

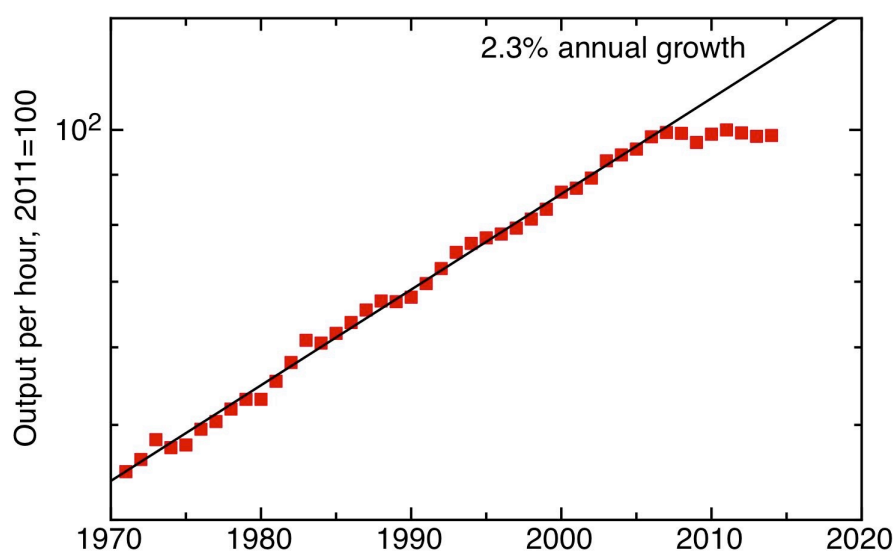
Innovation, research, and the UK's productivity crisis

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The UK is in the midst of an unprecedented peacetime slowdown in productivity growth. After taking stock of the scale of the UK's productivity problem and discussing why it matters so much, both economically and politically, I'll set the context for the following discussion with a provocative association between productivity growth and R&D intensity. I then review what can be said from more careful analyses of productivity, looking at the performance of individual sectors and testing some more detailed explanations of the productivity slowdown. I'll pick out the role of declining North Sea oil and gas and the end of the financial services bubble in the UK's poor recent performance; these don't explain all the problem, but they will provide a headwind that the economy will have to overcome over the coming years. Finally I return to a more detailed discussion of innovation in general and the particular role of R&D, finishing with some thoughts about what should be done about the problem.

The scale of the UK's productivity problem

The UK's current stalling of productivity growth is probably the UK's most serious current economic problem. In terms of output per hour, the last five years' productivity performance has been by far the worst period in the last 45 years. Many other developed economies have had disappointing productivity growth in recent years, but the UK's record is particularly bad. Amongst other developed economics, only Luxembourg and Greece have done worse since 2007, according to a recent OECD report¹.



¹ See table A2, p83 of *The Future of Productivity*, OECD, 2015
<http://www.oecd.org/economy/the-future-of-productivity.htm>>the future of productivity

Figure 1. Labour productivity since 1970. The fit is an exponential corresponding to constant growth of 2.3% a year. ONS data.

My plot shows the UK's labour productivity - defined as the GDP generated per hour worked - since 1971. What's striking about this graph is how closely productivity has followed a trend of constant 2.3% a year growth. What conventional wisdom tells us was the economic chaos and stagnation of the 1970's - the three day week, the bursting of the Barber boom, the IMF bail-out, the Winter of Discontent - barely makes an impression. Likewise, the deep early 80's recession, the subsequent recovery, the bursting of the Lawson boom, the post ERM recovery - again, all are barely visible as small fluctuations around the relentless compound growth of productivity. This steady progress changed abruptly with the financial crisis in 2008. Since then productivity growth has essentially stopped.

By 2014, the productivity gap between what we'd have expected on the basis of the pre-crisis trend and current performance had opened up to nearly 20%. This is a once-in-a-lifetime event; if we can't work out why this happened and reverse it the political and economic consequences will be serious.

Why productivity matters

Fundamentally, rising living standards and rising productivity are directly linked. Average wages in the long run should rise in proportion to rising labour productivity, unless there is a substantial change in the division of returns between capital and labour (which has not yet happened in the UK, unlike the USA). Overall economic growth can only come from a combination of growth in productivity and growth in number of hours worked. In the UK in the last five years, such economic growth as we have seen has arisen from employment growth, largely amongst recent immigrants. The government needs there to be significant GDP growth over its term of office in order to bring public finances back into balance; since much further expansion of employment growth is unlikely, a recovery in productivity growth is essential if the government is to meet its deficit reduction targets.

