A Brief History of Time: From the Big Bang to Black Holes *by Stephen W. Hawking*
(Bantam, London, 1988) pp. x + 198, $A34.98, ISBN 0 593 015118 5

The economics profession is being subject to much soul searching. The prevailing equilibrium methodology is being scrutinised and an increasing number of economists are coming to reject it.[1] Whilst wading through economic journals, which seem to be more of an elegant jumble of mathematical rigour than a coherent theoretical explanation of the real world, a sense of disquiet begins to arise. The question that inevitably floats up from such pages is: where did it all come from? How was it that "the bustle of Adam Smith's world" came to be replaced by "a model puppet show in which the real world has been stripped of everything but its economic motivations"?[2] For the past century, economics, made up of "[c]onsiderations so abstract...it would of course by ridiculous to fling upon the floodtime of practical politics"[3], seems to have lost its applicability. Why did this highly abstract methodology come to dominate the economics field?

Stephen Hawking's book, although having virtually nothing to do with economics (at least on the surface), provides part of the answer, Professor Hawking is a theoretical physicist at the cutting edge of cosmology, among other specalities. As such, he is the Lucasian Professor of Mathematics at Cambridge University, a chair once occupied by Newton and Dirac. For the layperson, an attempt to read any of Hawking's other works would be doomed to failure, even to understand the titles. *A Brief History of Time* is the exception, for the excellent reason that it is directed at the uninitiated. In fact, only one mathematical equation appears in this book (Einstein's famous $E = mc^2$), a feat many economists would have trouble repeating. As such, the book provides an insight into the developments that have occurred in physics since the Newtonian revolution in clear and understandable prose, straight from the horse's mouth, as it were.

The method of economics has come directly from the physical sciences, in particular, Newton's mechanistic view of the world and its equilibrium outcome. Subsequently, for the economist perplexed at the current state of the profession, Hawking's book is an excellent starting place to look for some answers. Although Hawking is confined to a wheelchair by a motor-neuron disease, he has managed to compile what amounts to a history of physics, right up to the present day. He starts with Aristotle and Ptolemy, working through Copernicus and Newton, and covers the contributions of Maxwell, Rutherford, Planck, and, of course, Einstein, just to name a few. With a combination of anecdotes and a keen sense of historical perspective, Hawking allows the reader to gain some insight into the issues which have confronted physics in the past, and, indeed, those which confront the science today.

The book is also about philosophy and raises many questions, perhaps even more than it answers. For instance, while discussing the possibility of a Grand Unification Theory of Physics, Hawking digresses to contemplate the broader limitations of human rationality:

> Yet if there really is a complete unified theory, it would presumably determine our actions. And so the theory itself would determine the outcome of our search for it! And why should it determine that we come to the right conclusions from the evidence? Might it not equally well determine that we draw the wrong conclusion? Or no conclusion at all? (p.12).

Herein lies the link with orthodox economics. Traditional equilibrium economics is also essentially a deterministic view of the world. Neoclassical economists use the tools of mechanics in their analysis and the end result is just how its original proponents intended it. To quote Walras:

> Very few of us are capable of reading Newton's *Philosophiae Naturalis Principia Mathematica* or Laplace's *Mecanique Celeste* and yet, on the word of competent scientists, we all accept the current description of the universe of astronomical phenomena based on the principle of universal gravitation. Why should the description of the universe of economic phenomena based on the principle of competition not be accepted in the same way?[4]

Subsequently, for any economist wishing to understand the deterministic conception of the world it becomes important to have some knowledge of its methodological roots within the natural sciences. Hawking's book, with its concise coverage, is an excellent tool for this purpose. It can help the disoriented find their way again.

Not only may Hawking's book provide explanations for confused economists, but it may also offer some indication of what the future holds. Hawking asks whether time could, one day, flow backwards with effects coming to precede causes. In the Newtonian mechanistic conception of the universe, time flows along independently of what occurs within the universe. In orthodox economics, time is also a symmetrical entity and can drift in any direction. An equilibrium in the market is said to be independent of the dynamic path preceding that equilibrium. But is this really the case?

