Programme on Innovation, Higher Education and Research for Development (IHERD)

Background document

Research funding instruments and modalities: Implication for developing countries

Draft report

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Acronyms and abbreviations

BRICS	Brazil, Russia, India, China and South Africa
CoE	Centre of excellence
ERA-NET	European Union instrument for coordinating and structuring the European Research Area
GBAORD	Governmental budgetary allocations or outlays to research and development
GOVERD	Government intramural expenditure on R&D
IHERD	Higher Education and Research for Development
NESTA	National Endowment for Science Technology and the Arts
R&D	Research and development
RAE	Research assessment exercises
REF	Research excellence framework
S&T	Science and technology

Executive summary

The OECD has undertaken a study on "Research-funding instruments and modalities: implications for developing countries" as a part of a project on Higher Education and Research for Development (IHERD), financed by the Swedish International Development Cooperation Agency.

The emergence of the knowledge society as a key motif of economic development and welfare has increased focus on science and the organisations that produce and fund science. One of the more significant impacts of this shift has been an increase in the proportion of funds competitively allocated to block grant funding. Another is the move towards increased research collaboration and internationalisation. For these and other reasons, research-funding instruments (arrangements for allocating money to research groups, individuals and organisations) and modalities (practical arrangements for implementing research-funding instruments) have become strategic issues in science, technology and innovation policy. This report provides a descriptive and analytical overview of the state of the art in research-funding instruments and modalities, and presents their implications for middle and low income countries.

Research-funding instruments are often non-exclusive with the same instrument being employed for several purposes. Different purposes may also be clustered. For example, internationalisation may be achieved via projects or through grants and stipends. The greatest differences among research funders are found in the modalities they employ for operationalising funding instruments. Modalities are important for the strategic development and management of research funding because they determine the costs of administering and allocating funding.

One of the most significant developments in research funding is the heightened importance and means of international collaboration. International collaboration has moved from being an optional issue to an imperative for achieving national science, technology and innovation policy goals. Furthermore, the nature of collaboration has changed: previously, international collaboration focused almost exclusively on the research community and on mobility from middle and low income countries to high income countries; at present, international collaboration includes cooperation among research funders (e.g. through joint programming and ERA-NET instruments). Several emerging economies such as Brazil, India and South Africa are employing international collaboration instruments aimed at South-South collaboration. These developments suggest that new opportunities are opening up in research funding and collaboration in research funding for middle and low income countries. This report argues that capacity in the administration and management of research funding is therefore a key strategic competence for countries that wish to exploit these emerging opportunities.

1. Introduction

This report is a commissioned study for the Sub-programme on Research and Innovation Policy within the OECD Programme on Innovation, Higher Education, Research and Development (IHERD). The overarching programme objective of IHERD is to increase and coordinate strategic investments in research, higher education and innovation on a global level. The objectives of the sub-programme on innovation are:

- Initiating, conducting and coordinating research on global trends on science, technology and innovation systems and policies with particular emphasis on how these trends affect higher education and research institutions in middle and low income countries; and
- Creating learning opportunities for the dissemination and transfer of knowledge on research and innovation policy.

2. Objective and purpose

The report is intended to inform science policy in developing countries and to complement the extant available analyses of innovation-financing instruments with information about research financing and research-based, innovation-financing instruments. The report provides:

- Classification and descriptions of key state-of-the-art funding instruments and modalities used to provide public support for research and innovation (using criteria such as: objective, target population, financial mechanism, etc.); and
- Analysis of the main advantages and disadvantages of different instruments and modalities, with a view to assessing their impacts on key policy issues, such as capacity building and increasing the contribution of public R&D to innovation and economic growth. The analysis takes into account possible interactions (positive or negative) between the various instruments.

The report examines public funding of research and innovation, and focuses on areas of innovation support that intersect with research funding. As such, it does not cover public funding instruments and modalities aimed at firms. The area overlapping with industrial policy is covered in the NESTA-funded project on innovation (see Allman et al., 2011). Additionally, a number of available studies address innovation financing (see Edler et al., 2012; Georghiou et al., 2003; OECD, 2011; Papaconstantinou and Polt, 1997).

The material is targeted primarily at research funders[1] and agencies involved in the governance and funding of research and research-based innovation. The OECD has produced a large body of work on performance-based research funding (e.g. OECD, 2010a); this report differs from that work in that it focuses on funding instruments and modalities.

The report commences with a discussion of the rationale behind growing interest in competitive allocation of research funding in developing countries. This section also includes stylised facts about the R&D context of middle and low income countries. The next section examines definitions of the key terms used in the report: research-funding instruments and modalities. The following section offers a series of examples demonstrating the use of research-funding instruments and modalities. The report concludes with a discussion of the implications of the above for developing countries.

