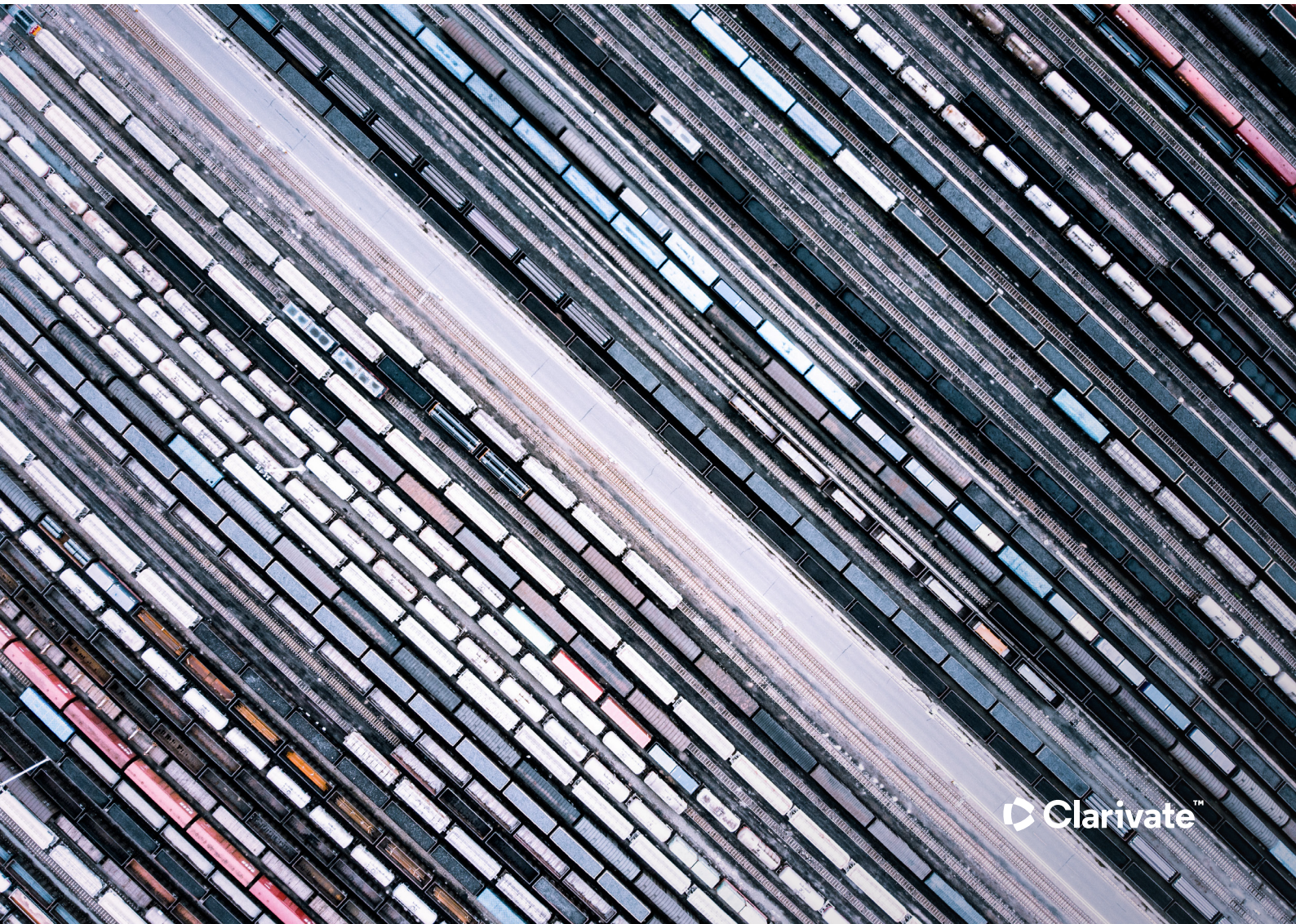
Institute for Scientific Information

Global Research Report
Research assessment: Origins, evolution, outcomes

What have assessment initiatives achieved?

Jonathan Adams, Ryan Beardsley, Lutz Bornmann, Jonathan Grant, Martin Szomszor and Kate Williams



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ISBN 978-1-7395906-1-1

Cover image: Freight train marshalling station, Harbin, Heilongjiang, China

Executive summary

This is a report about research assessment: its origins, how it works in different regions and what effects it may have had on higher education and funding policy. Six systems are described, the structure and performance outcomes of each is discussed, drawing on Web of Science data, and the burden of assessment for researchers, institutions and assessors is acknowledged.

- The United Kingdom set the first model for regular research assessment, which has had pervasive effects on institutional management and on researcher behavior.
- Australia has a comprehensive research assessment, seeking to measure both academic impact and wider societal benefit, but it does not influence direct research funding and may be unconnected to citation-indexed research performance.
- Canada focuses on 'knowledge mobilization' in specific research areas rather than assessing general research outcomes.
- Germany has promoted its research status using 'Excellence Initiative' block funding to research organizations without regular nationwide evaluations.
- While Hong Kong's research assessment system is similar to the U.K. model, it draws on a distinctive conception of scholarship and on socio-economic benefit as well as excellence.
- The introduction of New Zealand's PBRF can be associated with a marked improvement in its internationally comparative research performance.

The indexed performance of the research base improved in all six systems described in this report – in at least one case likely due to the assessment exercise – but there is no clear universal verdict on whether research assessment is a necessary or desirable agent.

What is clear is that there has been system change, certainly in Germany and probably in the United Kingdom. It has had major effects on institutional structures. It has unquestionably had pervasive effects on researcher behavior: demonstrable in the U.K. and widely reported elsewhere. The most important feature of any assessment system should arguably be the extent to which it attracts and retains the confidence of the researchers.

When considering the future of research assessment exercises, we examine the potential of Artificial Intelligence (AI) replacing traditional peer review. AI has had a profound impact on research, but there is a risk that machine learning solutions to assessment burdens may propagate existing biases.

Origins

This is a report about research assessment: its origins, how it works in different regions and what effects it may have had.

Formal research assessment is now widespread but was not always part of public funding. Prior to the 1980s, most governments' grant-awarding bodies only evaluated the applications from principal investigators. Research was an unpredictable and uncertain process, research support had been sufficient to meet high quality proposals, so assessment of outcomes and benefits was limited.

The European Commission's Framework Programs made extensive use of assessment: before the start, mid-term during a program and both at the end and two-three years after a program finished. This led to a general notion of establishing baselines and tracking research progress and outcomes. Wider economic and political changes in the 1970s and 1980s stimulated considerations of research assessment as part of a shift towards greater selectivity. First, the oil crisis of the 1970s severely impacted the capacity of western economies; second, the growth of the research base in many regions meant that researcher demands were exceeding resource supply.

