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Who Should Pay for Science?

A review of *The Economic Laws of Scientific Research*, by Terence Kealey (St. Martin's Press, 1996)

Everyone assumes that basic scientific research must be funded by government. Why? Because basic research is a "public good" whose benefits are shared by all and no competitive business can be expected to pay for something whose benefits must be shared. Terence Kealey, a working scientist (clinical biochemist) at Cambridge University in England, argues in this provocative new book that what everyone knows is in fact wrong. He contends that non-military science would not only survive without government funding, it would do better than it does now. Kealey arrives at a conclusion that most readers will think up-front absurd and by the end of the book makes it plausible.

Everyone knows that science must be publicly funded, but everyone also knows that nearly all the great leaps of classical science -- Newtonian physics, relativity, the atomic theory, thermodynamics, electromagnetism, evolution by natural selection, genetics, the theory of the circulation of the blood, and many others -- occurred with no government aid whatever. Few are troubled by this contradiction, because all assume that science and the world have somehow changed in ways that make government science funding essential: We now know how to "do" science in an organized way that is more efficient than the old haphazard method and lends itself to governmental programs. Science is more expensive now so that private funding is insufficient. Science is more necessary to economic competitiveness now so its support is a matter of national urgency. And finally, the "public good" argument: private sources might fund *some* basic science, but it won't be enough, so government must take the lead.

Kealey systematically demolishes all these arguments. For example, if science really is necessary for competitiveness, then private industry should be the first to fund it -- and it does. Research is essential for success in biomedicine and Kealey gives several examples showing that private funding is still dominant despite the government billions spent on biomedicine here and in other developed countries. And we're not talking about applied research, but basic, published science: "*Current Contents*, 11 July 1994, 37, 4, recently reviewed the institutions that produce the largest number of cited papers in biology, and of the top 7, two were private companies...one was a charity...three were private institutions (but which now receive government grants...) and only one was a wholly government-founded, government funded laboratory, the Institut de Chimie Biologique in Strasbourg."[1]

The view that scientific research can be reduced to routine best administered by a central bureaucracy originated with 16th century courtier, philosopher and political schemer Francis Bacon. Kealey contrasts the "Baconian view" with the free-market ideas of Adam Smith. Kealey first defends Smith against Bacon with wonderful historical illustrations. For example, he contrasts the Roman Empire with the "dark ages" that followed its dissolution, and points out that when commerce was under state control under the Romans technical innovation stagnated. But during the dark ages, when government was weak, all the great inventions that set the stage for the industrial revolution occurred: the saddle, the stirrup, the horseshoe the horse collar, the tandem harness (the chariot race in Ben Hur would in reality have been a much tamer affair), the water mill, the crank and several others. In the nineteenth century, he points out, British science received almost no government support "yet that did not prevent Britain from growing into the richest and most industrialized country in the world, nor from producing scientists such as Davy, Kelvin, Maxwell, Lyell and Darwin. Cu-

[1] Kealey, p., 273.

riously, nineteenth-century France and Germany, whose governments did fund science expansively, trailed behind." "Can government funding of science be so important?" he asks.[2]

But perhaps science really has changed. Surely something as important and difficult as artificial computation requires government support if it is to succeed? Well, no. The abject failure of the Japanese fifth-generation project (sidelined by the rise of the personal computer) and its equally unsuccessful European twin ESPRIT are recent examples. But there is also an older one that has created its own myth: Charles Babbage and his difference engine. In 1833 Babbage (the story goes) had this great idea for a mechanical computing device. He tried to get government funding for it and in the end got £17,000 (a huge amount) but still failed to finish his engine. Not enough funding, perhaps? Genius thwarted by short-sighted bureaucracy? Apparently not, because two Swedish engineers in fact succeeded by 1853 in building the engine, for much less money. But their business venture failed because the engine was little more use than conventional mathematical tables. Babbage meanwhile, continued to complain because the government would not fund his much more ambitious analytical engine, a forerunner of the digital computer. The device was in fact impractical (mechanical computers are too slow), so (Kealey contends) the British government were quite right to refuse to fund it. The good effect of all this, he writes, was that it "warned successive British administrations off science."[3]!

