



Public Science—Public Good?

A dialogue

Philip Moriarty[†] and Terence Kealey[‡]

Dear Terence,

I found your book, “*Sex, Science, and Profits*”,¹ an interesting, challenging and, if I’m entirely honest, at times infuriating read. Your central thesis—that science is not a public good but what you call “an invisible college good”—is rather at odds with my motivations for pursuing a career as an academic scientist and, as such, we shall have much to debate! Before discussing the question of science as an invisible college good, however, I’d like to focus on an issue very much related to the central theme of your book: the fundamental economic rationale for state support of science.

As you know, economics traditionally views fundamental (“blue skies”) scientific research as a public good—a non-excludable, non-rivalrous² good. The conventional argument is that as scientific research is a public good, the free market will not see sufficient return from its investment in science and the government must step in to address this market failure. Increasingly, however, university researchers are being driven, via the research councils, towards carrying out near-market research with commercial potential. This immediately raises the following important question: if the research is near-market and, moreover, no longer non-excludable (due to the emergence of a strong patenting/intellectual property rights (IPR) culture), why should the market *not* support it? State support of near-market research amounts in many cases to corporate welfare. On this point we are in broad agreement, I think?

Your argument in Ref. 1 (and elsewhere) is that state support of science crowds out private funding and that if state support were removed, industry and other private sources of funding would necessarily pick up the slack. As you know, this is a contentious

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¹ T. Kealey, *Sex, Science, and Profits*. William Heinemann (2008).

² In economics, a good is said to be non-excludable when it is impossible (i.e., extremely costly) to prevent others gaining access to it. A good is non-rivalrous if its use does not prevent others from using it.

issue.^{3,4,4a} Even the OECD report⁵ to which you refer at length in Ref. 1 is equivocal on the issue of “crowding out”. Nevertheless, it is clear that UK industry spends far less on research and development (R&D) than the OECD average (1.1% in 2006 against an OECD average of nearly 1.6%)⁶ and that the private sector, the research councils, and the UK government increasingly look to university scientists to carry out R&D for industry.

Where we fundamentally disagree, however, is on the question of private *versus* public funding. Your argument is that science should not be publicly funded. The bulk of private funding would then come from industry. Why do you feel that industry, driven as it is—and must be—by the bottom line will fund, *at appropriate levels*, fundamental science with little or no short term market value? Moreover, there are very many examples of multinational corporations distorting the direction and results of academic research projects⁷—the knowledge protection ethos of industry often runs entirely counter to the dissemination culture which underpins (or should underpin) academic research. You yourself acknowledge that “some government money might protect academic freedom” (Ref. 1, p. 410). This is an extremely important point that warrants only a paragraph in your book—science under *laissez faire* will necessarily lead to an erosion of core academic principles.

Best wishes
Philip

Dear Philip,

You have done excellent work in protecting university science from being distorted by politicians who fail to understand that universities should not be in the business of corporate welfare, so I am pleased to discuss this issue with you.

First, there is no evidence that government funding of science has stimulated economic growth. The lead country economically between 1800 and 1900 was the UK (thanks to the Agricultural and especially the Industrial Revolutions) and since then 1900 the US has been dominant,⁸ but the British Government did not start to fund science significantly until 1913, and

³ P.A. David, B.H. Hall and A.A. Toole, Is public R&D a complement or substitute for private R&D? A review of the econometric evidence. *Research Policy* 29 (2000) 497.

⁴ P.A. David, From market magic to calypso science policy: a review of Terence Kealey’s *The Economic Laws of Scientific Research*. *Research Policy* 26 (1997) 229.

^{4a} T. Kealey, Why science is endogenous: a debate with Paul David (and Ben Martin, Paul Romer, Chris Freeman, Luc Soete, and Keith Pavitt). *Research Policy* 26 (1998) 897.

⁵ *The Sources of Economic Growth in OECD Countries*. OECD (2003); http://www.oecd.org/dac/ictcd/docs/otherdocs/OtherOECD_eco_growth.pdf [Accessed June 21 2009].

