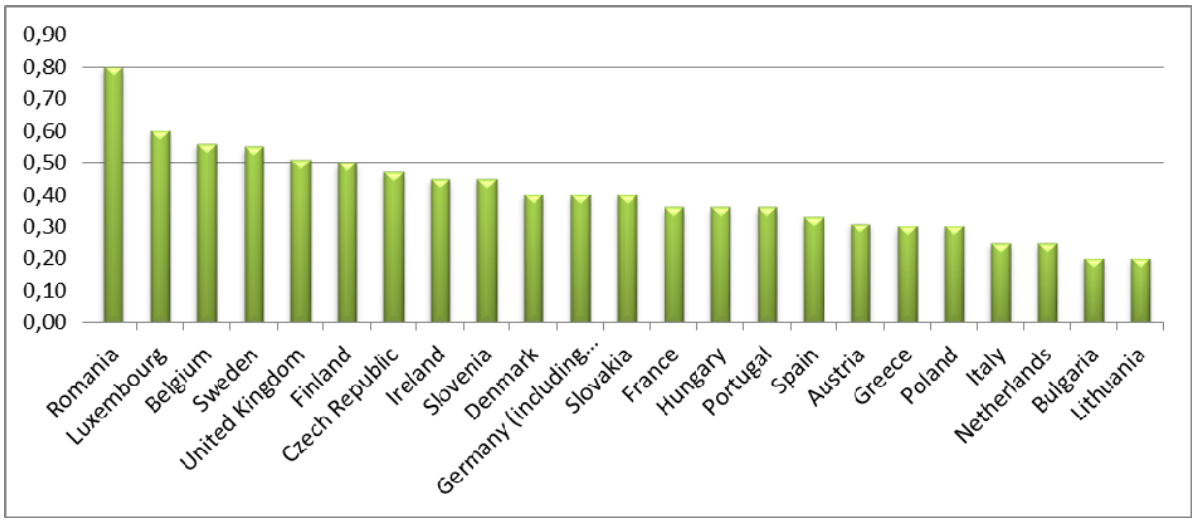
[1] ERA Communication - Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions A Reinforced European Research Area Partnership for Excellence and Growth, Brussels, 17.7.2012 COM(2012) 392 final
[2] Ibid. page 6

consequences in terms of modernisation/upgrading of national research systems, and possible drawbacks throughout the implementation process. This background paper seeks to highlight some of the issues involved in competitive funding, peer review and institutional assessment.

Setting the Scene

Work by the OECD and the European Commission has indicated that the share of competitive funding as a total of public R&D funding (GBAORD) varies from 20 to 80% among Member States with an average of around 40% (see Figure) being allocated through open calls for proposals. The remainder is institutional funding, allocated in a block. In some cases this is allocated through an evaluation of performance but the bulk of this funding is allocated without reference to competition.

Share of GBAORD allocated through calls for proposals



Source: OECD, based on preliminary data from the microdata project on public R&D funding of the Working Party of National Experts in Science and Technology (NESTI), 2009-2010 and Commission estimations for missing observations – extracted from Commission Staff Working Document Impact Assessment of ERA Communication, Brussels, 17.7.2012 SWD(2012) 212 final

The conclusion that is drawn in the Impact Assessment is that researchers, universities and research institutions face very different levels of competition for accessing public funding. This is seen as problematic because of evidence in the academic literature that excellence in science is linked to the degree of competition between researchers. For example Aghion et al find that each percentage of a university's budget from competitive grants is associated with an increase of 6.5 rank points in its Shanghai index calculated for the Academic Ranking of World Universities.[3] Hicks reviewed fourteen performance-based research funding systems and concluded that it was likely that the governmental goal of enhancing research excellence would be met.[4] She found that their most significant effect was to create powerful incentives within university systems driven more by the competition for

[3] Philippe Aghion, Mathias Dewatripont, Caroline M. Hoxby, Andreu Mas-Colell, and André Sapir, The Governance and Performance of Research Universities: Evidence from Europe and the U.S. NBER Working Paper No. 14851, April 2009

