

Performance-based research funding in EU Member States—a comparative assessment

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Abstract

Performance-based research funding (PBRF), the allocation of institutional funding on the basis of ex post assessments of university research performance, has been implemented in a large number of EU Member States. However, the characteristics of this funding scheme differ widely. Apart from differences in the volume of funding, there are major variations in the assessments that feed into the funding allocation formula. Even within the two main groups of metrics based and peer review-based assessments the approaches adopted vary. Some of the main strengths and drawbacks of the various options are discussed in this article. An analysis of national Global Budgetary Allocations for R&D data reveals the distribution of project and institutional funding and the potential for PBRF. Given the heterogeneity of performance-based funding approaches, a comprehensive comparative assessment of the funding involved in this instrument requires further work. Nonetheless Member State governments can engage in institutional learning from good practices.

Key words: performance based funding; research assessment; research funding; funding allocation; project funding; institutional funding.

1. Introduction

Since its inception in 2000, the European Research Area (ERA) has been meant to strengthen Europe's scientific and technological basis by improving the coordination of research activities, developing human resources and increasing the attractiveness of European research. One of the main priorities of the ERA involves the need to increase the effectiveness of public research systems (EC 2017) through the introduction of funding mechanisms linked to performance (EC 2011). The introduction and further development of performance-based research funding (PBRF) in many Member States over the past decades reflects this priority. This funding mechanism refers to the competitive allocation of organisational level (institutional) funding to research organisations based on the ex post assessment of their research performance (Hicks 2012). It differs from other modes of institutional block funding in which research funding is mostly non-competitive and of competitive project funding, for which funding allocations rely on ex ante assessment.

This article aims to analyse the extent to which PBRF allocation mechanisms are being implemented in the European Union's (EU) 28 Member States and to identify strengths and drawbacks of

different approaches. To do so, the study will build on both qualitative and quantitative data collection and analysis.

The qualitative approach relies on information collected through a network of national experts in R&I contracted by the Joint Research Centre (JRC) of the European Commission. The reports provided were supplemented by material from national policy documents and analyses published in the academic literature. The resulting national case studies were reviewed by National Contact Points in the national administrations of each EU Member State (Jonkers and Zacharewicz 2016).

The qualitative analysis is complemented by a quantitative data collection carried out in the framework of the Public Funding of Research (PREF) project conducted by a consortium led by CNR CERIS on behalf of DG JRC. This project aims at providing a comprehensive analysis of public research funding with a focus on the allocation mechanisms adopted in different countries. The analysis provided is broadly consistent with EUROSTAT statistics on Global Budgetary Allocations for R&D (GBARD), but provides a more fine-grained disaggregation by mode of allocation, managing organisations, and funding flows to performers.

This combination of qualitative and quantitative methodologies feeds into a broader analysis on good practices and possible adverse

effects of the different PBRF systems implemented in the EU28 Member States.

2. Defining research performance-based systems

With direct public funding constituting around 35 per cent of total R&D spending in European countries, public spending to research and development is widely considered as one of the main mechanisms for orienting science, technology and innovation policies (Cruz-Castro et al. 2011; Jonkers and Zacharewicz 2016). Over the past decades and particularly following the recent economic crisis, EU Member States have developed policy instruments and tools to increase the efficiency of their research funding allocations. At European level, this consideration for value-for-money has been translated into the first priority of the ERA: building more effective national research systems. To achieve this objective, Member States are recommended to introduce or enhance competitive funding, through calls for proposals or based on institutional assessments, as the main modes of allocating public funds to research and innovation (EC 2012). Similarly, the Council Conclusions of November 2011 recommend the introduction of mechanisms linked to performance and competition to improve the governance of the higher education system. This policy orientation relies on the assumption that enhancing competitive allocation mechanisms can lead to improvements in research performance by facilitating a more efficient use of the funding resources, by selecting the best research groups, promoting cooperation and competition among them, promoting research themes and supporting structural changes in the modes of knowledge production with the aim to increase societal impact (Geuna 2001; Braun 2003). While the use of such competitive mechanisms is spreading across the EU, national research policy frameworks differ widely. They generally evolve around the two main and traditional mechanisms of project funding and institutional funding. Building on these categories and the academic literature (e.g. Hicks 2012; Van Steen 2012), the aim of this section is to elaborate a conceptual definition of PBRF to further analyse its implementation across Member States.

Project funding is defined as ‘the total of national budgets in a given country, attributed to a group or an individual to perform an R&D activity limited in scope, budget and time, normally on the basis of the submission of a project proposal describing the research activities to be done’ (Van Steen 2012). Since the 1980s the importance of project funding has increased in many European Member States. As opposed to this specific type of funding allocation, organisational level (institutional¹) funding is defined as ‘the total of national budgets in a given country, attributed to a research performing organisation (university or Public Research Organisation), with no direct selection of R&D project or programmes and for which money the organisation has more or less freedom to define the research activities to be performed’ (Van Steen 2012). Institutional funding can be allocated in the form of non-competitive block funding. To a large extent this block funding may be earmarked for particular expenditures such as infrastructure or researcher’s salaries, especially in research systems where permanent researchers are civil servants. The university may have some discretion in allocating a non-earmarked part of this block funding to further support research activities (Cruz-Castro et al. 2011). Institutional funding can also be allocated in a variable/competitive manner. This can for example be tied to performance contracts. Another approach consists of ‘centre of excellence’ schemes in which

research organisations or research units are allocated institutional funding on the basis of an ex ante assessment of research potential. Alternatively, institutional funding can be tied to ex post assessments of the output and performance of universities. It is this latter type of competitively allocated institutional funding which is considered as PBRF in this article.