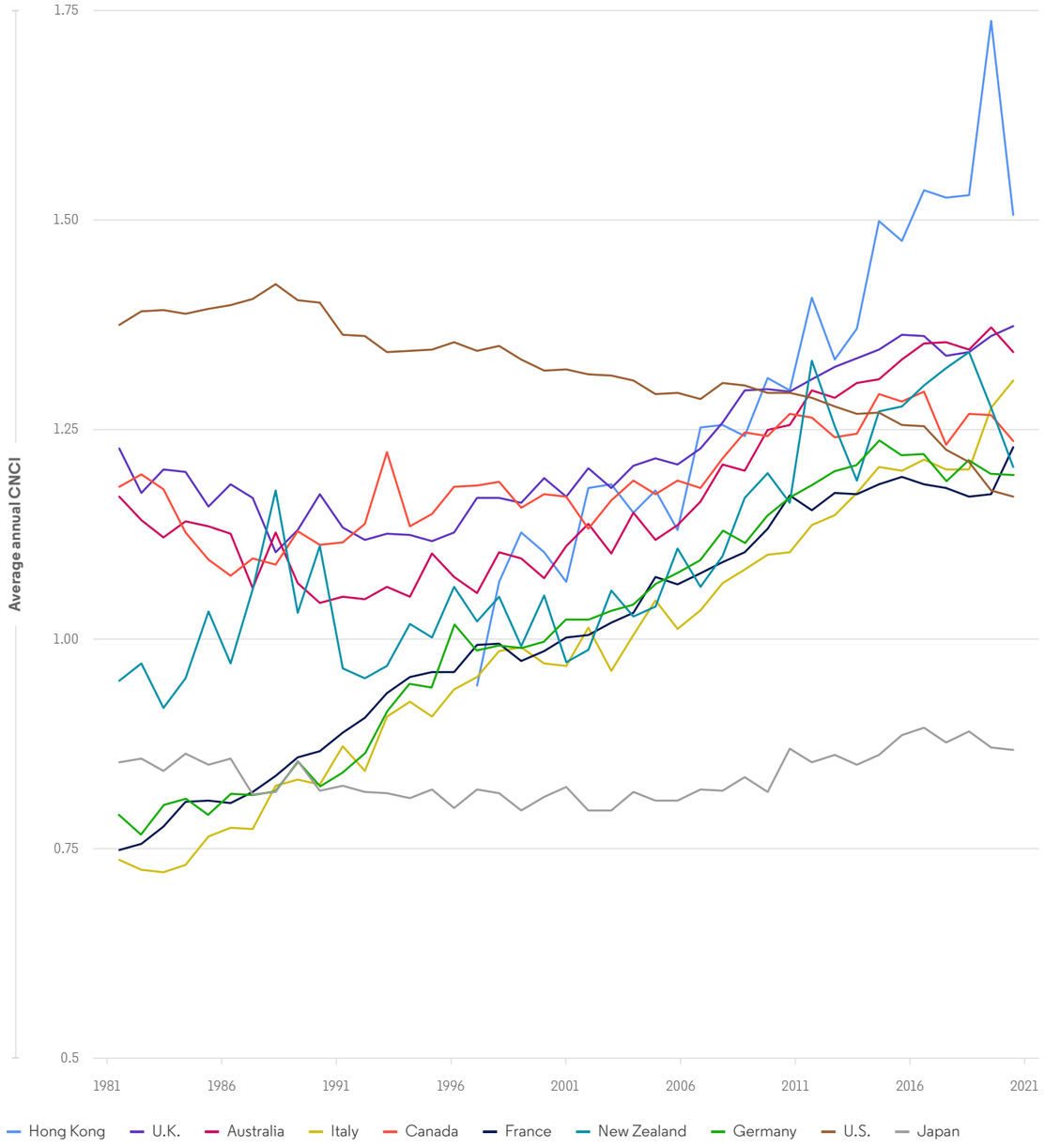
The first assessment of a public-sector research base was the United Kingdom's Research Selectivity (later Assessment) Exercise (RAE) introduced by the University Grants Committee (UGC) in 1986. By the mid-1990s it was widely agreed among the United Kingdom's research partners that the RAE had shifted attitudes to research and improved the U.K.'s comparative international performance. Hong Kong was among the first jurisdictions to adopt a similar process in 1993. New Zealand's sister process was the Performance-Based Research Fund (PBRF), which has been running cyclically since 2003. Australia instituted 'Excellence in Research for Australia (ERA)' in 2009.

Other countries/ regions piloted diverse forms of research assessment, but few pursued this consistently[1]. For example, Germany implemented comprehensive evaluation across higher education institutions and research institutes in the early 2000s, leading to major structural changes and funding shifts, but did not adopt regular assessment cycles. France, the Czech Republic and Poland have all explored and described possible research assessment but not then proceeded to implementation. Canada carries out research assessment in health and education that is often quoted as an international exemplar, but this is not applied in other disciplines. Ireland has central evaluation but has not done this in concert with institutions. The Netherlands and Sweden organize research assessment on an institutional basis, without funding implications.

In this report we discuss different approaches that are all associated with clear improvement in comparative research performance. The United Kingdom, Australia, Hong Kong and New Zealand have cyclical research assessment; Canada and Germany do not. Figure 1 shows how their citation-based research performance has changed over the last four decades. How much has assessment stimulated those who used it and those with whom they collaborate?

Assessment is not cheap, although it may be cost-efficient relative to funds distributed. It can be onerous for institutions, for the organizers and for those who assist in the assessment. As assessment diversifies from academic excellence into socio-economic impact it may be more complex and more costly. Alternatives are sought and so we also examine whether new technologies can help to speed the process and ameliorate the burden.

Figure 1: Category Normalized Citation Impact (CNCI) of countries/ regions discussed in this report and others in the G7. Citations accumulate over time at rates that are discipline dependent. CNCI compares the citation count of every paper with the year average for a relevant group of journals, and then calculates the average. The world baseline is therefore 1.0. The legend lists countries/ regions in descending order of their average CNCI for 2021.



Source: Web of Science

United Kingdom

The United Kingdom set the first model for regular research assessment, which has had pervasive effects on institutional management and on researcher behavior.

Jonathan Adams, Institute for Scientific Information at Clarivate

The United Kingdom was the early adopter of assessment and of subsequent structural changes, most recently the shift from the RAE to the Research Excellence Framework (REF) in 2014, introducing the 'Impact Case Study' (ICS) as a tool for assessing external research achievements.

The 1986 assessment was intended to identify the better and worse parts of the research base and to concentrate core (infrastructure) funding. This exercise, and its reiteration in 1989, began a process of cultural change in the system and structural change in the institutions. The Higher Education Funding Councils that replaced the UGC in 1992 adopted the concept and reified it in a structured Research Assessment Exercise (RAE), which was repeated in 1996, 2001 and 2008 before evolving into the Research Excellence Framework in 2014.

