Institution: Imperial College London
Unit of Assessment: 19 Business and management studies
Title of case study: Defending government investment in science research in order to foster economic growth

1. Summary of the impact (indicative maximum 100 words)

Prior to the 2010 Spending Review, UK universities (and others) feared the Government might renege on its promise to protect the Science Budget from austerity.

Research led by Professor Haskel established that investment in intangible knowledge has greater productivity-enhancing effects than previously thought, and that the largest benefits to general R&D and economic growth arise from research sponsored by Research Councils.

Aware of this research - explicitly cited as evidence during Spending Round negotiations [A] - Minister David Willetts averted a cut in the Science budget. Beneficiaries were not merely the academic community and science-oriented firms, but UK households who benefit from additional growth (relative to the counterfactual).

More generally, this research was used by the UK Office for National Statistics to include knowledge capital into the major revision to UK GDP data (first release in 2014) [B]. More accurate measures of productivity growth will inform business decisions and public policy.

2. Underpinning research (indicative maximum 500 words)

In 2006, Haskel was awarded an HM Treasury grant [7] to extend UK National Accounts to include company investment in intangible knowledge assets (R&D, design, artistic originals, R&D, worker training). Subsequent work, funded by the Department for Business, Innovation and Skills [8], the EU (FP7) [9] and NESTA [10-11], extended this approach to cover UK industries and other European countries. This phase of the research documented the link between business sector investment in intangible/knowledge assets and economic growth. This process occurs even in sectors doing little (traditionally measured) R&D, (e.g. retail, wholesale, financial services).

The research entailed substantial data gathering from multiple sources. Analysis was by time series and panel econometrics, augmenting traditional growth regressions to encompass knowledge capital and the possibility of knowledge spillovers. Having identified the role of knowledge capital, it was then possible to derive new national income accounts, making provision for both investment in knowledge capital and for its depreciation.

These new measures for the UK were published for the UK in Marrano, Haskel, Wallis, (2009) [1], Dal Borgo et al, (2013) [2] and Goodridge and Haskel (2012) [3], Goodridge et al (2013) [4] and for Europe in Corrado et al, (2013) [5].

This initial phase gave a better account of private sector productivity growth (technically the growth in total factor productivity, TFP) but did not analyse external forces upon it. To do so, Haskel and Wallis used new data from BIS on R&D spending by the public sector, examining the relationship between investment in *public* sector R&D, via the Science Budget, and *private* sector TFP growth, as would occur if there are knowledge spillovers from the public to the private sector.

The BIS data provided detailed information on the constituent parts of Science Budget spending on (a) research councils (*including* ERSC & AHRC) (b) HEFCE research-based spending (c) civil R&D spend and (d) military R&D spend since 1984. Controlling for other factors (such as the internet, foreign R&D etc.), the study showed that investment in public R&D is strongly correlated with private TFP. This is consistent with other studies on Europe, but updates them and uses the wider definitions of output and TFP that embrace growth of knowledge capital.

This work, subsequently published as Haskel and Wallis (2013) [6], was first posted on the internet in 2010 (Imperial College Discussion Paper) and cited by the Science Minister in a speech at the Royal Institution on 9 July 2010 [A]. The revised 2013 version also looked at updated correlations based on two new releases of the Science Budget data by BIS and revisions by ONS to the National Accounts: the original results are robust to these changes.

This research has taken place during 2006-2013 and is ongoing. Most of it, including the critical work on how public investment in science boosts private productivity, took place after Haskel joined Imperial College in 2008, as the timing of the below outputs attest.

3. References to the research (indicative maximum of six references)

Key Outputs

[1] Giorgio Marrano, M., Haskel, J., and Wallis, G., (2009), "What Happened to the Knowledge Economy? ICT, Intangible Investment and Britain's Productivity Record Revisited", *Review of Income and Wealth*, vol. 55(3), pp. 686-716;

[2] Dal Borgo, M., Goodridge, P., Haskel, J. and Pesole, A., (2013), "Productivity and Growth in UK Industries: An Intangible Approach", *Oxford Bulletin of Economics and Statistics* (online version, August 2012);

[3] Goodridge, P. and Haskel, J, (2012), "Film, Television and Radio, Books, Music and Art: UK Investment in Artistic Originals", *Intellectual Property Office Research Paper 2011/3*, July;

[4] Goodridge, P., Haskel, J., and Wallis, G., (2013), "Can intangible investment explain the UK productivity puzzle?", *National Institute Economic Review*, no. 224, May, pp. R48-58;

[5] Corrado, C. Haskel, J., Jona-Lasinio, C. and Iommi., M., (2013), "Innovation and Intangible Investment in Europe, Japan and the US", *Oxford Review of Economic Policy*, vol. 29(2), pp. 261-286 (previously published as Imperial College Business School discussion paper, May 2013);

[6] Haskel, J. and Wallis, G, (2013), "Public Support for Innovation, Intangible Investment and Productivity Growth in the UK Market Sector", *Economics Letters*, Volume 119, Issue 2, May 2013, pp 195–198 (previously published as Imperial College Business School discussion paper 2010/01, February 2010).

Grants and Related Funding

The original data were supported by the following grants (awarded when Haskel was at QMUL):

[7] HMT, £42,868 to work on UK intangible assets and growth in the UK economy, June 2006 - June 2007;

[8] DTI (now BIS), £9,882 for work on UK intangible assets, June - September 2007.

