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THE ROYAL SOCIETY

Submission to the 2010 Spending Review

Headline messages

1. Investment in science is vital for economic growth and international competitiveness. Our ability to attract the best talent and R&D investment is highly vulnerable to overseas competition.
2. Short-term budget cuts will put our long-term prosperity at risk. We oppose any budget cuts, but if necessary, they must be reversible, and followed by sustained investment once finances allow.
3. The UK should maintain its breadth of research, and prioritisation should remain in the hands of funding bodies and universities.
4. The balance of the current system (e.g. between Research Councils and quality-related (QR) funding) should be preserved where possible.
5. Below we outline three scenarios: flat cash, a 10% cash cut and a 20% cash cut. Our conclusion is that a flat cash settlement will be painful but manageable; a 10% cash cut will be damaging and will jeopardise the UK's science and innovation system; while a 20% cut will be irreversibly catastrophic for the future of UK science and economic growth.

The Royal Society welcomes the opportunity to contribute to Government decision-making about the allocation of public spending. Professor Adrian Smith FRS, the Director General, Science and Research at the Department for Business, Innovation and Skills has asked us to address a number of specific questions about the overall size of the research budget, the balance between quality-related (QR) and Research Council funding, the impacts and risks of potential budget cuts, and the way in which any cuts should be administered so as to minimise long-term damage to the science and innovation system.

In a period of painful financial adjustment, the UK must build on its strengths, and use these to revitalise and rebalance its economy. The Royal Society set out the case for sustained public support for science and innovation in our recent report *The Scientific Century*.[1] However, we recognise that the current circumstances demand more detailed advice. The curiosity of scientists is limitless, but public funds to support research are not. Choices have to be made about what to fund and how. These choices are complicated by the time cycles involved; research yields dividends over decades, and the time and space required for curiosity-driven research needs to be protected by policy makers.

UK science is a vital economic asset that has been strengthened by recent investment. Deep cuts will permanently damage our science base, threatening economic growth. Whatever short-term measures are necessary, over the medium to longer term the UK must retain its leading scientists and the foreign investment they attract. Any cuts must be administered carefully so that they do not cause lasting damage and can be reversed when the public finances allow.

1 UK science and innovation: a success story

Evidence of the economic contribution of UK science is clear. *The Scientific Century* report was reinforced by contributions from Sir James Dyson, Hermann Hauser, the Council for Science and Technology and the Science and Technology Committees of the House of Commons and House of Lords.[2] While these reports

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[1] The Royal Society (2010). *The Scientific Century: securing our future prosperity*. Royal Society: London.

[2] Dyson J (2010). *Ingenious Britain: making the UK the leading high-tech exporter in Europe*. Conservative Party: London; Hauser H. (2010). *The Current and Future Role of Technology Innovation Centres in the UK.* BIS: London; Council for Science and Technology (CST) (2010). *A Vision for UK Research*. CST: London; House of Commons Science and Technology Committee (2010). *The Impact of Spending Cuts on Science and Scientific Research*, HMSO: London; House of Lords Science and Technology Committee (2010). *Setting Priorities for Publicly-Funded Research*. HMSO: London.

differ in scope, they are unanimous in their conclusion that sustained investment in the science base must be central to the UK's strategy for economic growth and recovery.

Science is one of the UK's success stories. Our science base is the most productive among the world's leading economies and its quality is second only to the United States. Science has been an important factor in productivity growth and has underpinned the UK's economic prosperity over the last two decades.[3] In addition to the value of new knowledge, the ripples of investments in science spread far and wide. Clusters of innovative companies have emerged around UK universities. Graduates in science, technology, engineering and mathematics make vital contributions outside fields conventionally seen as 'scientific'[4] and are on average better paid.[5]

There is a strong multiplier effect from public investment. Businesses conduct two thirds of the UK's R&D, and charities fund more than a billion pounds worth of research in UK universities.[6] Far from crowding out private sector and charitable R&D, public spending underpins and increases it. There is a strong correlation between university and business R&D investments.[7]