Analysts and policymakers have used different understandings of performance-based funding. It is therefore useful to further define what is meant in this article by this funding allocation system by building on the definition developed by Hicks (2012). Doing so will allow one to assess whether Member States have implemented a PBRF system for the allocation of institutional research funding. To be considered as PBRF, Member States funding allocation systems must have the following characteristics:

- Research must be assessed. Evaluations are a necessary but not a sufficient criterion to qualify as a PBRF system. Evaluations of the output of degree programmes alone will not be considered as PBRF. This excludes many of the PBRF systems in the US states as well as a number of EU Member States funding systems. These will be touched upon but not considered as PBRF.
- Research evaluation must be ex post. Evaluations of project proposals or the evaluations of organisation level proposals for excellence initiatives are ex ante evaluations and are therefore not considered as PBRF in this article.
- Research output and/or impact must be evaluated. Research systems which distribute funding on the basis of PhD numbers alone are not considered to be performance based by Hicks (2012). In this report, they will be considered as a partial PBRF since PhD theses/Defences are considered research outputs.
- Part of the governmental allocation of university research funding must depend on the outcome of the evaluation. Formative ex post evaluations which are solely intended to provide feedback to universities or governmental actors will not be considered performance-based funding systems.
- The assessment and funding allocation considered take place at the organisation or sub-organisational level. The assessment of the performance of individual researchers and subsequent funding or salary increases to individuals is not included in this definition of performance-based funding systems.
- The performance-based funding system must be a national or regional system: intra-organisational funding allocation rules are not considered PBRF (Adapted from Hicks 2012).

3. Classifying PBRF systems

Following these elements of definition, the different national funding allocation systems will be classified according to the type of PBRF they have in place, distinguishing between:

1. countries which have no performance-based elements in their university funding allocation system and countries which allocate funding solely on the basis of education-related metrics or assessments (without research output considerations),
2. countries which base their funding allocation formula on quantitative metrics-based assessments highlighting those who use different types of bibliometric approaches and
3. countries which base their funding allocation formulae on peer review-based assessment exercises. The latter category can be separated into metrics-based peer review and ‘exclusive peer review’.

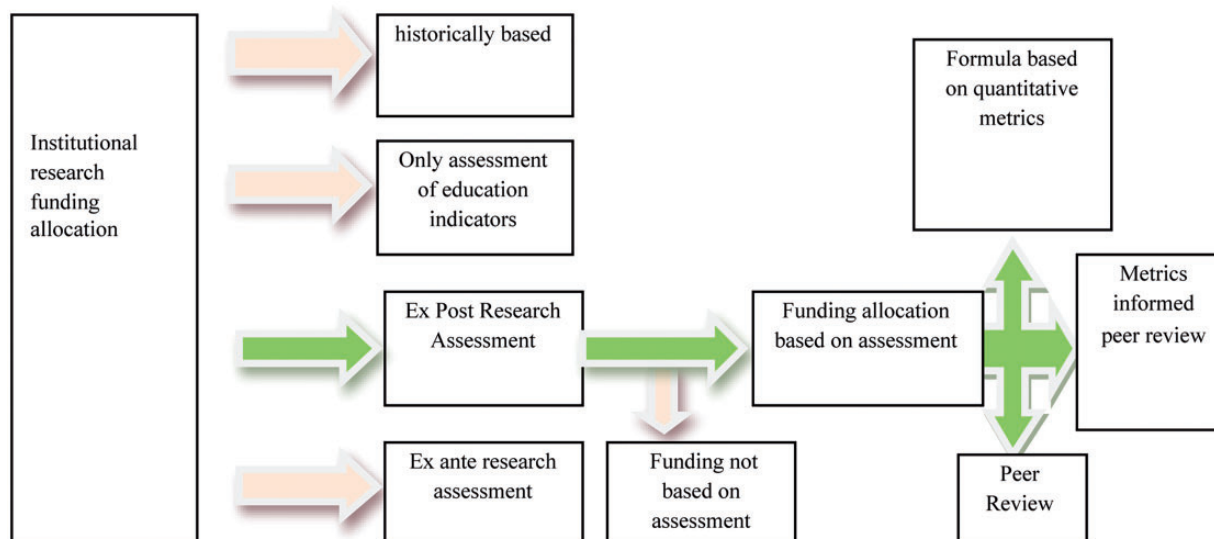


Figure 1. Research performance funding systems.

Formulae are generally used in the allocation of organisational funding and can be applied to the total amount of public funding transferred to the organisations or only to a part of it. Figure 1 gives a graphical representation of this definition of performance-based funding.

4. Methodology

This article is based on a combination of qualitative and quantitative data collection. The qualitative information was gathered through the Research and Innovation Observatory (RIO) of the European Commission's Joint Research Centre.² Analyses of national R&I systems in the EU 28 Member States are conducted on a yearly basis by a network of national experts and JRC policy analysts. These analyses are reported in the RIO Country Reports. The versions for 2014 and 2015 of these reports were used for the purposes of this study. They contained answers to a dedicated set of questions regarding public funding allocation systems. This material was supplemented with further interactions with the network of experts on the specific topic of performance-based funding. To complement these sources the authors have built on additional material, such as collected national policy documents and the results of analyses and assessments published in the academic literature. Further contacts with policymakers and academic research policy experts in several of the countries under consideration allowed to cross-check the information obtained. The resulting analysis was reviewed and validated by individual experts in each national administration of the 28 EU Member States.

