Why Scientists Don't Get More Money

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INTRODUCTION

In recent years in Australia, and particularly in the period following the Federal Government Budget of August 1984, there has been a crescendo of claims that science is being starved of funds, that politicians either don't understand or don't care, and that the future of the nation is thereby being jeopardised. The increased funding for science in the 1985 Budget has united, but not silenced the critics.

One specific outcome has been the establishment of a National Committee for the Promotion of Science and Technology to "promote understanding of how science and technology really work and to make a long-term case for appropriate support".

The prospect of scientists playing a more prominent role in explaining to politicians and the public the value of their activities is one to be strongly supported. The lack of a broad scientific literacy in the community may have had far more harmful economic and social effects than the level of funding for the small elite of researchers. However, if the campaign is to be carried out effectively and be of benefit to both the community and researchers, it needs to be founded on a clear understanding of the present position and of why arguments which were once persuasive about the value of research no longer apparently have much influence.

In this paper, I will focus on the situation in the university sector. The position of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) has recently been reviewed elsewhere[1] and could not be adequately treated here.

THE LEVEL OF FUNDING FOR UNIVERSITY RESEARCH

It has been widely argued that the level of funding for university research, and hence for the basic research which is the university's major responsibility, is far too low. One example is the assertion that:

> analysis of the funding of basic scientific research in Australia shows that the funding has been at grossly inadequate levels for many years over many governments.[2]

But convincing evidence to support the claim of "grossly inadequate levels of funding" is hard to find.

Detailed analysis of funding over the period 1974 to 1981,[3] for which reliable data are available based on the survey of the Australian Bureau of Statistics (ABS), leads to the following conclusion:

> The answer to the major question of contention is clear and unarguable. The level of funding for research in the universities, at the level of the institutions and the individual has not declined, if anything it has increased slightly.[4]

Total research funding to universities increased by no less than 29% in real terms over the period 1974 to 1981 (Table 1). Research expenditure remained a fairly constant 42-45% of university budgets, when all costs are included. The total research effort, measured in person-years, as a proportion of total staff also remained constant around the 45% level. The ratio of general staff to academic staff remained more or less the same, at 0.8. Finally, all measures of the level of expenditure showed a small increase in real terms, from $6,400 to $7,300 in direct costs per academic staff, and from $54,800 to $62,600 in total costs per effective full-time academic researcher (all costs expressed in 1979-80 prices).[5]

Table 1
University Research Expenditure
Constant 1979-80 Prices

	Direct Expenditure	Indirect Expenditure
1974		
$ (M)	108.8	88.2
%	55.2	44.8
Index	100	100
1976		
$ (M)	106.5	135.0
%	44.1	55.9
Index	98	153
1978		
$ (M)	117.2	138.4
%	45.9	54.1
Index	108	157
1981		
$ (M)	140.9	145.8
%	49.1	50.9
Index	129	165

These figures do not include an estimation of overheads, which are calculated at $80.3 M for 1978 and $92.6 M for 1981 (1979-80 prices) by the ABS (*Research and Experimental Development, Higher Education Organisations, Australia, 1981)* Cat. No. 8111.0, 1983.

Data on a comparable basis for the years since 1981 are not available. But the most recent Science and Technology Statement[6] includes estimates of the major component (approximately 45%) of university research budgets: funding by the Department of Education through the Commonwealth Tertiary Education Commission (Table 2). This amount includes indirect funding through salaries, the proportion of the General Fund devoted to research, the Special Research Grant, Equipment Grants, and funds for Special Research Centres.

Table 2

Department of Education Grants to Universities

($ million)

	1981-82	1982-83	1983-84
Current $	86.5	101.9	115.4
Constant $	68.2	72.9	76.4
	(1979-80 prices)		

These figures provide strong evidence that the level of funding for research in Australian universities has continued to increase in the three years since 1981.

Nor do international comparisons indicate a grossly inadequate level of funding in Australia. It is well recognised now that the relatively low level of R & D expenditure as a proportion of GDP, and of R & D employment as a proportion of the total workforce,[7] is almost entirely due to the extremely low level of R & D in Australian industry.

The most recent figure of .31% of GDP spent on higher education research is only a little below the median figure for medium R & D performing nations of .39% (itself raised by high levels of R & D expenditure in universities in Sweden, Switzerland and the Netherlands) and .36% for large R & D performing nations.

