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Measuring the societal impact of research

Research is less and less assessed on scientific impact alone—we should aim to quantify the increasingly important contributions of science to society

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Even before the Second World War, governments had begun to invest public funds into scientific research with the expectation that military, economic, medical and other benefits would ensue. This trend continued during the war and throughout the Cold War period, with increasing levels of public money being invested in science. Nuclear physics was the main benefactor, but other fields were also supported as their military or commercial potential became apparent. Moreover, research came to be seen as a valuable enterprise in and of itself, given the value of the knowledge generated, even if advances in understanding could not be applied immediately. Vannevar Bush, science advisor to President Franklin D. Roosevelt during the Second World War, established the inherent value of basic research in his report to the President, *Science, the endless frontier*, and it has become the underlying rationale for public support and funding of science.

However, the growth of scientific research during the past decades has outpaced the public resources available to fund it. This has led to a problem for funding agencies and politicians: how can limited resources be most efficiently and effectively distributed among researchers and research projects? This challenge—to identify promising research—spawned both the development of measures to assess the quality of scientific research itself, and to determine the societal impact of research. Although the first set of measures have been relatively successful and are widely used to determine the quality of journals, research projects and research groups, it has been much harder to develop reliable and meaningful measures to assess the societal impact of research. The impact of applied research, such as drug development, IT or engineering, is obvious but the benefits of basic research are less so, harder to assess and have been under increasing scrutiny since the 1990s [1]. In fact, there is no direct link between the scientific quality of a research project and its societal value. As Paul Nightingale and Alister Scott of the University of Sussex's Science and Technology Policy Research centre have pointed out: "research that is highly cited or published in top journals may be good for the academic discipline but not for society" [2]. Moreover, it might take years, or even decades, until a particular body of knowledge yields new products or services that affect society. By way of example, in an editorial on the topic in the *British Medical Journal*, editor Richard Smith cites the original research into apoptosis as work that is of high quality, but that has had "no measurable impact on health" [3]. He contrasts this with, for example, research into "the cost effectiveness of different incontinence pads", which is certainly not seen as high value by the scientific community, but which has had an immediate and important societal impact.

The problem actually begins with defining the 'societal impact of research'. A series of different concepts has been introduced: 'third-stream activities' [4], 'societal benefits' or 'societal quality' [5], 'usefulness' [6], 'public values' [7], 'knowledge transfer' [8] and 'societal relevance' [9,10]. Yet, each of these concepts is ultimately concerned with measuring the social, cultural, environmental and economic returns from publicly funded research, be they products or ideas.

In this context, 'societal benefits' refers to the contribution of research to the social capital of a nation, in stimulating new approaches to social issues, or in informing public debate and policy-making. 'Cultural benefits' are those that add to the cultural capital of a nation, for example, by giving insight into how we relate to other societies and cultures, by providing a better understanding of our history and by contributing to cultural preservation and enrichment. 'Environmental benefits' benefit the natural capital of a nation, by reducing waste and pollution, and by increasing natural preserves or biodiversity. Finally, 'economic benefits' increase the economic capital of a nation by enhancing its skills base and by improving its productivity [11].

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Given the variability and the complexity of evaluating the societal impact of research, Barend van der Meulen at the Rathenau Institute for research and debate on science and technology in the Netherlands, and Arie Rip at the School of Management and Governance of the University of Twente, the Netherlands, have noted that "it is not clear how to evaluate societal quality, especially for basic and strategic research" [5]. There is no accepted framework with adequate datasets comparable to, for example, Thomson Reuters' Web of Science, which enables the calculation of bibliometric values such as the *h* index [12] or journal impact factor [13]. There are also no criteria or methods that

can be applied to the evaluation of societal impact, whilst conventional research and development (R&D) indicators have given little insight, with the exception of patent data. In fact, in many studies, the societal impact of research has been postulated rather than demonstrated [14]. For Benoît Godin at the Institut National de la Recherche Scientifique (INRS) in Quebec, Canada, and co-author Christian Doré, "systematic measurements and indicators [of the] impact on the social, cultural, political, and organizational dimensions are almost totally absent from the literature" [15]. Furthermore, they note, most research in this field is primarily concerned with economic impact.

