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ROYAL SOCIETY TE APĀRANGI

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Dear Clinton

THE IMPACT OF SCIENCE – DISCUSSION PAPER

This letter sets out the response of the Royal Society Te Apārangi to the discussion paper on the impact of science. We make some general points, and then refer to some of your discussion questions.

General Points

The Society appreciates the detailed analysis undertaken in preparation of the discussion paper and we acknowledge the considerable effort that has gone into development of a model results chain. An implicit assumption underpinning the analysis is that where impacts have apparently occurred it is possible to undertake a process of attribution. Our view is that this is realistic only in a minority of situations[1] and that most impact arises within a complex environment characterised by many-to-many relationships.

Further, indirect benefits of research are likely to be at least as large as the direct benefits, and a focus on impact at a project level will inevitably place too much emphasis on direct benefits. For instance, it appears that diverse regional innovation systems are higher performing than specialised systems. The impact of one project therefore depends on the impacts of other projects and so impact should be considered as an emergent property of a research system, and is not the sum of individual impacts.

Public funding of higher education and research tends to have two tangible consequences – new knowledge, and skills development (such skills are really tacit knowledge or know-how). Some studies of the so-called tiger economies of the 1960s through early 2000s (Japan, Korea, Taiwan, China)

[1]Even apparently clean results from chain examples are not clear-cut. For example, say a new molecule is synthesised which has biological activity, a market develops for a drug based on the molecule, and there may be measurable health impacts. How much of the attribution goes to the manufacturing process development and how much to the original synthesis – is the impact net of the displacement of other treatments? Or what if data savy people (e.g. statisticians) might appear to have low impact by typical measures (e.g. middle author…), but without them the publication, treatment, analysis etc would not have happened or the novelty not explored. A research publication might have high citation rates not because of the importance of the project but the analysis of the data. Similarly for the development of software to support a project subsequently used in different ways.

attribute the development of competitive economies more to skill development which carried tacit knowledge into fledgling industries rather than to the direct application of research outputs. That is, the transfer of those skills out of the research sector was likely the more highly impactful.

Where the private sector has a high level of literacy of the research and development process, it will seek research input in their search for solutions, but seek to manage and control the process in-house. Such literacy is seen in a number of the high technology as well as primary sector companies in the New Zealand manufacturing and professional services sectors, and their use of the research sector is inconsistent with the linear results chain model set out in the discussion paper.

Likewise, where central and local government has a high level of literacy of the research and development process, it will seek research to inform policy development and manage social and environmental issues in the public interest. Such literacy is seen for example in the government appointing science advisers and employing researchers.

We would therefore be uncomfortable if attempts to assess impact delved below a very broadbrush approach. Rather, we believe that a well-performing system is characterised by:

- Demonstrable contributions to the body of knowledge,
- Demonstrable increases in tacit knowledge and know-how, with those skills contributing widely beyond the research sector,
- End-users progressively providing the resources to further develop products, processes or services using now knowledge and the skills transferred from the research sector,
- Connectedness and interaction

By overly focussing on seeking to demonstrate attributable impact, it is possible that the system can be inadvertently disincentivised away from, e.g. the second listed characteristic above, which may well be more important than some or all of the others.

An alternative framing that may be useful is the concept of using intellectual capital and human capital as intermediary proxies for impact. The research and development process can be viewed as taking financial capital and using it to create intellectual capital (representing the value of new knowledge) and human capital (representing the value of skills). The higher the intellectual and human capital development is, the greater the expectation of impact.[2]

New Zealand produces a very small proportion of global knowledge. However much of the impact sought in NZ depends on the global knowledge base. Hence growing New Zealand's absorptive capacity through human and intellectual capital development is critical for economic and social progress in a globally competitive environment.

Interaction and connectedness, supported by appropriate infrastructure, can also contribute to human and intellectual capital development, through increasing the opportunities for innovation at the boundaries of existing knowledge. This is another important characteristic of a system in which impact is sought, but within which attribution is very difficult.

