Indicator needs for the internationalisation of science policies

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Forthcoming in *Research Evaluation*, 20(1) March 2011

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Abstract

Science has long had an international dimension but policy-makers, research funders and research-performing organisations now pay increasing attention to research internationalisation, with a range of motives. Despite this, the evidence base for internationalisation strategy formulation remains weak. In this paper we elaborate an approach which identifies likely indicator needs from the policy process, explore examples of existing indicator use, and discuss the extent to which meeting each of our identified indicator needs is feasible. We conclude that decision-makers and indicator designers should work together to ensure that both new indicators and new approaches to mutual policy learning about their use and utility are developed in parallel.

1 Introduction

Science has long had an international dimension but recent decades have seen intensified collaboration and mobility amongst scientists, and the emergence of a more truly global science system. Research performing organisations and funding agencies increasingly promote internationalisation by modifying internal processes and incentive structures, offering support for international activities, and engaging in inter-institutional co-ordination schemes. Meanwhile, national policy-makers also seek to drive and manage research internationalisation, both to achieve science and innovation related goals and increasingly in support of other policy objectives. A number of countries have produced high-level internationalisation strategies and new forms of transnational, co-ordinated governance seem to be emerging[1].

Despite this, the conceptual and evidence bases in this area remain weak. The OECD Handbook on measuring globalisation (2005, p. 138) identifies a range of gaps as regards measuring internationalisation, ranging from migration of highly skilled personnel to allocation of national R&D funds. This list is itself far from complete. Yet attempts to make and implement strategy in this area presuppose a good understanding of the scale, scope and effects of existing international activities in science and innovation and of the interventions, incentives and framework conditions that might shape and encourage such activities.

Building on a review of internationalisation strategies and indicator use in a number of (mainly European) countries[2] and on a literature review on the dynamics and impacts of internationalisation activities[3], this paper *discusses* the use of indicators and *begins to elaborate* an approach to indicators which could underpin the development of public policies and organisational strategies for research internationalisation. We introduce a *functional indicator approach* along a stylised *policy/strategy cycle* and propose a portfolio of likely *indicator needs*. Finally, we discuss existing efforts to use indicators and explore the extent to which the construction and use of indicators appropriate to addressing each 'need' is feasible.

The discussion deliberately focuses on public policy and decision making in public funding and research organisations. This is not to say that individual motivations and other organisational dynamics are not important. Our focus on public policy and publicly funded organisations simply reflects the fact that the progressive development of international institutions and frameworks will, for the foreseeable future, continue to be rooted in politically set frameworks and decisions. Our discussion is focused on indicator needs rather than the phenomenon of internationalisation of research per se. Moreover, the broader internationalisation of *innovation* activities is not in the focus of this article, except inasmuch as it impinges on research policy goals and implementation[4].

The paper begins by briefly reviewing some major trends in the internationalisation of research and in related policy thinking. We then develop a framework within which we can categorise and make sense of indicator functions and purposes. Based on this we discuss likely indicator needs and explore some illustrative examples of current practices. Finally, we outline an agenda for further conceptual work in support of efforts towards a more systematic use of indicators in the design of policies and strategies in this area.

2 Starting point – the multiplication of internationalisation goals

A recent EU expert group on international cooperation in science and technology (EU Expert Group 2008, pp 25-30) and a broad country review (Boekholt et al, 2009) identify the following policy motivations for internationalisation (see Table 1):[5]

Table 1: Policy motivations for/goals of internationalisation policy

Access to scientific knowledge / improving knowledge production (complementarities)
Economic competitiveness **▪ more effective and efficient knowledge generation and transfer in a certain field** **▪ indirect contribution to the attractiveness and innovation dynamics of a country**
Responding to global challenges (problem driven), capacity building abroad (development policy through S&T)
Promoting political cooperation, dialogue, trust and aid for developing countries
Meeting the demographic and educational challenge of human resources for science, technology and innovation (talent seeking, brain circulation, securing adequate supply of manpower for S&T).

Source: modified from Boekholt et al, 2009

This list of motives illustrates that the purposes of policies for research internationalisation have broadened. In a "*narrow*", more traditional policy paradigm, policies were mainly concerned with the direct effects of internationalisation on science and the knowledge-based economy. However, internationalisation of research is increasingly used as a means for a whole range of other political purposes. This has been dubbed the emergence of a "broad" policy paradigm (Boekholt et al.2009a).