From our own individual viewpoint, time seems to flow in one direction only, towards the future. We remember only the past, and the future is uncertain. The deterministic view of nature cannot explain this phenomenon. Nevertheless, physics does provide an answer. The second law of thermodynamics is an immutable law which states that order will always, eventually, turn to disorder. The reverse is never the case. Thus, there exists an asymmetry with regard to time in that it can only move in one direction, away from the past. Physicists term this the 'arrow of time' (Chapter 9). Orthodox mechanical economics has not come to grips with this fundamental irreversibility. As such, physics may have more to offer economics in the future.

Stephen Hawking's book is about time (as the title would suggest). Therefore, it is important to economists who have in the past ignored this most important aspect of both the natural and social world. This is particularly the case for those economists interested in the social use of knowledge and information in the community. As Prigogine and Stengers have noted, "Communication is at the base of what probably is the most irreversible process accessible to the human mind, the progressive increase in knowledge."[5] Thus, Hawking's book can be considered a windfall to the economist interested in time. The book is written with a dry wit and clarity and I can wholeheartedly recommend it to anyone, not only the economist, who is interested in the philosophical and practical implications of developments within the natural sciences.

REFERENCES

1. E.g, R. R. Nelson and S. G. Winter, *An Evolutionary Theory of Economic Change,* Harvard University Press, Cambridge, 1982: and A. N. Rugina, 'Principia oeconomica: new and old foundations of economic analysis', *International Journal of Social Economics,* 13, 7/8, 1986, pp.1-67.
2. F. Y. Edgeworth quoted in R. L. Heilbroner, *The Worldly Philosophers,* Simon and Schuster, New York, 1980, p.92.

3. *ibid.*, p.173.
4. L. Walras in Rugina, *op.cit.*, p.59
5. I. Prigogine and I. Stengers, *Order Out of Chaos*, Fontana, London, 1984, p.295.

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Social Costs of Energy Consumption *by Olav Hohmeyer*
(Springer Verlag, Berlin, 1988) pp.xii + 126, Paper DM78, ISBN 0 387 19350 2

Olav Hohmeyer and his collaborators present a detailed assessment of the economic externalities which have arisen, and are expected to a rise, in the generation of electricity in West Germany over the period of 1975-2030. In an accessible, highly structured and compact manner, the book presents a wealth of detailed economic information on differences between private commercial costs and social or economic costs of: (a) fossil fuel power; (b) nuclear power; (c) wind power; and (d) solar power. The book is based on a report prepared by the Fraunhofer Institute for the Commission of the European Communities.

When externalities in electricity generation are considered, it becomes evident that the economic production costs of both nuclear and fossil fuel power are in excess of the commercial production costs, mainly because of adverse environmental spillovers. At 1982 Deutchmark prices (then approximately 2.5 marks per Australian dollar), the order of excess is 4-9 cents/kWh in the case of fossil fuels, and 5-12 cents/kWh in the case of nuclear energy (excluding breeder reactors). The excess is additional to paid-up costs of fossil and nuclear power of approximately 10 cents/kWh. These figures are subject to increases in real terms as time progresses (although no such increase has been allowed in the analysis for the excess). By contrast, real production costs per kWh of wind and solar energy have fallen rapidly in recent years with further — albeit asymptotic — reductions imminent.

The rising cost of non-renewable electricity generation and falling costs of renewable generation is expected to make wind energy commercially viable in West Germany before 1995, and solar energy before the year 2015. These dates can be brought forward about a decade by intervention aimed at internalising the external costs of non-renewable power generation. Accordingly, wind energy could already present a competitive alternative to non-renewable processes. In the absence of intervention, misallocation arises because of over-usage of electricity at prices in which environmental costs remain unaccounted, and because decisions on new generation plant will not then, for some years, exploit the advantages wind power has to offer.

Olav Hohmeyer's study is required reading for planners of electricity supplies. It is also highly recommended to students as an up-to-date case study illustrating the contribution which the discipline of environmental economics can make in real-world decision making. Finally, the book is a pointer for the direction which research and development in this field might take. Coal and uranium are presently important sources of income in Australia. Besides, fossil fuel electricity generation is commonplace. However, with new energy horizons in sight, major