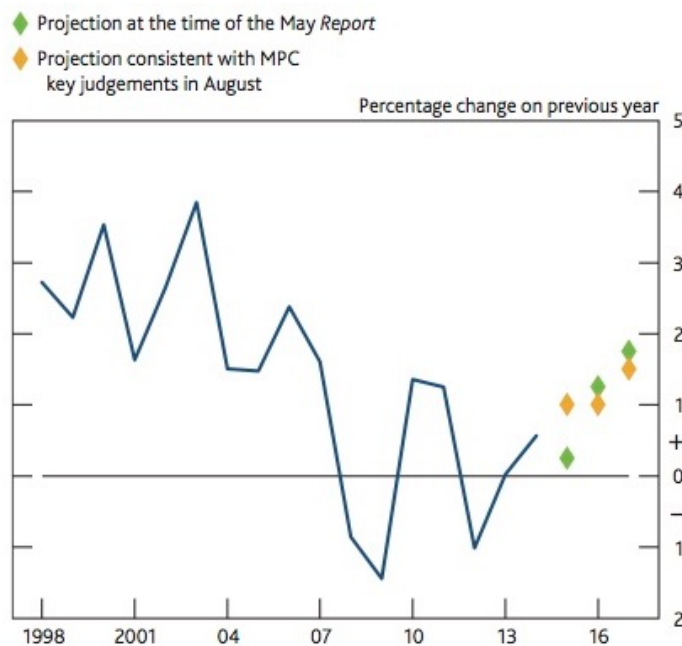
The official economic forecasts that underpin the government's borrowing projections assume that the recent productivity stagnation is a blip that we can expect to recover from through the natural self-righting tendencies of the economy. For example, the August 2015 Inflation Report² of the Bank of England detects the beginning of recovery, and projects an increase of productivity growth to 1.5% by 2017, as part of the slow recovery to a long term average of 2.25%, as shown in the plot below.

²<http://www.bankofengland.co.uk/publications/Pages/inflationreport/2015/au g.aspx>

What if this recovery has not yet started? What if the average long term rate of productivity growth is now different? For example, some modelling³ taking into account structural changes in the UK economy, comes to the pessimistic conclusion that the new stable long term average may now be closer to 1.4%.

It is the Office of Budgetary Responsibility that has the duty of independently assessing the government's economic plans, and their July 2015 assessment⁴ does indeed consider the consequences of lower productivity growth. It has what it engagingly calls a "*history repeats' scenario, in which we assume that we have made similar errors in our latest forecast to those that we made in June 2010*". This assumes that productivity growth stays stuck at 0.4%. The conclusion is stark: "*the Government would miss all its current and proposed fiscal targets*". In this event, the Government will have to fight an election with a background in which despite deep austerity, the public finances remain unrepaired, and living standards continue to stagnate.

It's difficult to look at the noisy data in the productivity growth rate chart below, and say that scenario looks any less plausible than the Bank's more rosy projection of recovery. To understand which is more likely, and whether there is anything policy can do to steer the outcome, we need to have some better answers about where the slowdown in productivity has come from.



Sources: ONS and Bank calculations.

³ The Macroeconomic Impact of Liberal Economic Policies in the UK, Coutts and Gudgin, Judge Business School, Cambridge

http://insight.jbs.cam.ac.uk/assets/2015_cbr-report_macro-economic-impact-of-liberal-policies-in-the-uk.pdf