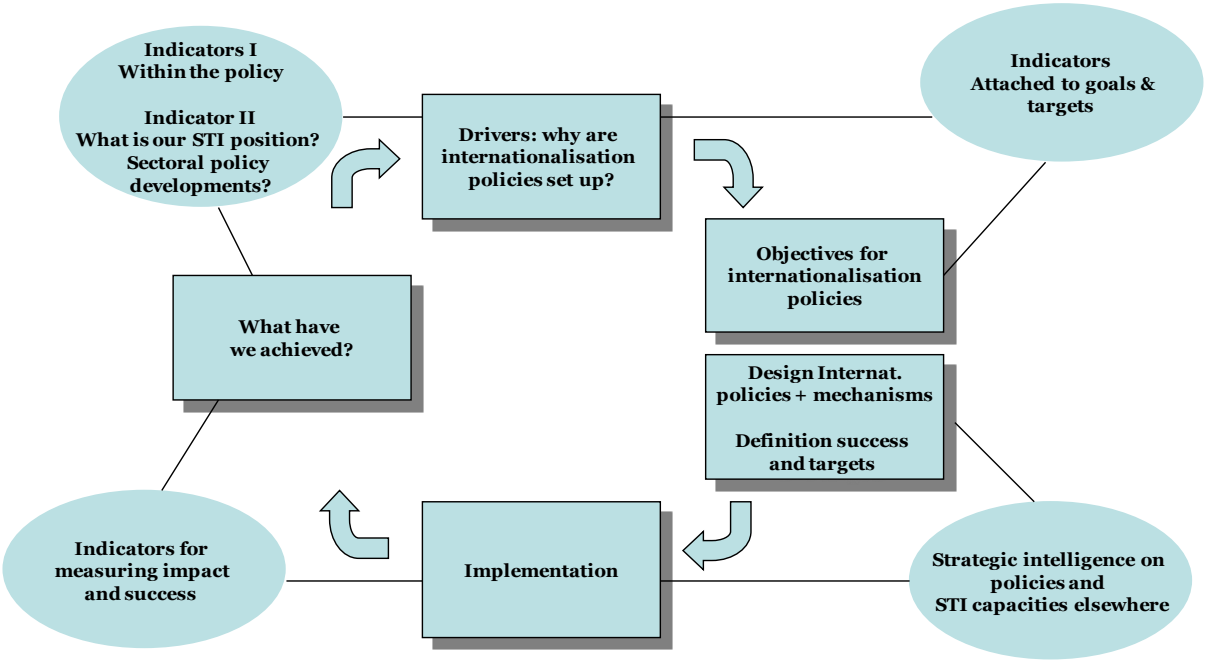
At the same time research performing organisations are increasingly making explicit internationalisation strategies.[6] A 2006 study showed that half of all German research organisations had developed explicit internationalisation strategies with a broad and ambitious set of goals. The four most important goals within those strategies have been knowledge generation, reputation (attractiveness as partner for research), spillover effects (capturing the benefits of internationalisation) and change in organisational practices (introducing international peers into evaluation processes, adopting international routines to promote further international activities etc.) (Ebersberger et al. 2007a, b, Ebersberger & Edler 2009).

3 Indicator roles in a stylised policy cycle

We suggest that the use of indicators in the context of policies to encourage research internationalisation must consider three dimensions: Indicators can be used to map the modes of internationalisation (*how*), the drivers of internationalisation (*why*), and the actors engaged in or targeted by internationalisation activities/policies (*who*). Further, the target community of internationalisation policies for research is vast, and with the rise of the broad policy paradigm has grown further. To be useful, indicators must be capable of representing the relevant activities of public research organisations, firms, funding organisations, government ministries and other public agencies responsible for research or for international research aspects in their respective remits. Moreover, the modes of international research are numerous, ranging from mobility (at individual, institute and firm level) and physical cooperation to virtual cooperation, cross-border contract research, participation in international research organisations and, finally, to various levels of coordination and joint programming at the level of policy and funding organisations. It is important to keep this multi-dimensional space in mind when discussing a conceptualisation of indicators for research internationalisation policy.

A further premise of our approach is that indicator needs will differ throughout the whole policy process. This is a highly stylised conceptualisation of policy–making. However, it does help us to conceptualise indicator requirements in a comprehensive fashion and highlights the quite different roles indicators may play at different points in the process. The different actors, modes, and drivers are integrated into Figure 1 below. In the following sections we will elaborate on the indicator needs that seem to emerge at each of these stylised stages.