The UK attracts a higher share of its R&D from overseas than anyone else in the G8. This investment is vulnerable to overseas competition if the quality of our science falls. Evidence shows that companies, especially foreign companies, choose to site their R&D labs near the best universities.[8]

Even after recent investment, UK public science spending remains relatively low by international standards.[9] As the UK contemplates budgets cuts, it is important to remember that most major economies have responded to the global downturn by boosting their investments in science.[10] At present, the UK competes successfully in the global market for world class scientists and R&D intensive businesses, but global competition for the most talented individuals, the most innovative firms and leadership in high-tech sectors is intensifying. The perception that UK science is in decline will result in a flight of talent and investment and will make the UK a far less attractive location for science and innovation.

Universities, companies and charities need a stable platform on which to make investment decisions. Whatever short-term measures are necessary, we urge BIS and HM Treasury to update the 2004 Ten Year Framework with a fresh 10-15 year strategy for science and innovation. Any changes to the size and balance of the research budget should be determined in this context. The elements of this system are interdependent, meaning that cuts to one part will have effects that cannot necessarily be predicted. Important factors, such as Lord Browne's Independent Review of Higher Education Funding and Student Finance, are still in flux, exacerbating uncertainty. In the context of a new long-term strategy, any cuts could be understood as an emergency measure, to be reversed with sustained growth when money becomes available.

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[3] Haskel J, Wallis G. (2010). *Public support for innovation, intangible investment and productivity growth in the UK market sector*, Discussion paper 2010/01. Available online at: http://eprints.imperial.ac.uk/bitstream/10044/1/5280/1/Haskel%202010-01.pdf.

[4] BIS (2010). *Economic Impacts of the UK Research Council System: An Overview Science and Innovation Analysis.*BIS: London; Royal Society (2009). *Hidden wealth: The contribution of science to service sector innovation*. Royal Society: London.

[5] DTI (2006). *Economics Paper No.16 Science, Engineering and Technology Skills in the UK*. DTI: London.

[6] Evidence provided by the Association of Medical Research Charities. Total research spending of all the charities under the AMRC umbrella was £965,524,608 in 2008/09. Charitable funding is weighted towards the life sciences, so the physical sciences are more dependent on direct public investment.

[7] Falk M (2006). What *drives business research and development intensity across OECD countries?* Applied Economics 38. Routledge: London.

[8] Abramovsky L, Harrison R, Simpson H (2007). *University research and the location of business R&D.* Economic Journal 117. Blackwell: Oxford.

[9] According to OECD figures for government expenditure on R&D as a percentage of GDP, the UK is 25th in the world, just below Canada, Sweden and Belgium.

[10] The Royal Society (2010). *The Scientific Century: securing our future prosperity*. Royal Society: London.

2 The reversibility of short-term cuts

The framework for the 2010 Spending Review, set out in the 22 June Budget, represents an enormous challenge to all areas of public spending. But severe cuts of 10% or more in cash terms, as have been proposed for departments such as BIS, threaten to devastate British science, impair the future growth of the economy and derail the UK's ability to govern effectively and tackle global challenges. Regaining our scientific pre-eminence, with all the economic and social benefits that this brings, would be impossible or cripplingly expensive for future generations. Deep cuts are likely to be compounded by shrinking business and charity R&D investment – a reversal of the multiplier effect described above. More modest cuts will still cause real damage to the UK science base, but are more likely to be reversible. The best comparable example is Canada in the 1990s. Here, science was spared the worst cuts and reinvestment began as soon as finances were rebalanced (see Annex 1).

3 Strategic priorities

The strength of the UK's research base flows, in part, from its breadth. We are ranked number two in the world across most disciplines, including arts, humanities and social sciences.[11] This leadership provides two clear benefits: first, a wellspring of new ideas, innovation and economic growth; second, cutting edge expertise provides vital 'absorptive capacity' – the ability to search for, adopt, exploit and diffuse knowledge from other countries.[12] We do not know what the 21st century counterparts of the internet, genomics or nuclear fission will be. Leadership on many fronts provides the UK with maximum absorptive capacity.