[2] Intellectual capital is different to intellectual property in that the latter represents a property right and does not indicate the potential value of anticipated impact.

Definition of Impact

In an idealistic world, referencing impact to "final results" seems attractive, but what is final? Full impact may take many decades! It is not the definition of impact that matters, but what the measurement system is based on. The Society would rather avoid a semantic argument between outputs, outcomes and impacts, and have a system based on agreed and realistic proxies for impact. We would encourage dropping of the term 'academc impact' – if new knowledge generation is meant then say this directly – it can come from a CRI or private research provider, not just a university. Other impacts can only really be attributable to the research if the research has first led to new contributions to the body of knowledge, or to tacit knowledge/ know-how.

Treasury Framework

We find the Treasury framework is potentially compatible with the approach set out above, except it lacks the concept of intellectual capital – the value of knowledge. Adding intellectual capital might make it suitable for use.

Mechanisms and processes

In our view, the sorts of intermediaries discussed are sensible, except proxies for intellectual capital are missing. It is interesting to compare another approach from within the New Zealand Research system in regard to impact evaluation; the judging criteria for the PM's science prize:

*Adjudication for the prize will be based on **one** criteria which is the extent to which a transformative scientifc[1] discovery or achievement has led to significant economic, health, social and/or environmental **impact** on or for New Zealand, or internationally. This may be evidenced in a variety of ways, for example;*

- *Successful development and deployment of new or improved products, processes, or services (including public services) based on the research.*
- *Advancement of Mātauranga Māori.*
- *Major changes to practice in an important professional community or an industrial, business, infrastructural or service sector, at least at a national level.*
- *Major changes in relevant public policy and/or government investment or operational strategy, for example in health, social policy, environmental protection, conservation, education, justice or emergency management.*
- *Significantly increased investment in the research programme over an extended period of time by potential or actual technology transfer partners or end users.*
- *Significant changes in the way a body of knowledge is organised and used (as a result of challenging previous conventional wisdom).*
- *Development of new methods that have advanced research practice in the relevant discipline.*
- *A high level of recognition through peer review processes, for example through publication in leading journals and the award or prizes.*

This list is non-exclusive, and not all evidence forms will be appropriate for any particular application. Each applicant should set out in the application statement the nature of the transformative scientific discovery/achievement, and of the impact.

The second and the last three indicators would be seen as early stage proxies for long-term impact, but interestingly, the fifth tends to reflect the idea of intellectual capital as something worth investing in. This example reinforces the point that impact assessment must use pragmatic proxies because looking to final impact is not realistic.

Generic Results Chain Model

In our view, this model overly linearises what are often complex and interactive realities. The serendipitous discovery often has more value than achievement of the original research aim. We would prefer the model is de-emphasised.

Worked examples

The example of the US NSF Impact Statement requirements in grants is actually based on discipline-specific guidelines that would need to be developed here.

Ante vs Post Evaluation

As discussed earlier, the goal is to identify some reasonable proxies that do not lead to perverse behaviour through researchers aiming to maximise those proxies rather than to maximise impacts for the benefit of New Zealand. This tends to point towards system level analysis rather than fine-grained analysis. Availability of good quality published data is both essential and useful to the sector.

From an economic viewpoint a useful proxy is how much the private sector is prepared to commit to be able to access or use research outputs – in essence how do they value the intellectual capital. In the public sector, changes in the way resources are allocated to social and environmental programmes can be viewed in much the same way.

The largest intangible is the impact of human capital which is most difficult to measure, yet it may be the largest impact. For example, it can be argued that a success factor for the tiger economies mentioned earlier was over-producing research-capable STEM graduates who had to learn business to get jobs, but then became the drivers of industrial development in their nations.

Ante-evaluation of potential impact is as best a guess – serendipity occurs so often in research that the real impact pathways often turn out to be quite different to what was anticipated at the onset.

Closing Remarks

The Society recognises that this discussion paper is just a starting point for further development of the approach. We trust that the comments set out in this letter are of assistance.

Yours sincerely,

Dr Andrew Cleland FRSNZ
Chief Executive