Figure 1: Indicator needs in a strategic policy cycle



Source: modified from Boekholt et al 2009

4 Indicator use and gaps

4.1 Stage 1: Indicators of the 'status quo'

A first role of indicators is to support an analysis of the status quo: what is the relative position of a system and its components in the global research system vis-à-vis other systems, and who is doing what? Such an analysis covers three distinct but inter-related dimensions:

(1) The analysis of the *strengths and weaknesses of a national research 'system'* or *organisation* (in order to define the starting point for international activities). This relates, for example, to relative scientific and technological advantages as defined through scientometric specialisation patterns, excellence patterns, etc. This is often done on the basis that strengths can be a powerful attractor to potential overseas partners, whilst an area that is weak may benefit from increased co-operation with those overseas researchers close to the leading-edge in that field.

(2) The *scope and scale of internationalisation of the research community* (individuals, research organisations etc.). First, indicators need to be able to characterise the scale and scope of the *various modes* of *international activity* as outlined above. Second, indicators should be in place to capture internationalisation for different kinds of actors, individual researchers as well as research performing organisations (whilst taking care to consider the variation expected in such patterns between sectors, field or technologies).

(3) Finally, the *policies, funding modes and other framework conditions* in which internationalisation takes place. The translation of drivers for internationalisation policies into specific objectives and concrete actions not only requires an understanding of the internationalisation of the research community but also an analysis of how open policy, programmes and frameworks are to internationalisation.

4.1.1 Measuring and understanding the status quo: the research community

Indicator needs

Individual researchers: Much indicator effort has already focused on absolute and relative levels of international collaboration. Indicators most often used are co-publications of authors from two different locations ("basic" research) and co-invention (for more application oriented research). Analyses explore the absolute numbers, the share of international co-publications out of all publications and out of all co-publications. Thus, co-publication analysis tells us about the relative importance of international collaborations that lead to tangible outputs (publications, patents) and the nature of these collaborations in terms of countries and disciplines (see, for example, Glänzel 2001, Glänzel & DeLange 2002, Schmoch/Schubert 2008, Mattison et al. 2008, Edler et al. 2007, Guellec & Pottelsbergehe 2001).

A second important focus has been *mobility*. Some relevant indicators have been constructed within the IISER[7] project of the European Union DG JRC-IPTS. This indicator set covers researcher stocks, research careers and researcher mobility (intra-EU, into and out of the EU). Many of the researcher mobility indicators specified presently remain unfilled by any data[8]. The indicators specified include the circulation of doctoral researchers within the EU (i.e. inflows, outflows and netflows); outflows to the US (e.g. country of origin of non-US citizen holders of US doctorates; function of non-US researchers in US universities; fields of specialization of non-US researchers in US universities); and inflows of non-EU researchers into the EU (country of origin of non-EU doctoral candidates in EU universities; ratio of third country to non-EU doctoral candidates; etc). It can be noted that the mobility indicators which have been used to date are largely focused on doctoral researchers with much less data available about other categories of researcher, reflecting the long-standing frustration that 'researcher' is not a unitary statistical category.

Organisations: Lepori et al. (2008) and Barré (2006) have convincingly argued that in order to understand the properties of a national 'system' it is important to understand the *positioning* of the various organisations that constitute that system (firms, research organisations, funding organisations, ministries), their behaviour vis-à-vis other actors in the system, their linkages and broader cooperation patterns and their activity portfolios in general. Moreover, the constitution of organisations, their compositions and governance structures need to be understood for a robust characterisation of the role those organisations play. Examples of *positioning indicators* (Barré 2006) would be share of co-operations in all project work, share of overseas members of staff etc.[9] A systematic and well-established set of positioning indicators for *research and funding organisations* does not yet exist, but some studies have looked at the forms and indicators of international research activities (Edler 2007, Universities UK 2008, Noir sur Blanc 1999). Some major positioning indicators for the international research activities of universities used in those studies are listed in Table 2 below[10]:

Table 2: Positioning indicators for Universities

Existence of an internationalisation strategy or plan, with targets, priority areas and priority countries
Existence of dedicated budgets and / or a central internationalisation unit to support international research activities (seed money)
Existence of an internationalisation unit to support internally
Number of international agreements at University /organisation level
Share of research projects with an element of international cooperation and/or using shared facilities, development over time
Number of international partnership or cooperation agreements at institutional level (may or may not be linked to education agreements)
Share of income from international funding sources
Share of staff from abroad, share of domestic staff spending research time abroad

Overall budgets spent on international activities and received from international sources.

Source: Own compilation

Many of these are indicators of general strategic orientation rather than of levels of activity or impact. In that sense they are highly complementary to the more output-oriented indicators already discussed.