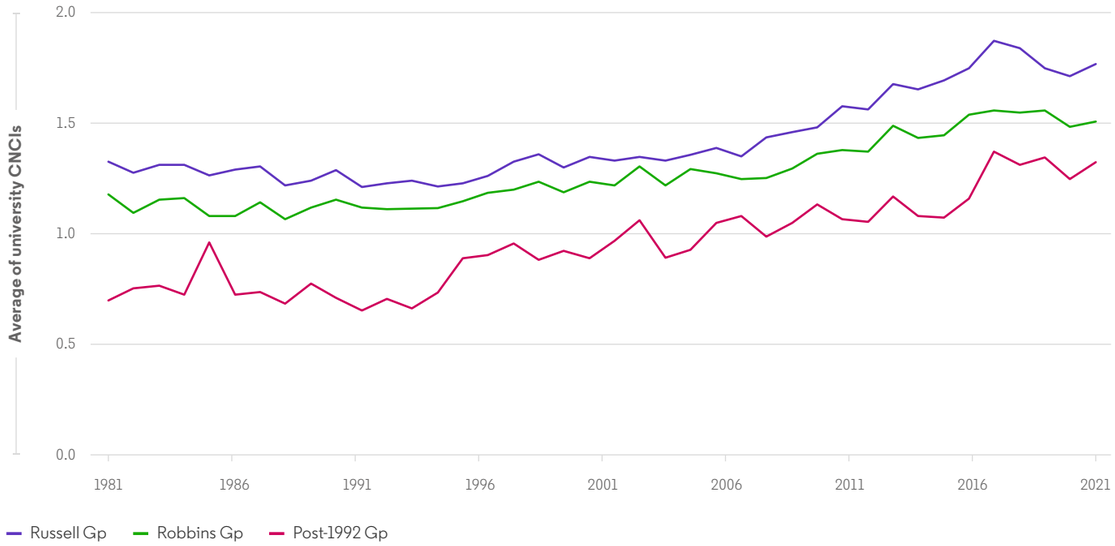
The first changes from 1986/89 to the 1992 cycle were simplification: a structured approach to the information requested from universities; a restricted number of submitted outputs; a reduction in the number of disciplinary panels (reduced further in later cycles); and the provision of data (results) that served both in a funding formula and as reputational indicators. Each university submitted data for assessment as a templated portfolio of subject-based Units of Assessment (UOAs) and covering staff, funding, students and publications (four per academic staff) as well as strategic statements.

The structure established in 1992 proved remarkably sound. There were many criticisms though few gained total acceptance: topics marginal to main panels were not always accurately assessed; the assessment of early-stage researchers and of those taking career breaks was not managed properly; game playing by research managers was evident. But the core method remained constant until 2014.

Two principal kinds of change occurred in the United Kingdom during the 1990s. One was an apparent improvement in the United Kingdom's average citation impact[2]. The U.K. citation impact relative to global baselines had declined in the 1980s but turned a corner after 1992 and was heading upwards. An analysis of the average Category Normalized Citation Impact (CNCI) of papers authored by researchers in U.K. universities and indexed in the Web of Science, a Clarivate solution, confirms that U.K. universities' average citation impact in the 1980s was dropping slightly. It stepped up after 1992, especially for the former Polytechnic Group with new funding, and began to rise steadily after 2000. It is also clear that the system remained highly stratified in terms of net research performance (Figure 2).

Easy 'grade' comparisons between institutions sharpened a competitive edge that stimulated the other major change: a system-wide restructuring of institutional research management. This was a profound shift from the collegial European academic model where researchers were essentially self-managed. First, senior academic managers with a specific research mission were appointed[3]; research strategy committees and then strategic plans appeared; funds were gathered centrally to spend on new appointments and initiatives. Second, this resulted in selective closures, reshaping of units within institutions and reallocation of resources.

Figure 2: The average annual Category Normalized Citation Impact (CNCI) of journal articles authored and co-authored by U.K. universities, grouped by historical sub-sectors: large, research-intensive universities founded before 1960 (Russell Group); institutions founded in the 1960s, some of which were colleges prior to 1960 (Robbins Group); and post-1992 universities with a prior existence (Polytechnic Group).



Source: Web of Science

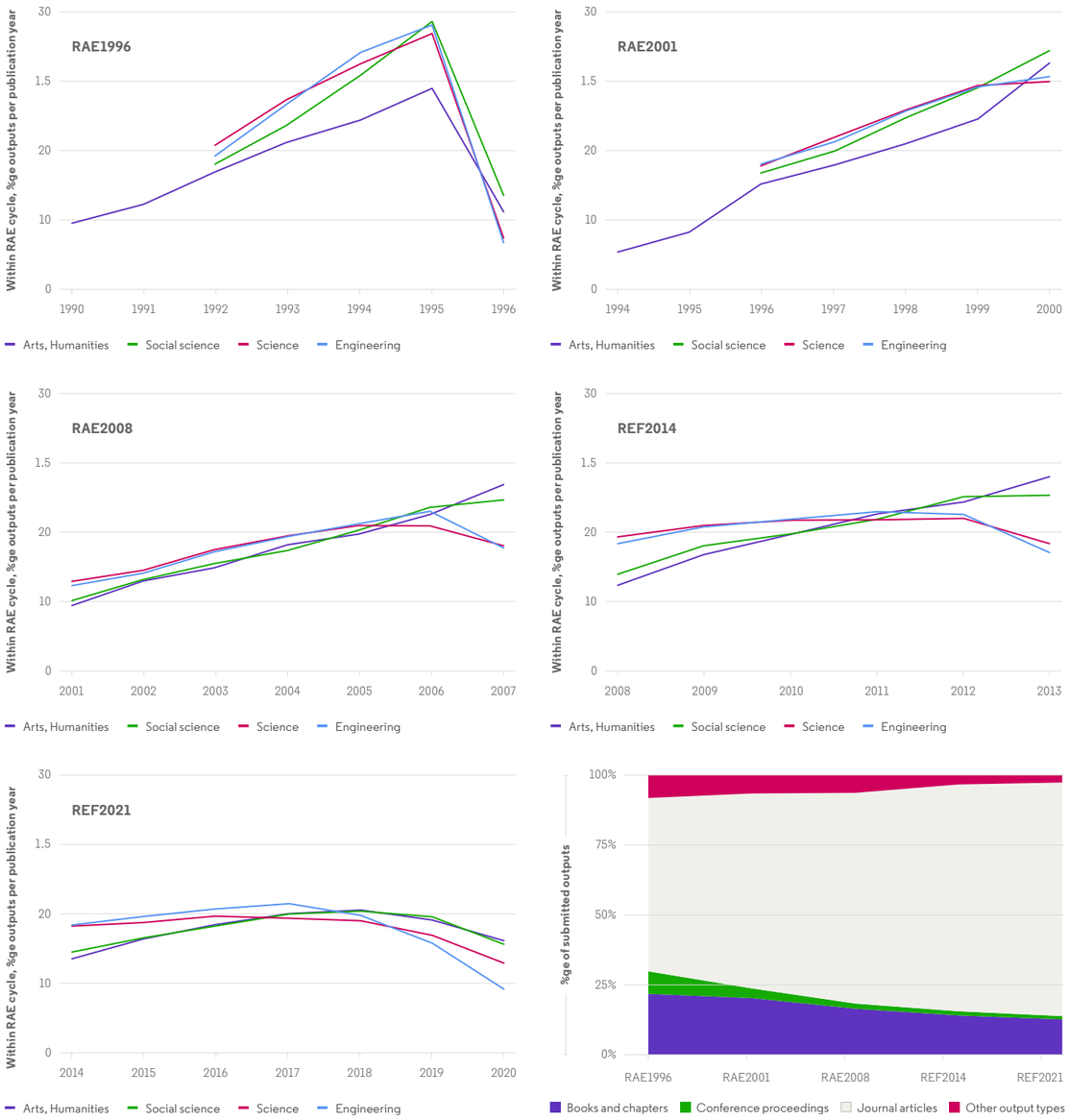
The restructuring and new awareness of research performance deeply affected U.K. research culture. Data from successive assessment cycles show how this modified the judgment of researchers and research managers about 'best evidence' of research achievement.

