Chapter 7

Research and innovation policy

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Chapter overview

In this Chapter we examine the ways in which research policy shapes the emergence of biotechnologies, focusing mainly on the UK and on the 21st Century. We conclude that the UK has no policy for emerging biotechnology generally as distinct from its policy for technology, and that policy for particular emerging biotechnologies (such as regenerative medicine) stands in for other life sciences. We find that technology policy, including in the life sciences, has become increasingly framed by the single dimension of economic growth, even to the apparent cost of improving health and well-being (at least in terms of attention given to these in relevant documents), and that even policy for biomedical technologies is framed in this way, except the policy of charitable funders who continue to have a substantial role.

We identify and discuss a number of assumptions that arguably underlie UK research policy and find that they are not well founded or well argued. For example, the commonplace notion that the UK is good at research but poor at commercialisation is not borne out by the evidence; the argument that conditions are in place for funding of biotechnology research to feed through into national prosperity is not well made; that the importance of biotechnology to the public good and its likely impact may be hugely overstated; the supposed ‘Haldane principle’ that the direction of basic research should be directed by researchers rather than politicians or industry is more honoured in the breach than the observance, directed as it is to securing ‘commercialisable’ innovations.

We conclude, as we did in Chapter 5, that the discourse on research policy has become detached from the realities of research and social values, and that that there is a need to reframe public research policy in a coordinated and less piecemeal way through an engagement with a broader range of societal interests.

Introduction

7.1 This Chapter is concerned with research policy, in particular, with the principles and assumptions behind public policies for research, as well as the policies of relevant charitable bodies. The policies of commercial businesses involved in biotechnology research will be dealt with separately, in Chapter 9. In the very crudest characterisation, public policy has two main levers with which to control research: *facilitation* using money obtained from general taxation and *inhibition* through legislation and regulation. We will address the question of regulation separately in the next Chapter; here we are mainly concerned with how funding is channelled to different institutions and projects of research, and withheld from others. Institutional biotechnology research is a significant public expenditure and this fact alone, as we noted in Chapter 4, brings it within the scope of the public interest.[468] Although our focus here will be principally on the UK, many of the issues explored are common to other countries, and policy is treated within an international context. Indeed, it is of ethical significance that the major impacts of research policy may well occur beyond the bounds of the jurisdiction to which the policy applies.

Policies for biotechnology

7.2 Although biotechnology has long been a central theme in UK research policy, ‘emerging biotechnology’ is not a term commonly used in official literature, either as an organising principle in policy, or as a budget category. Nevertheless, a great many more general policies and processes are relevant to research in emerging biotechnologies and we discuss these along with more strategic measures aimed at specific examples of emerging biotechnologies. In particular, in recent UK policy documents, emphasis has been placed on two areas that would currently qualify for this description: synthetic biology and regenerative medicine.

7.3 Our particular focus here is on how policy engages, or could engage, with the social and ethical concerns in which we are interested. We find very limited discussion of these issues, excepting the particular case of research ethics,[469] by both Government and charities, even when

[468] See paragraph 4.9.
[469] That is, ethics relating to the *conduct* of research rather than nature and selection of research.

research policy is directed to achieving impact on medical practice, for example. There is, however, a great deal of discussion of economic matters, which we will take up in a way that might seem surprising in a Report of this nature. However, this is important for two reasons. Firstly, because of the significance attached to economic considerations, social and ethical aspects are rendered much less visible. In the UK at least, despite occasional references to 'health', 'quality of life' and 'sustainability', discussion of innovation and technology in Government publications is framed very largely in terms of 'competitiveness' and 'economic growth'. (Medical charities are, for obvious reasons, concerned with health rather than economic competitiveness.) This is mirrored in the prominent role given to industry personnel in official bodies but it is important to note that all research policies are framed in this way, not merely those concerned with industry. Secondly, this focus on economic growth and competitiveness is itself a matter of choice and the dominance of this framing could – and, indeed, *should* – be challenged through public discourse ethics. Indeed, many of the economic arguments are arguably not as well-grounded as they appear to be and, even if they were, we would argue that they should not necessarily trump other considerations.

Investment in emerging biotechnologies

7.4 Biotechnology has been a concern of UK research policy for decades. The Spinks Report of 1980 led to the Medical Research Council (MRC) and the Science and Engineering Research Council establishing substantial biotechnology research programmes, and the (then) Department of Trade and Industry establishing a biotechnology directorate in November 1981.[470] By 1985, 40 small biotechnology firms had been established in the UK, possibly more than in all other countries of Europe put together.[471] The Biotechnology and Biological Sciences Research Council (BBSRC) was established in 1994. The Cambridge Laboratory of Molecular Biology (LMB) was at the centre of the effort to foster innovation, and some spin-outs from this enjoyed notable success; for example, Cambridge Antibody Technology and Domantis were later acquired by large pharmaceutical firms.[472] As a result MRC and LMB scientists received substantial royalty income, outstripping the value of the MRC grant that supported the initial work.[473]

7.5 Despite this interest in biotechnology research and development (R&D), 'biotechnology' is not a category used for reporting research expenditures for the public or private sectors. We can, however, reach some broad conclusions that are significant for policy. The first is that terminology can mislead: for example, 'biotech' firms are not the main funders of biotechnology R&D.[474] In fact, pharmaceutical firms outspend biotech firms even on biotechnology R&D.[475] It should also be noted that much biotechnology is outside medicine and it is likely that here, too, established large firms spend more than biotech firms. Furthermore, the private sector outspends the public sector on R&D. Although this cannot be established directly for biotechnology, it is likely to be the case for *medical* biotechnology given that the total UK public sector spend on health related R&D was reported to be approximately £1.5 billion in 2008/2009,

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470 See: Advisory Council for Applied Research and Development, Royal Society and Advisory Board for the Research Councils (1980) *Biotechnology: report of a Joint Working Party* (London: HMSO).

471 Although also approximately one-tenth of that in the US. See: Yoxen EJ (1985) Government promotion of biotechnology *Physics in Technology* **16**: 234-41.

472 Cambridge Antibody Technology was acquired by AstraZeneca and Domantis by GlaxoSmithKline, both in 2006. See: Attwood K (2006) GSK snaps up Domantis to move into biotech field *The Independent* 9 December, available at: http://www.independent.co.uk/news/business/news/gsk-snaps-up-domantis-to-move-into-biotech-field-427735.html; BBC News Online (2006) *AstraZeneca to buy CAT for £702m*, available at: http://news.bbc.co.uk/1/hi/business/4771615.stm. We return to the economics of biotechnology acquisitions in Chapter 9. See paragraph 9.8 to 9.12.

473 "By 2005, the annual revenues from LMB inventions – £20 million, with the lion's share stemming from the Winter patents – exceeded the total MRC block grant to the LMB…In 2008 the annual income had risen to £70 million." de Chadarevian S (2011) The making of an entrepreneurial science: biotechnology in Britain, 1975-1995 *Isis* **102**: 601-33.

474 An editorial in *Nature Biotechnology* notes: "…much, if not most, of the biological products and biological techniques now resides outside of the group of independent public companies that we survey. Pharma spends $65 billion a year on R&D, 25-40% of it either devoted to biological products or using the techniques of biotech." Nature Biotechnology editorial (2010) Wrong numbers *Nature Biotechnology* **28**: 761.

475 Hopkins M (2012) *Emerging biotechnologies: can we find out who funds R&D and what they support?*, available at: www.nuffieldbiothics.org/emerging-biotechnologies-evidence-reviews, p6.

while biomedical charities were reported to have spent £1.1billion, and private industry claims to have invested £8.9 billion.[476] We may therefore conclude, albeit cautiously, that the main centres of decision-making where support for biotechnology is decided are:

- a handful of large pharmaceutical and industrial firms;
- Government bodies concerned with research (principally research councils);
- medical charities; and
- a large number of dedicated biotechnology firms.