For quantitative data on project versus institutional funding use is made of data collected in the framework of the PREF project carried out by a consortium coordinated by CNR CERIS on behalf of DG JRC of the European Commission. This project aims at providing a comprehensive analysis of public research funding with a focus on the allocation mechanisms adopted in forty different countries between 2000 and 2014. The outcome of this analysis is broadly consistent with EUROSTAT statistics on GBARD, but provides a more fine-grained disaggregation by mode of allocation, managing organisations, and funding flows to performers. Definitions and

categories correspond to those adopted in the 2015 edition of the Frascati Manual. For a small set of countries (e.g. France, Portugal, Czech Republic), more significant discrepancies appear due to methodological differences between the data collection processes. The full results of the PREF study are presented in Reale (2017). The report is accompanied by ID cards of national funding systems which are available on the RIO website.³

The qualitative data analysis partially consists of a classification system of the assessment approach used to inform the performance-based funding allocation formula. The following criteria are considered:

- 'Historical' refers to the practice in many systems to base the allocation of institutional funding on the funding allocation distribution that was used in preceding years.
- The first group of criteria which many systems use to allocate not only education but also research funding are 'education metrics'. These metrics can involve both inputs (students enrolled) and outputs (BSc and MSc graduates) of Higher Education Institutions. A related metric refers to PhD degrees awarded. The latter is however often considered a research output measure.
- *Bibliometric indicators* refer to indicators based on scientific publications. In this table, bibliometric indicators are separated into three categories. The first refers to counts of publications. Often the publications are not only counted alike, but weighted according to the publication type and the rank or citation impact of the publication channel. Publication level citation impact analysis may also be added.
- Other (input or output) indicators frequently used in research performance assessments are classified here as 'other formula elements'. They include the number of *patents*, which may be restricted to e.g. PCT and EPO patents or may also involve patent filings at national patent offices. One indicator which could be considered both an input and a performance metric is the amount of funding which is generated through *participation in national or international research projects*. External funding generated by *contract research* for companies or public administrations, income from *Knowledge Transfer activities* and spin-off companies generated are other variables that are considered in

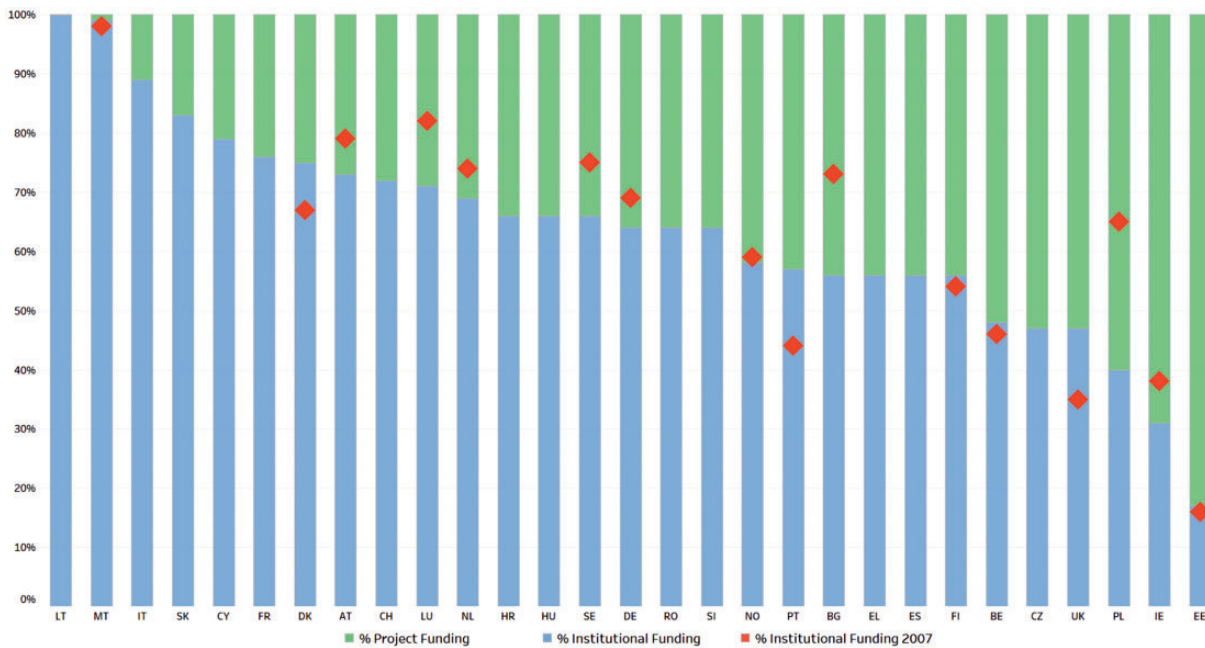


Figure 2. Percentages of Institutional and project funding out of total GBARD. Source: PREF, 2014. Reference year is 2013 for AT, ES, UK and 2015 for FR. Spain figure does not include regional funding. Due to methodological issues, the data provided for FR, LU, and PT differ from data reported by Eurostat (Lepori 2017).

many systems. Two other indicators included in Table 1 refer to diversity measures such as the gender composition of staff and internationalisation indicators. The latter points out to the degree of international experience of staff, the attraction of foreign PhD researchers and/or the engagement in other international activities. Since participation in international projects was already considered in the preceding category it is not included here.

5. Results

To gain an understanding of prevailing funding systems in the Member States, Figure 2 first provides an overview of the relative importance of project versus institutional funding in 2014. It is based on data collection through the PREF study (Reale 2017). Project funding is by nature competitive funding. However, it is based on ex ante evaluations of research proposals, rather than on ex post assessments of research outcomes. Figure 2 does not make a distinction between institutional block funding and performance-based institutional funding, but when countries implement PBRF Systems it implies that part of the institutional funding is allocated in a competitive manner. The share of institutional funding thus provides a certain indication of the potential for performance-based funding in a system.

On the basis of the available data, we can make a distinction between a few different groups of Member States according to the relative importance of project versus institutional funding. A first group of countries is characterised by a high level of institutional funding. A second group of countries shows a greater balance between institutional and project funding. The qualitative analysis of the evolution of funding mechanisms in the different Member States presented in the next section will provide greater insight in the extent to which this funding is allocated through PBRF. There is a third group of countries which is characterised by relatively high shares of project funding in comparison to block funding. It is

relevant to know that some of the countries in this third group, such as the UK, also make intensive use of performance-based funding (Cunningham 2015), thus increasing the share of ‘competitively allocated funding’. When compared to the data available in 2007, the relatively large share of institutional research funding does not hide a general tendency towards the increase of project funding (Figure 2). However, the figure also shows a wide variation in the evolution of country systems over this period: some show strong growth in project funding (e.g. Ireland and Poland), while others show a strong decrease (e.g. Denmark, Portugal). This wide variation demonstrates that project funding is a potentially important indicator for mapping the changes in policy priorities for R&D funding and the volumes of resources thus mobilised.