This can be seen in the types of output submitted by the researchers and the spread of those outputs within each assessment cycle[4] (Figure 3). In the early years, the preferred output type for the engineers were conference proceedings while the social scientists favored monographs and natural scientists submitted almost entirely journal articles.

The engineers and the social scientists progressively switched to submitting journal articles instead. Judgment on 'time' also shifted from early cycles, which reflect a strong recency bias ('my best work is my latest work') to RAE2008 by which point the scientists and engineers were picking a wider spread of documents across the census period. By REF2014, the spread across years was more even and, in data for REF2021, a bias has emerged towards the earliest years. This shift has also spread to the social sciences and humanities.

Rising citation impact and new institutional strategic and management structures might be judged as the intended outcomes of this policy initiative. But how has research assessment influenced academic judgments about their 'best' work? This is probably due not to policy but to external context. Bibliometric analysis was little known in 1992 but the online Web of Science created in the late 1990s enabled wider access to publication and citation data, unavailable for monographs and patchy for conference series. New bases for judgment on 'value' were spawned: articles displaced proceedings and the relative impact of new, recent and older publications became evident.

Figure 3: The evolving pattern of submitted output types and their publication dates in relation to the successive cycles of U.K. research assessment.



Australia

Australia has a comprehensive research assessment, seeking to measure both academic impact and wider societal benefit, but it does not influence direct research funding and may be unconnected to citation-indexed research performance.

Kate Williams, University of Melbourne

Despite a modest population (ranked 55th in the world at 25.5 million) and its relatively isolated geographical location, Australia is ranked 4th in the Highly Cited Researchers 2021 report from Clarivate and 10th in the Nature Index.[5]

The 1988 Dawkins reforms[6] led to the emergence of a larger and structurally more varied university research sector absorbing 19 universities and 46 colleges. Research funding became more competitive under a new Australian Research Council[7] but assessment was introduced later.

The Australian Government sought to move ahead of the curve in 2004 by developing Australia's Research Quality Framework (RQF), which later informed the design of the United Kingdom's first REF[8]. However, this lost momentum when the RQF faced strong academic opposition and it was abandoned in 2007 at a change of government.

A replacement came in the form of Excellence in Research for Australia (ERA, 2010), a framework aimed at recognizing Australian university research strengths which bibliometric data indicated were improving strongly.

ERA is run by the Australia Research Council (ARC) and assesses research across all fields using several metrics,[9] with a final score for each unit determined by expert committees.

Two broad categories of indicators inform evaluation: research quality, based on citation analysis or peer review; and research activity, based on research outputs and research income according to criteria based on eligible researchers. Importantly, ERA's metric focus places emphasis on the academic impact of research rather than its wider societal impact. The first complete ERA round took place in 2010, with results released early in 2011, and went through three more iterations in 2012, 2015 and 2018. The next round of the ERA will run in 2023.

Figure 4: Changes in Category Normalized Citation Impact and the percentage of Australian papers with an international co-author, compared to the incidence of research assessment (Excellence in Research for Australia, ERA) in Australia. The timeline shows the Dawkins policy innovation of 1988 (blue circle) and the years when ERA assessment occurred (blank).

Source: Web of Science

Following repeated calls in government reports from 2009[10] for a specific assessment of wider societal impact, the first Engagement and Impact Assessment was conducted in 2018.[11] The methodology was shaped through consultation with university and industry stakeholders through a Steering Committee, working groups and a pilot study in 2017. The Engagement and Impact Assessment is not integrated into the ERA but runs as a complementary exercise. Engagement and Impact Assessment evaluation sought to incorporate for the first time a review of the broader impact Australian research has on society, evaluating how well academics interact with research users and demonstrating how universities transform research into impacts on the economy, society, environment, culture and other areas.

Australian methodology distinguishes engagement from impact, in contrast to other research impact evaluations throughout the world such as the United Kingdom's REF.

Another key difference from other systems is that the Australian assessment focuses specifically on the institutions' mechanisms for fostering or enabling research impact. The impact submission takes the form of qualitative studies that highlight both the impact that emerged from the study and the institutional approach that made this possible. An engagement narrative and engagement indicator data are included in and considered together with the engagement submission.

The evaluation is carried out by panels made up of both academics and experienced research end-users. There were five evaluation panels in 2018: social sciences; creative arts and humanities; science and technology; health and life sciences; and research on Aboriginal and Torres Strait Islanders. The findings were published in February 2019.

A key feature of the Australian research landscape is the relationship between assessment and funding. The development of Australia's research assessment programs has been accompanied by declining trends in investment and research prioritization. Since 2013, Australia has trailed the OECD average GERD[12], dropping from 0.67% in 2012 to 0.51% in 2019.[13] The COVID pandemic saw a reverse of this trend, with investment of 0.60% (AU$12.7 billion), bringing it up to the OECD 2018 average. A related feature has been the increasing importance of universities' discretionary funding contribution to research from 41.3% in 2008 to a high of 50.7% in 2018, reflecting declining government block grants and external research funding.[14] This trend also reversed with increased funding to universities the pandemic, reducing discretionary funding to 36.2%. However, despite these overall trends, remarkable international collaboration has seen research outputs rising substantially over the years, doubling from 2011 to 2020.[15] As a result, productivity per researcher and per GERD is relatively high. International collaboration has fostered citation impact above the G20 average, and the highest overall share of highly cited papers in the G20.[16]

In Australia there is no direct relationship between the results of the evaluation and research funding, again unlike the United Kingdom. The historical assumption is retained: that good results lead to better outcomes in terms of attracting students, institutional support and external funding.