While public policy needs to take account of the research policy of private sector organisations, we do not address the latter directly here, but instead address the role of such organisations separately in Chapter 9.

Strategic orientation of R&D policy

Evolution of strategic and interdisciplinary advice

7.6 The UK's advisory framework for biotechnologies underwent a structural reorganisation following a comprehensive review in May 1999, at a time when the major focus of biotechnology policy was genetics, as it was then understood.[477] The review concluded that the arrangements for regulating individual products and processes operated satisfactorily but that there was insufficient strategic clarity as a result of fragmented advisory committees that lacked transparency and responsiveness to social and ethical issues that were of concern to the public.

7.7 The subsequent reorganisation saw a number of *ad hoc* committees consolidated under a smaller number of broad cross-departmental strategic functions. These functions were provided by, for genetically modified foods, the Food Standards Agency (FSA, established by the Food Standards Act 1999) and two new bodies: the Human Genetics Commission (HGC) and the Agriculture and Environment Biotechnology Commission (AEBC). These bodies were established to operate at a high level and appointments to their boards had the significance of major public appointments (even though they were, initially, within the gift of Ministers). The membership of these bodies was deliberately diverse[478] and they were given the specific role, as well as resources, to deliberate broadly and openly, to interact with the public, and to provide independent advice to Ministers across Government – even when such advice was not sought – on the 'big picture'. However, eventually the vision became somewhat more domesticated and problem-focused: the HGC concentrated on elaborating implications of genetic testing identified in its first Report, *Inside information*, and exploring approaches to public involvement in policy making at an increasing arm's length from Government; the FSA continued to operate principally an executive agency that internalised certain advisory functions, and the AEBC was wound up in 2005.

7.8 In 2010, a review of arm's length bodies was undertaken,[479] ostensibly brought about by the financial crisis and the need for greater efficiency in Government agencies. Following this

[476] Ibid, p16, citing Morgan Jones M and Grant J (2011) *Complex trauma research in the UK: a rapid review of the funding landscape*, available at: http://www.rand.org/content/dam/rand/pubs/documented_briefings/2011/RAND_DB613.pdf.

[477] Cabinet Office (1999) *The advisory and regulatory framework for biotechnology: report from the Government's review*, available at: http://webarchive.nationalarchives.gov.uk/+/http:/www.berr.gov.uk/files/file14498.pdf.

[478] Though all expert in some way, the disciplinary diversity of membership is consistent with the findings of a 1999 MORI public survey commissioned to support the review. When asked who they felt should be involved in making decisions on their behalf in the regulation of the biological sciences, respondents placed advisory bodies comprising experts and people with different viewpoints higher than central Government itself. See generally: MORI (1999) *The public consultation on developments in the biosciences: A MORI report investigating public attitudes to the biological sciences and their oversight*, available at: http://webarchive.nationalarchives.gov.uk/+/http://www.bis.gov.uk/files/file14580.pdf.

[479] In the Coalition agreement, the commitment that "We will reduce the number and cost of quangos" comes, as a distinct plank of policy, under the heading 'Deficit reduction'. HM Government (2010) *The Coalition: our programme for government*,

review, in 2012 the HGC was closed down, mirroring the fate of the AEBC. The future of the FSA was also put into question. The 'successor' to the HGC is the Emerging Science and Bioethics Advisory Committee, which follows the model of a scientific advisory committee rather than a strategic advisory body in that it is sponsored by the Chief Scientific Adviser for the Department of Health in England, and its terms of reference are, unsurprisingly, restricted to health.[480] Nevertheless, it is the "main UK advisory body on the wider implications of developments in bioscience and its impact for health"[481] and provides a forum to consider and develop coordinated advice across the wider science, health and academic communities to help set priorities in response to new developments.

7.9 In light of the decline of overarching strategic advisory bodies, two contractions are discernible. Firstly, a reduction in the importance of interdisciplinary deliberation on issues within biotechnology policy producing interdisciplinary framings of the issues; secondly, a withdrawal of policy discussion from sites where public access and participation is possible, leading to a reduction in the range of voices and the type of considerations that have an audience at the highest levels of policy making. These developments therefore arguably represent a decline in the institutionally recognised sites and channels for public discourse ethics to bear upon national policy in relation to emerging biotechnologies.

The growth of the 'growth agenda'

7.10 There has been a very important change in the ecology of UK research over the past four decades. Aside from moving from a very research intensive economy in the 1960s to one with a research intensity well below that of many other economies, there has been an important change in public funding of research, namely the reduction in departmental civil R&D expenditure. This reduction has meant that approximately one half of all public R&D expenditure is spent through the Higher Education Funding Councils and the research councils.[482] We should recall, however, that there is no single Government research policy, and that in each of the sectors research policy is made on a different basis with different aims in mind.[483] However,

available at: http://www.direct.gov.uk/prod_consum_dg/groups/dg_digitalassets/@dg/@en/documents/digitalasset/dg_187876.pdf, p16.

480 The distinction between advice and administration developed in a way that was somewhat less clear-cut than the high level policy documents suggested. First, a host of Scientific Advisory Committees (SACs) of experts (usually convened by officials), with closely defined remits, continued to exist for all departments. Almost all Government departments maintain a number of SACs. Although nominally offering scientific expertise, these may also creep into offering ethical advice, an idea that may be encouraged by (although not discharged by) the presence of 'lay' members on the committees. Consequently their function is often ambiguous and vulnerable to mission creep in at least two dimensions: (1) from advice to oversight and regulation; (2) from strictly scientific advice, which always needs to be interpreted in its relevance to public policy, to advise on broader implications. Although established by departments, SACs are loosely marshalled by the Government Office for Science headed by the Government Chief Scientific Adviser (who advises the Prime Minister rather than a BIS Minister). The Government Office for Science produces a Code of Practice that is supposed to reinforce the independence of these committees. The other main source of advice comes from arm's length bodies that flourished in the 1980s. Executive non-departmental public bodies such as Human Fertilisation and Embryology Authority (HFEA – the statutory regulator of assisted conception and human embryo research) have a statutory function to provide advice to the Secretary of State upon request, but also have significant discretionary powers to make 'regulatory' policy within the framework set out in legislation. The HFEA is an interesting case, as it was established as an 'ethical regulator' (unlike the majority of health regulators whose purpose was largely to protect the interests of service users by providing an external product/procedure approval and quality assurance function). In other words, its decisions were guided – in part, but necessarily – by reflection on a set of principles abstracted from a negotiated (but shifting) public settlement on where moral lines should be drawn, rather than simply by the need to provide reasonable levels of protection for patients. Part of the HFEA's role is to track this shifting settlement and respond to it as long as it appears to remain within the parameters agreed by Parliament. The Government could also draw advice from more apparently 'administrative' agencies such as the MHRA.

481 Department of Health (13 March 2012) *Department seeks chair and members of science and bioethics advisory committee*, available at: http://www.dh.gov.uk/health/2012/03/esbac.

482 In 2010, of UK public funds spent (in cash terms) on R&D, the Government spent £3.2 billion, the research councils £2.9 billion, and the HEFC £2.3 billion. The Ministry of Defence spent approximately £1.8 billion. See: Office for National Statistics (2010) *Gross domestic expenditure on research and development, 2010*, available at: http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-257461, Table 1; Defence Analytical Services and Advice (2010) *UK defence statistics*, available at: http://www.dasa.mod.uk/modintranet/UKDS/UKDS2011/pdf/c/ukds.pdf, Table 1.7.

483 By 'sectors', in this context, we mean not only the public, private and charitable sectors but also the different Government departments and the research councils.

discussion of research policy is often presented, not least by Government, as if it were one policy, particularly through the emphasis on the connection of research and growth, ignoring the diversity of agencies and policies. Thus, while the particular principles that might or might not apply to research council policy should not be conflated with principles that might or might not exist for different parts of Government research policy, it is clear that research councils are expected to play a significant role in the generation of economic growth, a role which would once have centred on civil departments which themselves had responsibilities for active industrial policies in their sectors.

