

Science in Government by J. Ronayne

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At a time when concern with science and technology policy is reaching renewed heights, it is timely to find a book published which puts the whole question in a historical and international perspective.

Science policy essentially addresses itself to stimulating and directing research so that it might best serve the social, economic and political requirements made upon technology. Its antecedents lie as far back as the 17th century, Professor Ronayne tells us, and it is fascinating to find, in his historical review, that the economic arguments for science policy were as much to the fore in the writing of Charles Babbage in 1830 as they are today. Babbage, a mathematics professor at Cambridge, can be credited, as Ronayne shows, with having foreshadowed many of the issues that are at present under debate.

He argued first that there was an important link between the quantities of a nation's research in pure science and its international economic performance. To the extent that this can be interpreted to suggest a direct relationship between R&D expenditure and growth rates, the researches of B.R. Williams¹ argue that Babbage's faith in the effectiveness of research may have been misplaced. Nonetheless, as Ronayne recalls from the work of Langrish, the benefits from pure research are significant: the flow of new investigation techniques, the people trained to use the techniques, and design innovation in instruments developed to apply them.

Implicitly, Babbage also seems to have subscribed to what these days is called the linear model of technological innovation in which pure research is seen as the first and essential step in a process leading to the commercial exploration of a new technical idea. Much of Ronayne's second chapter is devoted to discussing the credentials of this model and the policy implications which flow from it. Inevitably, given the plethora of recent findings on this question, Ronayne rejects the linear model as a plausible general account of the innovation process. Instead he echoes Jewkes, Sawers and Stillerman² in concluding that "the sources of invention are numerous, scattered and varied" (p. 61). It is disappointing that he does not explore the matter further. Rosenberg³ has presented us with accounts of compulsive sequences of innovation driven by imbalances in the existing technology. Nelson and Winter⁴ have provided a rigorously argued case for the evolution of technology, building on foundations laid by Simon. Ronayne contents himself with a description of the 'demand-pull' arguments derived from Schmookler⁵ and his followers. Many would now agree with Mowery and Rosenberg⁶ (quoted p. 68) that: "Both the underlying evolving knowledge base of science and technology as well as the structure of market demand play central roles in innovation in an interactive fashion . . ." It is a conclusion that, to most economists, must now seem almost self-evident and, given his obvious interest in the historical perspective, one wonders why Professor Ronayne is not more curious as to why it took so long to emerge.

Appropriate policy prescriptions spring from a proper understanding of how processes work. In the area of science and technology, a belief in the linear model suggests action to counteract a tendency to underinvest in

research since, while it is indispensable for progress on this view, it is also costly, yet its benefits are not easily grasped by those who undertake it. Babbage foresaw that the market might not reward pure science on sufficiently generous terms to encourage it in socially optimal quantities and Ronayne rehearses the conventional arguments of Arrow⁷ in this connection.

The more it can be shown that R&D is market responsive, on the other hand, the less it is possible to argue that the market is failing to generate appropriate signals. Ronayne argues eclectically that sometimes innovation does flow from a linear pattern, that R&D is not always founded on precisely perceived market demand, and that there is scope for market failure to arise. Policy to stimulate scientific research is therefore in order but should not be confined purely to subsidy: the customer-contractor principle and venture capital institutions, for example, might be alternatives.

Having said that much, Ronayne devotes Chapter 3 to discussing the perennial problems of *how much* to allocate to science and what criteria to use in deploying funds among projects. He argues that economists offer answers in principle, based on notions of pay-off and return, which turn out to be almost impossibly difficult to apply in practice. What then? If science is desired for its intrinsic value, "science as culture", the only relevant criteria for funding seem to be quality of project and research team — and only scientists can be judges here. If science is desired for the technological advances it permits, criteria will relate to essentially subjective perceptions of how projects may vary in their contribution to achieving social objectives by solving technological problems. As Ronayne suggests, these approaches lack rational objectivity. Analytical techniques (cost benefit analysis, ranking methods, etc) may appear to offer solutions, but then they may also do as much harm as good.

Almost all of the rest of the book is given over to a description of the science policies adopted in the USA, UK, Australia, Germany, Canada, Japan and Belgium. This is a useful compendium. A final chapter briefly places science policy in the framework of recent economic events.

The general reader will find this book helpful in giving an idea of the "lie of the land" in a controversial area still full of unresolved problems. Specialists, however, may feel that aspects they consider important in the debate have received unduly superficial treatment.

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REFERENCES

1. B.R. Williams, 'Research and economic growth — what should we expect?', *Minerva*, 3, 1964, pp. 57-71.
2. J. Jewkes, D. Sawers, R. Stillerman, *The Sources of Invention*, Macmillan, London, 1958.
3. N. Rosenberg, 'The direction of technological change: inducement mechanisms and focusing devices', *Economic Development and Cultural Change*, 17, 1969.
4. R.R. Nelson and S.G. Winter, *An Evolutionary Theory of Economic Change*, Harvard University Press, Cambridge, Mass., 1982.

5. J. Schmookler, *Invention and Economic Growth*, Harvard University Press, Cambridge, Mass., 1966.
6. D.C. Mowery and N. Rosenberg, 'The influence of market demand upon innovation: a critical review of some recent empirical studies', *Research Policy*, 8, 1979, pp. 103-153.
7. K. Arrow, 'Economic welfare and the allocation of resources for invention', in National Bureau of Economic Research, *The Rate and Direction of Inventive Activity*, Princeton University Press, 1962.

Technology and Employment in the Electronics Industry by *Luc Soete and Giovanni Dosi*

(Frances Pinter, London, 1983) pp. xiii + 90. £35.00 (pb), ISBN: 0-8618-7378-4

Technology and its effects on employment are central to the economic and social issues of our time. Much of the concern expressed about technological change relates to its effects on both the nature and number of jobs. There is a popular demand for quantitative estimates of the effects of technology on employment, but they are rarely attempted with significant rigour.

This book addresses these issues in a series of analyses of the effects of technology on employment in the United Kingdom 'electronics industry'. The authors chose this industry because it has a combination of qualities with potential to revolutionise the economic system, including a dramatic effect on costs and substantial improvements in technical performance in a wide range of goods and services. They have taken pains to separate electronics industries (based on microelectronics) from electrical (or electro-mechanical) ones, and have made some informative comparisons between them. This is a useful book for readers who appreciate a quantitative approach to the relationships between technology and employment. Two comments are in order on its presentation: explanations of abbreviations that may be well-known to UK readers (such as MLH) would have assisted other readers, and the price seems high for a relatively short paperback with poor quality binding.

The book is divided into three Sections. The first, which contains some less-than-lucid jargon, reviews readily available information and briefly discusses the effects of major technological changes on both the electronics and electrical industries over the post-war period. On the input side of innovation the authors show that UK expenditure on research and development in electronics has increased almost two-fold in real terms since 1975, is far greater than capital expenditure, and compares well with major competitors in electronics and computers. However, the share of government funding of R&D has risen steadily to more than 50 per cent, most of which is defence-related, so that private industry spends less on R&D than these competitors — a problem not unique to the UK. In other parts of the engineering sector there has been no comparable increase in R&D. On the output side of innovation, patent data reveal a serious decline in the comparative UK position over a decade. A brief chapter on the role of UK government policy in relation to the electronics industry makes the point that most government support schemes are aimed at raising awareness of electronics technology. The rate of diffusion of the technology is surprisingly slow, given its major advantages, and the