Current practice

Boekholt et al (2009) find little evidence that policy-makers systematically assess the *need and scope for* cooperation when mapping the strengths either of other countries or of their own community. There is certainly no uniform or dominant approach for monitoring the international activities of the science and innovation community. Data is certainly collected by funders or research performing organisations and some countries have started to look more systematically at the need for and opportunities from international activities as part of the development of explicit internationalisation strategies (e.g. Germany, Ireland, UK, Netherlands, Finland - see CREST Working Group 2007). Some countries use indicators to take a general overview: for instance France, where the specialist public institute OST provides regular reports on science, technology and innovation activities and performance (within France and globally), regularly publishes indicators on international co-publication,[11] and produces one-off studies on the co-publication profile of the French research community. However, this practice is neither uniform nor widespread and systematic across Europe[12].

Two areas in which some countries do use data more systematically are *industrial R&*D and – more recently – *mobility* of researchers. For both these issues countries rely heavily on OECD and EUROSTAT data to benchmark their relative attractiveness and performance against peers. As to firm R&D, for many years, the OECD and various national survey systems have delivered aggregated data and analysis based on firm report data, patent data, FDI and trade data, and national policy makers have learned to use those datasets.[13] However, even here the policy makers feel they know too little about the ways in which international activity translates into 'spillovers' to the domestic system, and about how SMEs, who are not generally engaged in FDI or international patenting, can best profit from internationalisation.

It is also unclear how systematically the data on internationalisation activities which is collected by *research performing* and *funding* organisations is used in higher level policy processes. For instance research performing organisations are rarely required to systematically report international agreements or mobility[14].

Some indicator construction for university internationalisation has taken place in the context of the CEIHE project (Classifying European Institutions for Higher Education) led by the Centre for Higher Education Policy Studies at the University of Twente[15.] They have developed and piloted a series of indicators for classifying universities along a range of dimensions including the internationalisation of teaching and research (CEIHE, 2008). The indicators proposed and explored in that study are listed below in Table 3. In many cases aggregated data does not exist and the CEIHE project has also had to pilot the collection of these data from individual institutions. Finally, Boekholt et al (2009) find little evidence of work to understand the *effects* of international activities within research organisations.

Table 3: CEIHE internationalisation indicators for HEIs

Number of degree seeking students with a foreign qualifying diploma as a share of total student enrolment
Number of incoming students in international exchange programmes as a share of total student enrolment
Number of outgoing students in international exchange programmes

Number of international staff members as a share of total staff members
Number of students in joint degree programmes (with an overseas HEI) as share of total student enrolment
The institution's income from EU/internat. research programmes as a share of total research income

Source: CEIHE, 2008

4.1.2 Measuring and understanding the status quo: policies and frameworks

Indicator needs

A clear picture of existing supporting structures and policies for international activities, both at the national and international level, would seem to be a key part of any status quo analysis. Research policy instruments tend to serve multiple policy goals[16] (Flanagan et al, 2010). 'Mainstream' national funding instruments are accompanied by instruments specifically designed to promote internationalisation (e.g. fellowship schemes and grants). Here then, status quo analysis would need to take account both of the degree of openness of mainstream funding instruments to internationalisation activities *and* the extent to which internationalisation activities are promoted/supported by dedicated instruments. Suggested approaches are listed in Table 4 below.

Table 4: Approaches to capturing international orientation of research funding instruments

The 'openness' of national programmes (e.g. the actual level of (funded) participation of overseas actors)
The number and activity level of dedicated programmes for outward mobility/collaboration and inward mobility/collaboration, international research agreements and other international collaboration activities (e.g. bilateral agreements, dedicated budgets (reciprocal or not), number of projects and/or partners, etc.)
For EU and associated member states, participation in European schemes (Framework Programme, but also including more strategic schemes such as ERANET and Technology Platforms). For all countries participation patterns in other trans-national programmes (e.g. Human Frontier Science Programme) and participation and activity patterns in International/Intergovernmental Research Organisations.
The governance structures that relate to the measures, i.e. the adequate positioning indicators as defined above.

Source: Own compilation

Current practice

Many countries lack a full picture of the internationalisation of their own *policy activities* and the effects of this. This is not so much an issue of evaluation (see below), but about the *starting point* for strategic initiatives. A few countries (e.g. Germany, UK, Ireland, Finland) have conducted more systematic empirical analyses to understand the scale and scope of internationalisation. In their analyses Germany and Ireland have included both the public research organisations and the policy support level. In Ireland, a systematic screening of all departments and agencies and of a large sample of research organisations and researchers was conducted (see FORFAS / ACSTI 2008, Breathnach 2008; Brazil is taking a similar approach, Boekholt et al. 2009b).