Similar to project funding, the use of research performance-based funding is progressively increasing at the cost of institutional block funding. Over the last decade, many European countries have implemented some form of RPF allocation mechanisms. Table 1 provides a classification of the institutional level funding allocation systems in place in the Member States as of 2014. A distinction is made between three different systems: those that are considered to have no research performance-based funding system in place, those who have implemented a limited RPF and those which are considered to have implemented a performance-based system. In the latter case, a distinction is made between those systems which rely primarily on the peer review of research units/organisations and those systems in which the assessment of research performance is primarily based on quantitative assessments of research output. The funding formulae used to allocate institutional level research funding, in addition to assessments of research also tend to take into account a number of other variables, including for example education, socio-economic impact or diversity-related assessments. The latter assessments can again be based on either quantitative metrics or qualitative assessments (such as in the UK). An overview of the main criteria on which such assessments are based is provided in Table 1.

Table 1. Dominant assessment approach for the allocation of performance-based funding in the EU28.

Country	No RPBF										Limited RPBF										Quantitative formula with bibliometric assessment										Peer review			
	BG ^a	CH	CY	EL	ES	HU ^b	IE	LU ^c	LV ^d	MT	RO ^e	SI	AT	GE ^f	NL	BE (FI)	BE (WA) ^g	CZ ^h	DK	EE ⁱ	FI	HR	NO	PL ^j	SE	SK	FR	IT	LT	PT	UK			
Education metrics	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Historical Bibliometrics	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Publications	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Journal impact based	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Citation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
PhD graduates	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Patents	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Project funding	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Business funding	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Gender/diversity	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Internationalisation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Peer review	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Performance	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Contracts	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			

Notes: In addition to the criteria included in the table, AT, NL, DK, EE, and FI also have engaged in the signing of performance contracts and use these as a determinant of the performance-based funding allocation. For more detailed descriptions of the funding allocation systems in place in the EU Member States, see Jonkers and Zacharewicz (2016). CH and NO are added as a complement to EU 28 Member States.

^aBulgaria did have a PBRF system in its education law for several years, but this appears not to have been implemented. In the new law however, a PBRF system has been introduced again (Todorova and Slavcheva 2016).

^bHungary The introduction of a PBRF system in Hungary is foreseen.

^cLuxembourg has only a single university, it was not considered to have a PBRF system to allocate institutional funding between universities. However, its performance contract has many of the trappings of PBRF systems.

^dLatvia has used assessments to change the allocation of its funding of PROs. For universities it has recently implemented a PBRF system, this is not yet reflected in this overview table. See Annex 1 of Jonkers and Zacharewicz (2016) for more detail.

^eIn Romania some steps have been taken to design an institutional funding system linked to performance assessment, in practice this is not yet implemented.

^fIn Germany, the institutional funding of universities is mainly provided at the regional (Laender) level. These have increasingly included quantitative assessment criteria and/or performance contracts, but the nature of their funding allocation procedures differ from state to state (Van Daalen et al. 2014)

^gBelgium (Wallonia): for the Special Research Funds, the education-metrics based system will still be partially linked to the historical distribution among universities during a transition period (2014–16). For the concerted research actions, there is also a transition period with performance criteria being gradually introduced into the funding allocation formula from 2016 onwards.

^hIn 2009, Czech Republic introduced a research performance-based methodology to allocate research funding. This methodology, based exclusively on quantitative indicators, was modified for the period 2013–15 and introduced some peer review assessment elements. After 2016, bibliometric informed peer review should become the main mode of assessment (Štíholec and Škuta 2016)

ⁱEstonia does have performance contracts for universities for which universities are assessed on a number of education metrics. This does not concern the allocation of research funding.

^jPoland used to base its funding formula partially on historical considerations. Since 2015 however, this variable has been removed (Klincewicz 2015).

In the systems which are considered to be based on a peer review assessment, variables such as the impact of the research output, number of PhDs, patenting behaviour, etc. can also be considered. Since the main or at least an important element of the assessment mode is qualitative these systems are here grouped under this heading.

The (limited or large) number of indicators considered should not necessarily be taken as an indicator of the level of sophistication of the system. For example the UK REF system is one of the oldest and most developed PBRF systems; however, in the table it is not considered to include many indicators in its funding formula.

5.1 Classification of countries according to their PBRF systems

As shown in Table 1 many European countries have implemented some form of performance-based research funding. The exceptions are Bulgaria, Switzerland, Cyprus, Greece, Hungary, Ireland, Luxembourg, Latvia,⁴ Malta, Romania, Slovenia, and Spain⁵ (Alexander 2015; Jonkers and Zacharewicz 2016; Tsipouri 2015; Warrington 2015). In the cases of Malta, Cyprus, and Luxembourg, this is probably a partial consequence of the relatively small size of the system (Malta and Luxembourg only count one single university). In other instances, i.e. Greece, the absence of performance-based funding may be due to resistance from the academic community which has protested heavily against suggestions to introduce performance-based evaluation and allocation models (Tsipouri 2015). This group also includes countries that allocate funding on the basis of education/training based metrics (student inputs, number of graduates, etc) and related metrics only. Another traditional metric is to base funding allocation decisions on the number of research staff in the organisation. This criterion is not performance based and while most countries base part of their funding allocation on the basis of this indicator it is considered part of non-competitively allocated block funding rather than performance-based funding. Countries like Spain, Slovenia, Hungary, and Germany have pursued some of the goals of performance-based funding, such as international excellence, by awarding centres or units of excellence to universities based on the assessment of proposals (Kottmann 2012 in Hicks 2012; MINECO 2015; Döry 2015; Fernández Zubietta 2015). Since these initiatives are based on voluntary ex ante selections of proposals they are not considered as performance-based funding systems in this report. Many of the countries that did implement PBRF have also engaged in the setup of centres of excellence type funding programmes, including Norway with its Centres of Excellence, Poland (KNOW), Finland (Centres of Excellence in Research), France (IDEX), Denmark, Sweden,⁶ and Austria (Institute of Science and Technology) (Bitard 2015; Cuntz 2015; Jacob 2015; Klincewicz 2015; Saarnivaara 2015).