⁶ See, for example, Times Higher Education, Leader, 12 February 2009.

⁷ J. Washburn, *University Inc.: The Corporate Corruption of Higher Education*. New York: Basic Books (2005); D.S. Greenberg, *Science for Sale*. University of Chicago Press (2007); C. Langley, S. Parkinson and P. Webber, *Behind Closed Doors: Military Influence, Commercial Pressures, and the Compromised University*. Kent, UK: Scientists for Global Responsibility (2008).

⁸ A. Maddison, *The World Economy: A Millennial Perspective*. OECD (2001).

the American Government not until 1940,¹ so both countries became the richest in the world in their day under scientific *laissez faire*. Moreover, their underlying rates of economic growth have not noticeably risen since 1913 and 1940 respectively—at least not in ways that can be attributed to government funding of science.

Some converging countries such as 19th and 20th century Germany and France did enjoy significant funding by government of science, but others such as Switzerland or Japan converged just as well under scientific *laissez faire*, so convergence seems not to have been encouraged by the government funding of science.

Finally *The Sources of Economic Growth in OECD Countries*,⁵ which surveyed the major factors ranging from the different national macroeconomic policies to the different national labour productivity decompositions that might explain the different economic growth rates of the 21 leading economies of the world between 1971 and 1998, concluded that it was business-performed R&D, not publicly-funded R&D “that drives the positive association between total R&D intensity and output growth.”

We of course need pure science, but not only does industry spend about 7% of its R&D budgets on pure science,⁹ but the philanthropic sector can be huge unless it is crowded out by Government: Carnegie, Rockefeller, Wellcome etc. flourished before Government moved in.

Such counterintuitive findings are not restricted to science. Daniele Checchi has reported that the government funding of education seems to have no positive effect on educational outcomes,¹⁰ and Charles Murray has reported that government social security measures seem not to foster—and may indeed impede—welfare.¹¹ I’m not sure, moreover, that anyone has chronicled a positive effect on aggregate national health outcomes of the government funding of (individual) patient health care (as opposed to funding genuinely public health care such as sewers).

Crowding out is certainly one putative mechanism to explain the failure of these various government programmes, but another may simply be that they are not actually public goods.

Let me leave on another counterintuitive note: when the Wellcome Trust and other not-for-profit bodies started to fund the sequencing of the human genome, we were told that it had to be done by them because business would never fund it. When Craig Venter moved in, we were then told that it still had to be done by the not-for-profit sector because business *should* never fund it. When the arguments for the public funding of science become so casuistic, a person becomes sceptical.

Yours
Terence

Dear Terence,

Thank you for your kind words regarding my, let’s say, bolshiness on the matter of the government’s focus on attaining short term economic return from academic research. I unfortunately can’t agree

⁹ C. Freeman & L. Soete, *The Economics of Industrial Innovation*. London: Pinter (1997).

¹⁰ D. Checchi, *The Economics of Education*. Cambridge: University press (2006).

¹¹ C. Murray, *Losing Ground: American Social Policy, 1950-1980*. New York: Basic Books (1984).

that I have done “excellent work”. This is not just a question of modesty (false or otherwise!) on my part. To date, my and many others’ arguments have been ignored entirely by the research and other funding councils because the political ideology *du jour*, that academics must demonstrate quantifiable socioeconomic impact, trumps reasoned debate, evidence and statistics. This impact agenda feeds directly into our discussion and I’ll return to it below.

Much as I would like to pick apart your argument that *laissez faire* capitalism is a panacea for each and every societal ill—you cover health, education, and social welfare in a single short paragraph (!)—we are limiting ourselves to relatively short exchanges here so let’s stick to the matter at hand: the question of whether academic research is a public good and whether it should be supported by government funding.