Hence it must be concluded that the available data do not support the scientists' views that basic research is grossly underfunded and has suffered a dramatic decline.

One of the reasons for the scientists' perception may be that most scientists do not recognise indirect expenditures, largely for their own salaries, or overheads, as forming a part of research expenditure. While from the government's point of view these form part of the costs of the performance of research in universities and must be included to allow for comparison with other sectors, from the university researchers' point of view the majority of these expenses are fixed costs. Funds to employ qualified researchers and to purchase land, construct buildings, pay for rates, water, electricity, etc., are the baseline for contemplating a research capability. To actually perform worthwhile research requires a level of 'free' funds, well above that of the fixed funds.

Table 1 shows that the growth in the Australian research budget since 1974 has, to a very significant extent, been in the form of indirect expenditure. In other words, the largest proportion of the research budget is accounted for by the attributable proportion of salaries for staff employed to carry out or support research along with performing other duties.

I will return to the implications of this position later in my paper.

The importance of 'free funds' to researchers may also explain the apparently strong pre-occupation among university researchers with the level of funding for the Australian Research Grants Scheme (ARGS), generally considered the premier funding source for supporting basic research. Its Chairman has described the ARGS as "the major mechanism for supporting basic research", even though it now constitutes no more than 6% of the total research expenditure in universities. Such a statement may constitute rhetoric in pursuit of the former glory of 20 years ago, when the ARGS did dominate the research scene. It could also be argued that this particular focus of the scientist's concern reveals a myopic pre-occupation with a situation which no longer exists and the need to adapt to new conditions. On the other hand, after allowing for the very substantial direct or free funding from the Commonwealth Tertiary Education Commission (CTEC) (constituting 27% of total direct funds in 1981), and the special funding of medical research through the National Health and Medical Research Council, the ARGS is the major mechanism for supporting research largely determined by the researcher's own interests. Hence, the importance of this Scheme, even apart from the considerable prestige associated with receiving such a grant.

Herein lies perhaps the biggest difference in perception between the Government and politicians on the one hand, and the scientists on the other. The latter see a research funding of $23.88 million in 1985 (funds available through the ARGS) and consider this entirely inadequate. The Government see an expenditure of somewhere in the vicinity of $600 million in 1985 and wonder whether the taxpayer is getting good value for the investment.

Recognition of these differences in perception is essential for any plan of action, either to improve the political standing of research or to organise it more effectively.

THE ARGUMENT FOR THE ECONOMIC VALUE OF RESEARCH

The essential argument that has been made, in a variety of guises, to support the claim for government funding for basic research has been that such research provides the basis for long-term economic development and prosperity. Thus the Chairman of the ARGS referred in a newspaper article to "the threat to long-term investment in the future of this country posed by ignoring the importance of open, non-directed research and development". And in a recent survey of ARGS research funding, it was stated that "Strength in basic research is of critical importance in developing ... the knowledge base and expertise required to adapt new technologies and research to applied ends".[8]

Such a view was first clearly espoused, at least in the modern era, by Dr. Vannevar Bush in his influential report to President Truman in 1945 entitled *Science, The Endless Frontier.*[9] Bush, who was Director of the Office for Scientific Research and Development (OSRD), previously the National Defence Research Committee, was asked by President Roosevelt to consider how OSRD's experience could be used after the War. Bush's views were unequivocal:

> Basic (pure) research leads to new knowledge. It provides scientific capital. It creates the fund from which the practical applications of knowledge must be drawn. New products and new processes are founded on new principles and new conceptions which, in turn, are painstakingly developed by research in the purest realms of science.[10]

Thus, as was ably argued by Ronayne,[11] what has become known as the linear model of innovation, and the notion of science policy being essentially policy to support science, were born at a time when the enormous achievements of science in the national interest were evident to all. The arguments became so entrenched that they were accepted as fact until recently; and even today, as evidenced in the current concern, they form part of the litany of modern science. But, neither the linear model of innovation nor the conception of science policy as 'science push' have the intellectual and political authority of the past; nor are they seen as appropriate to present conditions. Scientists must learn that repeating the arguments of the past is no longer likely to prove persuasive.