In addition to the countries without any PBRF system, three categories have been identified. The first one is composed of Austria, Germany, and the Netherlands. Hicks (2012) did not include the Netherlands and Austria among the countries which have implemented PBRF systems because they do not base their funding allocations on assessments of research outputs. However since successfully defended PhD theses could be considered a research output, the countries that include this indicator as an element in their funding allocation systems are considered as limited research performance-based systems.

The second PBRF category bases institutional funding allocation mechanisms on assessments of research outputs as assessed through

quantitative bibliometrics. This group composes of Belgium, Czech Republic, Denmark, Estonia, Finland, Croatia, Norway, Poland, Sweden, and Slovakia. Bibliometric-based formulae generally rely on three main different approaches, the simplest of which consists of counting publications in national and international journals (as well as in many countries books and conference proceedings). However, some analysts have argued that this practice encourages publication in lower impact journals to boost output (Butler 2003). This finding was recently challenged by Van den Besselaar et al. (2017) and Schneider et al. (2016) but has been influential in the design and evaluation of performance-based funding systems. To avoid perverse incentives, it is most often coupled with at least one of the two following approaches.

Journal-based assessment allows taking into account quality criteria. For example, in the Danish, Finnish, and Norwegian systems, disciplinary panels of researchers evaluate more than 20,000 peer-reviewed journals and scholarly book publishers and divide them into two or three levels. Publications in the most prestigious journals and book publishers in each field, representing maximum 20 per cent of the world's publications, receive a higher weight than publications in the other outlets. The three countries collaborate on developing their systems with support from Nordforsk, the Scandinavian research funding body (Grimpe 2015; Sivertsen 2016). Poland has a PBRF tradition that goes back to the 1990s. It underwent an evaluation of its PBRF system in 2008 and revised the evaluation process for its 2013 evaluation, for which it uses the journal impact factor (Klincewicz 2015). Here the Committee for Evaluation of Scientific Research Institutions (KEJN) conducts detailed assessments on the basis of the following criteria: counts of publications taking into account impact factors of specific academic journals, patents, revenues from industry co-operation and external R&D funding normalised by numbers of R&D employees of an organisation, scientific awards of researchers, patents, and financial outcomes of commercialisation of research results. In 2013, the evaluation criteria were substantially modified to further promote organisations conducting world-class research. Journal impact factor-based assessments were also briefly used in the Czech Republic (Malek et al. 2014).⁷ After 2016 a new system of RDI evaluation and distribution of organisational funding developed by the Technopolis Group is scheduled to be gradually implemented (Good et al. 2015; Srholec and Szkuta 2016).

Whereas the previous countries based their bibliometric assessment on counts of publications, potentially weighted on the basis of the quality of journals, Flanders and Sweden have explicitly introduced a combination of output and publication level citation-based impact metrics. The objective consists of taking into account both the volume as well as the actual impact of the research output. In Belgium (Flanders), the share of the competitively allocated institutional research funding (the BOF-Key) has increased from 10 per cent when it was first introduced in 2003 (DeBackere and Glanzel 2004) to 36 per cent in 2008. In the latest revision in 2012, the weight of the social sciences and humanities have increased on the basis of a specially developed publication database that was custom made for this purpose (DeBackere and Veugelers 2015). In addition to the citation-based impact assessments, Flanders also considers journal-based indicators in its formulae. Sweden has also implemented a sophisticated field weighted impact measurement system to assess university output (Hicks 2012; Jacob 2015; Sivertsen 2016). Field differences can be taken into account either by applying field normalisations in publication level citation analyses (e.g. SE, Flanders), or by taking into account weighted output assessments according to the type and level of prestige (e.g. DK, SF, NO).

A comprehensive representation of the published output in all fields can be achieved by developing a complete custom-made bibliometric database for the Social Sciences and Humanities, as was done in Flanders (Belgium) or by using nationally integrated Current Research Information Systems that cover all fields comprehensively (DK, SF, NO).

Formulae used in bibliometrics-based funding allocation tend to take into account many other factors than publication and citation metrics alone. These can include employment of graduates; external research funding; faculty characteristics and qualifications; faculty size; student enrolment; graduate students graduated; PhD defences; impact of research; participation in international research projects; collaboration with industry; and private sector funding (elaborated on Hicks 2012). In many systems (see e.g. Denmark, Norway, Poland, and Czech Republic) also the variable part of institutional research funding retains an element that is based on previous funding decisions (historical factors), which are used in part to avoid too large swings in research funding that could cause instability (Hicks 2012; Srholec & Szkuta 2016). In particular, Norway is one of the European countries with a long tradition of PBRF (e.g. Solberg 2016; Kalpazidou Schmidt 2012). While the majority (70 per cent) of institutional funds to HEI are given as block funding, the remaining 30 per cent is distributed on the basis of reported student performance, research performance, and strategic research considerations. Since 2003 a new funding structure has been in place for funding higher education institutions and consists of three components: block funding, a teaching component based on reported student performance, and a research component. This last feature consists of four dimensions, being scientific publications,⁸ PhD candidates, competitive funding from the Research Council of Norway and Regional Research Funds, and funding from EU framework programmes. The funding system is still undergoing further change, with a last reform in 2016. In Poland, the weight of this historical element has been decreasing since 2011–12 and was removed in 2015. Nowadays only the outcomes of the most recent evaluation are taken into account.