You must get a strong sense of *déjà vu* when debating this topic, given that we are retreading ground that you covered with Paul David⁴ and Keith Pavitt¹² (amongst many others) over a decade ago. One of the criticisms that David levels against your writing in *The Economic Laws of Scientific Research* is that you tend to “[pluck] out a particular historical nugget to produce as evidence for a view that blatantly ignores other facts and conclusions reached in the source whence it has been drawn.” Although you strongly rebutted many of David’s criticisms,^{4a} this particular point continues to carry some weight. It is, for example, directly applicable to your oft-quoted, and apparently damning, “conclusion” from the OECD report of 2003 that it is private, and not public, sector R&D that drives the positive association between total R&D intensity and output growth.⁵ As you must know, this statement is *immediately* qualified in the OECD report: “*The negative results for public R&D are surprising and deserve some qualification...there are avenues for more complex effects that regression analysis cannot identify...other forms of R&D (e.g., energy, health and university research) may not raise technology levels significantly in the short run, but they may generate basic knowledge with possible “technology spillovers”. The latter are difficult to identify, not least because of the long lags involved and the possible interactions with human capital and associated institutions.*”

In your econometric analyses in both *The Economic Laws...*¹³ and, more recently, in *Sex, Science, and Profits*,¹ you take a similar broad-brush approach when considering the degree to which publicly-funded research stimulates economic growth, glossing over the complexity inherent in the “innovation ecosystem”. The human capital factor to which the OECD report alludes is critical: a key output of publicly-funded university research is our graduates—“trained problem-solvers” who can “translate knowledge into practice”.¹⁴ As Salter and Martin put it, the benefits of publicly-funded research are subtle, largely indirect, and difficult to quantify.¹⁴ By believing that simple (econo)metrics and historical parallels¹⁵ can somehow adequately capture the total socioeconomic return of publicly-funded research, you are making the same category error as the research councils, the Higher Education Funding Council for

¹² K. Pavitt, Road to ruin. *New Scientist* 3 August 1996; T. Kealey, You’ve all got it wrong. *New Scientist* 29 June 1996.

¹³ T. Kealey, *The Economic Laws of Scientific Research*. Basingstoke: Macmillan (1996).

¹⁴ A.J. Salter and B.R. Martin, The economic benefits of publicly funded research: a critical review. *Research Policy* 30 (2001) 509 .

¹⁵ I must admit that porting arguments based on late 18th/19th century economic development directly to early 21st century society seems to me to be about as valid as using classical Newtonian physics to describe the quantum mechanical properties of the electron.

England (HEFCE), and the Department of Business, Innovation, and Skills in their drive to impose economic impact criteria in peer review and research assessment. A 2006 report from the Prime Minister's Strategy Unit¹⁶ got rather closer to the truth, stating that the rate of economic return on basic research is effectively incalculable.

Your assertion that pure or basic science will be adequately funded by the private sector also requires a rather more nuanced analysis. The definition of basic/pure/fundamental science is of course a vexed issue, but it is worth noting that Battelle's 2009 Global R&D Funding Forecast¹⁷ makes the important point that "...the term 'basic research' as interpreted and applied by industry is not the same as that employed by other sectors. In general, the term as applied in an industrial context is perhaps better defined as 'directed basic research', i.e. generally directed toward activities in support of the lines of business,¹⁸ rather than pure research that's directed toward establishing a baseline of knowledge." Your claim, on the basis of historical examples and aggregate measures of industry R&D funding, that disinterested curiosity-driven research—in, let's say, particle physics and astronomy—will somehow be sufficiently supported by the private sector in a *laissez faire* funding regime is far from convincing. Moreover, the decision by Alcatel-Lucent (the parent company of Bell Labs) to shut down its basic science research programme is just the most recent example of the private sector's increasing focus on near-term market-driven R&D at the expense of fundamental research.

On your final point regarding the public/not-for-profit sector *versus* Venter's involvement in genome sequencing you conflate two distinct arguments. The pharmaceutical and biotechnological industries have a troubling history of selectively distorting the results of scientific research in order to improve their bottom line¹⁹ and there are entirely valid concerns regarding the extent to which human genome information should be freely available in the public domain and not subject to potential patenting and intellectual property rights (IPR) protection. As I recall, the "should not" arguments were voiced in parallel with the "would not" arguments, so I am not entirely convinced by your claim of casuistry.