Thus, the primary policy mechanism has relied on competition for prestige to produce institutional effects. For example, the metric focus deters academics from pursuing alternative outlets for wider audiences beyond the peer-reviewed journals.[17] There has also been a substantial shift from basic research to applied research and experimental development.[18] Universities also "modify their systems and processes in the research area to best position them for research evaluation systems and to maintain their legitimacy with a key stakeholder, the government."[19]

The evidence suggests that Australia's internationally comparative research performance was well on the way up before ERA was conceived. Without a clear mandate to inform funding allocation, the value of the ERA and the Engagement and Impact Assessment remain under-specified. Acknowledgment that vision and objectives for Australian research assessment require rethinking are reflected in the recent decision to pause the 2023 ERA evaluation round. In announcing this decision, the ARC couched the change in policy as a prioritization of "a modern data driven approach… informed by expert review."

Canada

Canada focuses on "knowledge mobilization" in specific research areas rather than assessing general research outcomes.

Jonathan Grant, Different Angles

Canada's approach to impact is distinct from both the U.K.-Australia use of performance management frameworks and Germany's laissez-fare system. Canada has a long history and culture of integrating knowledge mobilization and evaluation across the research life cycle. Its strategy is to focus on and assess 'knowledge mobilization' to inform research impact planning and generation, rather than focusing on retrospective assessment. In other words, Canada's focus is on learning about the process that links research to impact and, with that knowledge, improving translation and mobilization activities.

Canada has a long and rich history of programmatic evaluation, of research and more broadly across the public sector. The government has progressively refined its systematic performance and evaluation practices not only for accountability but to assess policies and improve practice.

For example, from its foundation in 2000, the Canadian Institutes of Health Research (CIHR) has had a rolling schedule of program evaluation and a dedicated office to support such activities. Some years after the founding of CIHR, the Canadian Academy of Health Science (CAHS) convened an international panel on the return on investments in health research, resulting in a 2009 report[20] under the chairmanship of Cy Frank who went on to be CEO of Alberta Innovates Health Solutions (AIHS) between 2013 and 2015.

The CAHS Impact Framework provides a roadmap to understand the real world of research and its impacts, with multi-dimensional, complex and non-linear feedback loops, characterizing impact pathways. Informed by the Buxton and Hanney Payback Model,[21] the CAHS framework uses five impact categories (and subcategories) and provides a starting menu of 66 preferred indicators and metrics that can be used to assess research impact.

AIHS (now Alberta Innovates) took forward the work of CAHS and founded the International School of Research Impact Assessment (ISRIA),[22] hosting five iterations of the school – both international and regional. Capacity building continues through the Impact Action Lab at Alberta Innovates which delivers impact planning and assessment courses and integrates knowledge mobilization and implementation science practices for scaling impact.

At the same time, a separate line of enquiry was developing in Canada around knowledge transfer, translation and mobilization. Canada was seen as a world leader in this emerging field with a strong academic pedigree generating clear, and now largely uncontested evidence, that research gets into policy and practice when it is co-produced with user communities.

Building on these two foundations, Canadian researchers define knowledge mobilization as the "intentional effort to advance the societal impact of research". [25] Critically such an approach has spread beyond biomedical and health research and is applicable to all research disciplines.

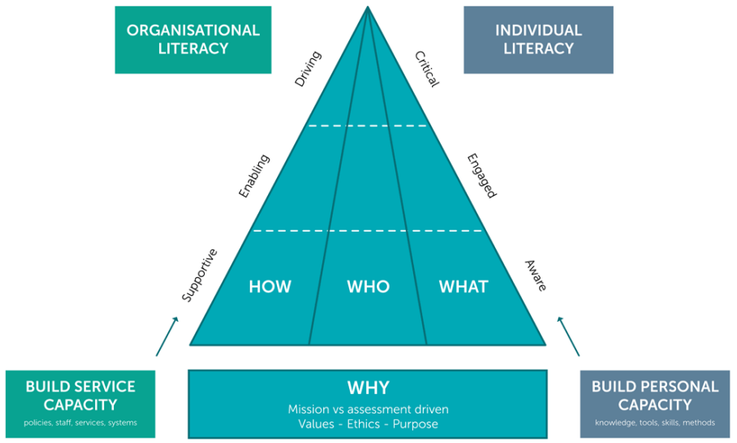
With that in mind, Research Impact Canada (RIC) is a network that aims to build institutional capacity. Amongst other conceptual frameworks, RIC uses 'impact literacy', defined as the ability to "identify appropriate impact goals and indicators, critically appraise and optimize impact pathways, and reflect on skills needed to tailor approaches across contexts" (Figure 5).[26]

RIC, in its words, aims to "maximize the impact of research for the public good." The key difference between the Canadian and U.K. approaches is that it is formative not summative. It aims to support and develop knowledge mobilization activities, institutionally and individually, with a view that this leads to societal impact of research.

By contrast, retrospective assessment is summative, leading to a public 'grade' and potential financial reward. As a result, the research impact (and assessment) community in Canada can be characterized as more grassroots through communities of practice that foster fellowship and shared learnings to understand what works, under what conditions and why.[27]

Which, if either, approach is likely to lead to a greater degree of research impact? It is not yet feasible robustly to answer such a question, but it is interesting that the emerging debate about research culture in the United Kingdom is often framed in the context of research assessment.

Figure 5: Revised model of impact literacy. Impact literacy encompasses four elements that characterize impact pathways: How, the intentional and emergent practice to create impact; What, the measurement and articulation of manifest impacts; Who, the human force that facilitates the integration of how and what; and, Why, a baseline understanding of the motivations for pursuing impact and the concomitant ethical considerations (Bayley & Phipps, 2019).



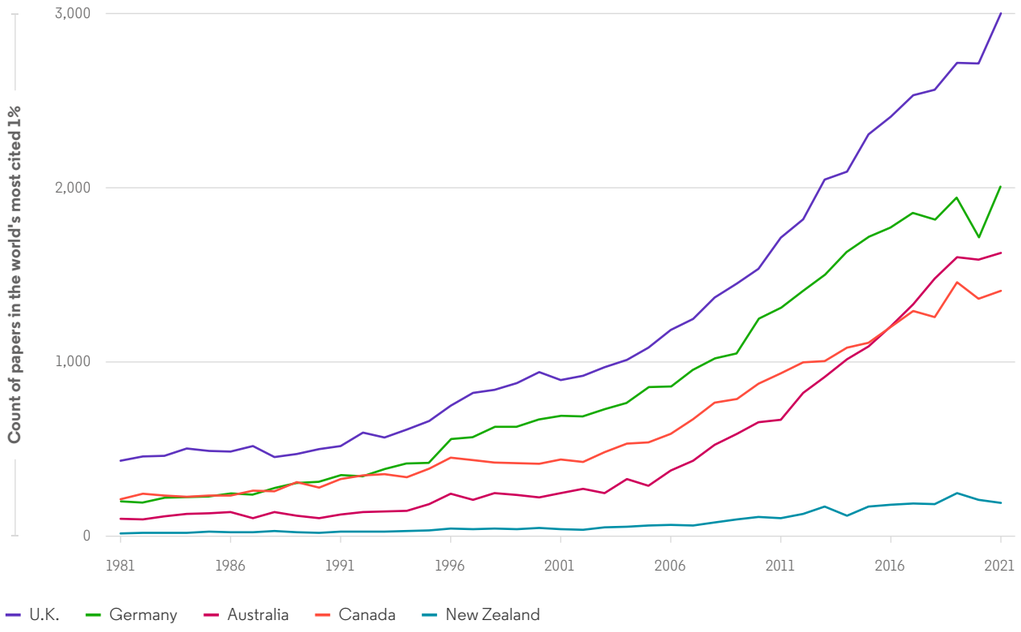
Germany

Germany has promoted its research status using 'Excellence Initiative' block funding to research organizations without regular nationwide evaluations.

