



## Science: exploration and exploitation

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I should start by laying some cards on the table—my background over many years is as an academic, at Oxford and Dublin, and in industry, running a spin-out nanoscience company in the USA and earlier on in Switzerland. This gives a perspective on both sides of the public/private debate, but just as importantly, spending a lot of time outside the UK gives a perspective on how they do these things elsewhere—the UK is not the only country in this debate. A historical perspective is also significant: science is a cultural activity that has been going on for a lot longer than the current political view appears to recognize. Let us recall some words from Francis Bacon (1605): “Science discovery should be driven not just by the quest for intellectual enlightenment, but also for the relief of man’s estate,” and that really summarizes the problem we are facing in today’s debate.

What is science and what does it do? It is not a belief system, but rather an exploratory process—checking out what’s happening in the world out there, and mapping it. Science is valuable, because its results really do relieve man’s estate, as well as giving the reasons why nature is the way it is—why the sky is blue, for example. The workings of the world become not a matter of prior belief, but rather can be checked and tested by anyone, along with the practical benefits. So the combination of these two things is valuable, and as a result science has always been supported and funded at various times by both public and private means. It’s worth noting in passing that this does not just mean government and for-profit corporations. That is too simple and polarized a view of science funding, which would needlessly constrain our debate. There is a kind of intermediate sector, namely philanthropy. The universities of Oxford and Cambridge for example, and many other of the world’s leading universities, were built to a considerable extent on philanthropy. The founders did not have especially commercial aims; there was a broad consensus that it was good to undertake this kind of exploring and exploiting activity over long times. The question is, how do you balance those two as drivers of science?—that is what we are really arguing about here today. Both are necessary. How do you find a sensible balance between open exploration for knowledge, and exploitation to “relieve man’s estate”?

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At this point I'm going to put on my American hat and stand on one side of this fence (I'll stand on the other side in a second). Ultimately, if you don't have a productive technically-based industry, you will not have the wherewithal to engage in extensive open research, so exploitation of science is essential. Furthermore, if you are going to relieve man's estate and get practical business output and benefit, the process has to be effective. You have to have some plan in management terms. You are making an investment and expecting a return. Any corporate entity, any government, has to do that, and indeed taxpayers rightly expect some tangible benefit from their investment—implying that you have to have some idea of where you're going and what you will deliver. Now, this is fine for a short-term or well defined objective, and science should anyway help with those, which is why the development part of R&D takes much or most of the available resources. However, careful planning comes up against one of the basic features of science: if it is real exploratory science you do not actually always know where you are going—Vannevar Bush made this point when US science was surging after World War II.

Surprises are, in a way, the best aspect of science. There is more to the world than a business plan (despite what HM Treasury might think), as illustrated by two rather well known quotations. One, from *The Bard*, is “there are more things in the heaven and earth, Horatio, than are dreamt of in your philosophy”—or, to paraphrase, you do not always know what is going to happen in research. The other, from a rather different character, is “what about the unknown unknowns?” Both quotations capture the uncertainty inherent in science exploration and the need for a long view.

In the process of going from A to B we might find that C is more interesting. I would go as far as to say that a scientific research project that delivered all its deliverables, and only those, was actually a failure. One should have found something beyond. There has to be room for both things—open exploration, plus the fact that you have actually got to show a practical benefit and deliver what you promise. It's actually the unexpected and new that generates the really valuable new industries of the future. There is a synergy as well as a tension here.

What constraints are put on that open exploration process? There are no obvious subject constraints in the natural world. Efficient communication is vital to test new ideas and results, so there may be a risk from securing intellectual property (IP). The associated secrecy can block communication, and proprietary methods are often not open to scientific test. So the line in exploitation has to be carefully drawn not to restrict exploration. IP must not shape research.

What about the viewpoint that scientists should be able to research whatever they like in seeking general enlightenment? Apart from the matter of finite resources, there is another more brutal fact—namely that science is internally competitive. Good scientists spend a lot of time deciding “this or that subject just isn't so interesting, and therefore let's stop doing it and do something else more interesting.” To paraphrase Nevill Mott, “the hard part of managing science is shutting down the beta.” Science already has its own means of making choices, even in open exploration, and there is no automatic entitlement to be funded to research whatever one likes. This is so without considering practical outputs. We can see that even pure exploratory research is actually quite structured already. Adding a need to exploit appears to just add more structure, but it must not conflict.

How to resolve the tension? Well, I have a particular perspective on this which you may or

may not like, but which might help to bridge the gap by a little bit.

We are agreed on the need to preserve the core university function, namely producing people, and upholding the freedom to explore. There is also a duty on us as scientists to actually do something useful for our fellow men, however they may invest in us, whether it be as government, or commercial corporation, or philanthropist. Someone believes scientific research is a good thing and is putting money into it; we have a duty to return something from that investment, whether it be products or general public enlightenment. This is actually part of innovation policy.

I have an analogy for you. The process of getting ideas out of science into products somewhat resembles, I like to think, a stool with three legs. That is, there are three drivers. One of them, which is certainly important, is what universities do. They produce the new science and technology, but most of all, they produce the creative skilled people who are essential. That is one leg. Another leg concerns the regulatory, legal and physical circumstances, environment and so forth—all the things that are necessary to actually allow one to, say, drive a car down the road, to have a contract for doing various things, to make a plan, have freedom of thought, and all that—that is the second leg. There's a third leg, which is sometimes ignored in the UK, and that is fiscal—investment, tax, incentives. All three legs have to work and be competitive internationally to have an effective exploitation process. It's no good compensating for the weakness of one leg by just reinforcing the others.

There are three legs in this simple picture, and I have to say—from my perspective—that the way they are arranged differs in the UK from some other countries. We are in fact incredibly strong on one of those legs, which is the university and research side, the intellectual and scientific sector. By any measure the UK punches well above its weight. We've got great people. The second leg, the regulatory one, is also not too bad, and is quite competitive internationally. A lot of things work well and there are few constraints on what science can do. The point I really want to make is what about the third leg? What about R&D spending and taxation? Is the UK actually competitive or leading in these? Not very. Why do companies move to Dublin or Zurich? One reason is really very simple—very low corporate tax rate. Why do you build a small company in the USA rather than here? It's not because there are worse people here—I would rather build companies here in fact, but in the USA you get resources from SBIR,<sup>†</sup> state support, favourable taxes, etc., as well as a huge market to amortize investment. The fiscal aspects matter a great deal, and the UK is not so competitive. You can see what happens in those few areas that the UK does favour with competitive taxes—such as the effective 10% rate for private equity (till recently).

The process of exploitation for economic benefit involves pull from the commercial sector as well as push from the research sector. It is no good going around beating universities, saying to their staff “be more effective in exploitation”, while at the same time putting a ball and chain (compared to other countries) around small companies, preventing them from competing effectively in the world. Why is Britain so bent on preserving what it calls “a level playing field” in commerce? Every other country is clearly un-levelling the field as fast as they can. The United States for example is far from having a level playing field for its companies: it (rightly)

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tilts everything it can in its own favour, which is part of why it is popular to set up companies there. Even university academics find it attractive to run spinout & technology companies under such circumstances—it's not necessary to cajole them!

The old saw is that the UK has a great record of new ideas but is not so good at exploiting them. My message in this debate is we need to keep and sustain the sources of new ideas, and not kill the golden goose with micromanagement. However, to make the process of exploitation effective we need a competitive environment which makes it attractive to set up technology business in the UK, and this means competitive fiscal conditions. Scientists should deliver both enlightenment *and* relief of man's estate, and both should be attractive options in the UK.