7.11 The promotion of economic growth has, in fact, featured quite centrally in the aims of research councils for many years. In the last Labour Government, Treasury policy was set out in the *Science and innovation investment framework 2004-2014*. The opening sentence of this document arguably sets the tone for what followed, stating: "Harnessing innovation in Britain is key to improving the country's future wealth creation prospects."[484] The aim was, over ten years, to increase R&D intensity in the UK economy (that is, the gross domestic expenditure on R&D as a proportion of gross domestic product (GDP)) from approximately 1.9 per cent to 2.5 per cent.[485] This initiative was based on the assumption that increases in public sector R&D spending would lead to increases in private sector R&D spending. These increases in private sector spending have not, however, been forthcoming.[486] Funding allocation for research councils increased by about 26 per cent between 2004 and 2008,[487] and there were also increases in HEFCE research funds. However, the research intensity of the economy did not increase significantly: research intensity was 1.68 per cent in 2004 and 1.86 per cent in 2009 (in 1986, it was 2.22 per cent);[488] there was barely any growth in real absolute expenditure on R&D by the private sector, which fell from 1.17 per cent of GDP in 2001 to 1.12 per cent in 2009 (it was 1.05 per cent in 2004[489] and 1.53 per cent in 1986.)[490] Despite sobering experiences of this kind, however, the EU has recently agreed a new set of research intensity targets with the objective of delivering economic growth.[491]

From research to innovation

7.12 While the policy focus on simply increasing research intensity has borne little fruit, the ambition to increase the economic impact of the UK research base through innovation processes has gained greater attention, particularly as pressure on public finances has increased. The Technology Strategy Board (TSB), established in 2007, has as its goal "to accelerate economic growth by stimulating and supporting business-led innovation."[492] The policy set out in the document *Innovation and research strategy for growth* makes this emphasis clear.[493] The

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[484] Department for Innovation, Universities and Skills (2004) *Science and innovation investment framework 2004-2014*, available at: http://www.hm-treasury.gov.uk/d/spend04_sciencedoc_1_090704.pdf, p5.
[485] Ibid, p7.
[486] HMRC (2004) *Spending review*, available at: http://webarchive.nationalarchives.gov.uk/+/http:/www.hm-treasury.gov.uk/spending_sr04_science.htm.
[487] Department of Trade and Industry (2005) *Science budget allocations: 2005-06 to 2007-08*, available at: http://www.bis.gov.uk/files/file14994.pdf, p6.
[488] Department for Business, Innovation and Skills (2012) *SET statistics - science, engineering and technology indicators*, available at: http://www.bis.gov.uk/assets/biscore/science/docs/s/12-499-set-statistics-2012.xls, Table A3.1.
[489] Ibid, Table A3.2.
[490] Ibid.
[491] One of the five 'headline targets' for measuring progress in meeting the goals of the Europe 2020 growth strategy for the EU and, conspicuously, the only input target (the other four being outcome targets) is for three per cent of the EU's GDP (public and private combined) to be invested in R&D/innovation; "…more R&D/innovation in the economy, combined with more efficient resources, makes us more competitive and creates jobs". European Commission (2011) *Europe 2020 targets*, available at: http://ec.europa.eu/europe2020/targets/eu-targets/index_en.htm.
[492] See: http://www.innovateuk.org. The TSB further describes itself, aims and methods: "…the UK's national innovation agency. Our goal is to accelerate economic growth by stimulating and supporting business-led innovation. We understand business, and our people come mainly from business. We work right across government, business and the research community - removing the barriers to innovation, bringing organisations together to focus on opportunities, and investing in the development of new technology-based products and services for future markets." Technology Strategy Board (2011) *Concept to commercialisation: a strategy for business innovation, 2011-2015*, available at: http://www.innovateuk.org/_assets/0511/technology_strategy_board_concept_to_commercialisation.pdf, p2.
[493] For example: "… Government can be an important driver of innovation. We will support independent bodies, like the Technology Strategy Board, to intervene when the market is unable to foster innovation alone in critical technologies or sectors." Department for Business, Innovation and Skills (2011) *Innovation and research strategy for growth*, available at: http://www.bis.gov.uk/assets/biscore/innovation/docs/i/11-1387-innovation-and-research-strategy-for-growth.pdf, pV.

overall rationale is confirmed in the 2010 allocation document that lays out the science settlement:

> "Research Councils and Funding Councils will be able to focus their contribution on *promoting impact through excellent research, supporting the growth agenda*. They will provide strong incentives and rewards for universities to improve further their relationships with business and deliver even more impact in relation to the economy and society."[494]

7.13 Apparent from successive policy documents stretching back before the 2010 general election is a movement towards the Government choosing very particular areas of research to focus on and doing so in consultation with the private sector.[495] This is what would be expected given the focus (however unrealistic) on research policy geared towards innovation in the private sector. However, it is noteworthy how the framing of such decisions have become progressively more narrowed to the economic dimension, almost to the exclusion of other considerations. Combined with this narrowing of the decision frame around economic criteria is a conviction that the expected outcomes can be achieved through a suitable alignment of favourable conditions. This is epitomised by the extension of technology 'roadmaps' to the life sciences supported by 'leadership councils' comprising academics, industrialists and research councils.[496] For example, a synthetic biology roadmap, published in August 2012, contains recommendations to "provide a compass-bearing for the synthetic biology community, helping to align interests towards future growth opportunities…"[497]

7.14 Synthetic biology was selected as an area to which support should be given, according to the Department of Business, Innovation and Skills' document *Innovation and research strategy for growth*, on the basis of a 'robust analytical framework', drawing on expertise in business, the TSB, the research councils, public sector research establishments, universities, and infrastructural organisations. This was used to evaluate technologies against a number of key criteria:

- the potential size of the global market, and its rate of growth;
- the range of applications for the technology across a number of economic sectors;
- the capability of the research base to develop these technologies (number of published papers, active research projects);
- number and strength of UK firms and their supply chains relative to international competitors, and their ability to adopt and exploit the technologies; and

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494 Department for Business, Innovation and Skills (2010) *The allocation of research science funding, 2011/12 to 2014/15: investing in world-class science and research*, available at: http://www.bis.gov.uk/assets/biscore/science/docs/a/10-1356-allocation-of-science-and-research-funding-2011-2015.pdf, p5. (Emphasis in original).

495 The documents to which we refer include: Department for Business, Innovation and Skills (2011) *A vision for UK research* available at: http://www.bis.gov.uk/assets/cst/docs/files/whats-new/10-584-vision-uk-research; Department for Business, Innovation and Skills (2011) *Innovation and research strategy for growth*, available at: http://www.bis.gov.uk/assets/biscore/innovation/docs/i/11-1387-innovation-and-research-strategy-for-growth.pdf; Department for Business, Innovation and Skills (2010) *Technology and innovation futures: UK growth opportunities for the 2020s* available at: http://www.bis.gov.uk/assets/foresight/docs/general-publications/10-1252-technology-and-innovation-futures.pdf (in which 53 specific future technologies and innovations were identified. See p25ff).

496 For example, the synthetic biology 'leadership council' is co-chaired by the Minister and a senior industry figure, with the roadmap group chaired by the industry co-chair of the Council. See: House of Lords Hansard (6 December 2011) *c695*, available at: http://www.publications.parliament.uk/pa/ld201011/ldhansrd/text/111206-0002.htm.

497 Research Councils UK (13 July 2012) *Research roadmap paves the way for UK synthetic biology*, available at: http://www.rcuk.ac.uk/media/news/2012news/Pages/120713.aspx. See also paragraph 6.33ff.

