Science and Technology Options Assessment

Measuring scientific performance for improved policy making

Summary of a study

IN-DEPTH ANALYSIS

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1 INTRODUCTION

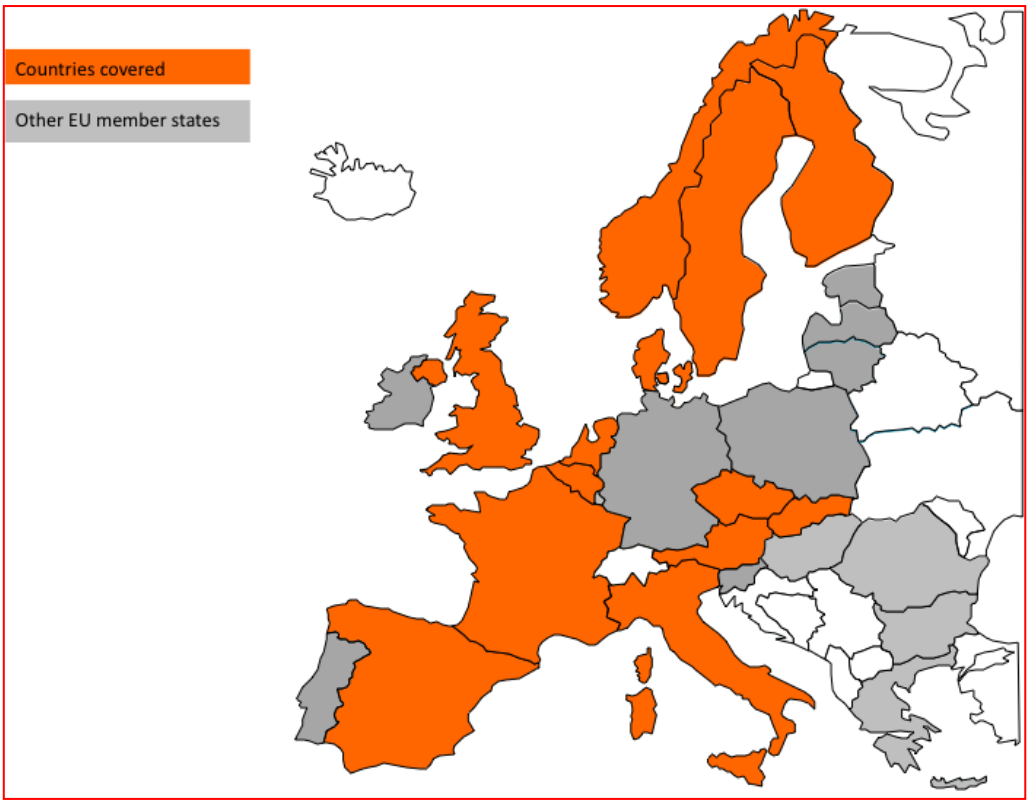
This study had as its main objective to analyse the desirability and feasibility of creating a transnational system for collecting and monitoring research performance data (on inputs, outputs and productivity) in order to improve policymaking and to identify relevant research policy options.

For this purpose, we analysed the key policy drivers, i.e. the key reasons why there is growing pressure for monitoring and measurement of research in Europe – pressures that ultimately drive a desire for a more integrated way to understand not only research performance but also its efficiency and effects. We also looked into current approaches to the collection of strategic information and research performance assessment in Europe and at the national levels in the Member States and considered benefits and challenges.

The methods used for the analysis included an extended document and literature review, interviews and case studies.

We covered 13 countries in Europe in this study, i.e. 12 EU member states and Norway (Figure 1,). The analysis covered countries in Northern, Western, Southern and Central/Eastern Europe as well as close to all of the most important research-performing countries. The 16 EU Member states that are not covered in this study are: Bulgaria, Croatia, Cyprus, Estonia, Germany, Greece, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Romania, and Slovenia.

Figure 1 Geographical scope of the study



2 MAIN FINDINGS OF THE STUDY

In this chapter we set out the context and argue for the desirability and feasibility of a European integrated research information infrastructure.

We first describe the current need for strategic information at European level among all actors in the Member States as well as at European level, defining the policy context and drivers that influence those needs. An analysis of the tools and methods used for the collection of the strategic information needed showed the inadequacy of the current approach to respond to those needs.

In Chapter 2.2 we report on our main findings related to the current trends for the assessment of research performance and the collection of strategic information in the Member States. Also in this case we first provide a view on the needs and the sources, tools and methods for research performance assessment. We discuss the current use of national research information systems as tools for the collection of strategic information at the national levels and, in a final chapter, provide an overview of the current drive for harmonisation and integration of information among stakeholder communities across Europe.

Chapter 3 contains our conclusions on the desirability and feasibility of a European integrated research information e-infrastructure.