[1] The term research "funder" is used here to avoid confusion. Countries differ radically in terms of use of terminology. For instance, the term "research council" is used in several countries to designate organisations that fund research. In others, research councils function as research providers outside the university system and have a status similar to that of research institutes or the research department of a government ministry.

3. Research funding for development and inclusive innovation

The recent financial crisis has reinforced the view that economic development needs to be based on sustainable paths to inclusive growth. This approach, taken together with increasing attention to environmental sustainability and corollary issues such as alternative energy and transport, has resulted in a renewed focus on building capacity for innovation. The OECD's innovation strategy draws upon the recent experiences of BRICS (Brazil, Russia, India, China and South Africa) countries and stresses the importance of innovation for emerging and developing countries (OECD, 2010a, 2012a). The strategy identifies three areas of particular significance for developing countries: (i) innovation for growth and addressing socio-economic challenges; (ii) innovation to contribute to inclusiveness (see also Srinivas, 2006); and (iii) the need for openness to foreign sources of knowledge (OECD, 2010b; see also Almeida and Fernandes, 2008; Chang et al., 2009). This report draws upon the OECD's innovation strategy and an issue paper for the Sub-programme on Innovation under the IHERD programme, which identified increased national interest in competitive funding of public research as a key trend for financing research-led innovation. Public research includes higher education and publicly funded research institutes, and no distinction is made between expenditure on higher education (HERD) and expenditure on governmental research institutes (GOVERD).

Hitherto, the study of research funding has been for the most part praxis driven, with little or no academic research on the topic.[2] Funding agencies themselves often commission evaluations of their individual programmes, many of which are in the public domain. Likewise, policy brokers such as the OECD have provided overviews and synthetic reports on research funding (EC, 2010; Hicks, 2012; OECD, 2010a). Taken together, the quality of the available material is variable and there is a need for more systematic academic research in this area. Research funding is therefore a poorly understood field and research funding in developing countries even more so. The prevailing view on research funding in developing countries is that funding levels are very low and researchers face numerous constraints. Furthermore, the bulk of research funding in developing countries is usually public, obtained either from national governments or through international development cooperation.

A review of the literature reveals that the two strongest areas of research activity and funding in developing countries are agriculture and health, with transport and energy a joint close second. These are also the areas in which there is the most publicly available data. All four areas represent a high concentration of development cooperation funding. However, further examination reveals a world of differences among developing countries. Brazil, for example, devotes 1.08% of its GDP to research of which 0.59% constitutes governmental budgetary allocations or outlays to research and development (GBAORD). South Africa devotes less than 1% of which 0.39% is GBAORD, and India devotes 0.71% of which 0.47% is GBAORD.[3] The variation in the level of public funding for R&D among the aforementioned countries is in no way a predictor of the capacity of the individual country to use R&D to achieve economic growth.

[2] Some exceptions to this rule include a small tradition in the political science stream of rational choice research, which focuses on research funding. This work employs the principal-agent perspective. Aside from this, one can find analyses of research funding in the evaluations of research councils' programmes. There is a wealth of programme-specific analyses, however these focus on evaluating the instrument in a specific context.

[3] Ministry of Science and Technology, S&T Indicators, June 2010, cited in UNESCO (2010).

Furthermore, high public investment in R&D is not a goal in itself, but is best regarded as an investment in infrastructure for the knowledge base of the economy. Econometric studies indicate the possibility of a high correlation between business R&D expenditure and economic growth (OECD, 2010). GBAORD is therefore important in that it provides a base upon which business can build and transform research into innovation and ultimately economic growth.

All countries face the challenge of scarcity, but it is in situations of acute scarcity that creativity and the capacity to develop innovative solutions are most imperative. The last two decades have thus seen an increasing focus on performance-based research funding in the public sphere. While this is most intense in OECD member countries, the available literature suggests that developing countries are showing an increasing interest in performance-based research funding. Research capacity is an important prerequisite if developing countries are to use their human capital to the best advantage to achieve economic growth. However, research is an expensive and uncertain exercise and, for this reason, it is important to have access to a broad range of data and information regarding governance practices for the effective steering and funding of public research.

4. Defining the key terms: research-funding instruments and modalities

What are research-funding instruments? What are funding modalities? Although the terms "instruments" and "modalities" are used regularly among research funders, very few documents define either term. For the purposes of this report *a research-funding instrument is taken to mean an arrangement for financing or disbursing money to research performers*.[4] A research performer may be an organisation, an individual, a group of organisations or a group of individuals employed at different organisations. The most common types of research-funding instruments are block grants, projects and programmes. Some research funders may also employ additional instruments such as vouchers, grants and stipends. Funders funding not only research, but also innovation activities close to research, most commonly use the last three. For example, many research funders now provide proof of *concept funding*. This is funding intended to support work needed to demonstrate the commercial potential of a research finding. Typical activities included in proof of concept funding are business plan preparation and patent application. Many funders refer to proof of concept funding as a grant rather than a project, although there is frequently little difference between these two instruments, with the exception that grants almost always come free of co-funding requirements. Research funding is fairly standardised at least with respect to the types of instruments available to the funder. As a result, there is considerable overlap between the instruments deployed by public actors, such as the German Research Council and the National Science Foundation, and private research foundations such as the Howard Hughes Foundation and the Wallenberg Trust. Furthermore, corporate R&D also uses similar instruments. Regardless of the funder or the level at which the funding is distributed, funding will be allocated either for a project, a programme or, in the case of block grants, as direct budgeting support for salaries, and so on. Corporate R&D contexts also employ projects or programmes as funding instruments to support specific initiatives.