- ability to capture and protect the value we create (patenting, embedding and exploiting intellectual property).[498]

7.15 Synthetic biology was chosen as an area which should be supported because "[e]stimates put the world market at around $100 billion by 2020. The UK produced 14 per cent of all global research papers between 2005 and 2010. The potential applications include bacteria that feed on pollutants, new biofuels, drought and disease resistant crops. The UK has leading companies in these sectors."[499] The *Strategy for UK life sciences,* published around the same time, similarly notes that synthetic biology "was recently identified by the TSB as a key emerging technology with the potential to create a billion pound industry within the UK in the next decade."[500]

7.16 The *Strategy for UK life sciences* in fact corrals the whole area of medical research (on which it is almost exclusively focused) into the guiding objective of generating economic benefit. The essential assumptions behind the Strategy appear to be that the life science industry is large and fast growing, and, in particular, that the UK has a strong record of life sciences research. The fact that the contribution of the life sciences industry to growth does not match this record is explained by the further assumption that the realisation of this potential growth is held back by problems in clinical research, translation, and a failure to exploit the potential of the National Health Service.[501] Similar arguments underlie the recent MRC, BBSRC, Engineering and Physical Sciences Research Council (EPSRC), Economic and Social Research Council and TSB document *A strategy for UK regenerative medicine*.[502]

7.17 It is worth stressing that the discussion of impact in these documents, extensive as it is, is of expected and hoped-for impact, rather than of impact of past research. Indeed a striking feature of research policy documents is the lack of assessment of previous cases, conspicuous given that there has been at least 30 years of emphasis on the economic exploitability of academic research, and of large scale support for commercialisation.

Charities

7.18 Before discussing the assumptions that appear to underlie current research policy, we should note the contribution of medical charities, which fund very substantial amounts of research in the UK. Three bodies dominate funding: in order of expenditure these are the Wellcome Trust, Cancer Research UK and the British Heart Foundation.[503] In these cases, and indeed most

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498 Department for Business, Innovation and Skills (2011) *Innovation and research strategy for growth*, available at: http://www.bis.gov.uk/assets/biscore/innovation/docs/i/11-1387-innovation-and-research-strategy-for-growth.pdf, pp28-9.

499 Ibid, p29.

500 Department for Business, Innovation and Skills (2011) *Strategy for UK life sciences*, available at: http://www.bis.gov.uk/assets/biscore/innovation/docs/s/11-1429-strategy-for-uk-life-sciences, p10.

501 Ibid.

502 Medical Research Council (2012) *A strategy for UK regenerative medicine*, available at: http://www.mrc.ac.uk/Utilities/Documentrecord/index.htm?d=MRC008534. It is claimed in this document that "Regenerative medicine is an emerging discipline that holds the promise of revolutionising patient care in the 21st Century", that the "UK is a leading player globally in the science that underpins regenerative medicine", and that, currently, "the UK is at the forefront of this rapidly evolving field" (p2). The document, however, is essentially a report on current funding arrangements mostly for 'underpinning' (i.e. basic) research in this area. It is not, in fact, clear that regenerative medicine can be treated homogeneously as an 'emerging discipline' because it embraces too heterogeneous a group of technologies (gene therapy, stem cell grafts, tissue engineering etc.).

503 In 2011, the Wellcome Trust Group spent £641.8 million on charitable activities (£392.6 million on 'science funding', £117.3 million on the Wellcome Trust Genome Campus, £74.7 million on 'technology transfer' and £57.2 million on 'medical humanities and engagement'); Cancer Research UK spent £340.4 million on charitable activities (£324.7 million on 'research' and £15.7 million on 'information and influencing public policy'); the British Heart Foundation spent £310.3 million on charitable activities (£120.7 million on 'research funding', £34.5 million on 'prevention and care' and £155.1 million on 'expenditure in furtherance of charitable objectives'). In 2010/11, the MRC spent £264.4 million on research grants and £25.9 million on 'other research' (which largely relates to joint funding and strategic partnerships). See: Wellcome Trust (2011) *Annual report 2011*, available at: http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_publishing_group/documents/web_document/wtvm053879.pdf, p45;Cancer Research UK (2012) *Beating cancer, saving lives: our annual report and accounts, 2011/12*, available at: http://www.cancerresearchuk.org/prod_consump/groups/cr_common/@abt/@gen/documents/generalcontent/cr_088965.pdf, p23; British Heart Foundation (2011) *Where your money goes: annual review 2011*, available at: http://www.bhf.org.uk/publications/view-publication.aspx?ps=1001757 and Medical Research Council (2012) *Annual report and accounts 2010/11*, available at: http://www.mrc.ac.uk/Utilities/Documentrecord/index.htm?d=MRC008586, p106.

other instances where charities fund research, the aim of research is to have an impact consistent with the charitable aims of the organisation in question, for example the improvement of public health, rather than the improvement in profit margins in the pharmaceutical industry or indeed improvements to the UK economy itself.[504] The documents we reviewed (strategic plans, grant writing guides etc.) also reflected the difficulty of properly assessing non-economic impact: there was little in the way of explanation as to how such impact could be properly quantified and measured, although the Wellcome Trust has produced an 'assessment framework' ("established to enable progress to be tracked against… ten key indicators of progress…"[505]).This attempts to capture both quantitative and qualitative information with regard to the impact and outcome of Wellcome Trust funded research.[506] However, such documents are retrospective in nature and understandably offer little in the way of a framework for *predicting* impact on this basis of past work. Other documents reviewed that dealt with issues relating to funding decisions noted considerations such as "tangible impacts on health" and "discernable impact on wider policy development and practice";[507] novelty and relevance;[508] and, "relevance to cardiovascular disease, scientific merit, [and] timeliness".[509]

7.19 Published sources provide little guidance on how charities identify research priorities, although the main three medical charities all stress scientific excellence and impact on human health as key criteria. As with Government policies, there appears to be no special role granted to the concept of emerging biotechnologies within the published policy documents of those charities.

Framing research policy

7.20 In view of the history of commercialisation in the life sciences, there is a dilemma for policy that is orientated by expectations of substantial national economic benefit: if past evidence is irrelevant to newly emerging biotechnologies then it provides no basis for the expectation; if the evidence is relevant then the expectation is likely to be misplaced.[510] Understanding this dilemma involves examining the commonplaces and assumptions that frame the dominant policy discussions. This is, of course, not to explain these claims fully (since it merely begs the question of how those commonplaces came about in the first place), but to draw attention to the lack of explicit reflection on this on the part of those who assert them. In this section we therefore discuss the background assumptions in the documents to which we have already referred. Specifically, we look critically at the framing of choices through which important conditions, namely funding of different technology trajectories, are set.

504 In a review of some of the five largest (by expenditure on medical research) charitable funders' policy documents we found that only Arthritis Research UK explicitly mentions 'economic' impact as a specific goal, stating that it aims to "[r]educe the economic impact of arthritis on the individual patient, their family and the wider economy". See: Arthritis UK (2012) *Annual report and financial statements 2010-11*, available at: http://www.arthritisresearchuk.org/about-us/~/media/Files/Annual-Review-and-Reports/12570-Report%20-Accounts-2010-11.ashx, p5.

505 The Wellcome Trust (2011) *Assessment framework report 2010/11*, available at: http://www.wellcome.ac.uk/About-us/Publications/Reports/Biomedical-science/WTVM054494.htm.

506 See: Wellcome Trust (2012) *Assessment framework report: report summary 2010/11*, available at: http://www.wellcome.ac.uk/stellent/groups/corporatesite/@policy_communications/documents/web_document/WTVM054488.pdf.

507 Wellcome Trust (2005) *Strategic plan 2005-2010: making a difference*, available at: http://www.wellcome.ac.uk/stellent/groups/corporatesite/@policy_communications/documents/web_document/wtd018878.pdf, p27.

508 Cancer Research UK (2006) *Grant writing guide*, available at: http://www.cancerresearchuk.org/science/prod_consump/groups/cr_common/@fre/@fun/documents/generalcontent/grant-writing-guide.pdf, p1.

