incommensurable analyses. Both are still chipping away at the great question of the relations between knowledge and power: not only political power but also the power to control or modify nature that comes from applying knowledge. The question was posed aphoristically nearly four centuries ago by Francis Bacon: human knowledge and human power meet in one, he asserted, but he could not yet sense the awesome complexity of the confluence. He set out the agenda, but he didn't solve the problem. In the 20th century, the question he crystallised has emerged as surely one of the most momentous facing nations and, for that matter, humankind as a whole. The failure of these two books, intellectually sophisticated though they are, to offer an adequate answer shows, I fear, that we will enter the 21st century with the Baconian agenda still unfinished.

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Cognitive Economy: The Economic Dimension of the Theory of Knowledge
by Nicholas Rescher
(University of Pittsburgh Press, Pittsburgh, 1989), pp. x +168, $US29.95, ISBN 0-8229-3617-8.

Rescher credits Charles Peirce with being the first theorist to stress the role of economic considerations in the theory of knowledge. He says this book starts from Peirce's brief discussions and tantalising observations and is "an effort to pick up the torch and pass the flame along". His effort is admirable but success would require that scientists, economists and policy analysts both understand what is in this slim volume and be willing to carry the torch. The majority are, unfortunately, likely to respond with the same resentment and hostility that greeted Fritz Machlup's inclusion of academia in 'the knowledge industry'.

We are confronted with the "unavoidable economic dimension. Economic factors shape and condition our cognitive proceedings in so fundamental a way that they demand explicit attention . . . [O]nly by heeding the concrete processes that engender our knowledge in a way that takes account of their economic dimension can we adequately explain the nature of its operations and properly understand the character of its products" (p. 150).

He is aware of "the inescapable realities of resource limitations" (p. 149). "The limits of science are very real, but they are not inherently intellectual matters of human incapacity or deficient brain power. They are fundamentally economic limits imposed by the technological character of our access to the phenomena of nature. The over-optimistic idea that we can push science ever onward to the solution of all questions that arise shatters in the awkward reality that the price of problem solving inexorably increases to a point beyond the limits of affordability" (p. 150).

Affordability is accentuated by technological escalation with its "massive economic ramifications" (p. 137). "The enormous power, sensitivity, and complexity deployed in present-day experimental science have not been sought for their own sake but rather because the research frontier has moved on into

an area where this sophistication is the indispensable requisite of ongoing progress. In science, as in war, the battles of the present cannot be fought effectively with the armaments of the past" (p. 134). The result is that "the purchase price of significant new findings constantly increases" (p. 137).

An economic perspective is shown (Ch.6) to helpfully illuminate the theory of inquiry. The case studies of epistemological issues range over Hempel's paradox of the ravens; Goodman's grue paradox; the significance of generality; novelty tropism; making versus postponing decisions; and symmetry arguments. And treasured features of the organisation of the scientific enterprise are likewise shown to have an economic basis. The open, early exchange of information and sanctions against cheating, falsification, and carelessness are based in increased, shared productivity. Departures from the general policy of information sharing, e.g., scientific journal secrecy practices, have "a perfectly plausible rationale in cost-benefit terms" (p.35). According great value to priority (p.60); co-operation and team effort (pp.37-8); and building trust (p.45) all rest ultimately on economic rationality.

All this leads Rescher to the view that "The commodity of information illustrates rather than contravenes the division of labour that results from Adam Smith's putative innate human "propensity to truck, barter, and exchange". The market in knowledge has pretty much the same nature and the same motivation as any other sort of market — it is a general-interest arrangement" (p.46). "[A] communicating community is a sort of market-place with offerers and takers, sellers and buyers" (p.49).

His discussion renders applicable the emerging information economics. Knowledge is capital (p.4) and maintenance of credibility an asset (p.53). Both senders and receivers of messages incur substantial costs (pp.53-4). There is a role for economies of scale (p.58). In trying to apply his ideas of cost effectiveness and cost-benefit analysis, he is compelled to clarify the "actual importance" (p.80) of matters being investigated.

Earlier Rescher used emphasis on the economic dimensions to help formulate the trade-off between informativeness and security (p.62). While the former turns on generality, exactness and precision, the latter concerns the effort to avoid misleading people. Rescher goes on to focus on cognitive importance which he thinks "enormously complex" (p.75), pivoting on such parameters as significance, centrality, generality, and fertility. He visualises this domain like a map of cities in a country with their transport linkages. "Significance reflects the comparative size of a given unit. Centrality is determined by the extent of its enmeshment in the overall network — by how many links this unit has with others. Generality and fertility are reflected in the volume of traffic moving along these links" (p.76).

In the final analysis, this complexity has to be reduced to a simple guide for allocating resources. What share of the science budget should project X have? What share of the national budget should science projects taken together have?

It is unfortunate that Rescher's deep understanding of the cognitive enterprise has not been exploited more systematically by the application of the ideas of information economics. Of such pioneers as Marschak, Machlup, Simon and Arrow, only Fritz Machlup makes an appearance — and then only to be ackonwledged (p. 155n2) for paying more than a little attention to the value of knowledge. The centrality and fertility of a blending and interaction of *Cognitive Economy* with recent developments in information economics have very considerable potential. One of many entry points would be the table of

structural advantages and disadvantages of information (p.99) as a means to develop a much-needed Lancastrian characteristics approach to the study of information.