The last PBRF approach identified in this study is highlighted in a third group of countries consisting of France, Italy, Lithuania, Portugal, and the UK. Each of them has opted for a funding allocation system which is based on peer assessment of universities and/or university groups. In most cases, these peer review assessments are heavily based on bibliometrics and other metrics and thus approach the second category in nature. Czech Republic had introduced in 2009 a research assessment system exclusively based on quantitative bibliometrics. This system is currently evolving towards a bibliometric informed peer review (Srholec and Szkuta 2016). There are also exceptions such as the UK in which bibliometrics play a lesser role. There are strong variations in the nature of the PBRF systems between these countries: especially the UK stands out as a country with a long tradition of PBRF allocation on the basis of an elaborate peer review system. On the other side of the spectrum, Italy relies heavily on bibliometrics to reduce the labour of peer review.

Peer review systems tend to bring together field-based committees which have some discretion for developing appropriate standards of judgment for their field (e.g. PL, IT, CZ, UK, FR). These committees may, for example, decide on how to evaluate different types of publications, books or other forms of intellectual output: be it Open Access databases, films, patents, plant varieties, etc, which may be more important in some fields than in others. In France, for example, the HCERES committees take into account PhD supervision in some fields (Mathematics) but not in others. In Lithuania the

weight given to the four categories differ between fields. For example, results of the evaluation of research production are given the highest weight in social sciences and humanities (80 per cent) as well as physical and biomedical sciences (55 per cent). Assessment of R&D activities in other fields of science mostly depends on institutions' capacities to attract funding from privately and internationally funded R&D projects (Paliokaite 2015). In the Czech Republic, peer review was used in assessing the publication output in the social sciences and humanities. In the natural science fields, the assessments are mainly based on journal (impact factor) based bibliometrics (Good et al. 2015; Malek et al. 2014; Srholec and Szkuta 2016). In the UK REF, in addition to the peer review of scientific impact, expert panel review is used to assess case studies submitted to explain the societal impact a group's research has had.

One major potential advantage of peer review is that it can have a formative as well as a summative element. As such it can help the organisation develop by taking into account ongoing organisational processes (and/or recommending the development others). Bibliometric assessments and the funding systems based on them are necessarily backward looking, whereas funding systems underpinned by peer review assessment can have a forward looking component (Sivertsen 2017).

6. Discussion

The implementation of PBRF systems aims to improve research cultures and facilitate institutional changes that can help increase research performance. Many EU countries have introduced, are introducing or are considering to introduce such systems. The introduction of PBRF should ideally be coupled with a sustained increase in public funding of publicly performed R&D since chronic underfunding may play as big a part in relative (under)performance of specific EU Member States as a suboptimal institutional framework. PBRF that is additional to, rather than replacing, core funding would furthermore reduce institutional resistance against its introduction.

The choice of assessment and allocation methods (quantitative/bibliometric research assessments, UK style peer review, bibliometrics informed peer review) to assess research performing organisations tends to be related to the level of analysis chosen (Hicks 2012). Peer review based evaluation tends to be used for evaluations at the departmental or research group level (Hicks 2012; Cunningham 2015; De Boer et al. 2015). Bibliometric approaches tend to be used for organisation-wide evaluations. In practice, most countries opt for university or departmental level evaluations to reduce the scope and resource demands of the assessment exercise.

6.1 Strengths and drawbacks of peer review

Advantages of peer review include first and foremost that it is grounded in specialised knowledge of the scientific field, its methods and literature. Another strength is that it can help assess elements of research which are difficult to quantify, such as novelty. Finally it can help to come to nuanced understandings of research in context (HEFCE 2015). While peer review tends to be held in high esteem in the academic communities and therefore has a relatively high degree of acceptance, it is not without its weaknesses. These weaknesses are partially practical. Peer review is difficult to implement in small countries in which the pool of experts is insufficiently large. Relying on international experts, as is done in Estonia, can be a solution to this problem though it precludes the assessment of some types of

research outputs made in the national language. Nepotism and a lack of transparency can hamper the openness and fairness that should be basic principles of the peer review process. Peer review is often also considered to be conservative, favour mainstream research and disadvantage interdisciplinary or heterodox approaches. This is partially because the organised scepticism that is inherent in the scientific enterprise can pose barriers to the acceptance of ideas or findings that contradict established ideas (Hicks 2012). Struggles over resources and influence between competing schools of thought/research for influence and resources can also play a role. As indicated, e.g. the French assessments include contributions to 'frontier research' in their assessment. Whether this favours interdisciplinary research and/or groundbreaking research within a disciplinary area is a potential topic for further empirical analysis.

Peer review is subjective by nature. To mitigate this, for example, the UK system requests two reviewers to assess each submitted publication. Frequently reviewers are partially guided by the reception of the submission within the academic world. Even in exclusive peer review systems, for example, journal impact factors are a predictor of the outcome of the exercise (De Boer et al. 2015).⁹ One of the most important drawbacks of peer review systems is the potentially large investments required in terms of resources and scientific manpower. For example for the REF, tens of thousands of submissions are reviewed by two reviewers in addition to the time invested in the disciplinary coordination committees for each of the fields considered (see De Boer et al. 2015; Geuna and Piollato 2016; Hicks 2012). According to the Stern Review the REF 2014 has cost 246 million Euro, considerably more than in 2008 when it has cost 66 million euro (Stern 2016; Sivertsen 2017). The use of expert reviews in the assessment of societal impact is also highly challenging. For example in the UK REF close to 7000 cases were assessed with close to 3,700 impact pathways (HEFCE 2015). Such a large variety of impact pathways may reduce the potential for comparative analysis of research unit's performance and introduce a high degree of subjectivity in the assessments (Bornmann 2012). Derrick (2017) provides an in depth analysis of the use of expert panels in the assessment of societal impact in the REF.

