

Governments need not fund science (at least, not for economic reasons)

by

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Introduction The years 1776 and 1947, the years of the Declaration of Independence and the promulgation of the Truman Doctrine, are existentially important in the history of the US. Less obviously, they are the two most important dates in the history of science funding.

1776-1947 1776 was not only the year of the Declaration of Independence, it was also the year Adam Smith wrote his *Wealth of Nations*, where he showed that economic or technological growth did not require governments to fund science: by 1776, industrialization was well-established in Britain (the flying shuttle had been patented as early as 1733) and experience had shown that the demand for new technology was being met within the workshops of industrialists:

If we go into the workhouse of any manufacturer ... and enquire concerning the machines, they will tell you that such and such an one was invented by some common workman.

Adam Smith, 1776, *Wealth of Nations*

Smith, moreover, specifically denied that industrial technology flowed from academic research: indeed, the opposite was true, it was academic science that flowed from industrial technology:

The improvements which, in modern times, have been made in several different branches of philosophy [i.e., pure science] have not, the greater part, been made in universities [i.e., they were made in industry].

Between 1776 and 1947 Adam Smith's observations were repeatedly confirmed by those economists who actually *observed* the industrial scene. Thus observers as various as Karl Marx and Joseph Schumpeter reiterated that science was, in the jargon, endogenous: markets produced all they needed.

The bourgeoisie, during its rule of scarce one hundred years, has created more massive and more colossal productive forces than have all the preceding generations together. Subjections of Nature's forces to man, machinery, application of chemistry to industry and agriculture, steam-navigation, railways, electric telegraphs, clearing of whole continents for cultivation, canalisation of rivers, whole populations conjured out of the ground – what earlier century had even a presentiment that such productive forces slumbered in the lap of social labour?

Karl Marx & Friedrich Engels, *Communist Party Manifesto* (1848)

Industrial mutation incessantly revolutionizes the economic structure *from within*.
[Schumpeter's italics].

Joseph Schumpeter *Capitalism, Socialism and Democracy* (1942)

Not only does the history of the UK confirm those observations (the British Industrial Revolution of the 19th century, like the British Agricultural Revolution of the 18th century, was *laissez faire* in science) so also does the history of the US. The US was *laissez faire* in science between 1776 and 1940, yet by 1890 it had overtaken the UK to become the richest industrialized country in the world. Meanwhile those European countries – including France and the German states – whose governments invested most in science failed to converge on the UK or the US, let alone overtake them.ⁱ

Opposition to the federal government funding of science was fueled not only by Adam Smith's writings but also by a Constitution that empowered the states. That opposition was so strong that in 1839, when James Smithson left Congress some \$500,000 to found the Smithsonian Institution, its acceptance was opposed by the defenders of states' rights. Senator John C Calhoun from South Carolina said the money "must be returned to the heirs," while Senator William Campbell Preston, also from South Carolina, asserted that if Smithson's money were accepted, "every whippersnapper vagabond ... might think it proper to have his name distinguished in the same way." Meanwhile, defenders of taxpayers' rights such as Andrew Johnson of Tennessee, the future president who was then in the House of

ⁱ It is commonly asserted that Germany overtook the UK during the 19th century, but Angus Maddison is one of many economic historians to have shown that is not true (*The World Economy* 2007, OECD). 19th century Germany excelled in certain areas of technology such as chemicals, but in other areas such as agriculture it so lagged that, overall, its economic performance was mediocre. It can be compared to the Soviet Union: by 1957, with the launch of *Sputnik*, the USSR was clearly the world's leading space power; it was also dirt poor.

Representatives, denounced any federal support for the Institution as picking the “pockets of the people”.

The years 1776-1947, therefore, saw the US fall into a fixed pattern: in peacetime, science was left to the private sector. Only in wartime did the federal government commission science, but – when peace returned – science reverted to *laissez faire*. So – to develop new military technologies such as iron-clad warships – the Civil War saw the federal government found the National Academy of Sciences and the Permanent Commission of the Navy Department, but after 1865 the National Academy was left to fund itself and the Commission was dissolved. During the Spanish-American War, the US Army funded the Smithsonian’s research into heavier-than-air aircraft (though it was the privately-funded Wright brothers who made that advance). And during the First World War the National Research Council was created, but after 1919 its funding progressively ceased. Equally, 1941 saw the creation of the Office of Scientific Research and Development (which oversaw the Manhattan project *et alia*) but after 1946 it was progressively defunded.