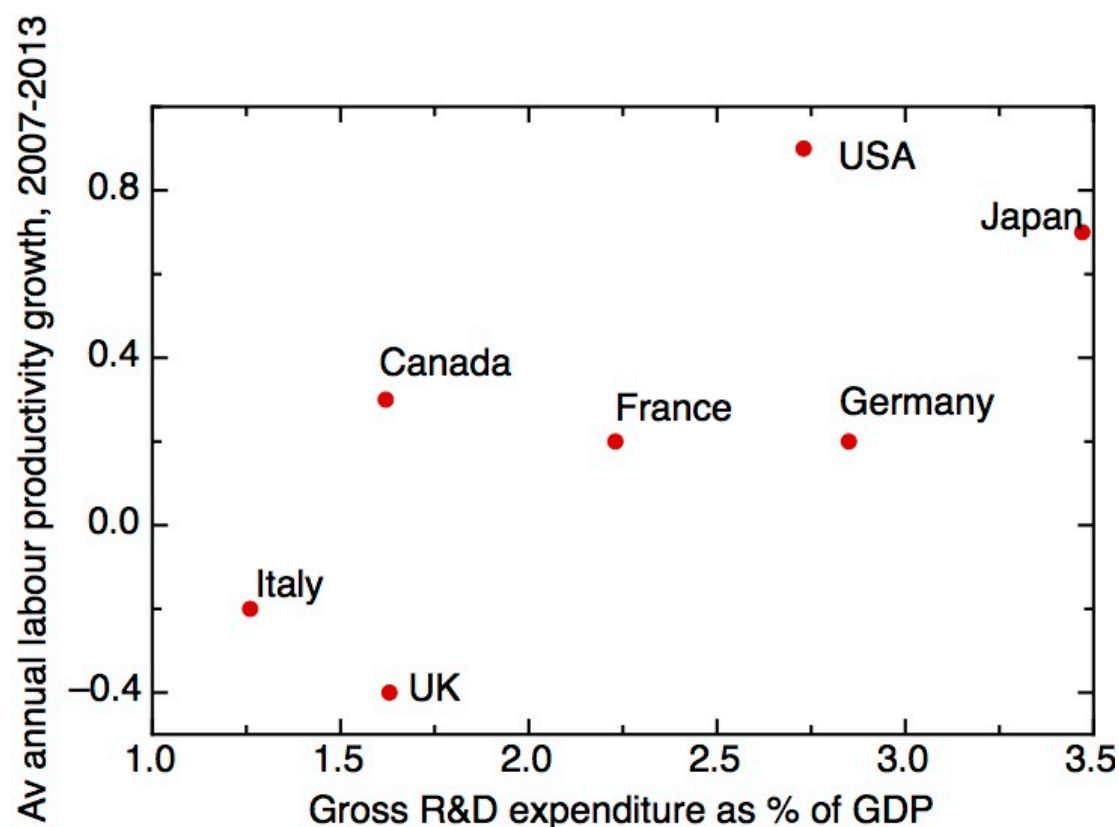
⁴ <http://cdn.budgetresponsibility.independent.gov.uk/July-2015-EFO-234224.pdf>

The Bank of England's current expectations for future productivity growth. From the Bank's August 2015 Inflation Report⁵ (figure 5.7).

The UK, weak for research and development, weak for productivity growth - what's the connection?

Economists agree that the fundamental origins of productivity growth are to be found in innovation, both technological and organizational. One key measure of the resources devoted to technological innovation is the R&D intensity of the economy, so it is natural to ask whether the current slowdown in productivity is connected to the UK's long-term record of lower spending on R&D (both public and private sector) compared to other developed economies.

The data for the G7 group of developed economies is shown in my plot. The UK is close to the bottom of the league for its R&D intensity, and its productivity growth has been the weakest of all the big developed economies. But it does need to be stressed that the correlation between productivity growth and research and development is not straightforward – productivity growth varies across different sectors of the economy, and can be affected by different factors such as the degree of capital investment. We need a finer grained analysis to understand the links.



⁵<http://www.bankofengland.co.uk/publications/Pages/inflationreport/2015/au g.aspx>

*Average annual labour productivity growth since 2007 vs current gross expenditure on research and development as percentage of GDP for G7 nations. Labour productivity growth was from table A2, p83 of *The Future of Productivity*⁶, OECD April 2015, GERD from OECD Main Science and Technology indicators.*

Analysing the UK's productivity slow-down

There are many theories of why the UK's productivity growth has stalled, and in the absence of proper analysis it's all too easy to choose a favoured hypothesis on the basis of anecdotes or a single data point, picked out to fit one's ideological predilections. Indeed, I could be accused of doing just that, by drawing attention to the UK's weak R&D record; others might immediately start looking at a lack of competitiveness in the economy, or insufficient deregulation, as the root of the issue. But it would be surprising if such a striking occurrence had just a single cause, so a more careful analysis should help us not just by ruling possible causes in or out, but by ascribing different weights to multiple causes.

A better analysis needs both to consider what we mean by productivity and its different causes in more detail, and to look at the economy on a finer scale, looking both at the productivity performance of different sectors and the balance in the economy between those different sectors.