In the UK, Ireland and Germany this kind of analysis has fed into the strategy making process, delivering for the first time a set of quantitative and qualitative indicators to understand international involvement and gaps. Recognising that simple quantitative indicators about international activities and supporting mechanism are not by themselves sufficient, these countries have attempted to promote careful and systematic dialogue amongst interested and affected actors to better understand the use of, needs for and shortcomings of quantitative indicators at country and institutional level.

There are few examples of systematic approaches that go beyond dialogue. One holistic approach has been conducted in the UK through the Global Science and Innovation Forum (GSIF). This sought to combine data provided by scientific attachés with data retrieved from reports of key funding and research organisations and a limited set of other studies. Data was acquired along four dimensions: international involvement (how engaged a specific country is in international programmes and fora); level of development; science; and innovation. Existing data was combined with specific studies (e.g. bibliometrics) and with positioning indicators for key research organisations in those countries. However, the exercise struggled to obtain qualitative positioning data and much of the data that was collected fell into the traditional category of input/output indicators of scientific activity. Nonetheless, is the exercise was felt to have improved understanding of the potential for research (and innovation) collaboration with other countries (Boekholt et al, 2009b).

4.2 Stage 2: Setting targets, making choices

Indicator needs

A second possible role for indicators is to support the *definition of more explicit targets* for policy and strategy at all levels. A key challenge is to define a *desirable* scale and scope of activities as, per se, more internationalisation is always not necessarily better. Setting targets, let alone measuring the associated benefits, is even more challenging with the rise of the *broad* policy paradigm. The superimposition of multiple policy objectives and contexts necessarily implies conflicting targets. Thus, thought must be given to potential target conflicts, to the prioritisation of targets, and to the management of trade-offs. While the discussion about target conflicts between or within organisations will inevitably be a political process, the thoughtful use of appropriate indicators should provide a systematic basis for such discussions.

Current practice

In practice, very few internationalisation strategies have explicit targets, and if so they are mostly qualitative. Further, targets tend to be simply focused on increasing the scale of internationalisation (more collaboration, more researcher mobility, etc) rather than on the contribution this delivers to the final goal(s). Demonstrating cause-effect relationships in complex systems is a common problem and intermediate activity indicators are easy to collect[17]. To have targets for the scale, scope and nature of international activities assumes that the effects of those activities on other policy goals and the system as a whole are known, but little generalisable knowledge exists, especially bearing in mind that a good mix will likely vary from one field or sector to another, from one national 'system' to another, and will change over time as the dynamics of the research or innovation system and field or sector evolve (Boekholt et al, 2009b).

4.3 Stage 3: Indicators to understand the international 'opportunity environment'

Indicator needs

Regardless of the policy goals driving internationalisation, good intelligence regarding potential international partners is vital. There are few systematic indicator systems in place for the identification of international partners (the UK GSIF case being a rare exception). Top-down prioritisation is done according to broad political criteria, whilst bottom-up activities are largely driven by the personal knowledge and personal networks of the research community. A more systematic approach would tie these together, taking 'demand' signals from the domestic research community into account

when identifying 'target' countries or organisations. Some possible indicator needs are shown in Table 5.

Table 5: Possible indicator needs regarding the international environment

Identification of scientific or technological 'hot spots' (technometrics, bibliometrics, peer reviews) or complementary capabilities and skills
Analysis of existing cooperation patterns
Identification of complementary policy structures and potential institutional partners (e.g. indicators for openness of programmes)
Where relevant, determining how STI collaboration could be linked to market opportunities abroad, both for public research and for firms (indicators to be used would be timing and speed of innovation diffusion in certain areas, existence of demanding users eager to collaborate with those at the research forefront, etc.)[18]

Source: Own compilation

Current practice

Perhaps the weakest link in the cycle is the use of indicators to support systematic attempts to understand the international 'opportunity environment'. Multiple actors are involved in defining the direction and contents of international activities and collaboration patterns often have a long and complex history. Decisions for new collaborations are 'easily' made (e.g. all countries have stepped up their ties with China, both through bottom up and through strategic top down actions), decisions to streamline or completely halt existing collaborations are more difficult.

A few examples illustrate different possible approaches. A first, highly pragmatic strategy is to utilise scientific attachés in embassies, where they exist. The extent and capacity of such networks vary from country to country, with France and the UK being much more active than, e.g. Germany. Generally, attachés report about general developments and act as brokers into the local systems. The UK has, in the GSIF process mentioned earlier, linked reporting by attachés to a systematic analysis of target countries, analysing them across a limited set of indicators: total number of scientific citations and share of scientific papers in most prestigious journals, number and development of patents, total and business R&D and development of student numbers. These were mapped against emerging strategic priorities. This country monitoring was accompanied by an in-depth analysis of the profiles of partner countries (by co-publication) and the gap between the expected level of cooperation (indicated through the publication profiles of partner countries) and actual cooperation activities (Adams et al 2007). In France OST produces regular reports on STI activities and performance. These contain the scientific profile not only of the advanced OECD countries but of emerging and developing countries, which puts the country in a good position to detect important developments early on[19]. A third, more discursive approach has been developed in Ireland, bringing together stakeholders to discuss specific international activities and international cooperation and co-ordination options.