[4] Diana Hicks, Performance-based university research funding systems, Research Policy 41 (2012) 251-261

prestige rather than the actual level of resources allocated. Some caution is expressed about the risk of compromising other values such as equality or diversity. Auranen and Nieminen examine the relation between university funding approaches and publication performance in terms of national efficiency in producing scientific publications.[5] Their work shows a clear differentiation between two groups of countries. The first, more efficient, group includes the UK, Australia and Finland well-known for highly competitive funding but also Denmark which during the period had a system that was not strongly competitive. The second group encompasses only countries with less competitive systems and demonstrates a substantial improvement in the efficiency for Sweden, which increased the proportion of competitive funding in the period, though the authors still describe its funding system as 'input-oriented'. The broad conclusion from these studies is that while increased competition is associated with higher performance levels, the underlying situation is complex and includes other incentives and environmental factors.

A different line of argument in support of competition is made by Mitsos et al (the High Level Panel on the Socio-economic Benefits of the ERA) who set out the fundamental arguments for an unequal distribution of funding.[6] They begin with the highly skewed distribution of scientific productivity across scientists, a finding that has held good since the 1920s when Lotka's Law[7] was proposed. In view of this, funding schemes should be based on the presumption that the most productive scientists will make better use of public resources. Put another way, more and better science will be produced for the same input. The argument is that it would be a wasteful, or even immoral, use of public funds were these to be spread equally. The Panel's report also suggests that competition is beneficial not only at the upper end of the distribution (for example those who apply to the European Research Council) but also has benefits at all layers and hence on the average of the distribution.

Characterising research systems and defining the limits of competition

The fundamentals of a research support system can be characterised in terms of three dimensions which between them condition the terms and framework for competition for resources:

1) *Selectivity*
   This refers to the degree to which there is prioritisation between fields. In the context of current initiatives such as Smart Specialisation and Key Technologies it normally results in targeted competition for resources against a set of predefined priorities. This highlights the processes by which those priorities are determined. Normally they combine scientific promise with socioeconomic potential. Policy decisions may concern the proportion of resources to be made available for 'blue-skies' or investigator-driven research compared with those which are targeted strategically.

[5] Otto Auranen and Mika Nieminen, University research funding and publication performance – An international comparison, Research Policy 39 (2010) 822-834

[6] Achilleas Mitsos (chair), Andrea Bonaccorsi (rapporteur) , Yannis Caloghirou (rapporteur), Jutta Allmendinger, Luke Georghiou, Marco Mancini and Frédérique Sachwald, High Level Panel on the Socio-Economic Benefits of ERA, Final Report, European Commission DG Research and Innovation (June 2012) EUR 25359

[7] Proposed by Alfred Lotka in 1926 this can be stated as being that the number of authors producing n articles is about $1/n^2$ of those publishing 1 article.

2) *Concentration*
   The principal question here is which institutions or research teams to support and the degree to which funding should be concentrated on the best performers. Hence, concentration is a natural outcome of competitive funding.

3) *Sustainability*
   This asks whether the funding model allows for the replenishment of human and physical capital within the research system, and hence maintains and grows institutions in the long-term. Unlike the previous two dimensions this feature can only be measured over time. The unit of measurement can be either the research institution or the system as a whole. The outcomes of selectivity and concentration decisions impact upon sustainability, while in the longer term sustainability determines which actors are available to take part in those choices.

Dynamics of Competitive Funding

By considering the interplay of these choices it is possible to understand some of the dynamics of competitive funding. For example the choice of a particular field for support predetermines which institutions or teams will be able to compete for those resources. As noted above it is concentration which is the most likely outcome of competitive funding. This takes place because weaker institutions or research teams are less likely to be able to invest in maintaining infrastructure and in developing the careers of researchers. Over time positive and negative cycles of development are evident.