The Government's desire to prioritise is understandable, and there is a persistent view that economic prosperity can be assured by capitalising on a small number of key capabilities or sectors. But evidence suggests that prioritising research areas that are expected to produce the greatest short-term benefit is neither possible nor desirable. Innovation is not predictable or linear and advances often occur serendipitously at the margins or intersections of disciplines.[13] There is no evidence that governments are any better at picking winners now than in the past. Far from guaranteeing rapid economic growth, stringent prioritisation may result in the UK missing out on nascent economic opportunities. There is a risk of paring down expertise in fields that will shape the UK's response to long-term issues such as environmental sustainability, resource scarcity and other, as yet unforeseen challenges.

The Prime Minister's Council for Science and Technology makes a clear distinction between downstream prioritisation and stimulating upstream research.[14] We agree with their assertion that, at the university end, the most effective way to ensure scientific strength and economic benefits is to support scientific excellence wherever it is found.

There is a substantial overlap between science and innovation policy, and industrial policy. The boundaries are now blurred further by the fact that they are housed in the same department. But it is vital that they are not mistaken for one another. The science budget must not be stretched to accommodate objectives or policies which should be dealt with by industrial policy elsewhere in BIS.

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[11] BIS (2009). *International Comparative performance of the UK research base.* BIS: London.
[12] Griffith R, Redding S, Van Reenen J (2003). *R&D and Absorptive Capacity: Theory and Empirical Evidence.* Scandinavian Journal of Economics 105. Blackwell: Oxford.
[13] The Role of Community Research Policy in the Knowledge-Based Economy: Report of an Expert Group to the European Commission (November 1st, 2009), Luc Soete (Chair)
[14] Council for Science and Technology (CST) (2010). *A Vision for UK Research*. CST: London.

4 A balanced science and innovation system

The balance between quality-related (QR) and Research Council funding has been relatively stable over the last two decades, with a slight trend towards the Research Councils, due in part to the introduction of Full Economic Costing and increases to MRC budgets following the Cooksey Review.

We believe that the present balance of QR and Research Council funding is optimal. Universities have adjusted well to this system, and disproportionate cuts to one pillar of the dual support system risk unbalancing the research base, affecting institutions and research fields in unpredictable ways. At a time of financial constraints, universities need the flexibility that QR funding provides.

The balance of funding among the seven Research Councils has also changed little over the last 15 years as budgets have grown, notwithstanding recent issues with the Science and Technology Facilities Council. This balance reflects the UK's strategic choices and its scientific strengths, and we see no reason to tinker with a system that is largely working well.

In recent years, the Research Councils have boosted investment in programmes that span disciplinary boundaries, connecting with government departments in 'challenge' areas of strategic importance – food security, ageing, the low carbon economy, etc. – without picking disciplinary or sector winners. We support the balance of investment in these activities. There is also evidence that business and charity partners like such programmes, as they bring a critical mass of research under a common umbrella.[15]

The last decade has also seen substantial investment in institutions and initiatives such as the Technology Strategy Board and the Higher Education Innovation Fund that act as a transmission mechanism between science and the wider economy. Although still relatively new, such initiatives are now an important component of the science and innovation system, helping to realise the economic potential of public investments in science.

5 Three scenarios

Below we present three scenarios for the coming spending round: flat cash, a 10% cut in cash terms and a 20% cut in cash terms. Inflation is likely to compound these cuts by around 10% over the four years of the coming spending period (2011-2015). In each of these scenarios, one key issue is the location of decision-making. There is a strong case for ensuring that detailed spending decisions are made by individual Research Councils, Funding Councils and HEIs.

The Royal Society has argued consistently against any cuts to the UK's research budget. If cuts are required, our analysis suggests that reductions of 10% or more in cash terms will be disproportionately and permanently damaging to the science base and to the UK's long-term economic prosperity. In addition to the direct impact of cuts, there are larger indirect effects on the wider economy that will take time to emerge. Business and charity R&D investment would evaporate, compounding the impact of diminishing public investment.