A fourth mode of understanding the international environment has been established by the German Federal Ministry of Education and Research[20] which set up a reporting system on international research and education activities and related policy developments in around 40 countries ("Kooperation international"). This service does not provide regular analytical insights on scientific "hot spots" based on some quantitative indicators, but it does point towards specific cooperation potential (e.g. through international cooperation fairs) and provides current information about policy initiatives, institutional and organisational developments that have proved very valuable for the decision makers in policy, funding and research organisations.[21]

4.4 Stage 4: Monitoring and evaluating

Indicator needs

A final stylised purpose of indicators is the monitoring of developments and the evaluation of specific measures to support international activity. On a first level, indicators should monitor how internationalisation of the national 'system' develops on the basis of status quo analysis (see above, stage 1). There is a need for indicators that capture the *development of international engagement* of the research community across the different possible modes of internationalisation and changes in governance and organisational positions. However, because internationalisation is only an end to other goals, monitoring would also have to *assess how international activity contributes to 'better" science and technological development, to competitiveness and to the societal and political goals associated with international STI activities* (linked to stage 3).

A second, more concrete function is the evaluation of internationalisation *actions and instruments* and the evaluation of *international dimensions in national programmes*. Indicators here should help the assessment of specific policy instruments that are designed to foster international engagement and the cost-benefit ratio derived from them for individual researchers, organisations and the country as a whole. Here again, the development of specific indicators is at its earliest stages, although promising examples can be found. This reflects the fact that many countries are just beginning to build systematic internationalisation strategies. Thus, the international dimension is not yet reflected in the broader literature on the evaluation of STI policy, and the international dimension of evaluation and measurement of success mainly comes in when countries assess relative performance (of policy instruments) against other countries (Georghiou & Larédo 2006).

Current practice

When screening existing monitoring or evaluation activity related to internationalisation, two levels should be distinguished. The first level is the assessment of effects of international activities, the second of evaluating the effects of policy instruments and framework conditions on collaboration patterns and their impact.

1) The effects of international research activities

International research activities are not an end in themselves, they are done in pursuit of scientific and other goals (Boekholt 2009b). However, no country that we are aware of has a system in place by which the effects of international activities are measured systematically. Policy-makers tend to rely on anecdotal evidence or on the "more is better" approach already mentioned. For instance many policy-makers assume that international co-publications are an indicator of excellence, but few systematically measure the extent of such co-publication. At the applied end of the research spectrum, there is little use of indicators such as contracting income, success rates in international collaborative programmes, etc, let alone comparisons of performance across sectors, or micro effects on company R&D effectiveness and efficiency or innovation performance. As regards international mobility, there is little systematic exploration of effects as measured through analyses of 'brain drain' or 'brain gain', e.g. through CV or citation analysis. Table 6 illustrates some examples of indicators used to measure the impact of international activities on organisations and on individuals in an empirical study for the German Ministry BMBF.

Table 6: Indicators for impact assessment (example Germany)

Institutional level: a range of indicators that tried to measure how international activities of public science effected quality, speed, reputation gains, changes in cooperation patterns, ability to access complementary or specialised knowledge, changes in thematic scope, organisational changes in the organisation, efficiency gains.
Individual level (impact of mobility): scientific career, cooperation with researchers, international teaching experience, and effects on publications, networking with overseas firms and career planning.
Policy: Assessment of framework conditions and policy: survey of individual scientists and leaders of research organisations and universities were surveyed.

Source: compiled from Edler 2007

2) Evaluating policies and programmes

Second, as already noted, little effort is made to assess the impacts of internationalisation in terms of the ultimate policy goals (e.g. contribution to foreign policy, solution to grand challenges, linkages to related national activities, etc.). To simply measure the changes in scale and/or scope of international activity itself – as mostly done – might be justified if the goal were to radically increase international engagement or to 'catch up' to the leading edge through strong international engagement. Even here, though, impact assessment is often limited to take up rather than focused on structural changes, lasting networks, contribution to common agenda setting, spill-over effects to other activities, etc. One example in which the lasting effects of internationalisation programmes have been looked at is the evaluation of the British Council International Programme which analysed subsequent project activities in the Framework Programme (Georghiou & Cunningham 2002).