As noted above, selectivity normally brings socio-economic criteria into consideration as a means of setting priorities. An example of a national drive to focus resources on priorities is the Polish National Research Programme, which defines the R&D directions and channels R&D funding into seven strategic research areas and disciplines which are considered to be crucial for the country's social and economic development.[8]

Prioritisation to achieve selectivity changes the terms of competition more broadly as successful candidates may be asked to demonstrate their potential for impact or their ability to attract co-funding from business or other sources. There are inherent challenges for prioritisation processes including:

- establishing a meaningful level of granularity to avoid generic categories (eg 'environment') that cover large proportions of research;
- interdependence of priorities, whereby one area may depend upon another that does not itself feature as a priority (eg mathematics); and
- a reluctance among researchers to identify negative priorities (items to be cut to allow resources to be focussed on selected areas.[9]

[8] Government of Poland, National Research Programme, Assumptions for the Science & Technology and Innovation Policy of the State

[9] Luke Georghiou and Jennifer Cassingena Harper, From priority-setting to articulation of demand: Foresight for research and innovation policy and strategy, Futures 43 (2011) 243–251

Barriers to entry may be high for those wishing to develop the capability to compete. This suggests that to maintain the benefits of competition in the medium to long term it is necessary to have channels that allow new entrants to the system to emerge and perhaps some incumbents who are past their best to exit (bit see comments below on peer review).

Scale and Critical Mass

Scale is an important element for sustainability. While studies suggest that the critical mass of a research group is normally not very large (10 or fewer members), the issue of critical mass does become important at the level of the institution where the ability to combine different disciplines is key to addressing socio-economic problems. In this case the advantage is derived from economies of scope rather than economies of scale per se.[10,11] Scale of course remains important when indivisible facilities are involved such as large scale research equipment or provision of doctoral training. Even here, the disadvantages of smaller scale activity can be mitigated by effective networking and shared activity, a key function of the ERA.

Elite Funding

In practical terms it is possible to modulate the effects of accumulation through success in competition. A recent trend among funding bodies has been to accelerate concentration by awarding larger and longer-lasting tranches of funding to elite researchers or teams. Pressures on international competition along with the earlier observation that the return on investment is higher from leading researchers have motivated the European Research Council organisations as well as national organisations such as the Wellcome Trust to place increased emphasis upon identifying and supporting this elite.

This strategy may contain inherent limitations. One concern is that that the elite either individually or collectively may not have the long term absorptive capacity to support sustained concentration. If leading researchers end up devoting very small amounts of time to each of a large portfolio of grants the policy is in effect funding their assistants by proxy while excluding the next level of highly excellent people. The challenge for the sustainability of competition is to improve the competitive abilities of that next level (a different task from that of bringing up the level of new entrants).

Modes of funding and the Balance between Competitive and Non-Competitive Project and Block Funding

All forms of research support can be allocated on a more or less competitive basis. Normally funding project proposals via grants is regarded as pure competitive funding but within that broader frame, as we saw in the discussion of elite funding above, it is possible on the one hand to design the terms of competition to create a fairly flat distribution with a high success rate moderated mainly by a quality threshold, and on the other hand to award major grants which attract large numbers of

[10] Johnston R, Effects of resource concentration on research performance, Higher Education 28: 25-37, 1994
[11] von Tunzelmann N, Ranga M, Martin B and Geuna A, The Effects of Size on Research Performance: A SPRU Review, June 2003, http://www.sussex.ac.uk/spru/documents/geunaost.pdf.

applications but where only very few are awarded. Similarly, at one end of the scale, institutional block funding can be allocated non-competitively on the basis of factors such as historical precedent or formulae based on the scale of activity (for example numbers of researchers by field but increasingly performance based criteria are being applied to drive the distribution of these funds. Institutional assessments are discussed in a following section but here it is worth considering the respective roles of competitive and institutional funding.

Benefits and Limitations of Competition

It is clear that competition incentivises researchers and to a large extent prevents those in senior hierarchical positions from using their influence to dominate receipt of resources. Ageing academies in pre-reform transition economies provided the archetype of institutional sclerosis in the absence of open competition. The shorter timescales and higher granularity involved in project funding allow resources to be flexibly applied as science develops and create a relatively simple line of accountability to ensure that the resources are used for the purpose.