As I discussed in an earlier blogpost on the productivity crisis⁷, growth economics conventionally considers economic growth to arrive from some combination of more labour - simply working more hours; more capital expenditure - buying more machines to do the work; and learning how to do things better. It is this collective learning how to extract more value from the same amount of input of labour and capital that growth economists call "innovation" and measure in a quantity called "total factor productivity" - TFP.

One explanation for a fall in productivity could be a shift in the balance between labour and capital. We normally expect, as the economy grows, for processes to be increasingly automated, so rather than having men with shovels dig ditches we buy more mechanical diggers - this process is called capital deepening. We can imagine the opposite happening - if wages fell, and labour were to become cheap compared to capital, then it might not be worth the expense to buy more machines. For example, there seem to be more hand car washes now than there used to be. Maybe this is because some motorists have a morbid fear of going through the mechanical car wash in their local garage, so they'll pay a premium price for an artisanal hand wash. But maybe the people doing the washing are desperate for a job and will wash cars for wages that make the capital expense of a machine uneconomic. That would be an example of capital shallowing.

We also need to look at the different sectors in the economy - some sectors have naturally high productivity, others naturally are lower. We should be careful in thinking about this to distinguish between the absolute level of productivity in a

⁶ <http://www.oecd.org/economy/the-future-of-productivity.htm>

⁷ <http://www.softmachines.org/wordpress/?p=1586>

sector from its rate of productivity growth (or shrinkage). For example, to anticipate some conclusions, with the development of North Sea oil and gas the UK economy grew an oil and gas sector which for a while had a much higher productivity than the sectors of the economy it squeezed out. This sectoral change in the UK economy resulted in an increase in the overall productivity in the economy. However, with the exhaustion of the more easily worked fields productivity in the oil and gas sector would decline, dragging down the overall economy with it.

A detailed analysis of recent productivity performance, that decomposes these different factors, has been carried out by Goodridge, Haskel and Wallis⁸. This seems to dispose of some popular theories for recent productivity weakness; evidence for capital shallowing, if any, seems weak, while shifts in the sectoral balance of the economy actually seem to have been working to increase productivity rather than decrease it.

Their conclusion is that our productivity problem is a problem of total factor productivity - and thus a problem of innovation, using that term in the economists' most general sense. There are two special sectors which, between them, account for a third of our problem. One of these is oil and gas, where declines in total factor productivity reflect the problems of a resource moving towards exhaustion, where increasing amounts of labour and capital are required to extract what oil and gas remains. The other is financial services, whose circumstances were changed in the aftermath of the financial crisis. But total factor productivity is a problem in virtually all sectors, and this must reflect failings of some form in our ability to innovate.

Two ongoing headwinds for UK productivity - the decline of North Sea Oil, and the end of the banking bubble

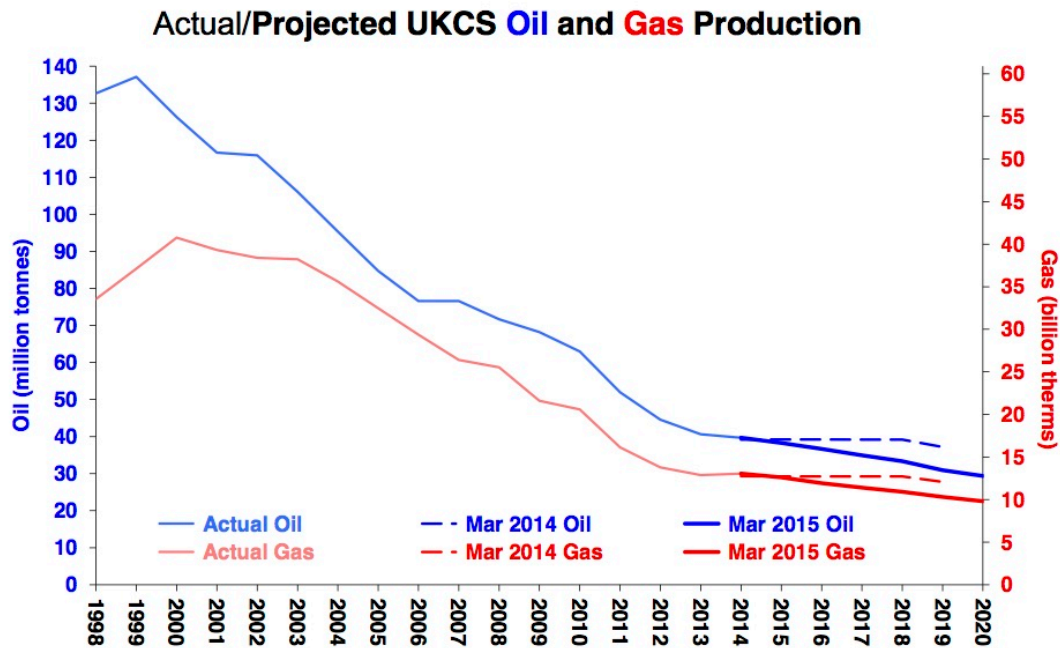
The importance of the decline of North Sea Oil and Gas shouldn't be a surprise to anyone. Offshore oil and gas production ramped up in the 1980's and 1990's, making the UK a significant world producer. As the plot below shows, oil production peaked in 1999, and gas one year later in 2000. Since then, there has been a steep decline in production, which is projected to continue more gently into the foreseeable future (this trajectory will be strongly influenced by oil prices, and is likely to be steeper the longer low oil prices persist).