Lutz Bornmann, Max Planck Institute

Germany has long been a leading nation in science. It is one of the five best performing nations in the Nature Index 2022[28] and in terms of numbers of Highly Cited Researchers.[29] Investment is higher than European Union (E.U.) neighbors, with GERD over 3% of GDP, and citation impact of its research is relatively good, especially in life sciences, securing a 14% share of the world's top 10% of papers[30] and annually authoring or co-authoring more than 2,000 papers in the world's top 1% (Figure 6).

Figure 6: The annual count of papers in the 'top 1%' of most cited papers published in journals indexed on the Web of Science indicates the effectiveness of German research policy.



Source: Web of Science

Germany has sustained its leading position in science despite using a funding model of research characterized by block funding without regular nationwide evaluations[31] unlike the assessment systems of the U.K. or Sweden.[32] Furthermore, unlike those countries, German research is carried out by both higher education institutions (especially universities) and institutes such as those of the Max Planck Society.[33] Institutional evaluations are carried out either by university departments themselves (on their own responsibility) such as the University Medical Center Göttingen (UMG),[34] or the institution is evaluated through specialized institutional groups (e.g., committees of experts). In lower Saxony, for example, universities can be supported at evaluations by the Wissenschaftliche Kommission Niedersachsen (scientific committee of lower Saxony).[35]

Evaluation approaches at non-university research institutions are long established. For example, each Max Planck institute evaluates research activity and resulting performance on a rolling basis as each project is initiated. Evaluation is centered on scientific advisory boards "which were set up in the 1970s as permanent evaluation bodies at the Max Planck Institutes".[36] Similarly, the Helmholtz Society, another non-university research institution, evaluated all its centers between 2017 and 2018 based on an extensive informed peer review process.[37]

In 2005, two measures were established by the Germany government to foster international competitiveness: (1) Pact for research and innovation (PFI) for non-university research institutions; and (2) Excellence Strategy (ES, a modified measure that followed the former Excellence Initiative, EI) for universities. Both measures have been modified over time but remain active. These measures were initiated partly as a reaction to the E.U. Lisbon-program in which member states committed to invest in education and science. The measures were linked to intense evaluation procedures for the participating institutions.

The PFI guaranties the German non-university research institutions (and the German Research Foundation, Bonn) a constant annual budget increase of (actual) three percentage points. In return, the institutions committed themselves to certain research-policy goals (e.g., more transfer of knowledge, products, ideas etc. from the science sector to other sectors of the German society): the realizations of the goals must be presented by the institutions in annual monitoring reports. The reports also include key indicators that evidence their success in reaching the goals. In addition to key data from the institutions, an independent research group (specialists in scientometrics) produces a bibliometric report with results on non-university research institutions and institutions from the higher education sector in Germany.

The EI was initiated in 2006 by the federal states and German government.[38] The initiative was based on an ex-ante evaluation with an objective to support only a small number of German institutions. Between 2006 and 2011, the EI focused on three funding lines: (1) graduate schools for the promotion of early career researchers; (2) clusters of excellence for the promotion of excellent research; and (3) institutional (future) strategies for the promotion of excellent university research. A primary goal of the EI was to break up an assumed institutional homogeneity in the German university system and thereby to shape institutional excellence.[39] The EI was replaced in 2018 by the ES, which focused on only two of the EI's priorities: clusters of excellence and institutional strategies.

The potential effect of the EI on the German science system have been investigated in several studies. Bornmann (2016) concluded that there was a positive effect from the establishment of clusters of excellence in the natural science, but less so in the life sciences. Civera et al. (2020) conclude that "the initiative not only stimulated the higher education system as such, but also the winner".[40] Klarl et al. (2018)[41] suggest that "not the political initiative per se, i.e., the treatment, but the announcement of the treatment triggered diverging performance paths within the German higher education system, thus positively contributing to augmented research performance of the promoted universities." Thus, as in the United Kingdom, both direct institutional and more pervasive systemic effects appear to have been realized by the German initiatives.

Germany has sustained its leading position in science despite using a funding model of research characterized by block funding without regular nationwide evaluations.

Hong Kong

While Hong Kong's research assessment system is similar to the U.K. model, it draws on a distinctive conception of scholarship and on socio-economic benefit as well as excellence.

Ryan Beardsley, Clarivate

Over the last three decades, the Hong Kong University Grants Commission (UGC) has established a consistent approach to assessing the research performance of universities, distributing its public funds largely via a system informed by the results of UGC's evaluation cycle, which applies to all of Hong Kong.

The UGC was established in the late 1960's on a backdrop of expanding government grants to higher education institutions and a rapidly evolving research landscape. UGC's scope increased in the 1970s to include polytechnic universities, which were granted university statis in 1994. Today, there are still eight predominantly publicly funded universities that fall under the aegis of the UGC and are therefore the subject of its Research Assessment Exercise (RAE).

Hong Kong was an early adopter of an RAE akin to the U.K. model. The first cycle, in 1993, was implemented with the goal of assessing research performance over all research subjects and institutions. Assessment was based on research outputs, reviewed by eight panels against a threshold which each determined appropriate to subject, rather than the United Kingdom's standardized quality rating.

The RAE1996 cycle was redesigned locally rather than by external consultants. The principal objectives and general scheme remained unchanged but with a stronger emphasis on quality, where RAE1993 lacked stringent requirements. The subject-based panels were larger and had more international members, and they were empowered to make a binary cut of those not meeting the Hong Kong standard of excellence, reducing the overall number of academics assessed.

The results demonstrated a significant overall benefit to the range and quality of Hong Kong research. Assessment was seen by UGC to have driven improvement in research and, at the same time, provided public accountability for the institutions.

The fundamental change in Hong Kong's status in 1997 imposed no significant operational assessment changes for RAE1999. There was, however, some revision of the methodology. The number of panels increased to 12 and membership was broadened to 42 international members of a total of 180 panel members, of whom 62 local and 8 overseas had prior RAE experience. Increased transparency was added to facilitate open moderation and to raise public awareness of the exercise and the panels' work.