2.1 A transversal need for strategic information at European level

There is a great need for a joined-up European view on scientific progress, productivity and quality. Actors at all levels of the European research system, i.e. European and national policymakers as well as research institutions, need access to more data and analysis about research and its performance across multiple domains and countries than has previously been the case.

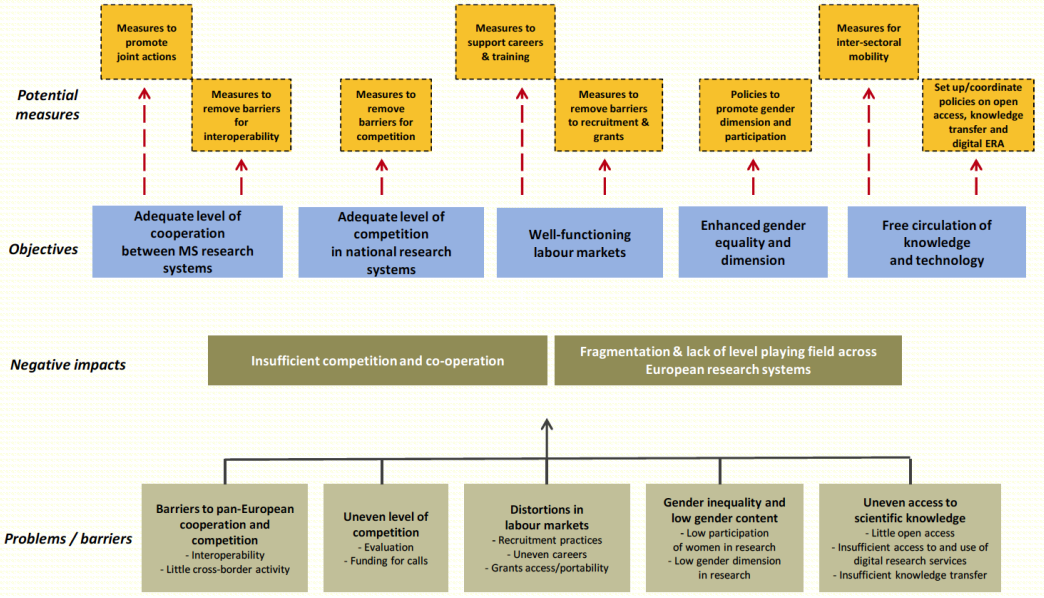
The policy context and drivers

Policymakers and the wider public have changed their perception of the role of research during the past few decades. Especially since the 1960s/70s, research is increasingly expected to support the attainment of explicit social goals, contribute to economic development and develop solutions for major societal challenges such as climate change.

The European Research Area concept is intended to facilitate the contribution of research to the 'knowledge economy' and for this reason, fosters consistency between European and national research policies as well as trans-national research collaborations.

In its 2012 Communication, the European Commission indicates a set of research governance practices that the European Member States are expected to undertake in order to complete the European Research Area. Exhibit 1, below, presents the drivers and problems identified to complete the ERA by 2014, as defined in the ERA ex-ante impact assessment (EC 2011b), which analysed the strengths and weaknesses of Europe's research systems.

Exhibit 1 Problem tree for completing the ERA by 2014



Source: ERA ex-ante impact assessment, 2012

The actions that Member States are expected to undertake related to the priority areas 1 and 2 are of particular interest for the topics covered in this study.

- The intent of Priority Area 2 is to enable transnational research and innovation "by exploiting synergies between national and international programmes, strategically aligning different sources of national and other funds at EU level rather than cross-border funding per se." The Commission envisages the definition of common priorities and joint research agendas, the implementation of joint research agendas, and the joint implementation and/or financing of calls and projects. For this purpose, Member States are invited to:
  - "Step up efforts to implement joint research agendas addressing grand challenges, sharing information about activities in agreed priority areas, ensuring that adequate national funding is committed and strategically aligned at European level in these areas and that common ex post evaluation is conducted.
  - Ensure mutual recognition of evaluations that conform to international peer-review standards as a basis for national funding decisions.
  - Remove legal and other barriers to the cross-border interoperability of national programmes to permit joint financing of actions including cooperation with non-EU countries where relevant".
- Priority Area 1 focuses on fostering open national competition, considered "crucial to deriving maximum value from public money invested in research". This includes open calls for proposals where peer reviewers include foreign experts, and institutional funding based on research performance assessments. The Commission paper argues, "While the balance between these two approaches may vary, they should be at the core

of research funding decisions in all Member States in order to overcome divergences in performance across the EU."