The term modality may be defined as the means or specifications used to operationalise/implement a funding instrument. Research funders employ a very limited number of funding instruments. Funders choose to meet new needs and purposes by customising existing instruments to new purposes as they arise. These differentiations are made at the level of requirements, terms of reference and so on. Modality is the term used to refer to these differentiations during implementation. One example of a modality for project funding is whether the call for applications requires one or two steps. Dividing the call into two stages, usually with the first stage requiring an abbreviated version of the project gives the funding body an opportunity to narrow the selection field by excluding projects that do not suit the purposes of the call at an early stage in the process. This approach has the advantage of reducing the administrative burden of the call on the funding organisation and on applicants.

Research funders often differ from each other in the modalities they employ for operationalising funding instruments. A variety of framework conditions decide the kinds of modalities available to a funder. These may be divided into level 1 and level 2 conditions. *Level 1 conditions* refer to legal and structural issues, such as the governance structure of the funding body, its mission, the nature of the R&D system it operates within and so on. For example, the Wellcome Trust, which

[4] A further ambiguity is that funders may employ different terminology to describe the same instrument. For instance, it is not uncommon to use the term "research grant" as a collective designation for all types of competitively allocated research funding. Thus a grant may in reality constitute funding for a project, programme or even a stipend.

is a global charitable foundation, operates under a different set of conditions from the Economic and Social Research Council in the United Kingdom, which receives its funding from the Department of Industry and Business. Level 1 conditions influence operational issues such as modalities through a variety of factors including potential recipients of funds, reporting regimes and so on.

Level 2 conditions refer moreover to the operational aspects of the funding. These types of conditions are shaped by Level 1 factors and the funding objectives. For example, if the funder wants to promote internationalisation, there is little practical worth in restricting the call to national recipients. Funders may however need to develop modalities that allow them in principle to circumnavigate Level 1 conditions. Internationalisation is a good funding objective to illustrate this point. Most public research funders are not mandated to disburse funds to foreign bodies or nationals. A call to promote internationalisation in such a context would require that foreign recipients be employed or partnered with a national body. This constitutes a specific modality.

Looked at from this perspective, research financing becomes a complicated and perhaps rather technical affair. Focus has hitherto lain on examining only certain aspects of funding (e.g. evaluation models). However, recent attempts across all countries to adopt a more strategic attitude to public R&D funding suggests that there is increasing recognition of the need to develop a knowledge base, which can be used as a basis for identifying best practices and sustainable policy. More importantly, the larger the share of public R&D funding allocated through competitive means, the higher the costs of governance of the system. It is at this point that detailed knowledge of the pros and cons of different types of modalities becomes indispensable to funders (Guston, 2008; OECD, 2011). This is even more the case for relative newcomers to the process of funding research.

5. Objectives of funding instruments

Research funding instruments are often non-exclusive with the same instrument being employed for several purposes. Different purposes may also be clustered. For example, internationalisation and career advancement are often coupled by offering grants to young researchers on condition that they spend time abroad. A good example of this type of instrument is the Marie Curie grant, a type of competitive funding administered by the European Union. The grant combines both purposes by linking career advancement to mobility. Internationalisation is also increasingly used as a way of organising and coordinating efforts to meet global challenges (OECD, 2012b). It maybe useful, however, to distinguish between internationalisation as a strategy and internationalisation as the objective of a particular funding instrument. In the global challenge context, internationalisation functions as a strategy for pooling resources, for example, the co-funding by two or more countries of large-scale research infrastructure. Conversely, the Marie Curie projects or Fullbright Fellowships are examples of internationalisation as the objective of a funding instrument. Likewise, discovery or capacity building may be teamed with proof of concept funding or collaboration with specific actors to promote spillovers such as innovation or commercialisation. It is not strictly speaking possible to specify all possible combinations of objectives, but the report strives to indicate the most typical combinations. During the research undertaken for this report it was found that many research funders have developed in-house handbooks that list the instruments they use, while some include instruments from funders that they benchmark themselves against. Further investigation showed that many such handbooks are organisation specific and function as checklists intended for internal use. One potential follow up to this study would be to collect examples of these internal handbooks and synthesise their contents for future usage by developing countries. This work would have to be guided by the needs of a clearly defined set of recipient developing countries and matched with handbooks of funding organisations from countries involved in bi or multilateral cooperation with the recipient developing countries.