In the 'broad policy paradigm' where internationalisation is but the means to other policy ends, the conceptual link to the final goal must be explicated and an attempt made to make the contribution of international activity to this end measurable. As one illustration, the Canadian Institute of Health Research has had an evaluation procedure that takes into account a whole range of goal dimensions (Boekholt et al., 2009a, p. 38). The institute has a mission oriented programme of activities, and as such the link between scientific excellence and direct impact on the societal goal (health) is more direct. Indicators used are shown in Table 7 below. With such a multi-dimensional framework the position of the programme can be more fully defined and changes over the years be monitored.

Table 7: Canadian Institute of Health Research evaluation indicators

Numbers of international collaborators in the programme
Proof of excellence and follow up funding
Governance adaptations (international peer reviewing, international Advisory Board members)
Impact on the next generation (training awards)
Integration into international research networks, both outward (overseas grants) and inward (overseas participants in national programme)
Knock on effects in terms of complementary programmes dedicated to specific societal challenges (agenda setting)
Recognition as an international best practice programme

Source: Boekholt et al 2009 (Canadian Background Report).

5 Conclusions: towards useful indicators for policy

5.1 Linking the narrow and broad paradigms

Reflecting on the challenges of the use and design of indicators under the 'broad' paradigm, two complications are apparent: *First,* within policy areas such as defence, foreign/diplomacy, health, energy, environment, etc., the relative roles of STI capacities and STI collaboration are less clearly

defined, as are the responsibilities for supporting those activities through policy. Many countries do not have mission or challenge oriented research and innovation responsibilities, but specialised research, technology or innovation ministries which cover the various activities across multiple domains. Core activities in these policy areas may not be linked to research and innovation activities, and therefore the *status quo*-analysis of capabilities as well as the knowledge on necessary adjustments and international agendas and actors may be less clear. Knowledge is dispersed across domain based and research/innovation policy actors, although in some domains national policy makers are more engaged in international research and technology arenas through organisations such as the International Energy Agency.

Second there is a severe challenge of horizontal coordination in terms of policy and of 'strategic intelligence'. Policy actors in different policy domains have overlapping, but still slightly different information needs and strategic intelligence opportunities. The aim of coordination and mutual adjustment must be to generate synergies, to link opportunities offered in international organisations to research strategies, and to diffuse strategic intelligence in the system.

5.2 Challenges for policy action

Governments are increasingly formulating ambitious internationalisation strategies but these are only partly evidence-based: at best policy-makers draw upon on evidence from ad hoc studies and transfer from other countries. Generally, little effort is made to measure the status quo. Target definitions and cost-benefit considerations are poor, and contribution to direct and indirect policy goals not traceable. The 'broad' paradigm introduces additional, often fuzzy rationales, potentially conflicting targets and potentially different approaches to indicators and policy analysis from other policy domains. This is not just an issue of indicators, it is an issue of strategic capabilities to design and use them. In this paper we make no prescriptive claims about the appropriateness of different possible rationales for internationalisation – we simply explore the potential indicator needs stemming from the 'broader' paradigm.

Policy makers are well aware of the need for better intelligence, but lack of capability, cost and uncertainty have held back developments. However, as the broad paradigm takes hold, the perceived benefits of internationalisation multiply, whilst there is a huge potential in coordinating and pooling activities across several nations (particularly at the EU level for member states). We consider, then, that further efforts can and should be made to work towards both a more systematic design and more concerted use of indicators.

A truly systematic approach would have to differentiate amongst different modes, actors, drivers, and stages of activity. Developing a concept that is able to capture all those dimensions would require policy-makers themselves to reflect more systematically about what their *actual* indicator needs might be. A step-by-step mutual learning process bringing policy-makers from different countries together[22] could

- Kick-start and promote debate about indicator needs and use
- Support policy-makers in the development and operationalisation of indicators by drawing upon experiences elsewhere
- Set up a clearinghouse[23] for relevant indicators and analysis
- Define areas in which countries could pool their data and the data finding activities whilst retaining a variable geometry
- Define areas for which a supranational or transnational approach of collecting and disseminating data is attractive
- Exploit existing variable geometry opportunities in terms of pooling countries with similar interests (for internationalisation of sectors or partnering with certain countries).