A flat cash settlement would be painful but manageable, and could only be delivered through substantial efficiency savings, and some rebalancing of investment priorities.

A 10% cash cut would present an acute challenge, and would fundamentally damage the quality, productivity and capability of the UK's research base, and its reputation overseas.

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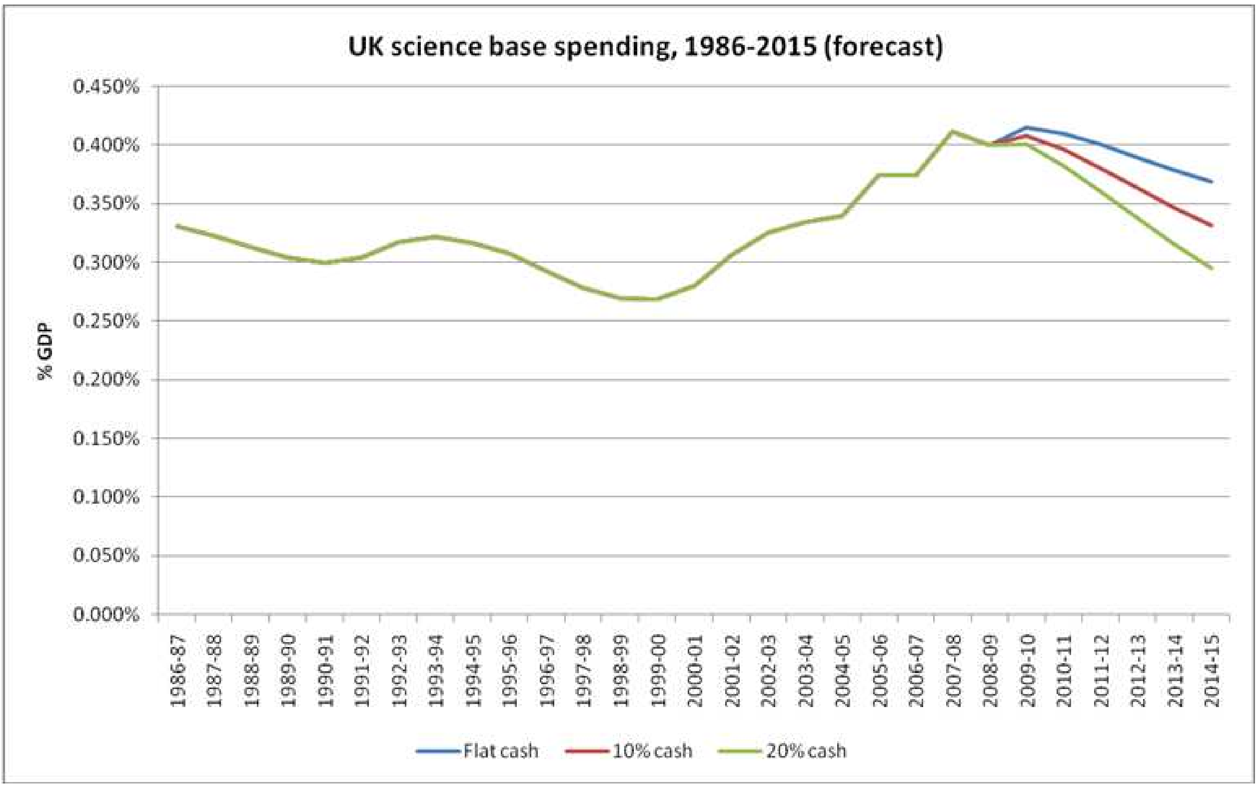
[15] See Pfizer's submission to *The Scientific Century.*

A 20% cash cut would have catastrophic and irreversible effects, compounded by the acceleration of investment in the USA, Germany, France, China and elsewhere.