When large quantities of oil, that could be sold for high prices, were being produced by a relatively small number of workers, this produced a substantial boost to the UK's productivity. Declining North Sea Oil produces two direct effects on overall productivity. Firstly, as the oil gets more difficult to extract, less output is created for a given input, so the productivity of the sector is reduced. Secondly, as the sector reduces in size, because its productivity

⁸ Accounting for the UK productivity puzzle: a decomposition and predictions, Goodridge, Haskel and Wallis
<https://spiral.imperial.ac.uk:8443/bitstream/10044/1/21167/2/Haskel%2015-02.pdf>

remains high relative to other sectors of the economy, the economy's overall productivity drops.

Indirect effects are more difficult to identify, but it's plausible to argue that North Sea Oil contributed to what economists call "Dutch Disease", in which the oil effect leads to a high value of the currency, making other tradable sectors, such as manufacturing, less competitive.



Actual and projected production of Oil and Gas in the UK Continental Shelf, according to DECC's latest Oil and Gas Projections⁹.

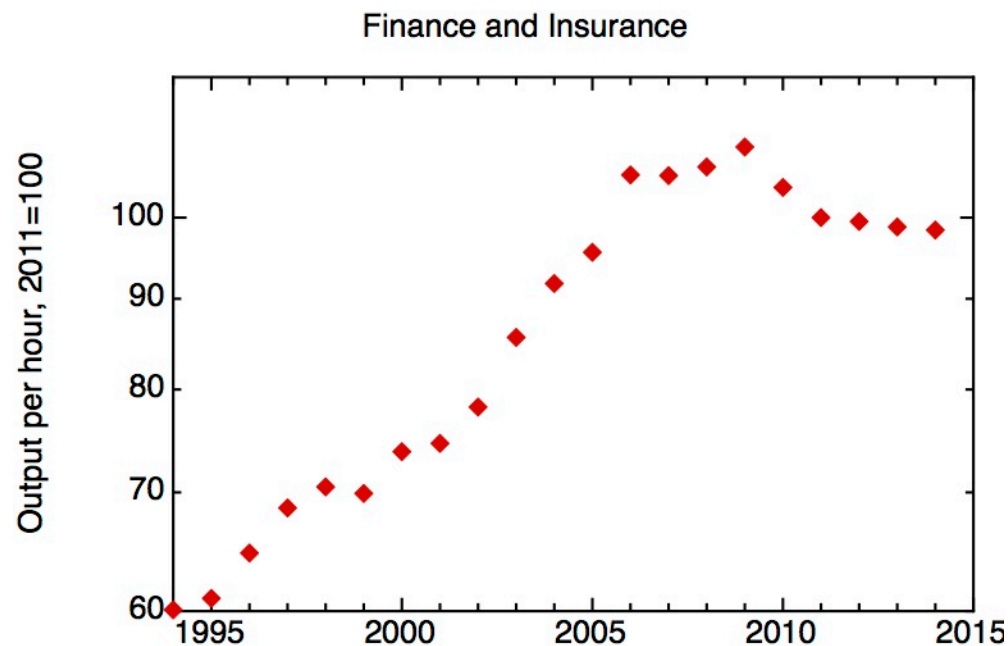
My next plot shows labour productivity in the finance and insurance sector. Just as North Sea Oil was peaking, in 2000, productivity in finance industry went into a new phase of fast growth. This growth slowed in 2006, went into a post-crisis reverse in 2009, and is still declining. Of course, what is meant by output in the finance sector is less clear than it is for oil and gas, where one can measure the barrels that come out of the ground.