THE LINEAR MODEL OF INNOVATION

The linear model of innovation can be summed up by the statement that basic research provides the discoveries from which all other progress flows. It posits that innovation, i.e. the development of a commercial product or process, occurs in a linear sequence running from basic research to applied research, experimental development and hence innovation. The model can be elaborated by the addition of prototype testing, market testing and production development in the final stages. But the direction of causality is evident: basic research leads the way.

There has been extensive research on the nature of innovation over the past twenty years; and gradually, through all the trials of any research activity, there have emerged theories, insights and empirical data which reveal the inadequacies of the linear model. Let me summarise three major criticisms of this model.

The first rejects the assumption that basic research necessarily initiates the process of innovation. While there have been examples of this kind, notably the atomic bomb, they constitute the spectacular exception. Research has shown that the vast majority of innovations are developed in response to the assessment of a 'market need' – an actual or potential market available for exploitation. In particular, it is the fusion of the recognition of market need and technical potential which characterises most successful innovations.[12]

However the 'science push' model contines to dominate much of Australian research organisation. The scientists' only responsibility is to produce the discoveries – the rest, often regarded as little more than a mopping-up exercise, is for lesser minds. By the same token, the scientists can claim full responsibility for any benefits that do arise. None of the development and marketing and service effort deserves any of the credit. While a precise division of credit is not possible, if the generally accepted figure of research representing 10% of total development costs is used, it might be fairer to ascribe to research only 10% of the return – a figure which places the value of the research in quite a different light.

The major point of relevance here is that many politicians and increasing numbers of the public no longer accept the 'science push' model. Thus the practice of asserting in glowing terms all the marvellous benefits that *might* emerge from research in the long-term is unlikely to carry much weight in the current political climate.

The second criticism rejects any kind of linear model as simplistic. Rather, the innovation process is said to be more accurately represented as complex and dynamic, involving an interplay between knowledge of scientific, technical, practical, financial and marketing issues in the arrangement of material elements to meet human or organisational needs. A variety of factors may be more or less important at different stages of a particular innovation. Thus basic research can be one important element of the process but it is only one among many.

A third criticism of the linear model is its ahistorical nature, assuming that the process of innovation will follow the same general pattern irrespective of economic condition or historical context. Thus the conditions from which Bush drew his experience may well have been appropriate to a 'science-push' linear model of innovation. Under the conditions of war-time, with national security placed above all else, support systems were well developed to rush each invention of the researchers through to production as quickly as possible. Moreover, the scientists were undoubtedly strongly influenced by the apparent needs of defence.

These conditions however, do not apply in the civilian economy. In particular, they do not apply in today's very different socio-economic structures where capital, technology and research have to a significant extent become internationalised. The requirements for successful innovation are evidently quite different now from what they were even in Australia only ten years ago.

The perception that has emerged strongly among analysts, bureaucrats and politicians over the past few years is that it is not the Australian research capability *per se* which is the major reason for our faltering economic performance, particulary in the area of manufacturing. Rather, it is in industry that the problems lie, with its domestic orientation, limited management and marketing skills, lack of venture capital and a scarcity of entrepreneurial skills. Hence it is to these areas that the Government needs to direct most of its support.

The research system, as I have argued elsewhere, is characterised by its marginal relationship to the production system:

> In this situation research takes the form of a 'welfare' function, rather than an investment. The self-reinforcing separation of supply and demand is reflected on the one hand by the emphasis on basic research and the loose connections between goals of research and economic and social need. On the other hand, the production system, with its dominance by overseas companies and low committment to local development, produces little demand which could influence or reorient the research system.[13]

Under these conditions it is demand policies rather than supply policies which are needed to ensure that research is linked to those benefits promised by so many scientists. At the moment, a strengthening of the research sector without attention to the creation of appropriate demand is likely to provide only a subsidy to foreign companies and national competitors.

Hence an appeal in terms of the promise of basic research is inappropriate and likely to be singularly ineffective. Rather, in accord with a long-term and larger view of the national interest, the scientific community might do far better to seek to promote appropriate demand policies, and encourage those links between the research system and the production sector which will bring the claims of the 'science-push' apologists closer to reality.