These requirements can be expected having significant consequences for the research governance in the Member States, including strategy development, and the funding and performance assessments models:

- A higher level of standardisation in terms of focus of research funding programmes, funding and evaluation practices in the Member States can be expected as longer-term outcomes, which should facilitate the collection of detailed information for research assessment purposes at a European transnational level
- The intention to increase the joint funding of research programmes and the opening up of national programmes for researchers in other countries no doubt will accentuate the need for national policy makers to have access to data beyond the national borders, e.g. on participation in such programmes by the research actors in their countries and the related outputs and outcomes
- The EC report considered that performance-based research funding, i.e. "the assessment of the quality of research-performing organisations and teams and their outputs as a basis for institutional funding decisions", is part of 'best-practice performance' in this context – "which all Member States should attain". Thus, despite the misgivings of some members of the research community, there is a strong drive from the state (at both national and European levels) for performance-based funding and the information systems needed to support it.

In other words, in the ERA research and research governance are becoming more 'European'. As a consequence, there is also a growing need for a European view on research performance and impacts - across all layers of the European research systems, from policy-makers to researchers.

This shared need should also be considered in the context of increasing demands for research performance assessments. Evaluation is an integral component of the 'evidence-based' policymaking processes, providing the needed input for priority setting and strategy development - at the level of policy-makers as well as research actors. Accountability, efficiency and effectiveness are key concepts that govern the relationships between government, public research-funding agencies, research institutions and researchers.

Current sources and tools for research performance assessment at European level

Evaluations rely on a set of sources and tools for the collection of evidence. These range from aggregate STI indicators developed at European and global level (the OECD and Eurostat surveys and manuals) to information systems for the management of research.

Policy-makers at the European and national levels make a considerable use of STI indicators in order to benchmark the performance of the science and innovation systems in their countries. STI indicators provide information at an aggregated (country) level, and while important progress has been made in recent years to align these indicators better with policy needs, evaluation and indicator development experts overall agree on the need for micro-economic analysis and access to micro-level data.

The inadequacy of existing STI indicators to meet current information needs has led to an increasing use of ad-hoc evidence collection projects, especially at the European level, in an attempt to improve the data base for these STI indicators. These studies are many, diverse, and fragmented. Studies have been funded in various Directorates General of the European Commission, aimed at filling perceived evidence collection gaps related to specific topics such as international collaborations for research. Coordination is lacking, with the risk of overlap and duplication and an overall lack of efficiency.

Experts recommend the development of a multi-level research information infrastructure – at the European level and beyond – for the collection of the needed micro-level data.

The European Commission Expert Group on the assessment of university-based research (Expert Group on Assessment of University-Based Research 2010) identified in the lack of reliable, comparable and comprehensive data a major challenge for the current implementation of research assessments. The availability of more fine-grained information and data, comparable at an international level, was a topic that was high on the agenda of this high-level group and needs were expressed for

- Comprehensive data and information on the context in which knowledge and innovation is created, covering the full policy-mix, taking into account the roles of individuals, consumers and government in the innovation process and including the local and regional dimensions
- A more detailed coverage of input data, including funding and other intangible assets such as software, human capital and new organisational structures
- An improved description of policies and funding models related to different typologies and focus areas of research, including interdisciplinary research
- Improved data and information - at the micro-level - on interactions between the actors in the system and the flow of knowledge and technologies, at national and international level
- Data and new methods of analysis to understand innovative behaviour, its determinants and its impacts, such as, e.g., the birth and evolution of innovative firms
- Data allowing for the measurement of the effects and impacts of research policies, in particular those implemented at both national and European level, for example related to the grand challenges, and going beyond the limited time frame determined by the analysis and data collection concerning projects and programmes
- The development of concepts and measures of innovation that reveal their impact on or contributions to achieving social goals

The Expert Group recommended the European Commission to 'invest in developing a shared information infrastructure for relevant data to be collected, maintained, analysed, and disseminated across the European Union.'

This concept is in line with current trends in extended use of research information systems and the launch of several initiatives to integrate or link these systems - at institutional, national and European level. It is also in line with current initiatives at a global level, including the Star Metrics programme that is currently running in the US, so there is room

for the creation of synergies, and or at least setting the pre-conditions for creating an internationally integrated system.

Another important source for performance benchmarking in the field of research is bibliometric databases, which collect information especially on the productivity of research (number of publications in peer-reviewed journals) and quality (for example through number of citations by other researchers). Sources are commercial bibliometric databases, primarily those maintained by Elsevier and Thomson Reuters.

Increasingly, however, alternative sources are gaining in importance, including the web – allowing for metrics as implemented in Google Scholar and 'altmetrics', and the Open Access Repositories. There is ongoing discussion in the academic community about how to define and measure quality in research, with repeated criticism of the currently dominant reliance on publication and/or citation data as a measure for quality in research.

2.2 Collection and use of strategic information in the Member States

In recent years, there has been a considerable increase in the development of national research information systems within Europe, exploiting current technological developments for an improved strategy development at the national and institutional levels. These national systems interconnect the systems existing at funding agency and institutional levels – often also to external datasets or systems such as the national Open Access Repositories. They allow for integration of the information that the interconnected systems contain at the national level; as such, they collect micro-data at the level of the national research system.