On the other hand it is also possible to have too much competition. There are three main reasons why all resources should not be allocated through granting mechanisms:

- Application processes for grants involve a high level of transaction costs in preparation and review. These costs are relatively insensitive to the size of grant awarded and may consume an increasing proportion of senior researchers' time.
- Institutional funding provides space for researchers to develop ideas which may not be ready for exposure to external competition and allows the institutions themselves to behave in a strategic fashion rather than running the risk of converging on 'hot areas' and leading to a loss of diversity in the wider research system.
- There are items of equipment and support services of generic benefit which are not easily attributable to individual grants. Since few funding agencies pay the true full costs of research, the long term absence of institutional funding leads to a 'hollowing out' of research institutions. This point was emphasised in two EUA reports on financial sustainability of universities which called on funders to reduce co-funding requirements and where possible to support research on a full cost basis.[12,13]

A recent report from the Royal Swedish Academy of Sciences identifies excessive reliance on external (and hence competitive) grant funding as one of the drivers of what they perceive as the underperformance of the Swedish research system.[14] It argues that this reliance means that universities focus on how to obtain funding rather than their own priorities, and furthermore that the scope for supporting individuals with new ideas has declined. A specific recommendation is that the ration of in house funding to external should not fall below 60/40.

[12] Thomas Estermann and Enora Bennetot Pruvot, Financially Sustainable Universities II - European Universities Diversifying Funding Streams, European University Association, 2011

[13] Thomas Estermann and Anna-Lena Claeys-Kulik, Financially Sustainable Universities – Full Costing: Progress and Practice, European University Association, 2013

[14] Gunnar Öquist and Mats Benner, Fostering breakthrough research: a comparative study, Royal Swedish Academy of Sciences, December 2012

There are also quite varied degrees of competition across different national agencies that award grants. Dawson et al note that the DFG in Germany has an acceptance rate for proposals in the range 50-60% while Denmark and the Netherlands are at around 30% and the UK 25%. They raise the issue of whether in a system with low acceptance rates the benefits of competition may be outweighed by the cost of proposals and their selection.[15] They suggest an inverse U-shaped curve relating competition and scientific performance. It is interesting to note that research councils in the UK have taken steps to shift the curve by introducing 'demand management' measures to reduce the number of proposals. These measures have varied from agreement of voluntary restraint by institutions through to sanctions against serially unsuccessful applicants. While such measures clearly reduce the transaction costs for the funding agency, they need careful design if they are not to shift costs to the applying institutions, for example by creating a pre-screening peer review process that duplicates the external competition.

Allocation of Funding via Peer Review

At the core of competitive funding models is the process by which resources are allocated. In the great majority of cases this is done by peer review. However, the term encompasses range of practices, assumptions and quality standards. A widely accepted definition was formulated by Gibbons and Georghiou in the first OECD report to address the topic of evaluation:

> *"Peer review is the name given to the judgement of scientific merit by other scientists working in, or close to the field in question. Peer review is premised upon the assumption that a judgement about certain aspects of science, for example its quality, is an expert decision capable of being made only by those who are sufficiently knowledgeable about the cognitive development of the field, its research agenda, and the practitioners within it."* [16]

The statement describes a form of peer review that is intrinsic to the practice of science. It is used in publication, career and resource allocation decisions and to an increasing extent as an instrument for ex- post evaluation. The format of peer review has also been applied to address wider criteria, notably the potential of research to contribute to economic growth and societal challenges. As these wider criteria are brought to bear the initial assumptions evident in the definition do not necessarily apply. Knowledge of wider criteria is not analogous to knowledge of science, being far more dispersed and not the result of a disciplinary consensus. These variants on scientific peer review are called modified peer review, merit review or expert review.

If we consider the core function some trends are evident. On the hand an international frame of reference is increasingly used as the standard for peer review, with the use of foreign peers being seen as the answer both to potential conflicts of interest in small communities and as a means of assuring stakeholders that the work stands up to global scrutiny. On the other hand the internationalisation of science means that foreign peers may be equally well if not better networked with those being judged than their national counterparts.