The only significant federal funding for science in peacetime was launched in 1862, for agricultural research within the land grant colleges, but that was to address the problem of *overproduction*. Virgin land was so cheap (and food was so cheap) that farmers were slashing-and-burning, so the land-grant colleges were founded to promulgate soil conservation: the market in agriculture had been working only too well.

Consequently, by 1940 the federal government was funding less than a quarter of US science or R&D, yet – as shown by the successes of the Wright brothers, Thomas Edison and Nikola Tesla, to say nothing of the great industries of Pittsburgh and Detroit – US science, technology and industry flourished. ⁱⁱ

The Truman Doctrine Curiously, the federal government has not, since 1947, abandoned its policy of funding science only in wartime, because since 1947 the US has been at permanent war.

In 1945 the director of the Office of Scientific Research and Development, Vannevar Bush, alarmed at the prospect of the peace-time demobilisation of his Office,

ⁱⁱ The federal and state governments were spending \$81 million pa compared to the private sector’s \$265 million, which included \$31 million for university and foundation research (T Kealey, 1996, *The Economic Laws of Scientific Research*, Macmillan, p 151). Almost all the governments’ research was for agriculture (which was economically irrelevant) or defense (defense research has only about 10 per cent of the economic value of civil research; Advisory Council On Science and Technology, 1990 *Developments in Biotechnology* HMSO, London).

published his *Science, the Endless Frontier* to advocate the creation of a federally-funded National Science Foundation. Initially his initiative floundered, and when in 1947 Congress passed a bill to create a NSF, it was vetoed by President Truman:

This bill contains provisions which represent such a marked departure from sound principles for the administration of public affairs that I cannot give it my approval.

But that was soon to change. In his leaving address George Washington had warned against “permanent alliances,” and against “excessive partiality for one foreign nation, and excessive dislike for another” (often summarised as his warning against “foreign entanglements”) but in 1947, in his Doctrine, President Truman reversed that non-interventionism: and having committed the US to the Cold War, he then sought, as all war-time presidents have sought, to bolster his nation’s defense by bolstering its science, and in 1950 he compromised with Congress and signed a new bill establishing the NSF.

In his 1947 veto Truman had complained that the bill would “vest the determination of vital national policies, the expenditure of large public funds, and the administration of important government functions in a group of individuals who would essentially be private citizens” but in the 1950 compromise it was agreed that the NSF’s director would be appointed by, and would report to, the President.

Truman had intended the NSF to be primarily a defense initiative (and contrary to myth, Vannevar Bush’s *Science, the Endless Frontier* – though it did address advances in health and the growth of the economy – was primarily a defense-orientated book) but – as Truman had feared – the NSF was subsequently captured by the scientists and their so-called ‘linear model’:

Government funding → pure science → applied science → technological growth

The linear model This model was first proposed by the English lawyer Francis Bacon in his 1605 book *The Advancement of Learning* (“If any man think philosophy and universality to be idle studies, he doth not consider that all professions are from thence served and supplied”). Bacon supposed science was a public good, calling it “a universality” whose benefits could not be monopolized by the funder (“the benefits inventors confer extend to the whole human race”). Consequently, he argued that the market would not fund it (“there is no ready money”) and governments, therefore, had to pay for it (“there is not any part of good government more worthy than the further endowment of the world with sound and fruitful knowledge”).

But Bacon had no experience of an industrial revolution, and his thinking was purely theoretical. Nonetheless other theoreticians including Friedrich List (*National System of Political Economy*, published in German in 1841) and John Stuart Mill (*Principles of Political Economy*, 1848) agreed with him, culminating in a curious episode of American intellectual thought.

To promote his ideas, in 1945 Vannevar Bush joined the US Air Force and the McDonnell Douglas Corporation in helping create Project RAND (now the RAND Corporation; Research And Development Corporation) one of whose missions was to lobby for the federal funding of science. Consequently RAND funded the two most influential papers in the modern economics of science, those of Richard Nelson and Kenneth Arrow, where they echoed Francis Bacon.¹ Nelson and Arrow asserted that because science is, in the jargon, “non-rivalrous” (an idea, unlike an object, can be used by an infinite number of people) and “non-excludable” (no idea remains secret for very long)ⁱⁱⁱ no private funder can retain the benefits of their funding, so no private entity will fund science.

And economists like Paul Romer² or Partha Dasgupta & Paul David,³ who have subsequently promoted ideas of “endogenous growth,” still describe science as a “merit good,” requiring significant public funding.