A presentation by Ben Martin from the Science and Technology Policy Research Unit at Sussex University, UK, cites four common problems that arise in the context of societal impact measurements [16]. The first is the causality problem—it is not clear which impact can be attributed to which cause. The second is the attribution problem, which arises because impact can be diffuse or complex and contingent, and it is not clear what should be attributed to research or to other inputs. The third is the internationality problem that arises as a result of the international nature of R&D and innovation, which makes attribution virtually impossible. Finally, the timescale problem arises because the premature measurement of impact might result in policies that emphasize research that yields only short-term benefits, ignoring potential long-term impact.

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In addition, there are four other problems. First, it is hard to find experts to assess societal impact that is based on peer evaluation. As Robert Frodeman and James Britt Holbrook at the University of North Texas, USA, have noted, "[s]cientists generally dislike impacts considerations" and evaluating research in terms of its societal impact "takes scientists beyond the bounds of their disciplinary expertise" [10]. Second, given that the scientific work of an engineer has a different impact than the work of a sociologist or historian, it will hardly be possible to have a single assessment mechanism [4,17]. Third, societal impact measurement should take into account that there is not just one model of a successful research institution. As such, assessment should be adapted to the institution's specific strengths in teaching and research, the cultural context in which it exists and national standards. Finally, the societal impact of research is not always going to be desirable or positive. For example, Les Rymer, graduate education policy advisor to the Australian Group of Eight (Go8) network of university vice-chancellors, noted in a report for the Go8 that, "environmental research that leads to the closure of a fishery might have an immediate negative economic impact, even though in the much longer term it will preserve a resource that might again become available for use. The fishing industry and conservationists might have very different views as to the nature of the initial impact—some of which may depend on their view about the excellence of the research and its disinterested nature" [18].

Unlike scientific impact measurement, for which there are numerous established methods that are continually refined, research into societal impact is still in the early stages: there is no distinct community with its own series of conferences, journals or awards for special accomplishments. Even so, governments already conduct budget-relevant measurements, or plan to do so. The best-known national evaluation system is the UK Research Assessment Exercise (RAE), which has evaluated research in the UK since the 1980s. Efforts are under way to set up the Research Excellence Framework (REF), which is set to replace the RAE in 2014 "to support the desire of modern research policy for promoting problem-solving research" [21]. In order to develop the new arrangements for the assessment and funding of research in the REF, the Higher Education Funding Council for England (HEFCE) commissioned RAND Europe to review approaches for evaluating the impact of research [20]. The recommendation from this consultation is that impact should be measured in a quantifiable way, and expert panels should review narrative evidence in case studies supported by appropriate indicators [19,21].

Many of the studies that have carried out societal impact measurement chose to do so on the basis of case studies. Although this method is labour-intensive and a craft rather than a quantitative activity, it seems to be the best way of measuring the complex phenomenon that is societal impact. The HEFCE stipulates that "case studies may include any social, economic or cultural impact or benefit beyond academia that has taken place during the assessment period, and was underpinned by excellent research produced by the submitting institution within a given timeframe" [22]. Claire Donovan at Brunel University, London, UK, considers the preference for a case-study approach in the REF to be "the 'state of the art' [for providing] the necessary evidence-base for increased financial support of university research across all fields" [23]. According to Finn Hansson from the Department of Leadership, Policy and Philosophy at the Copenhagen Business School, Denmark, and co-author Erik Ernø-Kjølhede, the new REF is "a clear political signal that the traditional model for assessing research quality based on a discipline-oriented Mode 1 perception of research, first and foremost in the form of publication in international journals, was no longer considered sufficient by the policy-makers" [19]. 'Mode 1' describes research governed by the academic interests of a specific community, whereas 'Mode 2' is characterized by collaboration—both within the scientific realm and with other stakeholders—transdisciplinarity and basic research that is being conducted in the context of application [19].