In theory, the goals of the implementation unit's[5] policy culture determine the purposes for which instruments may be employed; however, in practice national variations in priorities are not usually sensitive to the level of analysis addressed by this report.[6] The standard minimum set of objectives for research and innovation funding includes the promotion of internationalisation, career advancement, career renewal, capacity building, strategic priorities, collaboration with industry and commercialisation of academic research. Although the majority of these objectives are self-explanatory, a short definition of each is provided below to guide the reader.

Internationalisation: funding dedicated to promoting contacts over national borders. This is usually a blend of strategic-oriented funding aimed at inducing specific types of internationalisation goals, historical and foreign policy linkages, aid and development policy goals and so on. This type of funding can have an important strategic dimension when connected to issues such as access to large-scale research infrastructure such as CERN (OECD, 2008).

[5] This may be a country, research foundation or firm.

[6] The setting of priorities or the creation of roadmaps to determine the prioritisation of purposes or strategic priorities is increasingly becoming an issue in itself (for a discussion of road maps see OECD, 2008). There is growing discussion of priority setting and the development of tools for setting priorities. All countries are interested in this issue, but there is reason to believe that low and middle income countries are especially keen to build capacity in this area.

Career advancement: funding aimed at young scholars, usually recent PhD graduates. This funding objective excludes PhD students because in most countries PhD education is treated as part of the tertiary education system. Career advancement is therefore strictly defined as promoting the choice of research as a career after the PhD. Career advancement may also include special funding to promote the recruitment of disadvantaged groups or may be combined with internationalisation to promote the inflow of highly skilled labour. This category of funding may also incorporate an upper age limit (usually 40) beyond which the scholar is not eligible.

Career renewal: a new objective in many countries. During the era in which block grants dominated, it was assumed that universities, research institutes or national labs would take care of this function via their core funding. The increasing emphasis on internationalisation as well as the interest in stimulating university-industry collaboration has led research funders, such as the European Union, to include career renewal as a separate objective. A second motivation for this funding objective is to renew the skills of scholars who may have been less research active or lacked access to research possibilities.

Capacity building (blue sky research, science driven): usually reserved for funding directed at basic science research that is curiosity driven or intended to promote the development of a specific field or competence (e.g. nano technology, ICT, materials science). Countries may also choose to build capacity in a specific area of generic research (e.g. biotechnology) or a particular niche (e.g. agriculture-related bio-science).

Strategic research:[7] funding aimed at stimulating the research and innovation community to address a specific pre-defined area or areas of focus identified as a national priority. Funding intended to promote research on major challenges may be included in this category.

Collaboration with industry/public sector: promotes joint ventures between public research performers, industry and/or public sector. This may be intended to upgrade skills in industry, promote specific technological foci (e.g. precompetitive consortia) or address strategic priorities (e.g. major challenges).

Commercialisation of academic research: funding intended to promote science-based entrepreneurship. This category may include infrastructural support for entities such as technology transfer units, entrepreneurship courses, incubators and venture capital for university-based start-ups, as well as research and education.

[7] This is also referred to in some contexts as *targeted research*; however, funders more commonly employ the term used in the text. In addition, all research funding is effectively targeted, which renders this terminology rather ambiguous.

6. Type of instrument

Instruments can be structured by type and within each type there may be variations in modalities. The list of potential instruments includes: projects, thematic programmes, stipends, vouchers, R&D tax credits, awards, centres of excellence and loans. All of these are self-explanatory with the possible exception of centres of excellence. More information on COEs is to be found in OECD/IHERD report on *Centre of excellence as a tool for capacity-building* (Hellström ed. 2013).

6.1. List of most commonly available instruments for competitive allocation of research funding

Project funding: the most well-known instrument, seen as a generic denotation for all types of competitive fixed-term resource allocation. Projects are usually short to medium-term and allocated funding competitively. They have well-defined target groups and usually require that the recipient give a detailed account of objectives, potential results and beneficiaries, as well as a time frame.

Programme funding of a longer term nature: usually refers to a portfolio of projects grouped together under one theme and conducted by a collaborating group of actors. Research funders may use the term to describe either a group of projects administered under a single heading or a group of projects from the recipient perspective. In Sweden, for example, the Linne Centres of excellence scheme includes several Centres of Excellence that together form a programme from the perspective of the Swedish Research Council, which administers this scheme. However, from the perspective of the recipients, each Centre of Excellence is a programme in and of itself.

Grant: a term that may refer to a specific instrument or to funding instruments in general. In its specific form, a grant differs from a project in terms of the degree of freedom allowed to the recipient and the degree of administration required by the funder. Many charitable foundations employ this instrument, but ministries and research councils may also make limited use of grants. A typical example of a grant would be the Howard Hughes Foundations Medical Investigator Programme, which funds specific individuals rather than a research trajectory.

