



The economic impact of early 21st century scientific research

Never before in the history of the modern scientific era does it seem that the clamour to ensure that the only scientific work worth doing is that leading to direct economic benefit has been more intense than at present. In the United Kingdom, for example, this is now formally enshrined in the procedures for applying to receive public funding for scientific projects from the research councils—two pages exclusively devoted to economic impact must be supplied along with the six pages describing the scientific part of the proposed research, and having that one or more private commercial companies supporting the research greatly enhances the probability of obtaining public funds. Curiously, this movement reflects a kind of convergence between formerly opposing views. On the one hand we have the “linear” model, first promulgated by Francis Bacon, according to which scientific research deserves public support because it will inevitably lead to economically important (via their technological development) discoveries. On the other hand there is the constant search for technical innovation from commercial firms in order to maintain the profit rates that they need for survival.

We might call this combined movement the “converged model”.

One of its unfortunate corollaries is that it has engendered a tendency to only regard scientific research as significant if it is undertaken within the framework of a project to which specific funds have been allocated. This is precisely the model of research councils, national science foundations etc., whose aim seems to be to dominate scientific funding in the countries in which they operate. In other words they (and the governments that fund them) wish to eliminate open-ended research, of the kind that used to be carried out by university professors and some of the staff at the most eminent industrial laboratories (such as the former Bell Laboratories in Murray Hill, New Jersey), and which has been responsible for all of the outstanding discoveries (most of which later came to have enormous and far-reaching commercial significance) made in the last two centuries, and replace it by project contracts to undertake “research” that has been minutely specified in advance. This tendency represents a great distortion of science (considered as the process whereby new knowledge is produced). It ineluctably leads to the promotion of deductive rather than inductive science and the consequent deceleration (ultimately to zero) of the rate of acquisition of new knowledge.

The current (and still growing) dominance of this “converged model” is a very strange phenomenon, since any genuine scientist must feel that his creative potential is completely stifled under such a regime. It is impossible to imagine some of our great predecessors like Dewar, Rutherford or the Braggs operating in this fashion. There was no shortage of protests when the system started being introduced (in the 1960s, in the UK), yet the model has continued to gain ground, most recently in countries such as France and Russia, where it represents a dramatic departure from their traditional system.

Why, then, is it now so widely accepted? One explanation could be that it has finally been recognized that science is not a public good but an invisible college good.¹ In reality, however, that view is widely repudiated not only by scientists but also by the research councils and their governments, who staunchly uphold the “linear model”. Presumably the reason why private companies are, apparently anomalously according to that model, able to gain some exclusive benefit from “publicly-funded” research through their support of research council projects is because, through corporation taxes, the companies are directly contributing to public funds (and furthermore, by supplying goods for which there is public demand, contributing to general social well being). The net result of research council activity is then simply to dilute the potentially available capacity of scientists to undertake research by their having to deal with research council bureaucracy, and to reduce the financial support by having to pay the salaries of the bureaucrats.

Not many academic scientists, it seems, subscribe to the view that science is driven by technology, which in turn is driven by the need of companies to innovate in order to maintain their profit levels, although the current insistence on ensuring that “publicly” funded science pays due regard to transforming itself into commercial benefit is in accordance with that view. The reason for this apparent aversion may be that the technology → science model is embedded within the still current (i.e., post-Industrial Revolution) economic model—that is, essentially laissez-faire capitalism in which, *pace* Adam Smith, an “invisible hand” guides markets to efficient outcomes—in other words, under “equilibrium” conditions of free and perfect competition every citizen following his or her individual best interests contributes to the general good—which has been thrown into disrepute by the recent and ongoing financial crisis. Although some of its premisses, such as the existence of “equilibrium” conditions, have long been subject to strong academic criticism as being completely unrealistic, nevertheless there is a general reluctance to criticize the roots of the model, and demolish and rebuild the very foundations. Reforms are indeed advocated, but the most common call is for there to be more regulation (that is, even more state bureaucracy). With sound regulation, it is argued, banks can be kept under control and irresponsible speculation can be forever banished.

The reason for this lukewarm response to the crisis, and the apparent desire to return to business as usual as quickly as possible, may possibly lie in the still strongly present twin bugbears of National Socialism and Soviet socialism. Both are perceived to have had disastrous outcomes (*de facto* neither survived). The main alternative to laissez-faire capitalism is considered to be Soviet socialism, but it is no longer a credible alternative because of its demise. Furthermore, Mikhail Gorbachev’s perestroika, his failed attempt to demolish and rebuild its very foundations, remains as an ominous warning of the dangers of such demolition work. Actually, it seems as though China may have invented a third, and very successful, at least at present, alternative, but this is apparently not seen as something exportable, and the policy of reserving certain essential commodities (such as rare earth elements) for exclusive Chinese use is felt to be unacceptable in the rest of the world.

History suggests that one can expect a revolution in our means of production to spawn a new economic system. Certainly as far as the Soviet Union was concerned, the Information

¹ T. Kealey, Science is not a public good: it is an invisible college good. *Nanotechnol. Perceptions* 4 (2008) 98–100.

Revolution led to the introduction of laissez-faire capitalism, not because of anything new being produced but because it became impossible for the government to maintain control over what information was disseminated to the population, and it turned out that the majority did not have a naturally ascetic bent and hence were beguiled by the allure of consumerism, which is of course intrinsic to laissez-faire capitalism. Now we stand on the threshold of another revolution, the Nanotechnology Revolution, which promises the large-scale production of almost every conceivable artefact in a self-designed, customized fashion, rather than according to the Fordian concept of mass production. This should lead to the decoupling of manufacturing costs and personal incomes, the inseparability of which has been axiomatic ever since the Industrial Revolution. Coupled with the apotheosis of globalization as a result of the internet and mobile telephony, both enabled by nanoscale-feature integrated circuitry, it seems inevitable that laissez-faire capitalism will be supplanted, although probably not in a violent and bloody revolution because that implies the destruction of too much of the fabric of our present civilization, which is actually essential for maintaining our level of technology, including *a fortiori* nanotechnology. Hence a gradual transformation appears more likely.

These are some of the issues implicated by a seemingly innocuous question about the potential economic impact of nanotechnology research. The issues need to be apprehended and debated far more widely than at present and, as our new system slowly emerges, let us not totally discard all features of the old ones in a dogmatic and wasteful fashion, but let us rather examine them dispassionately for whatever merits they had, and rationally seek to incorporate those merits into the new system.

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