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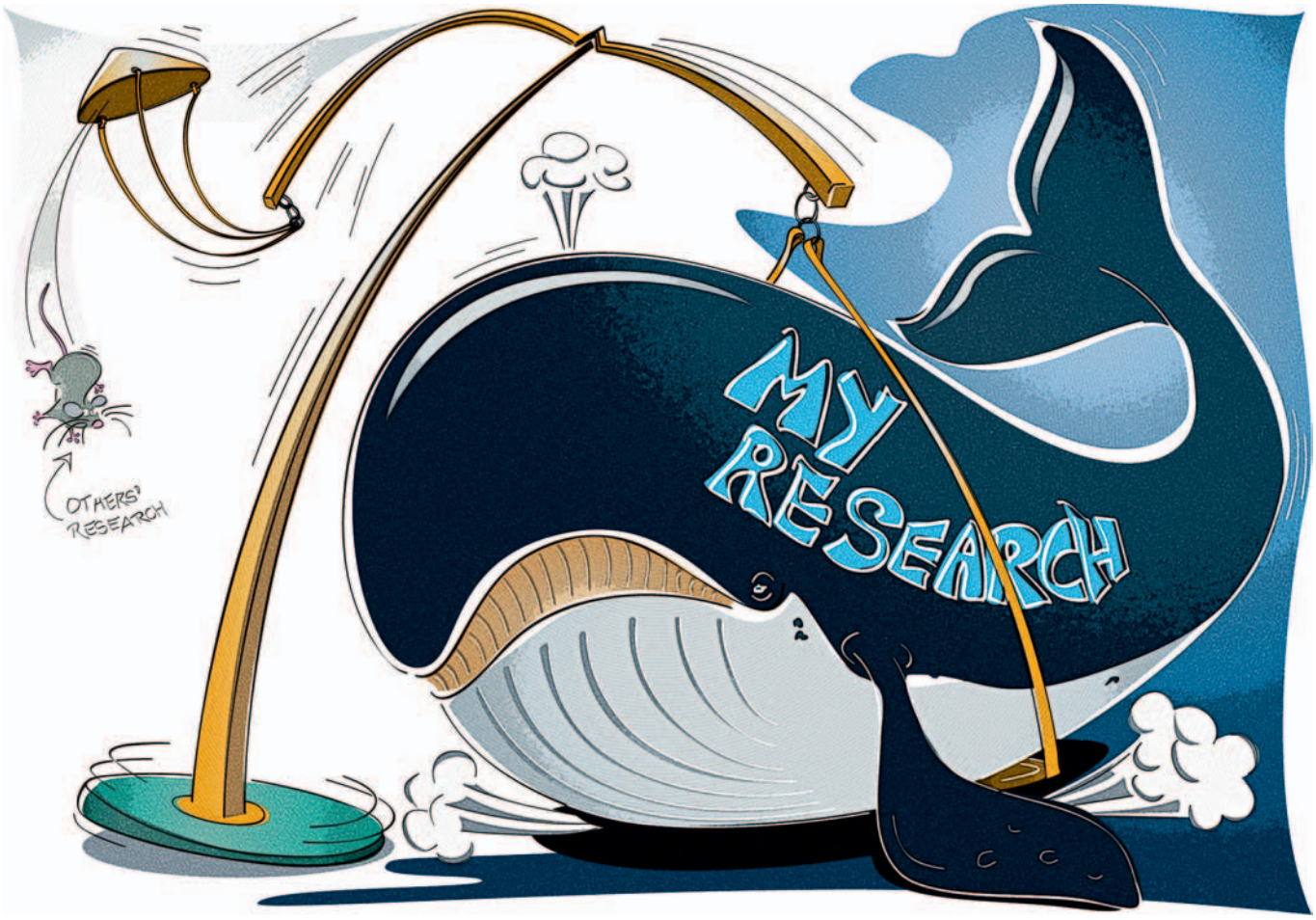
The new REF will also entail changes in budget allocations. The evaluation of a research unit for the purpose of allocations will determine 20% of the societal influence dimension [19]. The final REF guidance contains lists of examples for different types of societal impact [24].