Having gleaned so much from so few pages, it would seem almost churlish to offer criticism. I prefer to see my final paragraphs as part of that blending and interaction. At their deepest level these paragraphs raise questions about understanding, interdependence, and the role of time.

Activities and organisational arrangements that initially are cost effective and even measure up well in social benefit-cost ratio terms can, over time, assume a less favourable character. For example, economies of scale, scope and networking justify organisations like universities, research centres and institutes, and professional associations. So power is acquired and information may be embezzled. Such monopolisation exacts "an awful price from the community as a whole" (p.34).

As noted earlier technological escalation has massive economic ramifications. "The economics of scientific inquiry presents a picture of ongoing cost escalation that is strongly reminiscent of an arms race" (p.137). Is this sophistication "the indespensable requisite of ongoing progress" (p. 134)? Or is the cognitive enterprise, like the rest of the economy, subject to technology-push? After all, military technology is said to have outstripped human capabilities!

These issues become more important if we accept the thesis of in-built organisational obsolescence. The very economic characteristics of information and of the organisations we create to handle information — uncertainty, indivisibility, and their capital nature — dictate two features of experience: random events can have an important influence; and success will impose its blinkers. Even the cognitive enterprise will be subject to this form of obsolescence. Rescher comes close to this realisation when he contrasts "home-base", familiar (low cost) operations with "far out", less familiar (high cost) interactions (Ch.7). It is, I believe, important to know that this problem lies in the organisational design; a grave matter which the scientists, economists, and policy analysts, in conspiratorial fashion, continue to largely ignore. After all, the triumphs of science are surely so great that self-regulation, and even self-budgetting, would be justified!

Yet more complexities come with the institution of property. Rescher uses a fishing analogy in discussing the fineness of observational screening (p.164n57). The property analogy raises many questions. Who has fishing rights? Who owns the fish caught? Do factory ships and canoes compete? Is there a regulator of competition? The unresolved questions multiply if we ask these questions about the fishing in scientific waters, or more generally about the role of information in modern societies. A reader of Alvin Toffler's latest, *Powershift: Knowledge, Wealth, and Violence at the Edge of the 21st Century* with its global gladiators and information wars would surely find Rescher's cognitive entrepreneurs a gentlemanly lot.

And last of all, information economics provides a way of thinking about some of the Rescher elements that might prove productive. For example, information as capital is — with no thanks to maintream economics — widely accepted and can fit within a modelling of an economy. It is then useful to think, in the style of the economist's input-output framework, where the information is produced, how it is transferred, and how it is utilised. Or take another example. For Rescher, the knowledge market is pretty much the same as any other market. But information (and knowledge) can be a commodity to only a limited extent,

because of indivisibility and inappropriability. Rescher's proposition speaks to the scientific worker labour market rather than the market for the information such workers produce.

This is a tightly reasoned work that demands careful reading: the more widely read, the better. I sincerely hope those who read *Cognitive Economy* will turn to Rescher's *Scientific Progress* (1978) and *The Limits of Science* (1984).

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Technology and the Tyranny of Export Controls: Whisper Who Dares *by Stuart Macdonald*
(Macmillan, London, 1990), pp. xi + 206, £35, ISBN 0-333-49374-5.

Stuart Macdonald's book, *Technology and the Tyranny of Export Controls,* is filled with irony. Some irony is inherent in the subject of export controls, and is recognised — even emphasised — by the author. Some irony exists in Macdonald's presentation of his arguments and research. Finally, some irony arises from the vicissitudes of recent history, which have profound implications for any analysis of export controls.

Macdonald has taken as his subject the complex system of export controls that exists within the multilateral CoCom structure and the relationship of that system to the much more restrictive United States export laws. Given the two control systems in place, he has naturally had to focus the lion's share of his attention on US efforts to restrict the flow of goods and information to 'unfriendly' countries. This subject matter is inherently both political and economic, and he has willingly indulged himself in both levels of analysis.

Given this subject matter, and the timing of Macdonald's work, he had to deal at length with the export-restrictive policies of officials operating during the Reagan presidency. Macdonald recognises that national security export controls have some practical, psychological, and symbolic value. However, he argues, they have been grossly overextended by special interests and bureaucratic empire-builders, notably Richard Perle of the US Department of Defence. Although I agree with this broad premise, I occasionally found his depiction of his antagonists a bit monochromatic. Macdonald might have served his purposes better had he made the arguments he was countering more coherent.

It is the clash of a plausible broad policy involving national security with a badly flawed structure to implement that policy that provides Macdonald with his chance to bring out the inherent ironies of his subject. He does a fine job of documenting and supporting his positions: that US export controls do more to restrict Western productivity than Soviet Bloc productivity; that they restrain the military and economic potential of Western enemies by restraining and alienating US allies; that US regulation 'supports' a multilateral CoCom approach by rendering it almost superfluous; and that overbroad export controls restrict information transfer to the East by restricting information flow in the West. Perhaps better than any other recent author on export controls, Macdonald appreciates and documents these ironies.