The work in Haskel and Wallis was supported by:

[9] EU FP7 "Competitiveness, Innovation and Intangible Investment in Europe (COINVEST)", grant ref. 217512, £693k, October 2008-September 2010;

[10] NESTA, to develop the UK Innovation Index, £500K, April 2009-September 2010;

[11] NESTA, further work on UK Innovation Index, £200K, April 2011-March 2012;

[12] ESRC UK Innovation Research Centre (UK-IRC), ESRC, RES-598-28-0001, total value £2.3M, of which £1.02M for Imperial

In total these grants amounted to £700k directly to Haskel as PI on the two NESTA grants, plus his role as Principal Investigator in the €1.465K grant from FP7 and co-investigator in UK-IRC.

Published in a series of journals of international standing (Economics Letters, Review of Income and Wealth, Oxford Review of Economic Policy, Oxford Bulletin of Economics and Statistics, National Institute Economic Review);

Multiple grants from a range of sources, as above.

HM Treasury, Office of National Statistics, government ministers – all with access to highly proficient economic advice – all convinced by the research, have amended their data definitions and funding policies accordingly.

4. Details of the impact (indicative maximum 750 words)

The research made two main contributions. A methodology and new GDP statistics, now adopted by the Office for National Statistics, providing a sounder basis for future analysis and policy; and, based on these, analysis of the specific link between public science investment and private productivity (critical to defending the Science Budget from spending cuts in 2010).

ONS have revised their treatment of investment in two particular intangibles, artistic originals and R&D in 2013 and 2014. Both revisions incorporate Haskel's work [e.g. 5]. Spending on artistic originals will be revised upwards by around £1bn; larger changes will be made to R&D [B].

The more dramatic impact was on 'saving' the Science Budget. In a speech to the Royal Institution on 9 July 2010, the Minister of State for Universities and Science said [A]:

> "Government backing for research does make economic sense. I was particularly interested to read the recent Imperial College Discussion Paper by Jonathan Haskel and Gavin Wallis, 'Public support for Innovation, Intangible investment and Productivity Growth in the UK Market Sector'. It shows particularly strong spillover benefits from R&D spend on research councils. It shows a positive return from other forms of R&D too, but the spillover benefits seem to be greatest from the research councils. This is interesting evidence that research council spend is doing the job it should be doing – generating wider benefits across the economy as a whole."

On 22 July, asked about Spending Review negotiations by the Commons Science and Technology Committee, the Minister replied [C]:

> "I referred in the Royal Institution lecture to the piece of work by Professor Haskel and Dr Wallace [*sic*] particularly on measuring the economic impact of the work of the research councils, which is an excellent piece of work. We are drawing on that sort of evidence as we have these negotiations."

On 20 October 2010, the Spending Review cut BIS spending by 25% in real terms over 5 years (Webb & Meelow-Facer, 2010) [D]. The Science Budget however was held constant (in nominal terms), a considerable reprieve. As the *Financial Times* reported on the same day [E], 'Science escaped the big cuts that some researchers had feared from the government's spending review unveiled on Wednesday.' The Minister of State was quoted in the article stating that the 'scientific community has been able to produce empirical evidence about the economic returns from research. The Treasury buys the argument that scientific research contributes to long-term growth.'

Similarly, *The Times* [F] and *New Scientist* [G] cited the work by Haskel and Wallis as contributing to the favourable treatment of the Science Budget (see links below) and *The Times* quoted the impact figures in Haskel and Wallis in its leader, 18th October 2010 [H]. The "Geek Manifesto: Why Science Matters, page 105", quoted the report as being "particularly influential" [I]. See below for references to these sources.

The reach of the impact of this research is evidenced by the wide range of quotes indicating its influence, from Ministers to journalists. As for significance, a flat five year nominal spend of £3.5bn is about a 10% real reduction (if science inflation is 2%, note the latest BLS data estimate science inflation at 1.2%). If the counter-factual is the average BIS cut of 25% real, this is a relative improvement of £525m (=£3.5bn*(25%-105)). If the public R&D rate of return is 30% (Griliches, 1973) [J], this is a spillover significance of £157.5m, of benefit to the entire UK economy not merely the knowledge producing industries.

5. Sources to corroborate the impact (indicative maximum of 10 references)

[A] Minister of State for Universities and Science, Speech at the Royal Institution, 9 July 2010: www.bis.gov.uk/news/speeches/david-willetts-science-innovation-and-the-economy (archived link available here)

[B] Office of National Statistics press release 'The measurement of artistic originals in the UK', 21 June 2013 (PDF available here);

[C] House of Commons Science and Technology Committee, 22 July 2010: www.publications.parliament.uk/pa/cm201011/cmselect/cmsctech/uc369i/uc36901.htm (archived link available here)

[D] Dominic Webb and Adam Mellows-Facer, "The outcome of the 2010 Spending Review", UK House of Commons Library, SN/EP/5718, 22 October 2010, Economic Policy and Statistics Section (archived link available here);

[E] Clive Cookson and Sarah Mishkin, 'UK science spending flat at £4.6bn a year', Financial Times, 20 October 2010 (archived link available here);

[F] Mark Henderson and Roland Watson, 'Osborne gives science flat-cash reprieve for four years', *The Times*, 20 October 2010 (archived link available here);

[G] Roger Highfield, 'UK Science Minister: Research Must be Saved from Cuts', *New Scientist* Blog, 9 July 2010 (archived link available here);

[H] *The Times*, Leader Comment, 'A special plea: All departmental budgets will fall but cuts to the science budget should be limited', 18 October 2010 (archived link available here);

[I] Mark Henderson, 2012, *The Geek Manifesto: Why Science Matters*, Bantam Press, p. 105;

[J] Zvi Griliches, 'Research expenditures and growth accounting', In *Science and technology in economic growth*, ed. Bruce R. Williams, 59–83. New York: Wiley (article not available online).