Figure 1 – UK science base expenditure as a %of GDP under three scenarios[16]



5.1 Scenario one: *Weathering the storm*

This scenario is one of flat cash, freezing budgets for HEFCE, the Research Councils and key institutions such as the TSB. This would represent a real-terms cut, but efficiency savings and some rebalancing could, with considerable effort, maintain the science base at near today's levels of productivity and continue to build the UK's innovation capability.

UK science is the most efficient in the world and there is little excess capacity, so savings would not be easy to find. But efficiency gains are possible. The recent Wakeham review concluded that it should be possible for HEIs to reduce the indirect costs of research by 5% per annum through improved management and sharing of facilities.[17] There would need to be a scaling up of the shared services programme across the Research Councils (and possibly Technology Strategy Board). Some institutes may need to be merged, though this would not be without costs. There could also be a concentration of PhD training in fewer departments.

In these circumstances, the balance of investment in people, projects, institutes and infrastructure could remain the same. Similarly, the balance between QR and Research Council funding could be maintained, providing stability for UK universities. Capacity could be maintained across the spectrum of research.

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[16] Historic science base expenditure from BIS SET Statistics, release November 2009. Office for Budget Responsibility June 2010 forecasts for future UK GDP growth.

[17] Research Councils UK, Universities UK. Financial Sustainability and Efficiency in Full Economic Costing of Research in UK Higher Education Institutions. Available online at http://www.rcuk.ac.uk/cmsweb/downloads/rcuk/reviews/fec/fECReviewReport.pdf.

Investment would support a new generation of young scientists able to seize the opportunities of growth sectors and a growing international science base.

There would be external economic impacts of real term cuts. In the absence of a long-term strategy for investment, private and charitable R&D investment will be put at risk, although efficiency savings would be an incentive for university-industry collaboration, reducing the costs of industry-sponsored research. With a clear long-term strategy reaching beyond the spending review period, the prospects for maintenance of the UK's scientific leadership and reinvigorated economic growth are strong.

5.2 Scenario two: *Slash and burn*

A 10% cash cut would seriously jeopardise the productivity and stability of the UK's science and innovation system. It would mean the UK falling well below the European average in any simple comparison of the proportion of national wealth invested in research. The balance and focus of the research base would have to change. Choices would be forced to a large extent by existing commitments. Where institutions have fixed investments in infrastructure, savings would need to be found elsewhere.

There would be damage to the international reputation of UK science. With cuts of this scale, there is a risk that our brightest young people would be deterred from scientific careers by the perception that prospects in the UK are declining. And inevitably, some excellent scientists would be lured from the UK to pursue opportunities elsewhere.

Individual Research Councils would seek to prioritise and renegotiate ongoing commitments, subscriptions and infrastructure investment. Where this is not possible, they would need to cut usage while still paying high fixed costs, dramatically reducing the efficiency of their investments.

It is also likely that Research Councils would seek to reduce expenditure from research programmes by cutting grants and PhD studentships associated with new projects. Any cuts to funding for PhD studentships would be coupled with greater concentration of remaining PhDs in centres of excellence. This would amount to a restructuring of the HE landscape, with institutions working in a regional 'hub and spoke' model, heightening concerns about the disappearance of key research capabilities from parts of the UK.

Reductions of 10% would affect disciplines, research groups and facilities that currently have a critical mass of expertise and activity. Success rates for grant applications would fall, with negative consequences for the volume of activity and staff morale at research-intensive universities. These problems would be exacerbated by a possible loss of senior scientists to the US and elsewhere. Cuts at this level would also fragment the research base, and undermine the added value of large-scale multidisciplinary work, through cross-Council programmes or the Technology Strategy Board's Innovation Platforms.

Reductions to the science budget which is directly under BIS's control would have a knock-on impact on the R&D capabilities of other departments, which are likely to be under significant budgetary pressure. Policy-making across government is increasingly reliant on knowledge and expertise supported by the science budget, and now coordinated far more strategically by Government Office for Science and the network of departmental Chief Scientific Advisers.