Stipend: a form of funding that usually does not have a detailed reporting component. It may be used as a complement to another funding instrument or as a stand-alone arrangement. Stipends are used mostly for the allocation of small sums and are often not renewed. Some funders use stipends to subsidise scientific trips, purchase small-scale equipment or similar.

Voucher: essentially an undertaking by the funder to reimburse a third party for expenses undertaken on behalf of the recipient. The European Uion has a voucher scheme for small and medium-sized firms to source R&D services.

Some examples of currently used funding modalities applied to some of the funding instruments include:

- *One-step call*: open call with no or very few limits on the type of topic (e.g. call for research in the natural sciences or humanities);
- *One-step call*: thematic (e.g. global challenges);

- *Two-step call*: no limits on topics with very brief proposals for the first step and a full proposal for the second;
- *Two-step call*: thematic focus with very brief proposals for the first step and a full proposal for the second;
- *Restricted eligibility*: proposals must include specific partners (e.g. firms, public sector actors, international partners); and
- *Co-financing*: applicants must be able to finance a previously agreed percentage of the costs of the proposed research to be eligible for funding.

7. Target groups

As this report focuses on research and research-based innovation, the target groups are heterogeneous and include individual researchers, research groups, small and medium-sized firms, large firms, universities, start-ups, research institutes and so on. A particular instrument may be used to cluster specific target groups. For example, *career advancement* may be combined with *collaboration* to target constellations that include firms and postdoctoral researchers. In some instances, the explicit purpose of an instrument may be to create a previously non-existent target group by providing an incentive for actors to group themselves in specific constellations.

Table 1 provides an overview of objectives grouped together with the instruments most commonly used to achieve a specific purpose, and the most common target group(s) to which the instrument is directed.

Table 1. Grouping of objectives, instruments and target groups

Funding objective	Instrument	Potential target groups
Capacity building	Block grant, project, programme (thematic or open), Centre of Excellence (COE)	Research group, organisation,
Internationalisation	Stipend, project, programme, COE	Individual, organisation
Commercialisation	Award, expert support, venture capital	Research group, organisation, individual
Collaboration between public research organisation and industry	Voucher, R&D tax credit, programme, project, COE	SMEs, large firms
Strategic research (e.g. major challenges)	Project, programme, COE	Research group, individuals, UI consortia
Career advancement	Project, stipend	Young scholars usually recently graduated PhDs
Career renewal	Project, stipend	Senior research staff, R&D staff

While Table 1 shows a typical match of objectives, instruments and target groups, it is important to note that the more mature or advanced the research system, the higher the likelihood of combinations of funding objectives with a single instrument. This refers to the modality whereby more than one funding objective is pursued during the same funding call. For example, rather than administer two separate calls to fund an arrangement of scientific workshops and conferences and basic science projects, a funder may decide to cluster these objectives (see Table 2). This would require applicants to link their applications for funding workshops, conferences to applications for money to perform research. This modality can reduce the administrative burden on the funder and even promote more forward thinking among the research community. The disadvantage is that it will necessarily limit meetings to only those areas where ongoing research is mature enough to carry a successful application. Exploratory meetings needed to discuss potential new areas will not be facilitated by such a modality.

Another potential issue related to clustering funding objectives on the same instrument at the same time is complementarity among objectives. For example, the objective, *commercialisation*, may be complementary with strategic priorities, but the time frames for the research results and the

commercialisation process may differ so radically that these two activities may have to be funded and evaluated separately. It may be useful therefore to explore the carrying capacities[8] of instruments in terms of clustering of funding objectives. As mentioned earlier, funders often choose instruments for specific purposes based on a number of criteria. One such criterion is the type of evaluation protocol the funder has developed for a particular instrument. For this reason, the carrying capacity, that is the number of objectives for which the instruments can be used, will be determined by evaluation practices.

Table 2. Worked example of the modality of clustering funding objectives and target groups

Cluster of funding objectives	Target group(s)
Internationalisation Career advancement, career renewal Strategic priorities	Young scholars, senior scholars, large firms and SMEs
Capacity building, commercialisation and technology transfer, collaboration	Research groups, large firms and SMEs, non academic research performers
Commercialisation and technology transfer, collaboration	Academic and non academic R&D performers, firms

The issue of which objectives to pursue, how long for and at what cost is examined as part of a general priority-setting process undertaken at the organisation or country level. Once decided, the choice of instruments to promote the selected objectives is usually seen as an administrative rather than a political/strategic process. However, significant additional costs can be incurred if the instrument and purpose are mismatched. Likewise, the choice of one or the other modality for a specific purpose can save both time and money. Table 3 provides a worked example that builds on two of the most commonly used instruments: programmes and projects. The example captures two aspects: (i) the implications of different modalities for the same instrument, and (ii) the potential grouping of objectives, instruments and modalities.