Best wishes
Philip

Dear Philip,

Thank you for some excellent points. I don't want to repeat the arguments I've made before in my books (and thus earn your displeasure) but let me address some overall issues. The essential argument that justifies the government funding of science is the same whether it is made by scientists or economists: namely that there is certain research that is important yet which provides the funder of

¹⁶ *Public Funding of Science*; www.number-10.gov.uk/files/pdf/06-09-29_public_funding_of_research.pdf

¹⁷ *2009 Global R&D Funding Forecast*. Columbus, Ohio: Battelle (2009); <http://www.battelle.org/news/pdfs/2009RDFundingfinalreport.pdf> (2008)

¹⁸ Michel Callon's arguments regarding technological stagnation in what he terms a "perfectly privatizable" funding regime (i.e. "the market smothers the market") are particularly relevant here. [M. Callon, *Sci., Tech., and Human Values* 19 (1994) 395].

¹⁹ See, for example, footnote 7.

that research with no financial benefit. To the scientists that research goes by the name of “pure science”; to the economists all research—whether pure or applied—falls into that category because eventually all new knowledge leaks out to the benefit of everyone else, even though those “everyone else” never funded it, so funders are disincentivized and only governments will pay for it.

You’ve made some excellent points about the “true” nature of “pure” science and about the different definitions that industry and academe might make of it (implying that only governments would fund the very purest research) yet in those dreadful books of mine I’ve pointed out that the empirical evidence from history seems to show—whether we’re looking at rates of growth of GDP per capita or rates of growth of science as shown by papers, numbers of scientists or other bibliometric data—that *laissez faire* regimes such as the USA’s before 1940 or the UK’s before 1913 seem to show just as good and bounteous science (Faraday, Darwin, Edison, the Wright brothers) and GDPs per capita as did their contemporary dirigiste competitors in France or Germany, or as they have since Washington and London did start to fund science.

So let me cut to the chase and say this: the very theory of science as a public good is wrong (which is why the historical and bibliometric empirical evidence does not support the idea of the importance of government funding.) The only people who can access science are other scientists in the same field who sustain their expertise and tacit knowledge by benchmarking their work by publishing it. Joe Bloggs down the street cannot read the *Journal of Molecular Biology*, only active molecular biologists can (and they can’t read the *Journal of Plasma Physics*). And if the molecular biologists cease to be active they very soon cease to be able to access the cutting edge research by which new discoveries and commercial breakthroughs are made. Science, in short, is not a public good, it is a good available only to fellow members of the same club (indeed, scientific societies are very much like clubs, with elections to membership etc.) and club goods need no government subsidies in economic theory. Actually, I argue that science is not exactly a club good as defined by the economists because access to new science is not limited to those who pay formal subscriptions but, rather, to those who pay for access by publishing their work as the indirect payment into the collective of shared knowledge by which—and only by which—they can then indeed access the knowledge of others.

Indeed, in this 350th anniversary year of the Royal Society, let us ask: why did the scientists of the day create it? They did it (see *Leviathan and the Air-Pump* by Shapin and Schaffer²⁰) specifically to pool their knowledge collectively, calculating that the risk each took individually (on publishing) of empowering his competitors was more than compensated for by the empowerment each enjoyed by accessing the published research of his competitors. Non-fellows soon got left behind. And as von Hippel of MIT’s Sloan School of Management has shown, industrial scientists collude exhaustively for the same reasons.

To conclude, therefore, the very idea of science as public good is wrong—and once we drop it we find that the empirical evidence of the last few hundred years suddenly makes sense! Scientists trade knowledge with each other voluntarily, and that trade needs no government subsidies.

Yours
Terence

²⁰ S. Shapin and S. Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle and the Experimental Life*. Princeton: University Press (1985).

