RESEARCH IMPACT QUANTIFICATION

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The development of methods for the quantification of research impact has taken a variety of forms: the impact of research outputs on other research, through various forms of citation analysis; the impact of research and technology, through patent-derived data; the economic impact of research projects and programs, through a variety of cost-benefit analyses; the impact of research on company performance, where there is no relationship with profit, but a strong positive correlation with sales growth has been established; and calculations of the rates of social return on the investment in research.

However, each of these approaches, which have had varying degrees of success, are being challenged by substantial revision in the understanding of the ways in which research interacts, and contributes to, other human activities. First, advances in the sociology of scientific knowledge have revealed the complex negotiation processes involved in the establishment of research outcomes and their meanings. In this process, citation is little more than a peripheral formalisation. Second, the demonstration of the limitations of neo-classical economics in explaining the role of knowledge in the generation of wealth, and the importance of learning processes, and interaction, in innovation within organisations, has finally overturned the linear model on which so many research impact assessments have been based. A wider examination of the political economy of research evaluation itself reveals the growth of a strong movement towards managerialism, with the application of a variety of mechanisms - foresight, priority setting, research evaluation, research planning - to improve the efficiency of this component of economic activity. However, there are grounds for questioning whether the resulting improved efficiencies have, indeed, improved overall performances. A variety of mechanisms are currently being experimented with in a number of countries which provide both the desired accountability and direction for research, but which rely less on the precision of measures and more on promoting a research environment that is conducive to interaction, invention, and connection.

Progress on research impact quantification

There has been extensive research effort in developing a wide range of approaches to the quantification of the impact of research. Some of these are recognised as falling within the mainstream of work on the development and testing
of performance indicators and, more generally, research evaluation. Others have their origins in quite different concerns, and academic disciplines.¹

This work can be broadly divided into five distinct categories:

i) **Impact of research outputs on other research** – a wide range of science indicators based on the manipulation of citation data² have been produced. For example, relative comparisons of citation rates have been used to compare the performance of research groups, university departments, and universities as a whole in Australia.³ Essentially, the frequency of citation is used as a proxy for the 'importance', or 'impact', of a publication. While most analysts are careful to deny this can be taken as a direct measure of quality, in practice citation-based measures are accepted as a valid measure of relative importance, and hence of research impact.

ii) **Patent-based measures of the impact of research and technology** – patents constitute an alternative type of reference or citation, with an emphasis on industrial commercialisation, or at least, potential interest. Extensive analyses⁴ have identified a variety of patterns of linkage between the literature-based outputs of the research system, and its application in seeking to establish ownership of the intellectual property underlying an industrial application. However, it is recognised that the patenting process is marked by great variation dependent on both the industry of application and the knowledge discipline, and subject to a range of other idiosyncrasies, which represent limitations to the validity and comprehensiveness of these as quantified impact indicators.

iii) **Economic impact of research projects and programs by cost-benefit analyses** – an array of cost-benefit analyses techniques focussed on R & D projects have been developed. Some of these have been embodied in software programs, and are routinely applied in project evaluation and project selection.⁵ These approaches rest on the establishment in some way of the economic return, discounted in some appropriate fashion, from a project or program. When set against the cost, a calculation of the return on the investment can be made. Typically, returns of 1.5 to 15 times the investment have been calculated.⁶ However, while this approach does appear to be able to be used to calculate the economic benefits of a particular research project after it is completed, it is not able to provide a general measure of the impact of an area of research.

iv) **Impact of research on company performance** – analyses of the historical records of company performance, and of R & D investment, particularly in the US,⁷ has revealed a strong positive correlation between R & D investment and sales growth, with a predominant lag of 2–3 years. However, no such relationship with