THE VALUE OF KNOWLEDGE

In an altogether different and much deeper sense, the very progress of science and the exploitation of the control capability its knowledge offers has led to an undermining of the perceived value of knowledge. At the heart of modern science is the Enlightenment view of the perfectability of humankind through knowledge. All knowledge serves to dispel falsehood, ignorance and superstition. Every contribution towards knowledge is valuable, for each little nugget represents another step towards that secular goal of progress.

But the experience of our modern society offers increasing challenges to this view. It is quite evident that the vast accumulation of scientific knowledge has brought us neither certainty nor salvation. It has of course assisted in vastly improving standards of living, health and material goods, for some. But increase in scientific knowledge not uncommonly now serves only to demonstrate a new area of ignorance, or to provide such a welter of relevant information as to paralyse the process of choice. And as to salvation, there are far too many instances of science being used intentionally or accidentally with harmful results for it to be regarded by anyone but the most naive scientist as automatically and unquestionably beneficial.

Hence, at a deeper level than direct economic worth, there is a public unease about the values and achievements of science. The ethical issues raised by so much of genetic research and the research technology of *in-vitro* fertilisation go to the heart of some of our most cherished and deeply-held beliefs. Demonstration of benefits to some does not diminish the ethical problems one iota. The international dominance, if not capture, of science by 'defence' interests, at best fits very uneasily with adherence to a belief in progress.

Again the 'science-push' promise of rosy futures is now greeted sceptically not, as previously, because of doubts about the extent of its achievement, but because of fears about the extent and effects of its successes. The 'science-push' claim that scientists are not responsible for the way their knowledge is used is both untrue and irrelevant. For it is only by contributing to a restoration of belief in progress that public faith in science is likely to be restored.

THE ORGANISATION OF UNIVERSITY RESEARCH

This section examines the way in which the funding and performance of university research is organised in Australia. The intention is not merely to describe aspects of the system; descriptions abound.[14] Rather it is to point to some peculiarities which may require attention.

The first peculiarity lies in the extent to which the research budget for universities is determined not by research policy, but by education policy. For as we have seen, it is the CTEC General Fund which provides by far the largest support for research, largely in the form of support for indirect costs. Hence the increase or decrease in the number of undergraduate students, with its admittedly increasingly attenuated relationship with staffing and other resource levels, is still the prime determinant of levels of funding for research. In a period of growth this is undoubtedly an advantage to the universities. But with well-funded growth a thing of the past, it is remarkable that apparently so little has been done by universities to initiate some separation between education and research policy.

Some suggestions have been made by ASTEC that greater accountability could be achieved if more of these funds were distributed to universities, departments and even individuals on a competitive basis. Such changes have been stoutly resisted by CTEC. It is interesting to note however, that the CTEC Guidelines for 1985 indicated a desire for universities to develop research strategies aimed at achieving the most effective use of the funds available.

This brings us to the second peculiarity. For while the competition is fierce for the marginal but 'free' funds from sources like the ARGS, the distribution of the great preponderance of research resources is in accord with the principle that all contributions and potential contributors to knowledge are equal. This refers not only to the general practice among universities of distributing direct internal research funds on a formula basis, but also to the fact that in general all academic staff are expected to perform research and given the opportunity to do so. There is relatively little discrimination, based on the quality of research or researcher, in the provision of research time through release from other duties.

As a result of this situation, a 10% increase in university academic staff over five years in pursuit of education objectives can produce a 10% increase in university research expenditure, without the question ever being asked of whether it is in the national interest to increase this form of research by this amount. Moreover, this 10% increase flows to the new staff, irrespective of the quality of their research or their potential as researchers. Many bureaucrats and politicians have just this view of the organisation of university research. In the climate of disenchantment described in the previous section, it is hardly surprising that the pleas of academic scientists for a greater share of a fiercely contested cake tend to evoke little positive response.

There is a need for academic scientists to examine more carefully how and why their research is impeded by inadequate resources. One explanation of the view of scientists may be that the growth in university research budgets since 1974 has largely been in tied funds. The level of 'free funds' to initiate new research projects may well have substantially declined. If this is accepted, there is a need for scientists to put their own house in order to ensure that the very substantial research funding of the universities is put to more effective use. This should involve greater levels of competition for all research resources, including time.