Table 3. Worked example matching instrument and modality

Instrument	Implementation (modality)	Objective(s)	Pros	Cons
Project	*One step*: open call, no or very few limits on type of topics (e.g. call for research in the natural sciences or humanities)	Capacity building	• Provides a good overview of what the scientific community wants to do • No prior knowledge of the area required to prepare the call	• Does not allow much steering of choice of topics by the agency • Can be expensive and cumbersome to design a review process

[8] Carrying capacity here refers to the limits to complementarity among different objectives given evaluation practices.

				• Can be time consuming depending on the size of the community
Project	*Two step*: open call, no limits on topics, very brief proposals in the first step, full proposal for the second	Capacity building, strategic priorities, internationalisation	• Allows the agency some control in deciding which proposals get to the second round • Reduces burden on reviewers allows better structuring of the review process	• Some proposals will be disadvantaged by the shortened form • Process can take much longer if the lead time between steps 1 and 2 is not very short
Project	*One step*: structured call, limit on area of research, type of topic, extra conditionality (e.g. interdisciplinarity or industry collaboration)	Capacity building, strategic priorities, internationalisation	• Can be done fairly quickly depending on the area • Allows more steering of research from extra scientific sources	Requires a good grasp of the scientific area, knowledge of the local research landscape; and access to the international review committee depending on the narrowness of the specialisations and the size of the local research community
Programme	*One step*: thematic (e.g. global challenges)	Career development, capacity building, internationalisation, commercialisation, collaboration, strategic research	• Allows critical mass agglomerations • Can attract researchers from outside	• Requires additional review and monitoring procedures • Can be risky • Programme

			the national context/facilitate recruitment • Has potential for high visibility for the agency and low transaction costs (few large programmes) • Can lead to path-breaking results • Can support groups that the academy may not otherwise support • Is ideal for promoting strategic research	evaluation of the agency as well as the recipients may encourage low risk taking • Can contribute to entrenching specialisations and groups that may otherwise not be sustainable

A key issue to bear in mind is that all instruments are dependent on some type of selection process (e.g. peer review). This is a precondition for any of the instruments cited here except for R&D tax credits and vouchers. The ability to access peer review committees assumes that the funder has access to a network of potential reviewers. The search costs in terms of time may be quite high initially if funders do not themselves have access to large networks. The most common practice is to tap into existing networks of local academic groups through some institutionalised means. Funders differ in how they do this, but some common routines are to build disciplinary or area-based panels using the local research community. These panels may either be used for first instance reviews or to collect knowledge on international experts who may be suitable reviewers. A common problem in this respect is diversity. Funders have to find means of developing review panels that are sufficiently anchored in local tradition but also comprise international experts. Language and cost are the two most common obstacles. Developing countries may wish to explore collaboration with international organisations such as UNESCO and the European Union to obtain access to databases of experts who could act as potential reviewers. Collaboration through meta instruments (see below) is another way of increasing efficiency with respect to the review process.

Peer review is the oldest and most well respected form of review for research. However, it is not unproblematic and newcomers to the process of funding research should note that there are several complex issues with direct implications for practice. Additionally, evaluation methods like instruments have a range of modalities for implementation, such as design of review committees, but these lie outside the sphere of this report (see Guthrie et al., 2013). Most

funding agencies invest in some type of basic knowledge of how peer review works and the pitfalls and advantages for their staff. There is also a wealth of research available on this topic and it may be useful to compile a synthetic overview of different approaches to reviewing, best practices and so on. Recently, Rand produced a report that synthesises a number of alternative modalities to the implementation of the peer review system, which functions as a good complement to this handbook (Guthrie, et al. 2013).

8. Meta instruments

Meta instruments refer to instruments used for the purposes of coordinating research and innovation investments transnationally. For the purposes of this report, meta instruments are instruments used for coordinating other instruments. These differ from the instruments that form the main focus of this report in two ways: first, the target group for meta instruments is research funders as opposed to research-performing organisations; and second, meta instruments typically include a portfolio of research-funding instruments. Examples of meta instruments include the following:

- Canadian Networks of Centres of Excellence – an instrument for coordinating Centres of Excellence;
- International Opportunities Fund – a Belmont Forum Initiative intended to promote multilateral collaboration and funding of research on global environmental change. This initiative is open to developing countries;[9]
- ERA-NETs – the European Union instrument for coordinating and structuring the European Research Area; and
- Joint Programming – an EU initiative for coordinating research calls in specific areas across national member states. This initiative is similar to the International Opportunities Fund, but includes several different types of research areas.

Meta instruments merit the attention of developing countries primarily because they represent the state of the art in research funding. They are indicative of a trend in national research funding to facilitate global collaboration and promote the conduct of research and innovation in open global networks. This trend does not provide a route past structural obstacles such as intellectual property or incommensurability at the level of national regulation and so on, but it does increase collaboration and facilitate transfer of knowledge across research systems. The high level of participation among emerging economies such as Brazil, India and South Africa in these types of arrangements constitutes one way in which the research-funding landscapes in these countries differ from those of other developing economies.