509 British Heart Foundation (2012) *How we fund*, available at: https://www.bhf.org.uk/research/research-grants-1/how-we-award.aspx.

510 Part of this explanation may lie in understanding the 'productivity paradox' that has puzzled economists, which was summed up (in relation to computer technology) in the observation that "we see the computer age everywhere except in the productivity statistics." (Brynjolfsson E and Hitt LM (1998) Beyond the productivity paradox *Communications of the ACM* **41**: 49-55, citing Robert Solow. While this may point only to the unanticipated length of time by which productivity benefits lag behind technological diffusion owing to the costs and complexities of innovating (i.e. the benefits will show up *eventually*), the paradox relates to technologies that have already been developed and diffused. Development and innovation are formidable hurdles that still lie ahead when one is speaking of emerging biotechnologies.

7.21 Although stronger assumptions are made in many policy documents, the following beliefs are generally found together in some form or other as a background against which policy decisions are made:

- the UK 'science base' in the life sciences is exceptionally strong in international comparisons;
- the UK pharmaceutical industry – the research-intensive (non-generic) part – is a high-tech, high value-added industry that makes it economically extremely valuable to the UK;
- there is a causal connection between (a) and (b) in that the research base powers the success of the industry, and that the success of the industry ensures the applicability of research in the UK;
- biotechnology is becoming more and more important to the pharmaceutical industry (as well as some other industries where UK is less strong);
- some areas of the underlying science have 'cross-over potential', notably synthetic biology, so they might help to give the UK 'lift-off' in chemical and agricultural biotechnology; and
- public spending on research is, in many cases, justifiable only where there is potential to generate economic growth in the UK.

7.22 These assumptions are often surprisingly resistant to evidence. Particular ways of thinking, for example, about transformative technologies, about the nature of UK research and about its relationship to the UK economy, are prevalent in policy discussion without being subjected to scrutiny concerning either their foundation or their contemporary relevance. This is, in part at least, because policy makers operate within a detached world that is subject to dominant frames where, in this as in other areas, policy objectives shape the search for and interpretation of evidence, and where interested parties create influential narratives to which public policy responds.[511] It is an example of a phenomenon that we identified in Chapter 2, whereby the self-reinforcing nature of the discourse displaces ambiguous or even inconvenient evidence that challenges the integrity of the established frame as a foundation for judgment. The dynamic is similar to that that we observe creating the 'biotech boom' in Chapter 9.

'Britain is good at research and invention but bad at commercialisation'

Research and commercialisation of technologies generally

7.23 The idea that the UK is peculiarly good at inventing and/or scientific research is an important element in many arguments in research policy and, indeed, in the national self-image. This claim has become particularly focused on life sciences research and, in this area, is accompanied by the claim that the UK is also good at application but remains hampered by important barriers to commercialisation. This assumption would therefore give grounds for optimism and investment in biosciences and especially in commercialisation if the obstacles to commercialisation could be identified and addressed. The associated rhetoric is suggestive of notions of 'unlocking potential'.

7.24 The claim is conventionally grounded on evidence of comparatively high publication and citation rates for UK research. The obstacles to commercialisation are associated with terms like the 'valley of death' (that separates basic biomedical research from clinical application) and questions about the lack of a UK success story of the scale of Google or Apple. This supports a policy focus on innovation to unlock assumed economic potential.

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[511] See: Orlikowski WJ (2000) Using technology and constituting structures: a practice lens for studying technology in organizations *Organization Science* **11**: 404-28.

7.25 The two-part 'good at research, bad at commercialisation' argument has been a standard theme in discussion of UK research for well over a century. It is well established that the UK has been one of a small number of countries that have been notable for invention and research, and these few countries have long dominated research. However, this does not mean that the UK has been or is radically better than its main competitors in research, or indeed 'the best'. If we believe that the UK is in competition with other states over innovation, we should consider the position of the UK in relation to its peers as innovators, competing for the benefits to be had from innovation, rather than in relation to all countries, since other countries may have chosen to be 'innovation takers' (i.e. not investing in their own R&D).

7.26 The second part of the two-part claim – the idea that the UK has failed to develop research findings and inventions – is contradicted by much of its recent history. Until the 1970s, for example, development expenditure by both Government and industry was relatively high (except by comparison with the US). Furthermore, many new technologies were brought to market in the UK, including jet engines, nuclear power stations and pharmaceuticals. Of course, successful initial commercialisation does not necessarily mean economic success, but it would be hard to maintain that the UK Government or industry were ineffective, before the 1970s at least, in supporting emerging technologies and bringing them to market. Furthermore, the UK had a very good record of developing and using techniques pioneered elsewhere.[512]

7.27 While there may be no general cultural or historical basis for the two-part claim it may, nevertheless, be the case that the claim applies now. Across the board, in academic research, the UK fares comparatively well.[513] However, the publication and citation measures now commonly used to calculate this offer no reliable proxy for innovation. Neither do patent counts, where the UK's percentage of world patenting is well below Germany and just below France.[514] By a wider measure, including patents and R&D expenditures, the Organisation for Economic Co-operation and Development (OECD) does not currently place the UK as an innovation leader, but as an 'innovation follower'.[515] As far as commercialisation is concerned, industrial R&D is a key factor and this is clearly lower in the UK as a proportion of GDP that in countries such as the US, Germany, Japan, and the Republic of Korea, among others. To that extent the UK is no longer 'good' at industrial development in general.

Research and commercialisation in the biosciences

7.28 So, is the UK 'good at research' in the biosciences? Contemporary claims for UK research superiority generally draw specifically from the life sciences, and some analyses of citations bear this out.[516] Other figures put the UK performance, though strong in a global context, in a slightly more modest light.[517] What all the figures show, however, is that the UK generates a

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512 Such as the electronic television.

513 The UK accounts for roughly one per cent of the world population and 11.9 per cent of citations (Vaitilingam R (2010) *Research for our future: UK business success through public investment in research*, available at: http://www.rcuk.ac.uk/documents/publications/researchforourfuture.pdf, p5). Clearly, the UK does better than the world average, but this is only to be expected. We also need to compare with key competitors such as the US, Germany, and France. The UK does do better than these countries (other than the US), but the differences are not huge. For example, field-weighted citations between 2006 and 2010 were around 1.42, compared with about 1.2 for Italy, with Canada, Germany and France in between. (Elsevier (2011) *International comparative performance of the UK research base - 2011*, available at: http://www.bis.gov.uk/assets/biscore/science/docs/i/11-p123-international-comparative-performance-uk-research-base-2011, p36, figure 4.7).

514 Ibid, figure 7.1.

515 Department for Business, Innovation and Skills (2011) *BIS economics paper no.15: innovation and research strategy for growth*, available at: http://www.bis.gov.uk/assets/BISCore/innovation/docs/E/11-1386-economics-innovation-and-research-strategy-for-growth.pdf, pp39-49.

516 The Department for Business, Innovation and Skills, for example, reports that UK publications in bioscience from 2006-2009 received an average of 9.5 citations each, higher than any other country. Department for Business, Innovation and Skills (2011) *Strategy for UK life sciences*, available at: http://www.bis.gov.uk/assets/biscore/innovation/docs/s/11-1429-strategy-for-uk-life-sciences, p12.

517 For all countries the two big categories in terms of total numbers of papers are clinical sciences and biological sciences. (Health and medical sciences is much smaller, so we this for present purposes.) Elsevier (2011) *International comparative performance of the UK research base - 2011: appendix F: supplementary data*, available at: http://www.bis.gov.uk/assets/BISCore/science/docs/I/11-p123an2-international-comparative-performance-uk-research-base-

great number of research papers (both by absolute and *per capita* measures), and that the best of these compare favourably with the best in the world (in terms of citation impact). However, there are also a great number of papers produced in the UK that do not measure up in these terms (a slippage down the rankings in terms of citations per paper) with field weighted citation impact ranking of 12th in the OECD for clinical sciences and fourth for biological sciences. However, it is not the case that these are areas in which the quality of UK output is relatively higher compared to other areas of research.[518] So UK research in biosciences is strong, but not exceptional compared to other countries and UK biosciences research is not exceptionally strong compared to other areas of research.