The needs for strategic information

Actors actively involved in the production and use of research performance data encompass government bodies at the EU, national and regional/local levels, government agencies in charge of research and innovation governance as well as research institutions and their management and governing bodies, research groups, and ultimately the researchers themselves. Exhibit 2 gives an overview of these actors' needs for and use of strategic information, further described below.

Exhibit 2 Use of research information by the different stakeholders

		Governments and government agencies			Research institutions management & governance		
		EU and National Governments	Ministries responsible for research/ innovation	Government Agencies	Governing Bodies/ Councils	Executives/ Management	Research Groups / departments & institutes
Inform policies & strategies	Determine competitiveness / strategic positioning	x	x	x	x	x	x
	Improve performance and quality		x	x		x	
	Improve system functionality		x	x			
	Aid resource allocation			x			
Assess performance	Quality, sustainability, relevance and impact of research activity		x	x			
Other	Investor confidence/value-for-money and efficiency	x	x	x	x		x
	Recruitment					x	x

Based upon: Expert Group on Assessment of University-Based Research, *Assessing Europe's University-Based Research*, European Commission, DG Research, 2010

Universities and research institutions have become more dependent on competitive and contract funding – though some core funding is still historically determined, it is increasingly becoming performance-based, and responsibility for the quality of the research has substantially been delegated to institutions' own management and the researchers themselves.

The overall research context has changed considerably, characterised by growing competition and globalisation. It has provoked changes in the institutions' human resources policies, driving them to develop strategies in order to raise their scientific profile and attract specific and/or foreign researchers and students (Veltri et al 2009).

In this context, universities and research institutes rely on performance assessments in order to understand their strengths and weaknesses and measure their competitiveness, at an aggregate level and the level of individual departments and research groups. Results of these analyses feed into institutional strategy making (and eventually internal funds allocation) and help the institutions in their monitoring and reporting on outputs and impacts. Institutions also use this information for publicity purposes, e.g. to support student and academic recruitment, aid research partnerships (with private enterprises or other research institutions) and initiate or sustain investments.

Government agencies & ministries responsible for research have experienced an expansion of their responsibilities related to research governance. They are expected to exert their influence not only to ensure quality and relevance in research, including relevance from a socio-economic perspective; they are also required to define and tackle systemic failures, ranging from the institutional set up and the creation of opportunities for improved interactions between the various actors in the system, at national and international level, to ensuring the sustainability of competitiveness through the creation of critical mass in

strategic areas. Their need for strategic intelligence is closely linked to accountability, i.e. to provide evidence of the efficiency of management processes and the effectiveness of programmes and policies in reaching the expected benefits for society.

A further driver is the growing importance of the grand 'societal challenges', such as those identified in Horizon 2020, in research and innovation policy and as channels for funding. These challenges tend to cut across the responsibilities of individual ministries, creating a need for policy coordination and a demand for more integrated and harmonised strategic intelligence across different ministry domains. Clearly, this is likely to increase the level of need and interest for the kinds of integrated research repositories, information systems and analytics discussed in this report.

Finally, changes in the policy context in Europe have imposed new demands on the monitoring and assessment of research and innovation at the national level. The creation of the European Research Area, launched in the beginning of the 2000s, has led to a stronger collaboration and at times integration of national and European Commission research and innovation programmes and policies. National policies are therefore more firmly set within the European context, as are their outcomes and results.

As a consequence, the 'silo' approach for the measurement of scientific performance that has been adopted so far - with policy makers at national or European level having access to and analysing information only related to their respective national or European funding system and R&D policies - is no longer adequate to respond to the policy needs.

Current sources, tools and methods for research performance assessment

National policymakers typically rely on the use and analysis of statistics and indicators collected at the international level (OECD or Eurostat) for the analysis of the country's positioning on the international research and innovation scene, in most cases complemented by indicators deriving from data in international bibliometrics and patents databases. While these data sources give a view on the comparative performance of the national system, their lack of detail limits the possibilities for their use in the context of policy making at the national level.

Strategic information on which to build national policy making derives from ad-hoc evidence collections at the national level and/or information collected in research evaluation databases, i.e. information systems often developed for the purpose of guiding performance-based research funding allocations (PRF systems). The analysis in this study shows the strong influence of the national context on research performance assessment exercises, how they are performed and which indicators are included.

Overall, there are 3 models for the assessment of research: purely metrics-based exercises; the involvement of peer review panels; and the mixed model, combining these two approaches. The choice between metrics (mainly bibliometrics) or peer review is contentious. On the one hand, metrics-based systems typically encounter criticism in the research communities as an inadequate measure for their performance and the assessment of the quality in research. On the other hand, peer reviews for nation-wide performance assessments are particularly cost-intensive and are liable to other biases. Even in the context of the mixed model, the cost of the exercise – and in particular the cost/benefit balance – is a

topic for discussion. All assessment models, therefore, show a strong reliance on bibliometrics as a measure of quality in research.