The £64m business research element and £198m charity support element of QR would be vulnerable to cuts, as would support for public engagement with science. The loss of these funds would have a detrimental impact on the levels of funding HEIs generate from business and charities.

There is a real danger that business plans would be shaped by long-term, non-negotiable obligations rather than strategic choices. Looking ahead to 2015, the balance of the science base would be very different from the one we know now. We would be left with a fragmented UK science base that trains fewer PhDs, is less connected with business and less engaged with the public.

5.3 Scenario three: *Game over*

Our final scenario illustrates a 20% reduction in cash terms. By 2015, the percentage of GDP invested by BIS in R&D would be less than 0.3% (see figure 1), making us one of the lowest R&D spenders in Europe.

While a 10% cut to investment might leave open the possibility of a slow and painful recovery, a 20% cut would cause key parts of the research system to unravel, permanently damaging UK capabilities in key areas. Perceptions of long-term decline would become self-fulfilling. Spiralling inefficiencies would result, exacerbated by a loss of international confidence in the UK research base.

Existing commitments among the Research Councils are likely to mean that PhD funding and research projects would bear the brunt of cuts on this scale. HEFCE would be unlikely to be able to maintain its support for PhD training, and Research Councils would be forced to slash the number of PhD studentships, destroying an entire generation of home-grown scientists. International PhD students would also be less willing to come to the UK, meaning that the supply of low-cost research staff would collapse.

At this level, cuts would dramatically reduce the efficiency of current infrastructure. As thousands of research staff are made redundant by leading universities, the proportion of budgets paid in overheads would increase to the point at which many facilities would no longer be competitive, resulting in further losses of external income from companies, charities and overseas investment.

The UK's position in international league tables of science would fall. Mobile talent would look elsewhere for jobs and the UK's star researchers would leave. Overseas undergraduates and Masters' students would also be less likely to come to the UK, resulting in a collapse in revenue from overseas fees (currently worth around £1.5 billion to UK HEIs).[18]

For the Research Councils, a 20% cut would force a retreat from shared cross-Council priorities, and a narrow focus on 'core business'. The research base would rapidly atomise to the point at which strategic approaches to societal, industrial or policy challenges became almost impossible.

Funding councils would be faced with a choice between damaging the research base across all institutions and departments, or further concentrating funding in centres of excellence. The former would damage the research productivity of our leading scientists. The latter would dramatically reshape the landscape for UK research. Removing funding from the bottom 20% of departments, as rated by RAE 2008, would completely remove QR funding for more than 100 HEIs. The HEIs most affected would mostly be outside the South-East, in more economically vulnerable regions.

The longer-term impact resulting from deep cuts to research and infrastructure is likely to be irreversible. Rebuilding the UK's science base will be prohibitively expensive, and continued investments by other leading scientific nations would make it impossible to recover our scientific and economic leadership and to attract the best researchers back to the UK.

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[18] Vickers P, Bekhradnia B (2007). *The Economic Costs and Benefits of International Students.* Higher Education Policy Institute. Available online at http://www.hepi.ac.uk/files/32Economiceffectsofinternationalstudents.pdf.

6 Conclusion

In a period of painful financial uncertainty, the UK must build on its strengths, and use these to revitalise and rebalance its economy. Science is a source of enormous competitive advantage for the UK. If the right policy choices are made now, the UK can remain at the vanguard of international science and secure its prosperity over the coming decades.

The Royal Society continues to urge the UK government to match other major economies as they accelerate their investments in science and innovation. If there are to be any cuts, they must be administered in a way that minimises lasting damage. Whatever short-term measures are necessary, we urge BIS and HM Treasury to update the 2004 Ten Year Framework with a fresh 10-15 year strategy for investment in science and innovation.

We hope our advice is a useful contribution to Government decision making. We would welcome further consultation as the Spending Review moves to the next stage.