The introduction of the Carnegie Foundation's definition of research as a basis for assessment was a more controversial development. This was the first time a research assessment system had used this external body's criteria of 'four scholarships': discovery, integration, application and teaching.[42] The innovation fueled debate in the Hong Kong research community and the Carnegie Foundation was engaged to address some concerns surrounding shared understanding of the definitions. Views in the community were mixed on the success of the approach, but UGC maintained its adoption.

Prior to RAE2006, a decision was made to depart from the three-year cadence – which coincided with Hong Kong's triennial funding cycle – in favor of a six-year RAE cycle. Despite mixed reactions from institutions regarding the dispersal of funds, UGC decided to conduct the RAE2006 broadly in line with RAE1999. At the same time, to answer criticism that prior RAEs did not adequately differentiate between the highest performers, a portion of the funding moved to the Research Grants Councils bid process to reward research excellence.

The UGC reinforced the use of the Carnegie definitions of scholarship, emphasizing its aim of assessment on a broad front. It concluded that all eight institutions had "made remarkable improvements to achieve international excellence," a key component of its definition of quality.

At the time of RAE2014, 25% of UGC funding was awarded as part of the institutional block grant to provide provision for research, with allocations informed by RAE outcomes. From 2013, covering RAE2014, half (12.5% of UGC funding) would be gradually transitioned to the competitive bids process over nine years, confirming the differentiation commitment initiated in RAE2006. Concurrently, 50% of postgraduate places would be allocated competitively, shifting away from prior historical norms.

The Carnegie definitions were retained, but institutions were not required to classify an output to one of the four scholarships. There was a continued focus on quality and five categories of quality, (Unclassified to 4 star) were introduced as another differentiating mechanism. The panels were instructed to view the universities in terms of quality profiles, weighted: esteem measures (10%); peer reviewed grants (10%); and outputs (80%).

RAE2020 was modelled on the U.K.'s REF2014. Changes were made to the balance of weightings: research outputs (70%), impact (15%) and environment (15%). The impact and environment components of a quality profile were introduced to drive research that was socially and economically beneficial as well as academically impactful. As in the United Kingdom, institutions were required to submit Impact Case Studies, and assessment was made in terms of reach and significance. In line with a focus beyond the academic community "research end-users" and professionals in appropriate fields were engaged to assess such impact.

The chair of the UGC commented, "Universities performed well in research impact, which reveals that the universities did a good job in transferring their research to innovative solutions, bringing substantial benefits to society and significant and tangible changes to people's lives."

New Zealand

The introduction of New Zealand's PBRF can be associated with a marked improvement in its internationally comparative research performance.

Jonathan Adams, Institute for Scientific Information at Clarivate

The Performance-Based Research Fund (PBRF) and the process used to evaluate university research in order to distribute the fund are frequently not differentiated by New Zealand researchers. When people speak of "the PBRF" they refer as much to the work required to assemble evidence for assessment as they do to the resources subsequently disbursed.[43]

The PBRF was instigated following a key recommendation in the Fourth Report of the NZ Tertiary Education Advisory Commission (TEAC, 2001). Those arguments were elaborated by a Ministry of Education report on 'Investing in Excellence' (MoE, 2002) and by the TEC's Sector Reference Group (SRG/TEC, 2005), which are essential background documents for those studying the development of the PBRF process.

The primary aim of the PBRF, as with the U.K.'s RAE system was to encourage and reward research excellence in the higher education sector within New Zealand. The research performance of Tertiary Education Organisations (TEOs, including the eight universities, the three Māori wānanga, polytechnics, institutes of technology, etc.) is assessed on the basis of performance appraisal implemented via the peer review of an Evidence Portfolio (EP) submitted by researchers. Funding is geared against both this assessment and against External Research Income (ERI) and Research Degree Completions (RDCs).

The PBRF is managed, implemented and evaluated by the TEC on behalf of the New Zealand government. A first full assessment of the quality of TEO research via this system took place in 2003, a further partial round was implemented in 2006. The system has become progressively more comprehensive. In 2003, 22 TEOs submitted 8,018 EPs rising to 33 TEOs and 8,671 Eps in 2006. This was fully reviewed in 2008[44] before the Quality Evaluation was run again in 2012 and, after the 2018 cycle, it was reviewed again in 2019.[45] This led to further modification and the next cycle is planned for 2025.

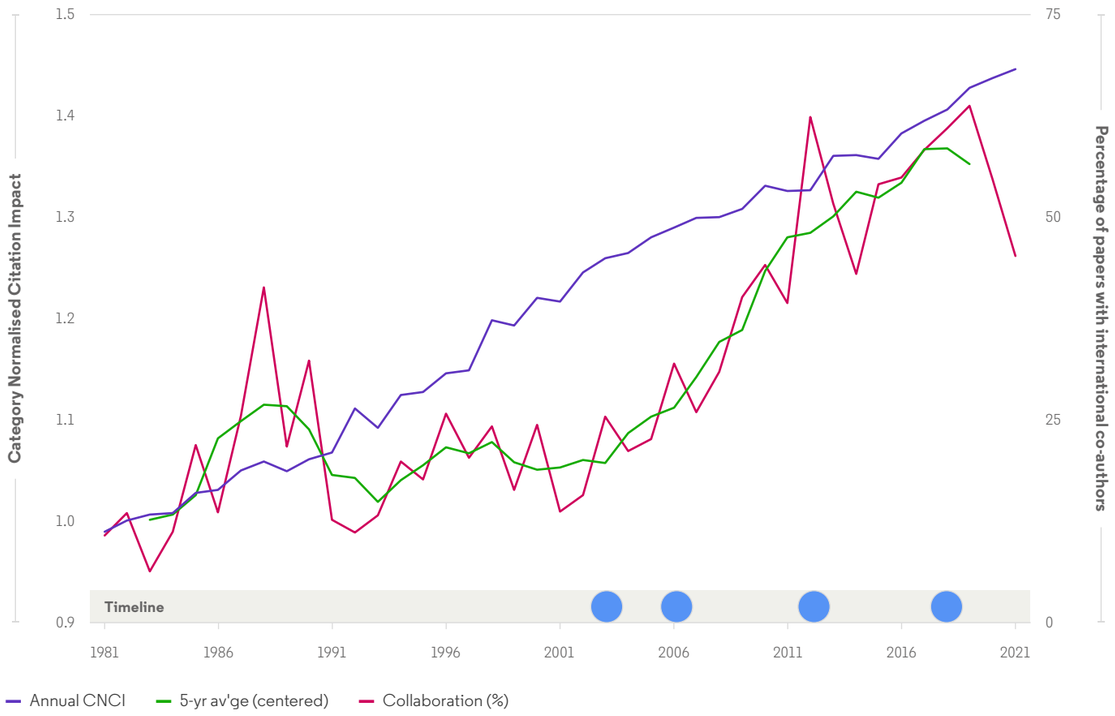
The evaluation strategy developed by the TEC and MoE had three phases. The first phase was to cover the implementation of a new fund (WebResearch, 2004). The second (the 2008 review) was intended to give a sense of emerging effects and any unintended consequences. The third is an ongoing longer-term assessment of outcomes.