Societal impact is much harder to measure than scientific impact, and there are probably no indicators that can be used across all disciplines and institutions for collation in databases [17]. Societal impact often takes many years to become apparent, and "[t]he routes through which



research can influence individual behaviour or inform social policy are often very diffuse" [18].

Yet, the practitioners of societal impact measurement should not conduct this exercise alone; scientists should also take part. According to Steve Hanney at Brunel University, an expert in assessing payback or impacts from health research, and his co-authors, many scientists see societal impact measurement as a threat to their scientific freedom and often reject it [25]. If the allocation of funds is increasingly oriented towards societal impact issues, it challenges the long-standing reward system in science whereby scientists receive credits—not only citations and prizes but also funds—for their contributions to scientific advancement. However, given that societal impact measurement is already important for various national evaluations—and other countries will follow probably—scientists should become more concerned with this aspect of their research. In fact, scientists are often unaware that their research has a societal impact. "The case study at BRASS [Centre for Business Relationships, Accountability, Sustainability and Society] uncovered activities that were previously 'under the radar', that is, researchers have been involved in activities they realised now can be characterized as productive interactions" [26] between them and societal stakeholders. It is probable that research in many fields already has a direct societal impact, or induces productive interactions, but that it is not yet perceived as such by the scientists conducting the work.

The involvement of scientists is also necessary in the development of mechanisms to collect accurate and comparable data [27]. Researchers in a particular discipline will be able to identify appropriate indicators to measure the impact of their kind of work. If the approach to establishing measurements is not sufficiently broad in scope, there is a danger that readily available indicators will be used for evaluations, even if they do not adequately measure societal impact [16]. There is also a risk that scientists might base their research projects and grant applications on readily available and ultimately misleading indicators. As Hansson and Ernø-Kjølhede point out, "the obvious danger is that researchers and universities intensify their efforts to participate in activities that can be directly documented rather than activities that are harder to document but in reality may be more useful to society" [19]. Numerous studies have documented that scientists already base their activities on the criteria and indicators that are applied in evaluations [19,28,29].

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Until reliable and robust methods to assess impact are developed, it makes sense to use expert panels to qualitatively assess the societal relevance of research in the first instance. Rymer has noted that, "just as peer review can be useful in assessing the quality of academic work in an academic context, expert panels with relevant experience in different areas of potential impact can be useful in assessing the difference that research has made" [18].

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Whether scientists like it or not, the societal impact of their research is an increasingly important factor in attracting public funding and support of basic research. This has always been the case, but new research into measures that can assess the societal impact of research would provide better qualitative and quantitative data on which funding agencies and politicians could base decisions. At the same time, such measurement should not come at the expense of basic, blue-sky research, given that it is and will remain near-impossible to predict the impact of certain research projects years or decades down the line.

CONFLICT OF INTEREST

The author declares that he has no conflict of interest.