Considering the costs in resources and time involved in a peer review-based assessment, peer review exercises tend to be implemented irregularly or with a considerable time interval between assessments. For example a number of years pass between the RAE/REF and the Italian evaluation exercises. As a result, funding decisions may be based on out-of-date information. The quantitative assessment approaches (e.g. BE (FL), SE, NO, DK, and CZ¹⁰) in contrast can often be implemented on a year by year basis.

6.2 Advantages and disadvantages of bibliometric approaches

The use of bibliometric indicators has various advantages over classical peer-based assessment mechanisms in which individual experts are requested to evaluate organisations. These advantages include their (1) relatively low costs both in terms of resources and time: bibliometrics is often used to 'short-cut' experts/expertise, for by allowing for an assessment of credit awarded by the scientific community as an indicator of scientific impact, non-expert evaluators can make an assessment of these publications without having knowledge of their content—though the extent to which they can do so in a meaningful way is contested by detractors; (2) their non-intrusiveness: the researchers and organisations evaluations do in theory not need to engage in administratively heavy procedures to

provide proof of their research output. The latter does not always work in practice though as in a number of systems, universities and individual researchers do have to provide the material on the basis of which they should be evaluated rather than relying on bibliometric assessments by outside experts alone; and (3) their perceived objectivity as they do not rely as clearly on the subjective assessments of individual reviewers, but instead are an indication of the use which is made of the publication by the whole scientific community.

There are, however, also a number of disadvantages of the (sole) use of bibliometric methods in assessments. The first is that while university level analyses are methodologically not too challenging, carrying out analyses at the departmental or research unit level can involve a considerable amount of investment in data collection and cleaning to ensure the data are assigned correctly (Debackere and Glanzel 2004). When funding allocations are based on these assessments it is crucially important that stakeholders have faith in this assignment as they may otherwise challenge the outcomes of the assessments. One of the main drawbacks of the use of bibliometrics is therefore that it is not accepted as a valid indicator of output and especially impact by academics, especially in some fields of research. Other drawbacks include that some research outputs, especially in the Social Science and Humanities, are not fully covered in the bibliometric databases. Bibliometric impact measures are sometimes considered to disadvantage certain fields, such as humanities (Hicks and Wang 2009). To avoid such bias, many countries using bibliometrics have developed specific evaluation modalities for the Social Sciences and Humanities.

Publication output-based measurements are said to incentivise publication strategies focused on quantity rather than quality (Butler 2003), though recent analyses question this argument (Van den Besselaar et al. 2017). The use of journal indicators, including the impact factor for research evaluation is the subject of debate and criticism from within the bibliometric and wider scientific community (e.g. DORA 2012; Hicks et al. 2015). As argued by Rafols et al. (2012) and others the use of journal-based indicators disadvantages interdisciplinary research. Findings on whether more sophisticated bibliometric indicators also have this problem are mixed (Rinia et al. 2001; HEFCE 2015). The outcomes of bibliometric assessment are in general sensitive to the methodology adopted and the choice of indicators which in the absence of clear standards may remain a subjective decision. A consensus appears to be emerging among bibliometricians on the more and less suitable forms of indicators (Hicks et al. 2015). However, it remains important to consider that the sole use and at times misuse of bibliometric indicators can create perverse incentives (e.g. gaming behaviours). Many leading bibliometricians argue that bibliometrics could be an input to rather than a replacement of peer review in evaluations of research organisations (Hicks et al. 2015). Most quantitatively oriented PBRF systems appear to be in conflict with the recommendations of Hicks et al. (2015). However, as Sivertsen (2017) argues, the PBRF models in e.g. the Scandinavian countries do not have evaluation as their prime aim as they use other approaches to formative evaluations of research organisations. Metrics-based approaches in his view, may have a role in transparent funding allocation systems that incentivise universities to promote certain behaviour among their faculty and providing an element of competition between universities.

6.3 Bibliometrics informed peer review

Partially for cost consideration and partially because of a recognition of the potential of bibliometrics to contribute to quality assessments, many governments have implemented a mixed approach in which the

peer review process is to a greater or larger extent based on or informed by bibliometric analyses (e.g. Italy). In the latest UK REF, peer review panels were given the option to receive the results of bibliometric analysis of the analysed departments—though departments are only asked to select a limited number of publications (per researcher). Some of the panels decided to make use of this, but were not given top-down instructions on how to use these metrics, apart from the indication that journal impact factors should not be used as a proxy for quality. Hicks (2012) argues that arguably ‘departmental or field level [performance based funding systems] using peer judgment based on indicators represents the current state of the art’. It is such systems which have been implemented in some countries in recent years. On the other hand, the Wilsdon review (2015) carried out for the Higher Education Funding Council for England (HEFCE) does not recommend that a systematic integration of bibliometric indicators in the REF would constitute an improvement in the UK context at present. In the UK, the debate concerning the potential of metrics to replace or inform the peer review system has thus continued and will probably continue to do so in the future.¹¹ It is also interesting to note that e.g. Sweden was considering to introduce a greater peer review component in new iterations of its assessment exercises—though it has since abandoned this initiative and is now exploring to include socio-economic impact metrics-based assessments in its funding formula. Performance-based funding systems thus do not clearly evolve in a single direction.