Especially in those countries where research performance assessments influence the allocation of institutional core funding for research (PRF), policy makers experiment with other measures for 'indirect' assessment of the quality in research, including criteria such as the amount of research funding gained from private or international sources, considered indications of 'excellence' or 'relevance' or both, and 'internationalisation' criteria such as the intensity of international collaboration and international mobility.

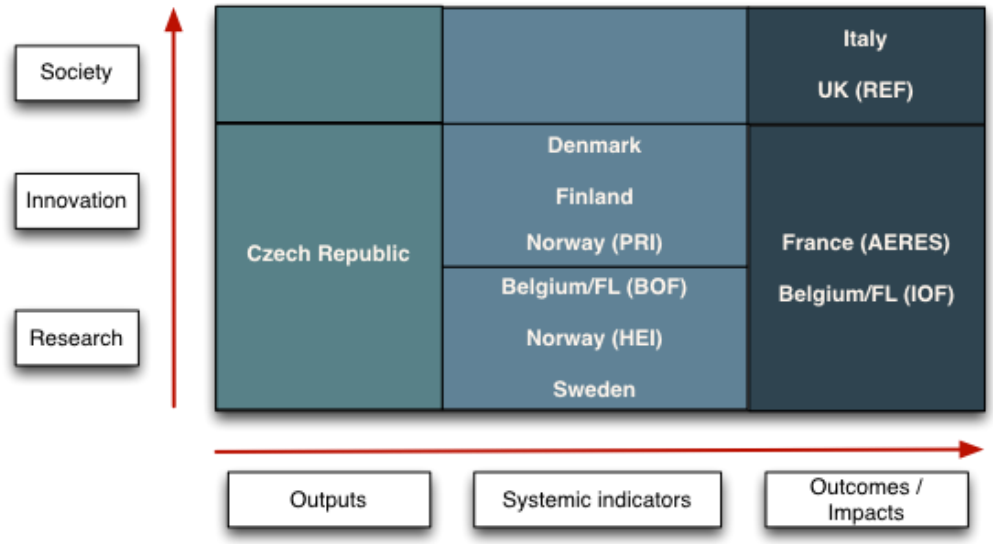
A main factor influencing the choice of indicators for the assessment of research performance is the vision on research and its role in society, and in particular, the concept of the pathways for knowledge creation and innovation. In some countries, such as the Czech Republic, the linear model prevails, seeing direct links between the inputs (funding) and outputs of research (). In other countries, the concept of an innovation system has gained ground and the dynamics and interactions between the various elements of a research system (actors, context, infrastructures, etc) are considered to be of primary importance. We categorised the indicators used for the monitoring and assessment of these factors as 'systemic indicators'. In PRF systems, these indicators have the function of steering research communities towards certain changes of behaviour, depending on the national context and the perceived failures in the research system. Outcome/impact indicators are seldom included and constitute a major hurdle for national funding agencies and evaluators.

Exhibit 3 maps the PRF exercises in the countries covered in this study in terms of indicator categories used (horizontal axis) and the scope of the indicators (vertical axis). On the horizontal axis, the assessment has an increasingly broad coverage from left to right. On the vertical axis, the scope of the indicators increasingly takes into account also the role of research in the 'knowledge economy'.

The Czech Republic is the only country that limits the indicators used to the output of research, even though it is the PRF system that covers research and innovation-related outputs in the most detailed and comprehensive manner. In a second grouping of countries, the PRFs include both output and systemic indicators; in Denmark, Finland and Norway this includes indicators related to innovation-oriented activities, such as research-industry interactions. Only a few countries look also into impacts. While the PRFs in France and Belgium focus on effects in the spheres of research and innovation, the models in Italy and the UK consider also societal impacts.

It should be noted that both in Norway and Belgium, the PRF models and indicators used take account of the characteristics of the research conducted.

Exhibit 3 Indicator categories in the PRF models in Europe (2013)



A challenge that most of these PRF systems are struggling with concerns the quality of the data, in particular related to the research outputs. The issue of data quality - and the reduction of data submission burdens for researchers and research performing institutions – is directly linked to the process for the data entry into the system. In many countries, this is a manual process, with the researcher or his/her institution inserting data directly into the research information system. The experience is that this system is prone to mistakes, omissions and duplication. It causes a burden on the researchers or institutions required to enter the data as well as on the public agency in charge of the cleaning and checking of the data.