Meta instruments also represent a learning opportunity for developing countries through the exchange of knowledge between research councils *qua* collaborators rather than as aid recipient and donor. In addition, meta instruments provide a networking mechanism for research funders closely coupled to the science system. This opens up possibilities for research funders to share databases on review committees, calls and so on. This in turn increases the capacity of the funder at the national level.

Lastly, the collaboration embedded in meta instruments may constitute an important strategic step in accessing and/or widening extant research networks and networks of research funders. Access to research networks provides benefits which are well outlined elsewhere and so are not covered here however it is the potential for policy learning that meta-instruments provide for middle and low income countries that is significant in this respect. In some cases, developing countries may want to create similar constellations at the regional level as a complement to their participation in more global networks. Many of the existing regional platforms in Latin America, Asia and Africa may be used to replicate these types of exercises.

[9] For more information on the Fund, see: www.igfagcr.org/index.php/about-us.

Two important examples of meta instruments are ERA-NETS and joint programming. Both examples are taken from European Union programmes and are open for third-party and candidate country participation. ERA-NETS and Joint Programming Initiatives are intended to promote the development of transnational and joint strategies and/or programmes. This includes, among others, common calls for proposals, transnational evaluation and dissemination, and transnational funding of research activities.

ERA-NETS include at least four dimensions:

- Systematic exchange of information and best practices
- Strategic activities
- Implementation of joint activities
- Transnational research activities.

ERA-NETS are open to member states, associated states and candidate countries, and each ERA-NET must have at least three members or associated states of which at least two are member or candidate associate states. ERA-NETS are open to developing countries if they partner with EU member countries. Additionally, the applicants must be: public bodies responsible for financing or managing research activities carried out at national or regional level; other national or regional organisations that finance or manage such research activities; or bodies operating at European level that include as part of their mission the pan-European coordination of nationally funded research. Thus a key requirement for participation is the existence of some type of research-funding agency structure in the participant country. Most, but not all, middle and low income countries have some type of basic research funding agency structure. A perusal of current, ongoing ERA-NETs reveals some developing country participation, notably Brazil, India and Taiwan. More importantly, certain emerging economies have developed their own versions of ERA-NETS, which are South-South in their orientation. These collaborations constitute interesting developments and should be monitored by both developing and developed countries as they represent enormous opportunities for innovation and creativity.

The objective of joint programming is to increase the value of relevant national and EU R&D funding by concerted and joint planning, implementation and evaluation of national research programmes" [10](Extant joint programming initiatives focus on issues such as agriculture and land use, urban development, water and anti-microbial resistance among others. The strategic importance of these themes for middle and low income countries cannot be over-emphasised. Moreover, these areas have long been identified as prerequisites for innovation (Hall et al., 2001).

[10] For more information: http://ec.europa.eu/research/bioeconomy/policy/coordination/jpi/index_en.htm, see also European Union, 2012.

9. Analysis of implications for low and middle income countries

This concluding section addresses the implications of the foregoing for middle and low income countries. The intention is not to present an exhaustive analysis,[11] but to focus on a number of key strategic issues related to funding instruments and to give an analysis of the implications of the state of the art for low and middle income countries.

Most middle and low income countries use block grants (i.e. direct institutional allocations), although there are indications that this is changing. Block grants are the cheapest form of allocation and they have the advantage of allowing better institutional planning. They also allow institutional autonomy to research performers and may function as a necessary corrective to steering. This corrective is functional as it is difficult for planners to foresee all kinds of research competences that may be required in the future. The block grant is also a good instrument for promoting bottom-up input. The initial logic underlying science policy dictated that competitively allocated funding would focus on strategic priorities, collaboration and so on. while block grant funding would be used to promote capacity building and basic research (Weinberg, 1963, 1964; Rahm et al., 2000; Stokes, 1997; Guston and Kenniston, 1994; Jacob and Hellström, 2012). This logic also fitted with the linear model of innovation that was the dominant orthodoxy. Many industrially developed countries have, however, reduced the portion of R&D funding allocated in this fashion for a number of reasons. Chief among these is the desire to increase the capacity to steer research funding more directly and to couple public research to specific societal objectives. Some countries have chosen to retain direct institutional allocations, but to make some portions of this funding performance sensitive. Thus far, most of these seem directed at increasing publication output as, despite the prevalence of rhetoric about relevance and social impact, bibliometric measures still dominate impact evaluations of research (Bozeman and Sarewitz, 2011; IDRC, 2011). The most radical version of this model is the UK's research assessment exercise (RAE) now renamed the Research Excellence Framework (REF). This is a large-scale peer review exercise carried out nationally where institutions are awarded funding on the basis of their performance in the exercise. The REF is implemented through a process which groups research areas into units of assessment. Each unit has a panel of reviewers responsible for evaluating the submissions within the area. This is a costly exercise and usually takes about one to two years. The benefit of the exercise is that it induces system-wide awareness of which outputs are counted, and there is systematic evidence to show that researchers respond readily to these measures. While it remains unclear whether the net increase in publication counts is worth the costs involved in the measures needed to sustain this intervention, it is certainly the most effective way to direct the research community's attention towards publication.