Yet the empirical evidence still shows them to be wrong – and that evidence has been collected by governments. Thus in 2003 the OECD, on studying the growth rates of the 21 leading world economies between 1971 and 1998, found “a significant effect of R&D activity on the growth process,” but it is only:

Business-performed R&D that ... drives the positive association between total R&D intensity and output growth ... ⁴

Equally, in 2007 Leo Sveikauskas of the US Bureau of Labor Statistics, using a different methodology, concluded:

The overall rate of return to R&D (research and development) is very large ... However, these returns apply only to privately financed R&D in industry [Sveikauskas’s underline].⁵

ⁱⁱⁱ In an 1813 letter Thomas Jefferson expressed these concepts colorfully: “He who receives an idea from me, receives instruction himself without lessening mine; he who lights his taper at mine, receives light without darkening me.” Jefferson, though, invoked those concepts not to argue for the government funding of science but for the abolition of patents.

Ronald Reagan once described an economist as someone who, when they see something working in practice, wonders if it will work in theory, and in 2014 Martin Ricketts and I provided the theory. We showed that, contrary to myth, science is not publicly-available (how many readers of this document can read Einstein's papers, even though those papers are over a century old?) Rather, science is open only to fellow scientists – who pay for their access by the papers they themselves contribute. And when science is modeled as a “contribution good,” the need for government funding disappears.⁶

One more, longitudinal, piece of American evidence shows governments need not fund science. Whereas before 1940 almost all American pure science was funded privately, today the private sector (in the shape of industry, foundations and universities) funds only half of it: the other half is funded by federal agencies including the NSF and the National Institutes of Health. And whereas before 1940 almost all US R&D was funded privately, by 1989 the federal government was funding two thirds of it (today it is only a third). Yet since 1830 the long-term rates of GDP *per capita* and TFP (total factor productivity) growth in the US have been steady (with GDP *per capita*, for example, growing at just under 2% per annum) and the inauguration of the federal funding for science had the following effect on long-term rates of GDP *per capita* and TFP growth: none.

Conclusion The evidence that governments need not fund science for economic reasons is overwhelming, and it is ignored only because of self-interest: the scientists like public funding because it frees them to follow their own interests, companies like it because it provides them with corporate welfare, and politicians like it because it promotes them as patrons of the public good (witness Bill Clinton's leading the celebrations over the mapping of the human genome.) So the empirical evidence is ignored in favor of abstract theories.

There are, of course, non-economic reasons, such as defense or the study of pollution, why a government might want to fund science (and a democratic polity, moreover, might not wish to be dependent only on private entities for its expertise in science) but in this document I cannot pronounce on these non-economic justifications for the government funding of research: only democratically-elected representatives have that competence. Here I can make only the technical argument that there is no credible evidence that governments need fund science for economic reasons.

But we can nonetheless note that in his own farewell address (known for its regrets for the “industrial-military” complex and for the “three and half million men and women directly engaged in the defense establishment”) Truman’s immediate successor as President lamented the effects of the federal government’s funding for science. He lamented the effects on the universities:

In the free university, historically the fountainhead of free ideas and scientific discovery ... a government contact becomes virtually a substitute for intellectual curiosity.

The prospect of domination of the nation’s scholars by federal employment ... is gravely to be regarded.

And he also lamented the effects on the federal government itself:

We should be alert to the ... danger that public policy could itself become captive of a scientific-technological elite.

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¹ Nelson, Richard, R. 1959. The Simple Economics of Basic Scientific Research. *Journal of Political Economy* 67: 297-306. Arrow, K. J., (1962). Economic Welfare and the Allocation of Resources for Invention, in *The Rate and Direction of Inventive Activity: Economic and Social Factors*. Princeton: Princeton U. Press 609–25.

² Romer, Paul. 1990. Endogenous Technical Change. *Journal of Political Economy* 98: S71-S102.

³ Partha Dasgupta and Paul David (1994) Toward a new economics of science. *Research Policy*. 23: 487-521.

⁴ OECD, 2003, *The Sources of Economic Growth in OECD Countries*. OECD. Paris.

⁵ L Sveikauskas (2007) *R&D and Productivity Growth: A Review of the Literature*. Bureau of Labor Statistics. Washington, D.C. www.bis.gov/osmr/pdf/ec070070.pdf

⁶ T Kealey, M Ricketts (2014) Modelling science as a contribution good. *Research Policy* 43: 1014-1024.