7.29 The second question to address is whether the UK is 'bad at commercialisation' in the biosciences? It is claimed that UK research in the biosciences has given rise to successful domestic commercialisation, such as to give confidence in the promise of future biotechnologies, with the pharmaceutical industry providing the guiding example that policy would like to follow and repeat in other areas. Figures that are widely available, however, give no evidence as to where the relevant research or development was carried out; they tell us only that firms with headquarters in the UK were quite successful in developing and selling drugs.[519] While this evidence therefore points to the fact that there is successful and profitable commercialisation by UK-headquartered firms, there is no such evidence that supports the suggestion that research carried out in the UK is similarly successful.

The safety of the assumption

7.30 In summary, there is little evidence to link the relatively strong underpinning research carried out in UK institutions with successful commercialisation of underpinning research by UK firms, despite the frequency of claims to this effect. In any case, as we have argued above,[520] historical experience of other fields – particularly in the physical and information sciences – may not be a reliable guide in the field of biotechnologies. Furthermore, the experience of domestic commercialisation in biotechnology, chiefly drawn from the pharmaceutical industry may not be a reliable precedent for other areas of biotechnology and, in any case, is relatively unremarkable (in terms of the specifically biotech component).

7.31 There are a number of conclusions that we can draw from the foregoing considerations that recommend caution and further reflection on the basis for UK policy in the life sciences. These relate to the features of emerging biotechnologies that we identified in Chapter 3. It is not clear that the UK's life sciences academic research sector is unusually productive, nor is it clear that

2011-f.pdf provides useful information on article and citation shares. For clinical science, in 2010 the UK world article share was 8.0%, second to US with several countries between 8% and 4% (p38). The UK citation share was 12.5%, in second place behind the US but ahead of Germany, which had around 9% (p60); the UK had 16% of the most highly cited papers (p93). However, for citations per article the UK was 11th in the OECD (p71); field weighted citation impact 12th in OECD (p82). For biological sciences, in 2010 the UK had 6.9% of articles, in third place behind the US and China but level with Japan and Germany, and 11% of the citation share, ahead of Germany at 9% (p62); within this, the UK had 14.5% of highly cited (p95). But citations per article were 4th in the OECD (p73); the field weighted citation impact 4th in OECD (p84).

518 "UK research quality is high across all subject fields. The UK's field-weighted citation impact is especially strong in fields where it has relatively lower publishing activity – especially mathematics, physical sciences and engineering". Elsevier (2011) *International comparative performance of the UK research base - 2011*, available at: http://www.bis.gov.uk/assets/biscore/science/docs/i/11-p123-international-comparative-performance-uk-research-base-2011, p39.

519 For example, it is claimed that "around one fifth of the world's top 100 medicines originate from UK research." (House of Commons Hansard (21 March 2012) *c799*, available at: http://www.publications.parliament.uk/pa/cm201212/cmhansrd/cm120321/debtext/120321-0001.htm.) The basis for this claim might be that 20% of the top 75 drugs by global sales were originated by firms whose headquarters were in Britain. (IMS/ABPI calculations Pharmaceutical Industry Competitiveness Task Force (2009) *Ministerial Industry Strategy Group, Pharmaceutical Industry: competitiveness and performance indicators 2009* available at: http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/@ps/documents/digitalasset/dh_113133.pdf, p26.) Another statistic suggests that medicines originating from UK firms captured a 16% value share of the world's 100 top selling drugs in 2008 (ABPI, cited in UK Department for Business, Innovation and Skills (2011) *Strategy for UK life sciences*, available at: http://www.bis.gov.uk/assets/biscore/innovation/docs/s/11-1429-strategy-for-uk-life-sciences, p25.). British firms' market share for products launched in the five years up to 2009 was 11%, 9th in the world (Association of the British Pharmaceutical Industry (2012) *Global pharmaceutical industry and market*, available at: http://www.abpi.org.uk/industry-info/knowledge-hub/global-industry/Pages/industry-market-.aspx, figure 3).

520 See Chapter 6.

this could transmute into a successful life sciences industry, not least because a strong pharmaceutical industry is not necessarily evidence of capacity to create new drugs. Furthermore, it is not clear that the business-focused policy, even if successful, would be the most effective in addressing problems of human health and welfare, in the UK or elsewhere. Government has, from the point of view of the growth agenda, sought to find areas where UK basic research is strong, and where there is a relatively strong industrial base, and in this case the life sciences sector appears to have particular promise, if it is the case that research advances can be captured in the UK. However, even though there is no obvious linked industrial sector, relative strength may be greater in other sectors of basic research. Furthermore, there are weaknesses in industrial areas where one might expect and hope for major developments in emerging biotechnologies, such as industrial biotechnology.[521]

7.32 To draw these conclusions is not to say that the policy focus on life sciences is misplaced, but rather that it is at least not as well-founded as it is often made to appear. This could be equally true, of course, of many alternative policies that are focused on emerging biotechnologies. These conclusions do not counsel against ambitious policy but call for candour, public reasoning and caution. Certainly there is a need for evidence-based policy in this area, but this does not merely mean an extension of currently used forms of quantitative evidence. There is a tendency to consider quantitative evidence as superior because it is more manageable, which has led to unhelpful, and occasionally absurd, attempts assess a greater range of impacts in quantifiable, and especially economic, terms. Rather than the attempt at reductionism of this sort to make relevant evidence manageable within an existing decision frame, **the determination of biotechnology policy should attend explicitly to diverse perspectives and bodies of evidence rather than privileging a single, quantitative frame of evaluation (such as economic costs and benefits, or costs and benefits reduced to economic values)**; this should be the case not only at the 'macro' level of Government policy but also at the 'meso' level of funding bodies and, indeed, at the 'micro' level of research (as we discussed in Chapter 6). This would encourage a more critical consideration of the interests that research may promote and, in particular, how it might promote the public good (and how this good is construed) rather than merely economic growth or wealth creation.

Scientific knowledge as a public good

7.33 The standard justification for state-funded research arises from a particular analysis of scientific knowledge being a 'public good' in the sense that this is understood by economists, namely, that it will not be adequately provided by markets, and that it is nevertheless desirable because it furthers the ends of society. (We discuss how the degree to which biotechnologies may be thought of as public goods in Chapter 4.) If scientific knowledge were a 'public good' in the sense of being 'non-excludable' it would be hard to explain state funding of research in a competitive multi-state world. Indeed, in such a world, the argument would be that states would, and should, *under*-invest in research. On this model, the deficit could only be made up by a world-state, not a national state.[522]

521 See, generally, Skibar W, Grogan G, Pitts M and Higson A (2009) *Analysis of the UK capabilities in industrial biotechnology in relation to the rest of the world – follow-up report to: assessment of current activity in the production of platform chemicals from renewable sources and horizon scan to forecast potential future developments in science and technology activity in biocatalysis*, available at: http://www.bis.gov.uk/files/file51237.pdf; Industrial Biotechnology Innovation and Growth Team (2009) *IB 2025 maximising UK opportunities from industrial biotechnology in a low carbon economy: a report to government by the Industrial Biotechnology Innovation and Growth Team* available at: http://beaconwales.org/uploads/resources/Maximising_UK_Opportunities_from_Industrial_Biotechnology_in_a_Low_Carbon_Economy.pdf.