For countries with little or no publishing tradition this may prove an important investment, as increasing publication counts is a necessary prerequisite for accessing international networks.[12] Issues such as access to large research infrastructures are also in part determined by scientific performance, thus some focus on scientific performance is necessary (OECD, 2001, 2010b). This

[11] An overview of performance-based research funding can be found in Hicks (2012).

[12] India has been very successful in leveraging access to scientific infrastructure in other countries as a means to building national capacity. This success was in part based on a combination of investments in local capacity development and the use of bilateral and internationalisation schemes (see Ramamurthy, 2011).

should not, however, be confused with increasing the social accountability of science. In fact, there is reason to believe that integration into international markets for science may best be pursued selectively and not promoted as a countrywide strategy. One rationale for this is that, in many instances, the focus on publication in international journals and excellence comes at the expense of research on local issues. This trade-off may be observed in all countries, but resource constraints may imply that it is more intensely felt in middle and low income countries (Chataway et al., 2007; Leach and Waldman, 2009).

As indicated above, the gains to be won from competitive allocation of funding must be weighed against the increased transaction costs it induces. Many of these transaction costs are not obvious and for this reason further explanation may be useful. In the first instance, some type of research agency structure is a necessary prerequisite for embarking on competitive allocation of research funds. There are several different arrangements for this and one indicator of the maturity of a research system is the diversity of arrangements for allocating research funding in a competitive fashion. For instance, some countries in addition to research agencies have research budgets allocated to ministries who in their turn commission research for specific in-house needs. The transaction costs for governance of the system will increase in proportion to the diversity of the arrangements for allocating funding. Transaction costs here refer to the actual administrative costs of running the system, the level of knowledge required to govern the system, and the amount of coordination that needs to occur. An additional problem is that, in some cases, private funding may outclass public funding and government officials may find themselves having to either compete with industry or collaborate on priority setting.

Allocation of research funding under a competitive-based approach has several advantages for the principal (research agency, ministry, etc.). Chief among these is that it allows targeting of funding allocations for research to specific objectives in a fashion that direct institutional allocations are not always able to achieve. Another advantage is that since the peer review system is the usual mode of evaluation, the focus on competitive allocation should lead to improved performance. The underlying reason for this is that scientists need to compete with each other to attract the funding. Two good examples of this are Russia and South Africa, both of whom are using competitive-based funding to revitalise their respective scientific bases. In both cases the instruments used are large grants targeted to excellent individuals and open to nationals and foreign scientists.[13] The European Union has a similar approach run by the European Research Council.[14] Although this grant focuses on basic science, it is not exclusively designed for this type of research.

These awards are necessarily large because they are aimed at top performers globally and they need to include the possibility of relocating key team members, equipment and so on. Such awards are becoming increasingly popular as they offer several possibilities for fast-forwarding capacity development; however these instruments may very well be beyond the reach of the poorest countries unless they are willing to restrict themselves to a few key areas of investment. Furthermore, many countries may well fear that even if they invest in such a scheme, they may risk losing such personnel to a higher bidder in the next round. This is always a risk and there are no ready solutions to this problem. However, this type of investment is simultaneously strategic and pragmatic. If a funding agency invests in a top researcher who then builds a team

[13] The two grants are the South African Research Chair scheme and the Russian mega grants. The Russian award is about EUR 360 000 for a period of two years with the possibility of extension for another two years.

[14] The grant is the European Research Council Advanced and Junior investigator awards.

including locals, this team must be provided with conditions that encourage all or some of them to stay. The larger the number of such investments, the less vulnerable future investments become as capacity increases. In other words, the traditional prerequisites for capacity building remain even at this level of investment. Finally, here as with other areas of competitive funding, a fairly well developed local competence is necessary to identify and evaluate potential candidates.

Research funding is becoming more globalised and with this has come an increasing degree of isomorphism at the level of practices and institutions. Centres of excellence are a good example of this and are undoubtedly the preferred instrument at the present time. While the centre of excellence instrument is unmatched for building capacity in a specific area, not all competences can or should be fostered in this fashion. For some types of infrastructural competences, such as research to support evidence-based policymaking, it may be both cheaper and wiser to build some of these competences regionally rather than nationally. Thus, certain kinds of support research for innovation and science policy may be better clustered regionally, while other aspects of research support for science policy could be done nationally. Research funding is an area where skill and knowledge can overcome many of the limitations of scarce resources.

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