Research information systems as a tool for the collection of strategic information

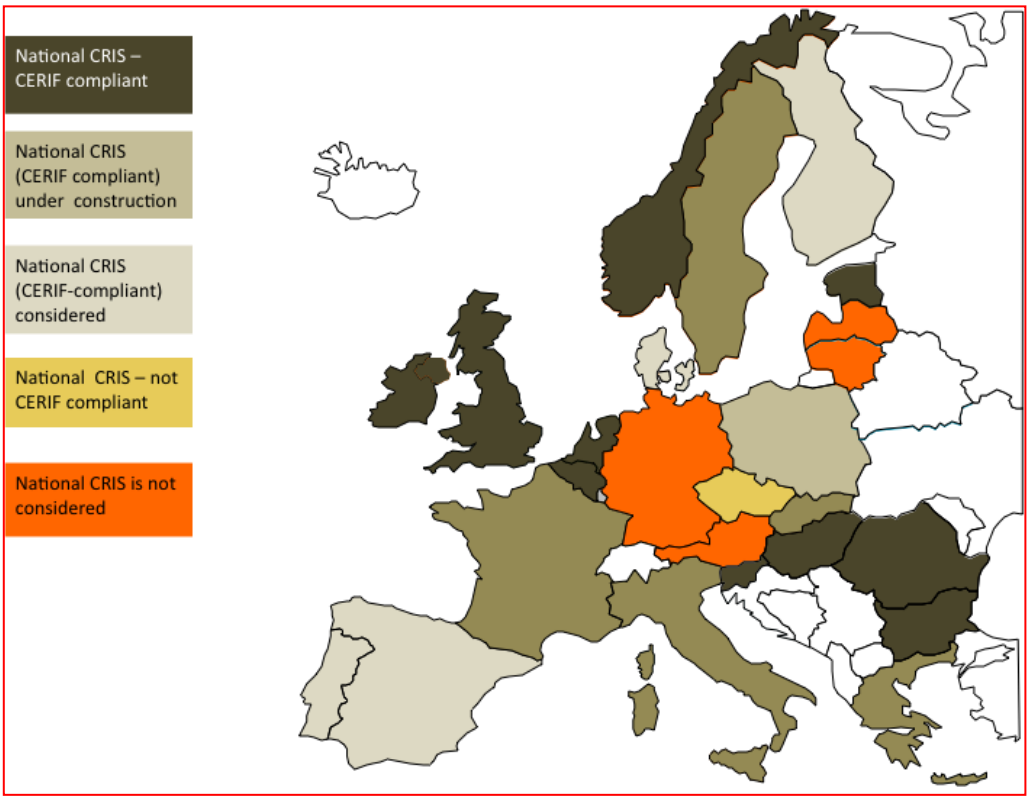
In recent years an increasing number of initiatives have been launched in Europe that interlink research information and management systems, publication databases and (national) research evaluation datasets. Some of these initiatives integrate or interlink institutional or public agency information systems, eventually creating national research information systems. The majority interlink research information systems with open access repositories. The common denominator for all these initiatives is the objective to improve the availability of information on research and its outputs, shorter- and longer-term effects.

Key drivers for the development of these national systems were the need for policy makers and funding agencies to reach a higher level of efficiency in the data collection processes, increase the quality of the data collected, and reach a broader and more comprehensive view on research in the country and its impact on the national 'knowledge economy'. These information systems also provide an opportunity to move away from the current strong reliance on bibliometrics and look for alternative methods and tools for the assessment of research performance. An important driver for the funding agencies is also the opportunity to have access to information also after the termination of funding agreements, recognising that outputs and outcomes from research often occur after funding has ended.

CERIF, the European standards for research information systems, has considerably facilitated this development. To date, 19 out of the 28 Member States have developed or are

in the course of developing national research information systems, close to all CERIF compliant; an additional 5 Member States are considering it; only Germany, Austria and 2 of the 3 Baltic States do not consider (yet) developing a fully national research information system (Exhibit 4).

Exhibit 4 National research information systems in the European Member States



National research information systems offer significant opportunities for all stakeholders in the national research systems and have the ability to respond to the multiple needs of researchers, research institutions and research policymakers.

A critical and typical feature of these systems is that mutual benefits are sought for both the research governance agencies and the research institutions and individual researchers, in an attempt to create a win-win situation and ensure co-operation in and acceptance by the research communities. These include efficiency gains in the reporting and collection of data and the possibility to re-use the data, e.g. in grant applications. Gaining access to a larger set of data also satisfies an often -expressed need of the research institutions for data and information that would allow them to compare and benchmark their performance with other institutions, thus improving their strategic decision-making. Access to research information by means of Open Access Repositories is important in particular for research groups and individual researchers.

In most cases, information is collected at the individual researcher level, using national systems for the standard identification of the researchers – even though the emerging international standard ORCID is increasingly used.

The drive for harmonisation, standardisation, and integration at the European level

Over the last decade, actors in various components of the research systems in Europe have been working on the basis for a standardisation of the processes and tools for the collection of data on research and research performance at European level. The ultimate aim of these efforts is to achieve comparability of the data collected and the harmonisation of research information systems.

Major actors in this context at the European level are Science Europe and EuroCRIS.