Along the way Kealey demolishes a few other myths: that basic science is essential for technological advance (it is sometimes essential [electromagnetism], but often the effects go the other way: science learns from technology [thermodynamics and steam engines]); that science is essential for economic growth (technology is, science isn't); and most striking of all, that government supports more science than the private sector would if left to itself. By comparing different countries, he shows that the larger the fraction of civil science supported by government the smaller the fraction of GDP devoted to science[4]. Astonishingly, a dollar of public investment in science seems to displace more than a dollar of private investment.

But what about the "public good" argument. Surely an activity like basic science whose benefits must be shared can never be attractive to a private investor? Kealey argues that "The biggest myth in science funding is that published science is freely available."[5] He points out that no one assumes legal knowledge is free just because it is published. Learning about published science has a cost. A company that wishes to keep up with current science must support active scientists. They must be "in the game." Even if your main interest is in copying others, you must support an operation that does some original work if you want to copy effectively. Kealey has other arguments, based on "first mover" vs. "second mover" costs, that help explain why it is that competitive companies will wind up supporting some basic research. Add to this the free availability of charitable funds in a small-government, low-tax economy, and basic science comes out very well without government funding.

Has Kealey put his finger on what's needed for effective science? Is private vs. public funding they key? There are certainly competing arguments. Yet many working scientists will agree that science is showing signs of stress. Perhaps it is no accident that writer John Horgan has just made a splash with his book *The End of Science,* which argues that all major scientific advances have already been made. Horgan's conclusion is highly unlikely, most scientists think. But he may be responding to a real phenomenon: diminishing innovative returns in science brought about by an increasingly homogeneous funding bureaucracy -- what physicist Rustum Roy in a recent *Science* editorial called "the world's most inefficient

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[2] Kealey, p. 2.
[3] Kealey, p. 81.
[4] Kealey, p. 243 et seq.
[5] Kealey, p. 228.

system for funding of research[6]." In the US there is really only one "buyer" for science: a handful of government agencies, dominated by the National Institutes of Health. Anyone in the grant-application business knows how the current system tends to punish major innovation (small increments are favored) -- now more than ever. No one who proposes to do something just to satisfy his own curiosity has a prayer of getting funded these days. Review groups have a pejorative phrase for such efforts: they are called "trust-me" proposals and they always fail. Yet this kind of undirected curiosity has been the source of *almost all* major discoveries.

The problem of missing out on long-shots is usually attributed to lack of money. Certainly off-beat proposals have less chance of success when the "pay point" is 10% than when it is 50%. Yet science funding in most areas is larger now in absolute terms than it has ever been, so the real problem may be elsewhere. Perhaps the solution is not to abolish government funding but to reduce its monopolistic features. Science is a Darwinian process and if it is to work there must be variation as well as selection. Variation is stifled by monopoly but favored by competition, so perhaps we need more competition not among scientists but among science-funding agencies. Kealey's book alerts us to the possibility that the flaws in the system may not be curable by minor modifications.

Terence Kealey has written a compelling and highly readable book that deserves to be widely debated. To me, as a working scientist with a long history of dealing with the granting and regulating bureaucracy (good people enmeshed in a juggernaut), his arguments ring true. Yet almost everything Kealey says opposes the conventional wisdom. Who's right? It's hard to know -- these are complex issues, after all. Unfortunately, defenders of the status quo seem reluctant to engage in debate. After describing his own repeated attempts to defend a position similar to Kealey's, Roy recently commented: "I have yet to find one similarly reasoned book or paper replying to these arguments[7]." It's time to hear a detailed refutation from those who believe that American science lives or dies by the present system.

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[6] *Science,* Volume 273, Number 5273, Issue of 19 July 1996, p. 291.
[7] *Science*, Volume 273, Number 5281, Issue of 13 September 1996, pp. 1477-1480