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[15] Dawson J., van Steen J. and van der Meulen B., Science systems compared: A first description of governance innovations in six science systems, Science System Assessment Report 0914, Rathenau Institute, August 2009

[16] Gibbons, M and L Georghiou (1987), Evaluation of Research: A Selection of Current Practices, Paris: OECD

In the context of ERA, the application of the highest standards of peer review is a core means of ensuring parity of quality between systems. This was one of the recommendations of the ERA Rationales Group in the context of creating a research friendly ecology.[17] Specifically the report saw a clear opportunity to raise standards across Europe through more transnational peer review and suggested that an ERA role could be to create a European College of Reviewers to facilitate the process.

While there are major challenges in bringing major sections of funding into a cross-border frame, mobility of peer review is far more achievable and a challenge that Europe's research funding agencies should find to be well within their capabilities. The practical issue of linguistic barriers is largely overcome through the widespread practice of soliciting proposals in English. This is not appropriate for culturally or linguistically based subjects, though expatriates may be able to assist in these circumstances. To the extent that international review can also be made formative, by provision of meaningful feedback, it is also a potential instrument of development. Some national funding agencies in Europe, particularly those in smaller countries make regular use of international peer reviewers. Others effectively internationalise a part of their activity by accepting the results of European Research Council evaluations to allocate some of their funding. Some transnational competitions, for example those of Nordforsk, operate with transnational teams of reviewers.

Limitations of Peer Review

It is important not to regard peer review as a panacea for all issues involving allocation of resources for research. As an approach it has been subject to a number of criticisms. A regular concern is that peer review approaches may promote conservatism by militating towards safe choices reflecting a consensus view and screening out work that may pose a radical challenge. Over emphasis on safe choices can come through excessive demands for preliminary data. The situation is exacerbated in situations of high competition where a less than positive view from only one among several reviewers can lead to rejection. Interdisciplinary research can be particularly at risk as it may stray from the norms of each of the disciplines whose panels take part in its judgement. A different discipline-related issue that can arise in peer review comes when panels are operating in parallel across fields. There is a risk that members may feel that low scores could damage the reputation of their own field. As a result, peer review may be characterised by 'grade-inflation' – a steady upward trend in the mean scores awarded - even though the level of discrimination and hence the proportion of projects awarded remains similar.

The necessary attention given to the track record of applicants can itself be a major barrier for new entrants, especially early career researchers. Concerns have also been raised about possible gender bias in peer review following a well-publicised critique in 1997.[18] Funding bodies generally recognise these issues and seek to mitigate them by offering specific competitions for new entrants and by stressing the need for interdisciplinary approaches.

[17] ERA Expert Group, Challenging Europe's Research: Rationales for the European Research Area (ERA), Commission of the European Communities, EUR 23326 EN, 2008 p.47

[18] Wenneras C. and Wold A., Nepotism and Sexism in Peer Review, *Nature* Vol 387 22 May 1997 pp 341-343

Incentivising Reviewers

To address issues such as potential conflicts of interest, increasing efforts have gone into pre-identification and recognition of peer reviewers, for example by giving them recognition or esteem via membership of 'colleges'. Modest financial rewards are offered by some agencies. This approach also addresses an emergent concern in peer review, the reluctance of many researchers to take on the additional burden of review when they are already heavily overloaded and subject to their own performance being assessed.

Role of Indicators

The interface of peer review with indicator-driven judgements and ranking tables is also of interest. Individuals, departments, institutions, subject fields or even whole countries may be measured and ranked using bibliometric indicators or by counting other artefacts of the scientific reward system, for example Nobel Prizes. Peer review may be used to moderate such indicators or indicators may be used to assist in peer decisions? It can be argued that many indicators are simply the summary of past peer-review judgements, for example the decision to accept a paper for publication or to award a prize to an individual.