7 Further information

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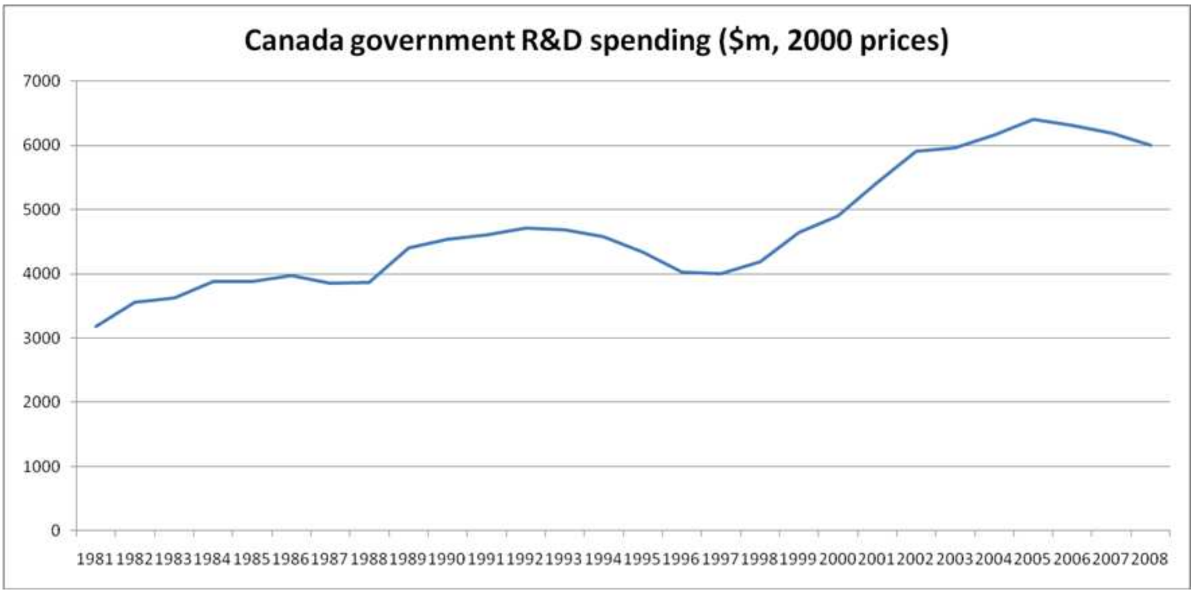
Annex 1: The Canadian experience

> *"What we must still achieve at the end of the day is a government that is fully capable of assisting the disadvantaged; a government that is unequivocally committed to our publicly funded national system of health care; a government that is more adept at providing those things the private marketplace cannot: things such as strategic support for aspects of science and technology."*
> Paul Martin, Canada's finance minister, 1993 to 2002.[19]

Examples of successful reductions in public investment are scarce. Many UK policymakers have been looking to Canada, where cuts in the mid-1990s have been cited as an example, albeit in very different economic and political circumstances. Through careful consideration of the public interest, the role of government, the opportunities for partnership and alternative sources of funding, the Canadian government was able to reshape its public spending.[20]

Yet the Canadian government also recognised that publicly-funded science was a vital seedcorn for future growth. Science investments were squeezed less than other areas of public spending and were reinvested in more quickly than other areas once finances improved (see Figure 2 below). This minimised damage to the science base and ensured minimal disruption to the flow of social and economic benefits from science and technology. The Government soon reversed the cuts of 1994/5, establishing the Canadian Foundation for Innovation in 1997 and 2,000 new Research Chairs in 1999.[21]

Figure 2



[19] Martin, P (1995). T*he Canadian experience in reducing budget deficits and debt*. Speech to the Federal Reserve Bank of Kansas City's 1995 Symposium.
[20] Bourgon J (2009).*The Government of Canada's experience eliminating the deficit, 1994-99: a Canadian case study*. Program Review, Institute for Government. Available online at http://www.instituteforgovernment.org.uk/pdfs/Canada's_deficit.pdf.
[21] See, for illustration - McIlroy A (2003). *Chrétien Brothers link worlds of science and politics.* The Globe & Mail:Toronto, Canada.