Dear Terence,

It's unfortunate but it appears that we are talking past each other. You stated that you didn't want to "*repeat the arguments that I've made before in my books*" but that is precisely what you did! The empirical arguments you make from history to back up your position on *laissez faire* science have already been carefully critiqued by a considerable number of commentators, academics, and economists^{3,4,14,21} and instead of redundantly retreading that ground, I would prefer to (re-)focus on the primary theme of *Sex, Science, and Profits*:¹ is science a public good?

I pointedly raised the issue of the impossible-to-quantify spillover and human capital effects associated with academic research, highlighted not only in the OECD report I cited⁵ but in practically every critique of your econometrics work I have read,^{3,4,14,21} but you side-stepped this to give me a synopsis of the theses of your books. Those spillover and human capital effects are, however, entwined with the central theme of your response (and, indeed, our entire "spat") so I hope you'll forgive me if I rather doggedly pursue the point.

Your thinking on the question of science as a public good has followed an interesting path. In an interview in *Scientific American* in 2003,²² you argue that Richard R. Nelson, an economist I believe both of us hold in very high regard, made the most damning criticism of your first book, *The Economic Laws of Scientific Research*. Nelson in fact does make a number of strong criticisms of your book²³ but it was his comments on the issue of science as a public good that motivated your development of the "invisible college good" argument neatly summarized in your most recent letter and discussed at length in *Sex, Science, and Profits*.¹

If we go back almost a decade before the *Scientific American* interview, however, we find in a cogently argued article co-written with Keith Pavitt²⁴ a spirited defence of the importance of human capital and technology spillover as key motivations for the public funding of academic research. Remarkably, your invisible college good premiss simply ignores these effects, assuming that the benefits of scientific knowledge and training are restricted to small groups ("colleges") of cognoscenti, rather than diffusing out into wider society. Echoing a point I made in my most recent letter to you and elsewhere,²⁵ it is these subtle and indirect benefits of "knowledge diffusion", rather than direct economic return via intellectual property or patenting of university research, which represent the vast majority of the pay-off of academic research.

The idea that, for example, biologists can't access the information in journal papers published by physicists, as you suggest, implies a rather outdated view of scientific research, imagining that it is carried out wholly within classical disciplinary boundaries. We both know that this is increasingly not how science operates. My research area—nanoscience—*thrives* on cross-disciplinary work. I, like so many of my colleagues, now regularly read papers written by,

²¹ R.R. Nelson, A Science funding contrarian (review of Ref. 13). *Issues in Science and Technology*, Fall 1997.

²² *The Economics of Science: Interview with Terence Kealey*, *Scientific American*, 3 March 2003.

²³ Although, to be fair, Nelson states that he has "*considerable sympathy for [your] overall position*", he notes that "*Kealey's own beliefs about the relationships between science and technology seem as inadequate as a general characterization as the linear model*". Moreover, and returning to a point made in my previous letter, Nelson emphasises that "*business support of basic research is limited and fragile*".

²⁴ *Try Business Class World Wide*, Times Higher Education Supplement, 18 November 1994.

²⁵ P. Moriarty, Public science: a public good? *Nanotechnol. Perceptions* 4 (2008) 101.

for example, chemists, microbiologists and, most recently, computer scientists in order to keep informed about the state-of-the-art in the field. The best nanoscience groups are those with a strong cross-disiplinary blend of skills and expertise. Similar interdisciplinary working methods are embedded in a wide range of modern scientific fields.

In summary, your argument that science is not a public good is flawed and is ideologically-, rather than evidence-, driven. Your econometric and historical analyses, as pointed out by Nelson (amongst many others), do not and *cannot* account for the subtle interplay of the public and private sectors in the development of science, technology, and innovation. Decoupling the role of public funding from the evolution of science in the private sector is practically impossible because of, in the language of a physicist or engineer, the outputs and inputs each contribute to a highly complex, highly nonlinear, multiparameter feedback loop. It is this feedback loop that drives scientific, technological, and thus economic, growth and development.