- Science Europe is the association of European Research Funding Organisations - RFO and Research Performing Organisations - RPO, which is a 2011 merger of the European Science Foundation (representing the research communities) and EuroHORCS (representing the funding organisations).
- EuroCRIS is a not-for-profit organisation that is dedicated to the development of Research Information Systems and their interoperability. It currently manages the European standard CERIF and includes among its members IT specialists in research institutions, funding agencies and research governance organisations from all over Europe and beyond.

An important development in recent years is the closer collaboration between these two organisations, more specifically the uptake and further development in the EuroCris of the outcomes from the ESF/EuroHorcs forum on internationalisation indicators.

In a recent development, euroCRIS is also trying to develop the CERIF standard so that it can better handle metrics. Members of EuroCRIS, predominantly IT specialists employed in national funding agencies, have set up an indicators workgroup, which will take further the work done in the ESF Fora. The expected result is CERIF-compliant software services that support evaluation of research including commonly used national or international methods. As an example, the set of indicators proposed by the ESF groups can be expressed in CERIF.

One of the main activities of this working group will be mapping all the indicators used in bibliometrics and scientometrics and describing how they are used around Europe in terms of measuring outputs, outcomes and impacts. At present time, the countries that are most active in the group are the Netherlands, Germany, United Kingdom and Norway.

In this context, EuroCRIS is also co-operating with Elsevier and Thomson Reuters, the scientific publishers that own the commercial bibliometric databases.

- Elsevier has developed 'Snowball Metrics' in collaboration with universities. This comprises a range of indicators that can be used for research and characterising research and are agreed with all the stakeholders. Elsevier works with euroCRIS to ensure that these metrics can be implemented using CERIF
- Thomson Reuters is developing a feature called "backward chaining". Typically, to measure impact one starts from the research project and tries to trace what the outcomes from the outputs were and what the impacts from the outcomes were. Thomson is trying to reverse that process by finding new stories on the Reuters' newsfeeds (e.g. "wonderful cancer drug saves 10,000 lives") and trace back to the research that caused the impact to occur, using intelligent text analytics.

These two major publishing houses have taken account of the success of Open Access Repositories and have aggressively been diversifying their businesses into research information systems and open access repositories as well as increasing their product and service offerings for research managers. These services not only encompass the use of bibliometrics in gaining scientific intelligence and monitoring competitors – well-established industrial uses – but also increasingly helping university research managers monitor institutional and individual researcher performance with the aim of improving institutional rankings and maximising income from performance-based research funding systems.

The understandable efforts of the traditional publishing and bibliometrics industry to protect its business by moving into these new areas means that control of research information systems, repositories and the analysis that can be done based on these is contested. It is not clear that a completely business-driven outcome would serve the interests of researchers, funders or policymakers.

3 CONCLUSIONS

3.1 A European integrated research information e-infrastructure

The trends in the Member States and their development or national research information systems have created a momentum for the development of a pan-European comprehensive research information infrastructure, geared to supporting science management as well as serving scientists. European policy-makers should exploit this opportunity and support and coordinate the development of a European integrated research information system.

Conclusions on desirability

A European research information e-infrastructure would facilitate the strengthening of the European Research Area and provide an opportunity for 'horizontal' connections (i.e. within and among the research communities) and cross-fertilisation, thanks to the opening up of access to data for and on research. We note that national paths for developing such interconnections exist, thanks to the current development of national research information systems. What is missing is the interconnection at European level, which has to pass through the national systems.

Presuming that the transnational research performance assessment system collecting information at the micro-level will take the form of a research information system, the specific added values of these systems can be expected to occur also in a transnational system:

- The current experience with national research information systems shows the value of these systems in terms of an improvement of strategy development capacities for all stakeholders involved.
- The efficiency and effectiveness gains that the national research information systems produced at the national level can be expected to occur also in the case of a European system, in particular in relation to the costs currently covered by the European Commission for the collection of the needed micro-data.
- Finally, the centrality of the research actors in the national research information systems, the attention to their needs and the search for a win-win situation in relation to the potential use of the system, and the alignment with the policies of open access to data cannot but be a positive factor also for the system at European level.

Such an e-infrastructure would enable sharing data on research across the European Research Area – and beyond. Benefits would include:

- For research institutions: the ability directly to compare and benchmark research performance with other institutions in Europe, taking into consideration the different missions of the institutions, their research infrastructures and national environments, thus improving the awareness of the institution's positioning in the European research landscape – beyond the analysis of bibliometrics
- For national funding agencies and policy makers: a comprehensive view of the complementarities of national research strategies versus other countries and the

European Commission; improved basis for comparisons and benchmarking of national research performance with other countries, in line with their respective needs

- For the European Commission: improved efficiency in the collection of micro-data, improving data availability, reducing duplication and enhancing the sustainability of data collection efforts
- For the research performance assessment community at large: the basis for an improved understanding of knowledge exchange mechanisms in the European research system, providing a comprehensive view on input and outputs

We consider it desirable that policy-makers at the highest levels in the European system make use of the opportunities offered by the latest developments in communication and information technologies and exploit the momentum created by the current development of national research information systems.