522 For a discussion of the economics of scientific and technical research, see: Nelson RR (1959) The simple economics of basic scientific research *Journal of Political Economy* **67**: 279-306; Hounshell DA (2000) The medium is the message, or how context matters: The RAND Corporation builds on economics of innovation, 1946-1962, in *Systems, experts, and computers: the systems approach in management and engineering, World War II and after* Hughes AC, and Hughes TP (Editors) (Cambridge, Massachusetts: MIT Press) Pestre D (2003) *Science, argent et politique: un essai d'interprétation* (Versailles: Quae); Arrow KJ (2011) Economic welfare and the allocation of resources for invention, in *The rate and direction*

7.34 In reality, much scientific knowledge does not meet the criteria of being a public good in this classic, economic sense. Scientific knowledge is, in fact, excludable to a large extent, through secrecy, patenting, or high costs of access.[523] The actual reasons states fund research are not self-evident, but are likely to be neither simply an acceptance of market failure nor a universal philanthropy. They may include, for example, military security and national economic growth. On the other hand, many things that states do, such as providing overseas aid, are not easily analysable in terms of a simple rule, such as to maximise gross national product, but recognise instead the complex interdependencies and trade-offs, on a number of different levels, of belonging to a global community. Even a ruthlessly competitive state may recognise advantages to cooperation or the expediency of developing overseas markets.

7.35 Among the ways in which the public good might be promoted by publicly funded research is through the creation of public knowledge available to all, created independently of private interests. In general, there might be a case for ensuring that the public and those acting in its interest have the countervailing knowledge required to assess private, interested claims for example, claims for the efficacy of particular drugs.[524] This would also entail active support for independent research, recognising as a central issue, that not all – indeed, not much – research will be independent.[525] Such public knowledge should contribute to a new and more explicit appreciation of the limits of knowledge and prediction in the face of uncertainties, with the aim of bringing an end to over-promising.

National research and economic growth

7.36 Innovation, derived to a significant degree from research and development, has transformed the world and has permitted large increases in both varieties and levels of output. The relationship between national R&D investments and national rates of economic growth is, obviously, highly dependent on particular circumstances, but it cannot be assumed that national R&D expenditures are a major determinant of national growth rates. The extent of the relationship will vary by country and with time, as well as with policy: what might hold for the US, or Japan, or the world as a whole, will not necessarily hold for any particular country.

7.37 Nevertheless, the assumption is made that national research is critical to national growth, and that if it does not lead to growth there must be a problem of translation, development funding, or investment. This is not necessarily so, however: most countries get most of their innovations from abroad (though it is worth noting that in some cases this might involve national R&D). The assumption that, as far as research is concerned, nations are economic and scientific units competing with each other, and that research is one of the most powerful weapons in that economic contest may well be mistaken. Nations are not generally competing with each other, something like free trade operates between nations, and research activity is only partially organised nationally.

7.38 In fact it might be quite misleading to identify R&D performed in a particular nation with that nation. Excluding defence and related R&D which is clearly national, most private research is concerned with the growth of particular firms, not the nation in which they contingently operate. Indeed in the UK, approximately 22 per cent of business R&D is funded from abroad (considerably higher than for other countries),[526] and the proportion of R&D carried out by

of inventive activity: economic and social factors, Groves HM (Editor) (Princeton, New Jersey: Princeton University Press) Mirowski P (2011) *Science-mart: privatizing American science* (Cambridge, Massachusetts: Harvard University Press).

523 We discuss the commercial exploitation of such knowledge in Chapter 9.

524 See: Angell M (2005) *The truth about the drug companies: how they deceive us and what to do about it* (New York: Random House); Borch-Jacobsen M (2010) Which came first, the condition or the drug? *The London Review of Books* 7 October, available at: http://www.lrb.co.uk/v32/n19/mikkel-borch-jacobsen/which-came-first-the-condition-or-the-drug; Agnell M (2011) The illusions of psychiatry *The New York Review of Books* 14 July, available at: http://www.nybooks.com/articles/archives/2011/jul/14/illusions-of-psychiatry/?pagination=false.

525 See, for example, Goldacre B (2012) *Bad pharma: how drug companies mislead doctors and harm patients* (London: Fourth Estate).

526 Department for Business, Innovation and Skills (2011) *BIS economics paper no.15: innovation and research strategy for growth*, available at: http://www.bis.gov.uk/assets/BISCore/innovation/docs/E/11-1386-economics-innovation-and-research-strategy-for-growth.pdf, p47.

foreign multinationals within the UK is much higher than this, at around 40 per cent.[527] Much of the remaining 60 per cent is performed by UK-based multinationals whose operations and success are not necessarily tied to that of the UK economy. The pharmaceutical industry reproduces these proportions.[528] At best then, only a fraction of R&D contributes to national growth, and the location of activities within a particular national boundary does not mean that they are part of a system working for national purposes. Nevertheless, it seems that, rhetorically at least, much research council funding is directed to increasing the rate of economic growth of the UK through both research output and the output of people trained in advanced scientific methods, who enable the economy to assimilate and exploit new knowledge, whether that arises from research in the UK or elsewhere.

7.39 Thus the proposal that the output of research could be the basis of billion pound UK industries within a few years is highly uncertain, not to say unlikely. Even taken more broadly, the argument in favour of strategic investment in research in particular areas needs to be made extremely carefully. Such arguments cannot be founded uncritically on the assumption that a straightforward and strong positive correlation between investment in research and national growth can be expected.

7.40 This might lead us to question the plausibility of the expectation that synthetic biology will create a business worth $100 billion by 2020[529] and that UK firms, or firms in based in the UK, will take a significant share (say 10%). Our reflections may be coloured by the recognition that, in recent years, apparently grossly inflated estimates for the value of nanotechnology industry were made, for example that the industry would be worth $1 trillion by 2016.[530] If this were considered to be a distinct possibility, then a question could be raised as to why private firms would not fund synthetic biology research entirely themselves. Or, the problem may be that, in the case of emerging biotechnology, the venture capital model for funding might not work as it has for information and communications technology.[531] If this is thought to be the problem, then major interventions and subsidies – more radical than those of the 1970s – would be needed, yet they are clearly not on the political agenda. Furthermore, we should recognise that if we were to have $100 billion industry by 2020, the research, and most of the development, would already have to have been done.

7.41 After 30 years of focus on biotechnology, the modesty of UK success stories in the policy literature is striking.[532] All of this seems to confirm a dissonance between the promissory rhetoric and the material uncertainties, of the sort that we identified in Chapter 2, which has led to policy based on the elements of the discursive frame – such as the assumptions we discuss here – rather than a reflection on how the uncertainties and complexities of the innovation process in respect of emerging biotechnologies specifically challenge this frame.

The centrality of biotechnology to a transformed future

7.42 It has been suggested that biotechnology will be central to a coming wave of social and economic transformation among those looking for a worthy successor to the information

[527] Ibid, p48.

[528] Sixty per cent of total R&D investment in the UK pharmaceutical sector was carried out by UK-owned firms in 2008 (see: Department of Business, Innovation and Skills (2010) *BIS economics paper no.2: life sciences in the UK – economic analysis and evidence for 'life sciences 2010: delivering the blueprint'*, available at: http://www.bis.gov.uk/assets/biscore/economics-and-statistics/docs/10-541-bis-economics-paper-02, pViii).

[529] Department for Business, Innovation and Skills (2011) *Innovation and research strategy for growth*, available at: http://www.bis.gov.uk/assets/biscore/innovation/docs/i/11-1387-innovation-and-research-strategy-for-growth.pdf, p29.

[530] Roco MC and Bainbridge W (2001) *Societal implications of nanoscience and nanotechnology*, available at: http://www.wtec.org/loyola/nano/NSET.Societal.Implications/nanosi.pdf, p3.

[531] For limitations of the venture capital model see: Browning J (2009) The incredible shrinking venture capital *Nature* **460**: 459.