- Include policy makers from other policy areas who are active in international policy activities (e.g. in International Organisations such as International Energy Agency or World Health Organisation)

5.3 Implications for indicator designs

Few dimensions of internationalisation are at present well served by existing indicators. In order to better match the broad range of drivers and intentions with evidence, a list of indicator deficiencies can be constructed that are relevant for the whole policy 'cycle'. While we know a lot about cooperation patterns of individual scientists and foreign direct investment of R&D of firms, we lack sufficient indicators and data to measure:

- international research activities of individuals, especially when it comes to mobility
- the positioning of strategic actors
- cooperation in innovation more broadly, with sectoral and technological differentiation
- embedding of overseas actors within a host system
- the extent to which international collaboration is pushed and financed through global endeavours
- the scope of internationalisation of national policy and funding programmes

Above all we miss indicators to measure the effects and impacts of international activities. Activity and output indicators often exist, and are often important in mapping internationalisation of researchers and research performing organisations. At the policy and funding level data is patchy and at all levels, even in cases where information on international activities is collected, there is little or no focus on impacts, whether positive or negative. Determining the impacts of internationalisation activities presents a significant challenge and here policy makers will have to work closely with indicator designers to determine innovative new approaches which can tackle this gap. Without better evidence in this regard, better data on activity levels will be of limited use.

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[1] Some authors even speculate about development towards a "global governance of science" based on a growing internationalisation of science-society discourse and the shared problem pressure societies face (Ozoliņa et al. 2009).

[2] The EU countries covered in a study by Boekholt et al (2009) were Estonia, Finland, France, Germany, Ireland, Poland, the Netherlands, Spain, Sweden and the United Kingdom, the non EU countries Australia, Brazil, Canada, China, India, Japan, Mexico, Russia, South-Africa and the United States, in this report we draw on those country reports, based on the summary analysis performed by of the authors within Boekholt et al. (2009, pp. 28-38), the original data on a large number of countries have been collected by a group of researchers within the study group led by Boekholt.

[3] Both tasks were performed within the context of a project for the EU Commission, led by P Boekholt (Boekholt et al. 2009a, b,). The paper builds on the relevant parts of Boekholt et al. 2009a, b and Edler/Flanagan 2009.

[4] Consequently, the paper does not cover the indicator needs of private companies.

[5] To make matters more complex, purpose and aspiration differs across scientific fields (EU Expert Group 2008, p. 30-34).

[6] The International Observatory for the Internationalisation of Higher Education www.obhe.ac.uk clearly documents this trend.

[7] Integrated Information System on European Researchers. See: http://ipts.jrc.ec.europa.eu/ activities/research-and-innovation/iiser.cfm

[8] Though a major new empirical study funded by DG Research (MORE – Mobility of Researchers in Europe) has filled some of these gaps. For more information see:http://ec.europa.eu/euraxess/index.cfm/general/researchPolicies

[9] The Third European Report on STI Indicators (EU COM 2003) in fact contains a range of those indicators that characterise organisations (e.g. Universities) within the European Science System.

[10] Many of those indicators are included in a study on ERA-Indicators 'Monitoring progress towards the ERA (Nauwealers, Wintjes et al. 2009).

[11] http://www.obs-ost.fr/fileadmin/medias/tx_ostdocuments/Partie5Graph_01.pdf.

[12] An example is a one-off large scale study on the internationalisation of the German research landscape (Edler et al 2007).

[13] Shapira et al 2009 have collected all data on international money flows for R&D, both private and public, showing that the ways in which countries collect data on flows is very different and short of what one would expect as basis for policy decisions.

[14] Except where required for legal reasons – e.g. equal opportunities monitoring or immigration enforcement.

[15] http://www.cheps.org/ceihe

[16] So for instance the delivery of new knowledge, the maintenance of a research capacity in a particular field or discipline (or in a particular institutional setting) and the development of new researchers often co-exist as shared goals of research policy instruments.

[17] An emphasis on activity measures can be problematic: take the example of researcher mobility, where 'more mobility' is generally regarded as a good thing. In reality mobility has asymmetric consequences both for receiving and sending research institutions and for the professional and personal lives of individual researchers.

[18] As noted above, the innovation dimension as such is not in the focus of this article, it is only dealt with when connected to science and research policy practices and objectices.

[19] e.g. http://www.obs-ost.fr/fileadmin/medias/tx_ostdocu ments/Partie5Graph_01.pdf

[20] http://www.kooperation-international.de/

[21] This has been found in the interviews within the study on internationalisation of public research in Germany (Edler 2007).

[22] For instance, at the European level.

[23] The data clearinghouse idea as such is not new, it has been revitalised in the European evaluation debate by Kuhlmann / Heinze (2004) and Edler / Kuhlmann (2006), the basic idea of a clearinghouse would be that data collecting institutions in the countries would report uniform indicators to a European collector for comparison, exchange, aggregation and learning, following uniform collection standards.