These phases reflect concerns that arose during the original policy design and to ensure the adoption of a system that originated elsewhere would be responsive in the New Zealand environment. First, the assessment system was complex, implementation needed to be seen to be aligned with policy goals and compliance costs should be minimized. Second, issues identified during the policy development should be re-examined. Third, longer-term evaluation should assess whether the policy has succeeded in lifting research quality.

The reviews in 2008 and 2019 collated very similar opinions, responses and criticisms to those made in the United Kingdom. For example, there had been criticisms of the transactional cost of participating in the PBRF but the 2019 panel "was not persuaded that the transaction costs incurred are undue or excessive, and many of the alternative options mooted would tend to increase transaction costs." However, the 2019 panel did suggest simplifying the assessment of research excellence to focus on publication quality and the completion of advanced degrees, dropping external research income as a proxy measure of research quality. Both reviews asserted the need to retain independent peer review assessments of research excellence in the Quality Evaluation.

The introduction of the PBRF seems to be associated with a period of progressive improvement in New Zealand's average citation impact, which had remained only slightly higher than world average through the 1990s and then began to climb steadily in the 2000s. The average CNCI is most readily tracked as a five-year rolling average since inter-year variation in a small country produces spikes and dips. The profile produced by plotting each five-year window against its middle year indicates a take-off right on the first PBRF cycle in 2003. If we plot against the last (terminal) year of a series, then the take-off point is just afterwards. Given the extensive prior consultation and preparation by the institutions, it seems reasonable to suggest that the steep line points back to the 'smoking gun' of the new research assessment. (Figure 7)

Figure 7: The average annual Category Normalized Citation Impact of journal articles authored and co-authored by New Zealand researchers. Data are grouped in five-year windows, plotted against the central year of each group (see text). Dates of the Performance-Based Research Fund assessment are indicated as blue circles on the PBRF timeline.



Source: Web of Science

Opportunities and pitfalls in information-based approaches to assessment

Artificial Intelligence has a profound impact on research but machine learning solutions to assessment burdens may propagate existing biases. Models of assessment outcomes reveal that apparently important predictors may link to factors unrelated to research impact.

Martin Szomszor, Electric Data Solutions

There have always been demands for technical solutions to reduce perceived assessment bureaucracy. For example, it was noted soon after the U.K.'s RAE2000 that there was a significant correlation between a university's per capita research funding and its average citation impact. Surely, then, bibliometrics would be a short-cut around peer review of detailed portfolios? Flaws in this were rapidly identified: first, that the residual variance in the data meant differences of tens of millions in spending for some institutions; second, that such variables as the numbers of university gardeners would produce similar statistical patterns.

Data science has changed and developed enormously over twenty years.

Artificial Intelligence is having a profound impact on the way research is conducted and utilized, creating new pathways to scientific discovery across a range of disciplines.[46] As the research ecosystem evolves, there is growing interest in how AI could be used to support various research assessment activities.[47]

In peer-review, plagiarism detection[48] is one area where this type of technology already shows promise, and a range of other pre-peer review screening checks, such as formatting tests, scope verification, statistical soundness, and quality of language, have been proposed.[49] In 2019, the National Natural Science Foundation of China (NSFC) piloted the use of AI to select researchers to review grant applications[50] and other councils have tested similar approaches to help identify domain experts.

In these scenarios, AI is used to support peer-review, reducing the burden for menial tasks but leaving the judgement of research quality to experienced, informed human experts.

Of course, the idea to use data and algorithms to replace this step is not new. Bibliometricians have been exploring this concept for more than 50 years and many argue that citation-based indicators can support robust evaluation in certain contexts,[51] not least because peer review itself is opaque, highly subjective and prone to bias.[52]

What this debate has made clear is that both the research system and the data we collect about it capture many forms of prejudice relating to gender, ethnicity, nationality, sexuality, age and more. Without proper consideration of these, machine learning solutions will only propagate these existing biases. This is a problem that is already familiar to those who make use of bibliometric indicators and an issue that has been at the forefront of the responsible metrics agenda.

The flip side is that the focus on automation draws attention to issues of transparency and repeatability: generally for the field of machine learning;[53] and specifically in research assessment. It may be a fortunate coincidence that both peer-review and the use of AI will benefit from a deeper understanding of what constitutes high quality research and how that information is encoded in publications, grant applications, case studies and other research artefacts. Peer panels need to explain their decisions but could debate this if challenged. Without an ability to explain decisions, it is doubtful that any AI systems could fully replace a peer-review process.

Recent experiments demonstrate that text-mining approaches may be sophisticated enough to identify on-trend papers through the recognition of key-phrases, but more complex deductions relating to novelty or veracity remain elusive.[54] Other approaches to model the outcomes of assessment programs reveal that the most important predictors represented factors not directly related to research impact,[55] instead being largely informed by gross metrics for individuals (e.g., h-index), institutions (e.g., student selectivity criteria), or databases (e.g., number of documents indexed in the Web of Science).

Outcomes and effects

Despite the differences in approach to research assessment, variation in its link to funding incentives and disparity in timing between similar systems, all the countries and regions in this report have improved in comparative research performance over the last forty years – at least insofar as bibliometrics is a guide.

It would be reasonable to argue that the PBRF has been a significant driver of New Zealand's performance, but this is more dubious for the United Kingdom and an untenable argument for Australia. Germany has improved significantly without research assessment (and so have its major European partners).

Assessment has influenced system change, certainly in Germany and probably in the United Kingdom. It has had major effects on institutional structures in the U.K. and probably in other countries and regions. It has unquestionably had pervasive effects on researcher behavior, which is demonstrable in the U.K. and widely reported elsewhere.

Institutional changes have led to more structured research management, clearer decisions about investment and improvements in research management information. These are all clearly desirable, from the perspective of public accountability, and beneficial. Changes in researcher behavior are more questionable and open to contrary interpretation.

Where next? The public policy agenda for research continues to evolve. The emphasis in the 1980s and 1990s was firmly on 'internal' academic research excellence, to support high quality innovative and fundamental research. Now, the emphasis has shifted towards the 'external' impact of research on society and in the economy: a shift from 'what do we want to invest in?' towards 'what do we get for our investment?' and a response to further restrictions on public funding generally.

A shift to more data driven and technological forms of assessment is advocated by some as a way of reducing the 'burden' of assessment. However, the data options remain unconvincing at present and are perhaps more susceptible to gaming than is any of the present systems.

One thing is evidenced by the longest running assessment exercise, in the United Kingdom. Research is a very long game, so assessment stability has great merit and, whatever the criticisms, the RAE/REF looks very much as it did thirty years ago, with impact case studies bolted on.

What the RAE did was to secure the confidence of the assessed that they were being treated with reasonable equity, and this is the only absolute requirement of a system where the outcomes are wholly dependent on the competence and commitment of the individuals who do the research.

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