This would also avoid the risks associated with a completely business-driven approach to the use of research information systems; it is not clear that such an outcome would serve the interests of researchers, funders or policymakers.

European policy-makers should therefore start setting the basis for the development of a European integrated research information system that would enable sharing data on research across the European Research Area – and beyond.

Conclusions on feasibility

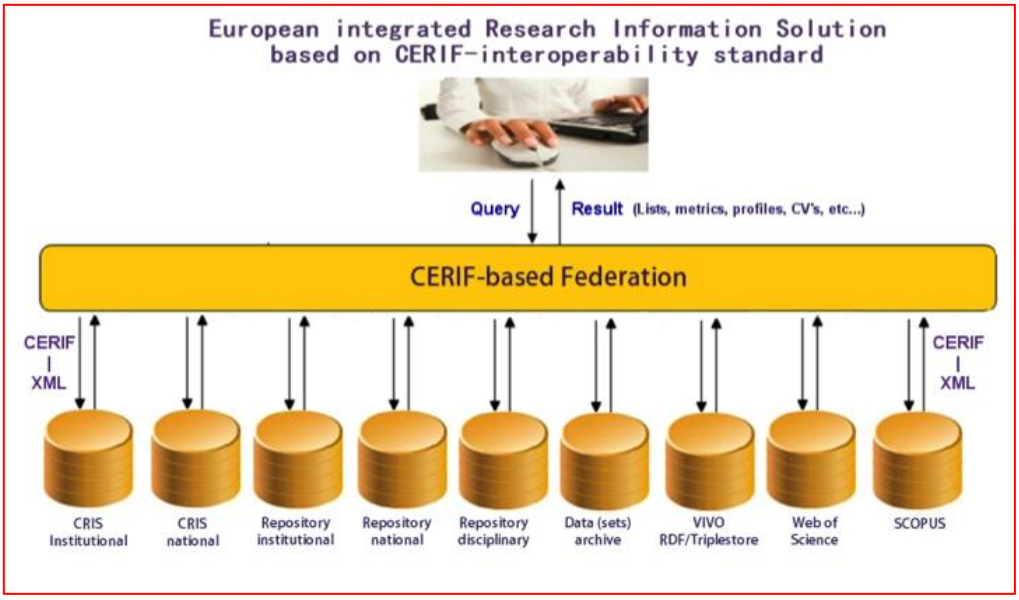
A European Integrated Research Information e-Infrastructure is technically feasible and in full alignment with the current policy context in the European Union.

The development of this e-infrastructure should not constitute a major technical endeavour, thanks to the recent technological developments and especially the maturity of the European CERIF standard.

It should not be considered as a substitution of the existing national research information systems, but essentially as an additional layer on top of them (see Exhibit 5, below).

It should have the features of a distributed infrastructure, inter-connecting the existing national research information systems, thus allowing for querying depending on the needs as well as for the eventual exploitation of the data in terms of indicators and/or metrics. In this context, the cost for the development of such a system should be relatively limited.

Exhibit 5 The CERIF-based federation of research information at the European level



Source: Keith Jeffery, STOA Science Metrics workshop, 2013

However, the achievement of a European Integrated Research Information Infrastructure is not feasible through bottom-up initiatives alone. *Early-stage steering at the European level* and *coordination* of the process towards integration is critical. It would ensure the inclusiveness of the process, involving all EU Member States and relevant stakeholder communities, as well as facilitate an acceleration of the development of national research information systems.

Ownership of the monitoring activities in relation to the fulfilment of the ERA objectives and current active support to the development of European research e-infrastructures make the European Commission the most plausible lead actor and coordinator.

3.2 Policy Options

To support and encourage the development of an integrated European research information infrastructure, the policy options are

- To recognise the need to overcome the current methodological challenges for science performance assessments and commit support to improvements both in theoretical concepts and the practice
- To support and coordinate the development of national research information systems in the European member states, ensuring interoperability and facilitating the acceleration of the implementation of these systems in Europe
- To support and coordinate the development of a standard approach to the definition of outputs and other indicators, recognising the need for its social construction in respect of the national needs
- To support and commit to the technical development of an integrated European research information infrastructure

The evaluation of research has become more important as expectations for research to support social and economic improvements have risen. However, there are currently a wide variety of measures to measure the impact of research, with some disagreements between policy makers and the research community about the aims and methods of evaluation. This study considers the possible options for improving the monitoring of research performance by researchers, research institutions and funding bodies. In particular, the feasibility of developing a transnational European system to monitor the inputs, outputs and productivity of research is considered.

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