What the financial crisis revealed was that some of the profits taken before the crisis represented the upside from excessive risk-taking, and when those gambles turned sour the tax-payer took on the losses. In effect, pre-crisis profits were overstated because the banks were benefitting from an implicit insurance against failure, whose premiums were being paid by the state. There are different estimates of the value of this state subsidy, reviewed in this Bank of England paper¹⁰, but even conservative estimates amount to £10's of billions.

⁹https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/414172/Production_projections.pdf

¹⁰ The Implicit Subsidy of Banks, Noss and Sowerbutts, Bank of England paper,

Our previous dependence on the financial sector also is likely to have had damaging indirect effects on our long-term economic growth prospects, as discussed in a recent Bank of International Settlements working paper¹¹. I discussed the role of excessive financialisation in suppressing private sector investment in research and development in my earlier paper *"The UK's innovation deficit and how to repair it"*¹².



Labour productivity in the UK's finance and insurance sector. ONS data¹³

Over the past few decades, the UK's economic prosperity has relied on North Sea Oil and the rapid growth of the financial services industry. Both have proved to be unsustainable; in the years to come we will have to find other sources of growth. To restore the economy's productivity growth to levels we have come to expect, we aren't just going to have to restore productivity growth in the other sectors of the economy to pre-crisis levels; we will have to increase it yet further to compensate for the continuing drag from oil and gas and financial services.

Quantifying the productivity benefits of research and development

http://www.bankofengland.co.uk/financialstability/Documents/fpc/fspapers/fs_paper15.pdf

¹¹ Why does financial sector growth crowd out real economic growth? Stephen G Cecchetti and Enisse Kharroubi, Bank of International Settlements working paper

<http://www.bis.org/publ/work490.pdf>

¹² The UK's Innovation Deficit and How to Repair it, R.A.L. Jones, SPERI paper no 6

<http://speri.dept.shef.ac.uk/2013/10/30/speri-paper-no-6-the-uks-innovation-deficit-repair-it/>

¹³ <http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-393176>

The UK's productivity problem is an innovation problem. This conclusion follows from the analysis of Goodridge, Haskel and Wallis¹⁴, at least if one equates the economist's construction of total factor productivity with innovation. This needs some qualification, because when economists talk about innovation in this context they mean anything that allows one to produce more economic output with the same inputs of labour and capital. So this can result from the development of new high value products or new, better processes to make existing products. Such developments are often, but not always, the result of formal research and development.

But there are many other types of innovation. People continually work out better ways of doing things, either as a result of formal training or simply by learning from experience, they act on suggestions from users, they copy better practises from competitors, they see new technologies in action in other sectors and apply them in their own, they work out more effective ways of organising and distributing their work; all these lead to total factor productivity growth and count as innovation in this sense.

There has been a tendency to underplay the importance of formal research and development in recent thinking about innovation, particularly in the UK. This has arisen partly because the manufacturing and ICT sectors, in which R&D has always been more prominent, have declined in importance relative to service sectors. In the period up to the financial crisis, it was noticed that the UK's productivity seemed to be growing very healthily, despite lower R&D spending than in competitor nations, which seemed to suggest that R&D had become less important for innovation than it had been before. The poor performance of the UK economy since the crisis has made the paradox of apparently strong productivity growth with weak R&D less puzzling, though.

R&D remains important, (as I argued in an earlier blogpost *Why R&D Matters*¹⁵) because it provides an organised and systematic way of bringing together teams of talented people with capital intensive equipment, to harness the new opportunities arising from the advance of science in the focused pursuit of new products and processes. R&D was itself an important social innovation, whose development was just as important in driving the second industrial revolution as the underpinning scientific discoveries in chemistry, electricity and electronics had been.

It is true, however, that it has been more difficult to apply these methodologies to the service industries, and this no doubt has contributed to the weaker productivity growth that we see in those sectors. There are high hopes that new ICT technology will change this, but it's difficult to see evidence yet that this is showing up in the productivity statistics. I suspect that we're still waiting for the

¹⁴<https://spiral.imperial.ac.uk:8443/bitstream/10044/1/21167/2/Haskel%202015-02.pdf>

¹⁵ Why R&D Matters, R.A.L. Jones.

<http://www.softmachines.org/wordpress/?p=1517>

social innovations that will allow us to fully benefit from the new technologies in services. For all the hero-worship there is of the brilliant individual inventor, the truth is that difficult and complex things are still only done by people acting collectively. Adam Smith's division of labour is as powerful a principle for innovation as it is for the rest of the economy.