REFERENCES

1. Salter AJ, Martin BR (2001) The economic benefits of publicly funded basic research: a critical review. *Res Policy* **30:** 509–532
2. Nightingale P, Scott A (2007) Peer review and the relevance gap: ten suggestions for policy-makers. *Sci Public Policy* **34:** 543–553
3. Smith R (2001) Measuring the social impact of research. *Br Med J* **323:** 528
4. Molas-Gallart J, Salter A, Patel P, Scott A, Duran X (2002) *Measuring Third Stream Activities. Final Report to the Russell Group of Universities*. Brighton, UK: Science and Technology Policy Research Unit (SPRU)
5. van der Meulen B, Rip A (2000) Evaluation of societal quality of public sector research in the Netherlands. *Res Eval* **9:** 11–25
6. Department of Education Science and Training (2005) *Research Quality Framework: Assessing the Quality and Impact of Research in Australia*. Canberra, Australia: Commonwealth of Australia
7. Bozeman B, Sarewitz D (2011) Public value mapping and science policy evaluation. *Minerva* **49:** 1–23
8. van Vught F, Ziegele F (eds) (2011) *Design and Testing the Feasibility of a Multidimensional Global University Ranking. Final Report.* European Community, Europe: Consortium for Higher Education and Research Performance Assessment, CHERPA-Network
9. ERiC (2010) *Evaluating the Societal Relevance of Academic Research: A Guide*. The Hague, the Netherlands: Rathenau Institute
10. Holbrook JB, Frodeman R (2011) Peer review and the *ex ante* assessment of societal impacts. *Res Eval* **20:** 239–246
11. Donovan C (2008) The Australian Research Quality Framework: a live experiment in capturing the social, economic, environmental, and cultural returns of publicly funded research. *New Directions for Evaluation* **118:** 47–60
12. Bornmann L, Daniel H-D (2009) The state of *h* index research. Is the *h* index the ideal way to measure research performance? *EMBO Rep* **10:** 2–6
13. Bornmann L, Marx W, Gasparyan AY, Kitas GD (2012) Diversity, value and limitations of the Journal Impact Factor and alternative metrics. *Rheumatol Int* **32:** 1861–1867
14. Niederkrotenthaler T, Dorner TE, Maier M (2011) Development of a practical tool to measure the impact of publications on the society based on focus group discussions with scientists. *BMC Public Health* **11:** 588
15. Godin B, Dore C (2005) *Measuring the Impacts of Science; Beyond the Economic Dimension, Urbanisation INRS, Culture et Société*. Helsinki, Finland: Helsinki Institute for Science and Technology Studies. http://www.csiic.ca/PDF/Godin_Dore_Impacts.pdf
16. Martin BR (2007) *Assessing the Impact of Basic Research on Society and the Economy.* FWF–ESF International Conference on Science Impact: Rethinking the Impact of Basic Research on Society and Economy, Vienna, Austria, 11 May 2007. Conference Presentation
17. Martin BR (2011) The Research Excellence Framework and the 'impact agenda': are we creating a Frankenstein monster? *Res Eval* **20:** 247–254
18. Rymer L (2011) *Measuring the Impact of Research—The Context for Metric Development.* Turner, Australia: The Group of Eight
19. Erno-Kjolhede E, Hansson F (2011) Measuring research performance during a changing relationship between science and society. *Res Eval* **20:** 131–143
20. Grant J, Brutscher P-B, Kirk S, Butler L, Wooding S (2009) *Capturing Research Impacts*. Cambridge, UK: RAND Europe
21. Higher Education Funding Council for England (2009) *Research Excellence Framework Second Consultation on the Assessment and Funding of Research.* Bristol, UK: HEFCE
22. Higher Education Funding Council for England (2011) *Decisions on Assessing Research Impact.* Bristol, UK: HEFCE
23. Donovan C (2011) State of the art in assessing research impact: introduction to a special issue. *Res Eval* **20:** 175–179
24. Higher Education Funding Council for England (2012) *Panel Criteria and Working Methods*. Bristol, UK: HEFCE
25. Hanney S, Packwood T, Buxton M (2000) Evaluating the benefits from health research and development centres: a categorization, a model and examples of application. *Evaluation* **6:** 137–160
26. SIAMPI (2010) SIAMPI workshop. Brussels, Belgium: SIAMPI http://www.siampi.eu/Content/SIAMPI/Report%20SIAMPI%20workshop.pdf
27. European Commission (2010) *Assessing Europe's University-based Research. Expert Group on Assessment of University-based Research.* Luxembourg: Publications Office of the European Union
28. Abbott A, Cyranoski D, Jones N, Maher B, Schiermeier Q, van Noorden R (2010) Metrics: do metrics matter? *Nature* **465:** 860–862
29. Bornmann L (2010) Mimicry in science? *Scientometrics* **86:** 173–177

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