Institutional Assessments

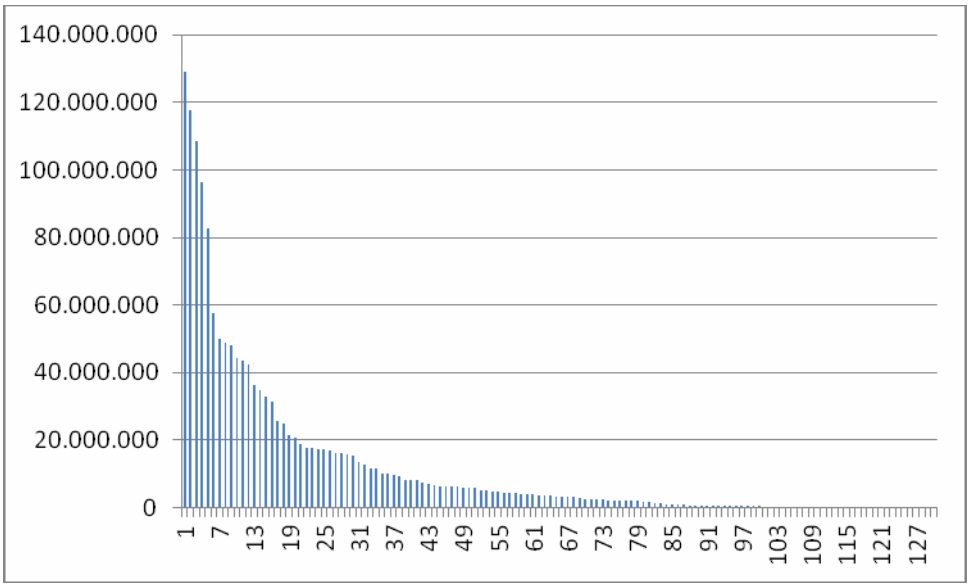
In addition to competitive grant funding, which assesses prospective proposals and individual researchers or teams, there is an increasing tendency to assess the work of whole institutions or of major areas of research within them. This may be with a view to allocating block funding for research in a more concentrated (and hence competitive) manner. While the general aim is the promotion of excellence, the specific approach varies between Member States. Three cases are presented below:

Case 1 – United Kingdom Research Excellence Framework

The United Kingdom allocates block funding for university research by means of a periodic ex post assessment of quality. Previously known as the Research Assessment Exercise, it is a long-established procedure that has evolved through six cycles since 1986. The current iteration known as the Research Excellence Framework (REF) is due to take place in 2014. Universities will be invited to submit a package of evidence to 36 disciplinary panels of (mainly national) subject experts convened by the funding bodies. This evidence will consist of selected publications (normally four outputs per submitted individual), case studies of impact achieved and text describing the wider approach to impact and the research environment, along with data on research income and doctoral students. These expert panels will assign profiles on a five point scale (weighted 65% for the outputs, 20% for impact and 15% for the research environment). These profiles will be combined with a volume driver, based on numbers entered, and a factor reflecting research costs in the field to inform the selective allocation of research funding to HEIs, with effect from 2015-16. The exercise is also seen as providing accountability and benchmarking information. While the future funding formula is not known, recent changes have focused resources exclusively on activity judged to be internationally excellent.

Figure 2 shows the distribution of research funding for HEIs in England for the Higher Education Funding Council for England. It can be seen that the top 5 institutions out of the 130 supported account for 34% of the funds and the top 30 for 81%. The great bulk of these funds were allocated on the basis of the results of the 2008 Research Assessment Exercise.

Figure 2 Concentration of Research Funding in English HEIs in 2011/12 (£)



Source: Own calculation based on revised allocations of HEFCE recurrent grants for 2011-12

Case 2 German Excellence Initiative

The German Excellence Initiative was launched in 2005 to promote outstanding research projects and institutions in Germany's universities. The aim was to strengthen cutting-edge research and to make German science and research more visible in the scientific community. A competition was organised to select outstanding projects in three areas: 39 Graduate Schools to promote young scientists and researchers 37 Clusters of Excellence to promote cutting edge research , and 9 Institutional Strategies on projects to promote top-level research . The competition was run by the Deutsche Forschungsgemeinschaft (German Research Foundation, DFG) and the German Council of Science and Humanities. A total of 1.9 billion euros was made available by the Federal and State Governments to fund the selected projects. The aim was very explicit:

> "*a departure from a long-cherished – and fatally wrong – conception that all universities are equal and hence should be treated equally. Instead, the Excellence Initiative pursued a path of inequality and of funding elites."*

The exercise is seen as highly successful, not only in academic terms but against wider indicators such as creation of jobs.