The direct contribution of R&D spending, both public and private, on productivity and economic growth has been estimated in another recent paper from Goodridge, Haskel, Hughes and Wallis¹⁶. The headline results of this econometric study are that the rate of return on public sector R&D is about 20%, and that a 10% increase in public R&D spend would result in an increase of private sector total factor productivity from 1.46% to 1.49% pa. To put this in perspective, public sector R&D spending fell by 5% in real terms between 2003 and 2013. Alternatively, the increase in public sector R&D spending (currently 0.44% of GDP in the UK) that would be required to bring it up to the OECD average (0.67%) would be about 52%.

This estimate of the return on public sector R&D is likely to be an underestimate – the extent to which the private sector economy can benefit from public R&D – its absorptive capacity – depends on the structure of the economy and the amount of private sector R&D being carried out. An economy like Germany's, with a larger manufacturing sector than the UK, gains even greater benefits from public sector R&D. It is known from many studies that one effect of public sector R&D is to “crowd in” further private sector R&D. This has two effects – the private sector R&D directly raises the productivity in the industries concerned, but it has the indirect effect of further raising the absorptive capacity of the economy and leading to further productivity gains.

What should be done?

Possible responses to the UK's productivity problem fall into three categories. There are some things that should be done, but probably won't be, because they are politically difficult. There are some things that should be done, and given that they are much politically easier than the first category there's really no excuse for them not to happen. And there are a few illusions that will appeal to some, but that we shouldn't waste time chasing.

To take the last first, we aren't going to be going back to the period of easy wealth from North Sea oil (of course it wasn't easy for the engineers and workers who delivered it in dangerous conditions, but it was easy politically). This isn't the place to discuss the pros and cons of fracking, but I can't help feeling that the enthusiasm we see in some quarters for fracking is essentially based on nostalgia for the resource boom of North Sea oil. But leaving aside political and environment considerations, the economics of shale gas and tight oil are difficult

¹⁶ The contribution of public and private R&D to UK productivity growth, Goodridge, Haskel, Hughes and Wallis
<https://spiral.imperial.ac.uk:8443/bitstream/10044/1/21171/2/Haskel%202015-03.pdf>

enough in the USA¹⁷ with oil less than \$50 a barrel, so it's difficult to see this happening in the UK on scale to make an impact in the near future.

The biggest thing that should happen, but probably won't, is a fundamental rethink of the way our financial services sector operates. Modern economies need strong and functional financial services sectors, to distribute capital to where it can most productively be used, to re-distribute risk according to different people's appetites and requirements, and to match people's needs to defer some of their consumption - i.e. to create reliable and cost-effective savings and pensions vehicles. The danger, though, is that over-strong finance sectors morph into what Acemoglu and Robinson (in their book *Why Nations Fail*¹⁸) call extractive institutions, extracting rents from more productive parts of the economy by exerting their political power. The evidence isn't overwhelming that the UK's financial services sector has been marvellously effective at fulfilling the former set of useful functions, and parts of it have certainly been slipping in the latter direction.

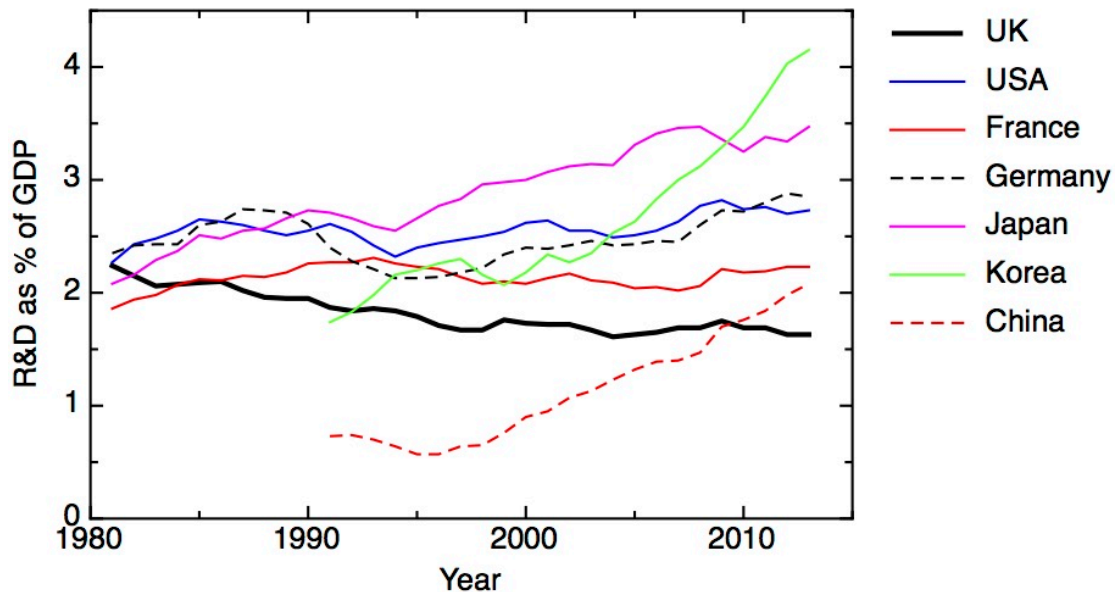
There are some things that should be easy to do, because they're conventional wisdom. More investment in public infrastructure, whether that's fast broadband or trains and other public transport, more investment in skills, more support for innovation.