6.4 Costs of PBRF

Several analysts recommend the introduction of performance-based funding systems in EU Member States which do not yet have these (ES, BG), since they are considered a (relatively) budget neutral way to improve efficiency (Todorova and Pérez 2015). There are however (considerable) costs, in money, time and resources, involved in doing the assessments on which the funding allocation decisions are made. The costs involved in the different types of exercises differ. Probably at the higher end of the scale are the large-scale assessment exercises carried out in the UK and Italy. But as argued by Geuna and Piolatto (2016), between these systems there are differences too. For the UK less than 1 per cent of total research funding is consumed by the evaluations exercise, whereas in Italy it is estimated to be above 2.5 per cent. This in contrast to the amount of funding which is allocated through the respective exercises which is higher (approximately 20 per cent of institutional funding) in the UK than it is in Italy (13 per cent). Apart from direct costs related to the running of the exercise (the set up and running of an evaluation agency; the contracting of peer reviewers; the data collection and analysis as well as the setup of an information system for this purpose; etc), consideration should also be given to the substantial costs borne by the research performing organisations in coordinating their research submissions (Geuna and Piolatto 2016; Hicks 2012). The metrics-based exercises as carried out in e.g. Poland, Czech Republic, and Finland are expected to be less costly and can partially for that reason also be carried out on a more regular basis. However, also in these countries universities are often responsible for submitting the material on which they are evaluated. This type of formula-based funding allocation systems, while difficult to design and implement, is also expected to have relatively low running costs as it does not involve (large teams of) peer reviewers. As discussed in the preceding sections they can also have unintended consequences. These types of systems therefore have to be very carefully designed and be open to fine tuning. The extent to which they are suitable to systems in different stages of development should also be considered.

7. Conclusion

This research is the first comprehensive overview of the assessment systems used to inform funding allocation systems in all EU Member States. The article is based on a JRC Science for Policy Report (Jonkers and Zacharewicz 2016) and a data collection exercise commissioned by the JRC to break down GBARD data by mode of allocation (Reale forthcoming). The article shows that there are major variations in public research funding allocation systems in Europe. These differences do not only manifest themselves in the relative variations in the distribution of project and institutional funding. Also the competitive allocation of institutional funding that has been advocated by national and European policymakers over the past decade shows important qualitative variations. While most of these systems base their funding allocation decisions in part on an assessment of the volume and quality of scientific research output, the way this output is assessed in the different countries is not the same. One group of countries mainly bases its funding allocation formula on the collection of quantitative metric. The other group of countries relies more on peer review. Within both groups there remain large variations in the methodologies adopted, the assessment criteria and metrics considered and the inclusion (or not) of various other variables related e.g. to education inputs and outputs, societal impact and diversity. Given these variations it is difficult to give a precise assessment of the volume of research funding which is allocated through performance-based funding in the different EU Member States. A first attempt to do this is being made in Reale (2017), an approach that will be further elaborated upon in the future.

In the absence of an assessment of the impact of the different types of performance-based funding systems and given the institutional differences between the higher Education and Research systems in the European Member States it is difficult to unequivocally recommend one type of best practice in performance-based funding systems. This article rather aims to present an overview of the options which national governments and policymakers have in the design of assessment systems to inform such systems, highlighting some of the strengths and drawbacks to inform policy learning and institutional imitation, which by its nature is inherently imperfect. To this end, the report underlying this article has already been used to inform a H2020 Policy Support Facility’s Mutual Learning Exercise¹² in which policymakers from diverse European Member States have been brought together in a year long process to learn from each other’s experiences. The final report of this exercise will be published shortly (DeBackere et al. 2018).

In 2017, the High Level Group chaired by Pascal Lamy called for an additional layer of institutional level funding to support universities to deliver a greater impact on their regional innovation ecosystems. The JRC has together with an outside expert, drafted a discussion paper exploring what an assessment framework underlying such an approach could look like (Jonkers et al. 2018).

Notes

1. While theoretical economic and sociological work (e.g. North 1990; Edquist and Johnson 1997) would seem to argue against the use of the term ‘institutional funding’, we follow the commonly accepted terminology and from here on refer to institutional funding when referring to organisational level research funding (Jonkers and Zacharewicz 2016).
2. <https://rio.jrc.ec.europa.eu/>
3. <https://rio.jrc.ec.europa.eu/en/library/pref-study-%E2%80%93%93-analysis-national-public-research-funding>

4. Latvia has recently introduced a performance-based funding system. It is not reflected in the overview table.
5. Institutional funding of universities in Spain is a regional competence. There is at least one region (Catalonia) which has introduced some form of performance-based funding system.
6. See, e.g., <http://www.nifu.no/files/2012/11/NIFUarbeidsnotat2012-4.pdf>
7. In the Czech Republic, initial reform plans were to allocate almost the full amount of institutional funding using performance-based formulae. However, a medium term modification of the evaluation methodology, called Metodika 2013, has been introduced for the period 2013–15 (Debackere 2013). On the basis of this methodology, level funding was to be allocated until 2016 (Srholec 2015). The first part of this assessment is based on an assessment of research output of publications in indexed journals weighted by journal impact factor. Peer review is used more in assessing the publication output in the social sciences and humanities (Srholec 2015). The Czech Performance Based Funding system has recently been reformed again following advice from the consultancy group Technopolis (see e.g. Good et al. 2015).
8. Calculated as ‘publication points’ with a weighting according to publication type (articles in journals; articles in books; books) and two levels of prestige—level 1 and level 2. Denmark and Finland use similar ‘publication points’.
9. This might also be due to the (non-standardised and undirected) use of bibliometrics by review panels (Derrick and Pavone 2013).
10. The new to be introduced Czech system would instead be based on a five yearly assessment.
11. Jo Johnson, the UK Minister for Universities and Science, has appointed in December 2015 a committee under the chairmanship of Lord Stern to review the way Britain allocates its funding for university research. The independent review, published in 2016, made twelve recommendations on the future operation of the REF. Apart from the inclusion of all research staff rather than a selected sample in the assessment, this review argues for a more transparent use of bibliometrics by review panels. The assessment itself should remain peer review based. <https://www.gov.uk/government/publications/research-excellence-framework-review>.
12. <https://rio.jrc.ec.europa.eu/en/policy-support-facility/mle-performance-based-funding-systems>.

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