Case 3 - Research Assessment in the Netherlands

In the Netherlands, there has been a long term system for assessment of universities which was originally intended to be an explicit means of resource allocation but evolved to an approach which helps a drive to excellence without that explicit connection. In the current incarnation, three organisations, the Academy, the Netherlands Organisation for Scientific Research (NOW) and the Association of Universities (VSNU) have adopted a Standard Evaluation Protocol 2009-2015 – (SEP) for evaluating research. The protocol is designed for broad research assessments, including assessment of the quality of researcher training, management, policy, facilities and societal relevance. An assessment according to the SEP 2009 - 2015 consists of an external evaluation conducted once every six years. It involves preparation of a self-evaluation report (including standardised data and a SWOT analysis) and a site visit by an evaluation committee consisting of international experts. There is an internal midterm review midway between two external reviews.

After a site visit the evaluation committee reports its findings to the board of the research organisation. It assigns a rating on a five-point scale ranging from Excellent to Unsatisfactory. The board publishes the report after discussions with the assessed unit and also makes clear its own position on the findings. The system is not used to allocate resources. It should be noted that the Netherlands is the counter case to the UK in the sense of having a successful university system with a fairly flat allocation of resources across institutions.

Small Country Perspective

The smallest Member States face particular challenges in developing effective research funding frameworks. These issues were explored by the ERA-PRISM OMC-NET (Policies for Research and Innovation in Small Member States to Advance the European Research Area). Project membership brought together countries with a population of less than 2.5 million (Estonia, Iceland. Latvia, Luxembourg, Slovenia (plus Cyprus in some activities) with three large country partners, France, Sweden and the UK. Key points of difference identified included concerns that maintaining broad coverage of science and technology can spread resources thinly meaning that capacity in a field might be dependent upon one or two key individuals. Hence, the ability to assemble interdisciplinary teams nationally may be inhibited where key gaps exist. The report went on to state that this creates a particular vulnerability to brain drain and highlights the importance of effective measures for inward and outward mobility of researchers.

Concerns were expressed about the trade-off between danger of "overspecialisation" on the one hand and "over generalisation" on the other. Small countries needed to find an equilibrium that could survive external shocks.[19]

Conclusions and Issues for Discussion

This background paper has sought to identify some of the arguments and pressure points that need to be confronted in the process of developing a balanced research funding system that drives up the standard of excellence and fulfils the goal of more effective national research systems. It is

[19] Quotes taken from ERAPRISM Deliverables D 5.2: Report on the challenges faced by R&D public funding systems in small (and transition) countries http://www.eraprism.eu

anticipated that the issues will be further illuminated through discussion and sharing of experiences in the Mutual Learning Seminar. A series of questions follows that may be used to structure that discussion:

1. **What is the optimum balance between competitive and block funding in a research system?** *Issues to explore could include:* Is that balance different according to national circumstances? What are the limits of competition? What level of concentration of funding of grant awards should a research system aim to achieve to maximise effectiveness? How can competitions for funding be designed to raise the level of effectiveness of national research systems? Which instruments are best to implement competitive funding? How can competitive funding be designed to encourage new entrants to challenge the incumbents?

2. **What measures can be taken to improve national approaches to peer review?** *Issues to explore could include:* How can the highest quality of experts be motivated to engage in peer review outside their own national contexts? How significant are the limitations of peer review and what can be done to mitigate these?

3. **What is the most effective way to incentivise institutions to improve their research performance?** *Issues to explore could include:* What degree of institutional autonomy is necessary for them to be able to respond to incentives that reward quality? What is best practice in institutional assessment? What level of institutional concentration on excellence is best for a research system? What are the effects on those not selected?