And this brings us back to R&D. If we are worried about innovation, which we should be, we need to worry about the way UK's very weak record in R&D undermines its innovation performance more generally. My plot shows the R&D intensity of the UK's economy over time compared to other major economies. The UK has seen a long-term decline in R&D intensity over the last few decades, and is now one of the least research intensive of the major economies, as I discussed in my earlier paper "*The UK's innovation deficit and how to repair it*"¹⁹. Policy makers have been aware of this for some time, but the apparently healthy pre-crash economy led to complacency that one could run an innovative economy at the technology frontier without R&D. This complacency is no longer sustainable, now the factors that kept the economy growing - oil and a bubble in the financial services industry - have gone away. Haskel's econometric analysis makes it clear that an increase in R&D intensity towards OECD average would have a material positive effect on productivity growth.

¹⁷ See e.g. <http://www.economist.com/news/business/21656671-americas-shale-energy-industry-has-future-many-shale-firms-do-not-fractured-finances>

¹⁸ *Why Nations Fail*, Acemoglu and Robinson
<http://whynationsfail.com>

¹⁹ *The UK's Innovation Deficit and How to Repair it*, R.A.L. Jones, SPERI paper no 6
<http://speri.dept.shef.ac.uk/2013/10/30/speri-paper-no-6-the-uks-innovation-deficit-repair-it/>



Research intensity of selected countries, expressed as gross expenditure on research and development as a percentage of GDP. Data: OECD main science and technology indicators, August 2015.

The majority of R&D is carried out by the private sector, and in the UK weakness in business R&D has been a major problem. But public sector R&D is also important for private sector productivity, both through providing a stock of new knowledge and skilled people that the private sector can use, and indirectly by encouraging the private sector to do more R&D on their account. Rather than “crowding out” private sector R&D, as some have implausibly argued, there is a multiplier effect by which increases in public sector R&D lead to increases in private sector R&D in innovative, high productivity, high growth companies. The reverse is likely to be true - a reduction in public sector R&D will lead to a disproportionate decrease in the overall R&D intensity of the economy. This is likely to happen rather quickly in the UK, where more than half of the business R&D is carried out by overseas companies, who are willing and able to relocate their R&D activities to more favourable economies very rapidly.

The connection between public sector R&D, the overall research intensity of the economy, and productivity growth is direct. The response through the system to further reductions in public sector R&D will be rapid, which makes it difficult to understand why such a reduction is even under consideration. But reversing the situation isn't to be done without some careful thought about how best to strengthen our overall innovation system, including business R&D both in existing companies and in fast growing start-ups, applied science and technology in support of the strategic goals of the state, and the more long-term discovery science done in universities and research institutes.

I've written in more detail elsewhere²⁰ about how we should rebuild our innovation economy. In short, we need a balance of long-term discovery science

²⁰ Rebuilding the UK's innovation economy, R.A.L.Jones, SPERI comment

with some serious and focused efforts to develop the new technologies we know we need. I think there's a wide consensus about what some of those needs are: to develop low carbon energy at a cost that is competitive, without subsidy, with fossil fuels, to create the healthcare technologies and social innovations that will allow us to care for an ageing population affordably. The alternative course, of continuing on our current path of stagnating productivity and stagnating innovation isn't inevitable. It would be a choice, and it's a choice we shouldn't make.

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