CONCLUSIONS

Anguished cries of 'anti-intellectualism', 'election-bound time horizons', 'political opportunism', and 'apathy' directed towards Government and politicians are likely to have little effect in changing the climate for the funding of research.

There is a need for scientists to recognise that the 'science-push' arguments on which they have relied for so long are now largely discredited, and that new and rather more subtle justifications will be required. They will need to accept the importance of demand policies, and seek to assist their development in a way that does not stifle creativity but allows research to be shaped more by the context of opportunities and needs. And they will need to take highly visible steps to increase the level of accountability and value of their own research.

The clamour that is heard is almost entirely about the needs of basic research. By comparison, how muted is the publicity about the level of targetted research being carried out, the links to industry and governments existing and being developed, the successful innovations and entrepreneurs.

Secondly, universities will need to take radical steps to put their own houses in order. Ways must be found to convert more of that 600 million dollars a year into money which produces research results. The competition for small-level free funds like ARGS is intense. But the distribution of the much larger sum is based on the somewhat embarrassing assumption among academics that they are all equally capable of formulating critical research questions and hence are entitled to an equal share of the available resources, including perhaps most importantly, time. The recently proposed Research Advisory Council in the Tertiary Education Commission might be able to take on the task of encouraging Australian universities to accept the implications of their own rhetoric. Moves along these lines are already underway in the U.K., where first steps have been taken to separate the base for the funding of teaching and research in universities.

The Australian Government has clearly signalled its intentions, with a major committment to demand-oriented R & D policies, particularly through the Management and Investment Companies Scheme and the 150% tax concession for industrial R & D. There is every opportunity for the universities to avail themselves of these resources through links with industry, the R & D capability of which is extremely limited. Such links, with the possibility of cross-fertilisation and better understanding, will in the long run strongly serve the interests of university research also. Government policies designed to increase the demand for research may prove far more positive for science and produce more funding in the long run than a simple increase in direct government subsidy.

Notes

1. The Australian Science and Technology Council (ASTEC) was asked by the Government to report on, among other things, "the rationale and appropriate economic, social and cultural objectives ... of government funding and performance of R & D in Australia, the implications of this for government policies and for the CSIRO". See ASTEC, *Future Directions for CSIRO* (Canberra: Australian Government Publishing Service, 1985).
2. C.V.H. Wilson, "Lobbying for Science", *Search* (1985), *16(1-2):* 2.
3. S. Liyanage and R. Johnston, "The State of Research in Australian Universities", *Search* (1985), *15 (1-2):* 24-30; and R. Johnston and S. Liyanage, *Australian Science and Technology Indicators Feasibility Study – Higher Education* (Canberra: Department of Science and Technology, 1983).
4. Liyanage and Johnston, *op.cit.* (ref. 3), p.29.
5. It has been argued, with good reason, that current levels of funding are substantially lower than they were at a much earlier period. One source claims that the total identifiable research expenditure per research worker (in 1982 $) was $11,070 in 1966 compared with $6,900 in 1981 (Federation of Australian Universities Staff Associations, *The Crisis in Basic Research,* 1983). This would not, however, explain the relative recency of the outcry among academics.
6. Department of Science and Technology, *Science and Technology Statement 1983-84* (Canberra: Australian Government Publishing Service, 1984).
7. For the latest comparison with OECD countries see *Australian Science and Technology Indicators Brief 1985* (Canberra: Department of Science and Technology, 1985), p.22.
8. Australian Research Grants Scheme, *Research Funding Survey,* 1984.
9. V. Bush, *Science, the Endless Frontier* (Washington: Government Printing Office, 1945).
10. *Ibid.,* p. 19.
11. J. Ronayne, *Science in Government* (Melbourne: Edward Arnold, 1984).
12. The literature is well summarised in D. Mowery and N. Rosenberg, "The Influence of Market Demand Upon Innovation: A Critical Review of Some Recent Empirical Studies", *Research Policy* (1979), *8:*102-153.
13. R. Johnston, "The Critical Barriers to the More Effective Appropriation of Research Results", in A. Birch (ed.), *Science Research in Australia: Who Benefits?* (Canberra: Australian National University, 1983), p. 137.
14. See for example ASTEC, *Funding of Basic Research in Australia* (Canberra: Australian Government Publishing Service, 1979).

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