Since we started our “spat” the UK has had a change in government. Worryingly, many in the Conservative-Liberal Democrat coalition cabinet share your ideological commitment to the superiority of free market economics and the private sector as compared to the public sector and state funding. It is remarkable just how effective David Cameron *et al.* have been in disseminating the message that the economic crisis was somehow the result of “big government” rather than what it actually was—a dramatic failure of the private sector in a *laissez faire* regime.

Laissez faire science in the 21st century, driven solely by the private sector as you suggest, would suffer similar failings. Not only would fundamental, far-from-market research be insufficiently funded (for the reasons discussed in my earlier letters) but the independence and reliability of academic science would be severely compromised. In typically “robust” language you state in Chapter 13 of *Sex, Science, and Profits* that “*University professors and practising doctors, therefore, publish findings that support their sources of money*”. As a university professor, and from one perspective, I take great issue with this statement! None of my findings—which to date have all been funded exclusively by the public sector—could be said to have been compromised by the funder.

From a different perspective, however, I agree with you. There is clear evidence from a variety of sources that funding provided by multinational pharmaceutical companies, for example, can severely distort and compromise the integrity of university research.⁷ I remain intrigued and not a little bewildered that, despite this evidence (and the discussion in Chapter 13 of your book), you remain convinced that funding from the private sector alone will always produce *disinterested*, trustworthy, and pioneering research results.

Best wishes
Philip

Dear Philip,

Thanks. You are right that we are arguing against each other but, in so doing, you have well summarized the areas that divide us, and so you have allowed us to stop our debate at this point. Nonetheless you are wrong in your assertions about my position! Let me address your assertions in reverse order.

Your assertion that disinterested science cannot be entrusted to the market because market funders are by definition interested is the very point I am making about its public funding: science is publicly funded so scientists will seek to prove that it therefore should be. There is nothing wrong with scientists seeking that self-interested proof because, as Thomas Kuhn showed in his 1962 book *Structure of Scientific Revolutions*,²⁶ individual scientists (though of course honest) cannot be dispassionate seekers after objective truth. Paradigms clash, and science is best served if individual researchers act as advocates for their favoured paradigm, to postpone the research community's dispassionate collective verdict over what is "truth" until all the data has come in and until all the arguments have been made (and, as is sometimes said quasihumorously, until all the original advocates on both sides are dead).

But as the economist Mancur Olson showed in his *Logic of Collective Action*²⁷ some arguments are lost before they are started because everybody has an interest in the same outcome. Science is one of those arguments, because (almost) everybody needs to believe it should be publicly funded. The scientists need to believe it for obvious reasons, industry needs to believe it because it is addicted to subsidies and it wants its R&D for free, and governments need to believe it because science is relatively cheap and its funding satisfies the lobbyists on the left such as yourself as well as those lobbyists on the right who seek subsidies for industry. Only libertarians, therefore, will challenge this paradigm.

Which is not difficult because, after 400 years of people repeating Bacon's argument that science is a public good, there is still no systematic empirical evidence that shows that its funding by government is of economic benefit. You have invoked "impossible-to-quantify spillover and human capital effects associated with academic research" and you have claimed that "Your [i.e., my] econometric and historical analyses, as pointed out by Nelson (amongst many others), do not and *cannot* account for the subtle interplay of the public and private sectors in the development of science, technology, and innovation" but those are not scientific arguments. If you are going to invoke "impossible-to-quantify" effects and if you are going to say that econometrics and history "*cannot*" (your italics) account for the effects you are claiming, then you are moving out of the zone of falsifiability into, what?

Finally, let me acknowledge that public goods do exist: the Erie Canal, which was the huge engineering project that transformed New York's and indeed the USA's economy during the early part of the 19th century, was a publicly funded project that was highly profitable in ways that can be quantified, which is why they have indeed been quantified. Economics is a quantitative science and all I am asking of those who have for 400 years advocated the public funding of science is that they should provide some systematic quantitative evidence to support their claims. Is that too much for a scientist to ask?

Yours
Terence

²⁶ T.S. Kuhn, *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press (1962).

²⁷ M. Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups*, 2nd edn. Cambridge, Mass.: Harvard University Press (1971).