[532] See the policy documents cited elsewhere in this Report (e.g. in paragraphs 7.12ff). See also: The Royal Society (2010) *The scientific century: securing our future prosperity*, available at: http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/publications/2010/4294970126.pdf.

revolution of the late 20th Century.[533] For example, the BBSRC's 2011-15 delivery plan, begins by asserting that "the 21st Century will be the age of bioscience." It continues:

> "Driven by new concepts and technologies, a biological revolution is unfolding in the same way that advances in physics shaped the early 20th Century and great leaps in electronics and computing transformed our lives over the past 40 years.
>
> Modern bioscience offers *enormous benefits to society and unprecedented opportunities for innovation and growth in multi-billion pound sectors of our economy* such as food and drink, agriculture, biotechnology, energy, health and pharmaceuticals."[534]

7.43 Claims such as these can come to stand as justification for the idea that the UK should be strong in these sectors and, indeed, that by not committing to them it would miss vital opportunities. We need to be wary of the assumption that high technology industries are all fast growing, that they are fast growing everywhere and that such industries are necessarily major drivers of economic growth. In the UK between 1992 and 2007 the contribution of high and medium technology sectors to the total growth in economic output was approximately five per cent, compared with approximately 20 per cent for Germany and 40 per cent for Japan and the Republic of Korea.[535] The pharmaceutical industry may, globally, be growing faster than the world economy, but its growth rate is far from exceptional, and there is no guarantee or evidence that pharmaceutical firms based in the UK with a high R&D-intensity will grow significantly faster than the world economy, or even the UK economy as a whole.[536]

Directing technologies and supporting diversity in research

7.44 A more critical approach is needed in response to the assumption that pharmaceuticals and biotechnology have been (or are) radically promising sectors from the point of view of economic benefit. In fact the most obvious and salient point about the pharmaceutical industry is that it has seen a significant *fall* in the productivity of R&D. Indeed, although the medical biotechnology sector has been subject to massive investments over 30 years, there has been relatively little return to date. There is also evidence on the supposed biotechnological revolution that suggests, at the very least, that claims for future biotechnology-led transformations should be treated with some scepticism.[537] Moreover, it would be a great mistake to equate improvements to human health *necessarily* with expenditures on pharmaceuticals, or the growth, productivity or profitability of the industry, as a large critical literature on the industry makes clear.[538] The case of pharmaceuticals may be a conspicuous case of what some analysts take to be a more general phenomenon, namely the possible

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[533] See: Freeman C (1992) *The economics of hope: essays on technical change, economic growth and the environment* (London: Pinter).

[534] BBSRC (2011) *BBSRC delivery plan 2011-2015: maximising economic growth in the age of bioscience*, available at: http://www.bbsrc.ac.uk/web/FILES/Publications/delivery_plan_2011_2015.pdf, p3, emphasis in original.

[535] Department for Business, Innovation and Skills (2011) *BIS economics paper no.15: innovation and research strategy for growth*, available at: http://www.bis.gov.uk/assets/BISCore/innovation/docs/E/11-1386-economics-innovation-and-research-strategy-for-growth.pdf, p33. See also: OECD (2012) *STAN database for structural analysis*, available at: http://stats.oecd.org/Index.aspx?DatasetCode=STAN08BIS.

[536] IMS Health (amongst other roles, an information provider for health care industries), reported that the total global pharmaceutical market grew 6.2 per cent annually for five years until 2011. Global GDP growth was 5.3 per cent in 2010 and 3.9 per cent in 2011. See: IMS Health (18 May 2011) *IMS Institute forecasts global spending on medicines to reach nearly $1.1 trillion by 2015*, available at: http://www.imshealth.com/portal/site/ims/menuitem.d248e29c86589c9c30e81c033208c22a/?vgnextoid=01146b46f9aff210VgnVCM100000ed152ca2RCRD&vgnextchannel=4eb65890d33ee210VgnVCM10000071812ca2RCRD&vgnextfmt=default and International Monetary Fund (2012) *World economic outlook April 2012: growth resuming, dangers remain*, available at: http://www.imf.org/external/pubs/ft/weo/2012/01/pdf/text.pdf, p2.

[537] Hopkins MM, Martin PA, Nightingale P, Kraft A and Mahdi S (2007) The myth of the biotech revolution: an assessment of technological, clinical and organisational change *Research Policy* **36**: 566-89.

[538] For example: Angell M (2005) *The truth about the drug companies: how they deceive us and what to do about it* (New York: Random House); Agnell M (2011) The illusions of psychiatry *The New York Review of Books* 14 July, available at: http://www.nybooks.com/articles/archives/2011/jul/14/illusions-of-psychiatry/?pagination=false; Le Fanu J (2011) *The rise and fall of modern medicine* (London: Abacus); Mirowski P (2011) *Science-mart: privatizing American science* (Cambridge, Massachusetts: Harvard University Press). See, also: Goldacre B (2012) *Bad pharma: how drug companies mislead doctors and harm patients* (London: Fourth Estate).

slowing of innovation in recent decades. Such a conclusion stands in sharp contrast to the repeated assertion that we are living in an age of unprecedented innovation.[539]

7.45 We conclude that a belief about what technologies will be of central importance, and which sectors will grow in the future, that is founded on self-reinforcing discourses that suppress ambiguity and uncertainty, may lead research agencies not only to fund the same areas but perhaps the wrong areas too. That is, research (and economic and other benefits associated with research) may be damaged by misplaced certainty about the future. It is therefore appropriate to ask, among other things, by what process research agencies in fact come up with research priorities, whether they are consistent with our understanding of uncertainty about the future, whether they embody an understanding of how such priorities have been arrived at in the past (and the success of such prioritisation), and whether policies seek to achieve or reflect consensus, and potentially causing unnecessary, and unproductive duplication of research.

7.46 Notions of selectivity and exploitability have guided UK research policy for at least 20 years.[540] Yet we appear to have little reflection on whether that policy has been a success. To support and cultivate better public reasoning **there is a need for serious evaluation and assessment of past research policies, both of Government as a whole and of particular public funding bodies, to understand in what conditions, if any, selective approaches to support for biotechnology are plausible**. The study of returns to UK public and charity research in treatment of mental illness and cardiovascular disease sponsored by the MRC, Wellcome Trust and the Academy of Medical Sciences represents an effort of this kind. However, this study did not seek to conclude which benefits could be traced directly back to particular UK medical research, but made assumptions about what proportion of beneficial effects could be attributed (arbitrarily) to British research; it also assumed that secondary effects would be of the same scale as in the USA.[541]

7.47 The emergence of biotechnologies is subject to a variety of conditions, which, according to their own degrees of freedom, adapt to and respond to each other in a much more complex and unpredictable way than linear models of research policy assume. Openness, the construction of technological objectives as collective challenges, and coordination of research on the presumption of sharing benefits can help to address this, but only partially and often only in the context of national policy discourse that accepts the assumptions we have sketched out here. Although the importance of understanding uncertainty in R&D decisions has long been acknowledged and argued for, it remains under-discussed in research policy.[542]

7.48 Selectivity and commitment to particular technologies are not, in themselves, undesirable, but they are not always necessary and may be undesirable when they crowd out alternative approaches in conditions of substantial uncertainty.[543] Caution therefore recommends that **policy makers should consider adopting an approach to social objectives that fosters diversity of research approaches, not just within the particular domains of individual funding bodies but across physical and life sciences, and the social sciences, combined with selective conditions of innovation that involve social benefit rather than just market value**.[544] Diversity in approaches to R&D is needed within nations and across nations.[545] Policy

539 For example: Cowen T (2011) *The great stagnation: how America ate all the low-hanging fruit of modern history, got sick, and will (eventually) feel better* (New York: Dutton Adult).
540 Edgerton D and Hughes K (1989) The poverty of science: a critical analysis of scientific and industrial policy under Mrs Thatcher *Public Administration* **67**: 419-33.
541 Health Economics Research Group (Brunel University), Office of Health Economics and RAND Europe (2008) *Medical research: what's it worth? Estimating the economic benefits from medical research in the UK*, available at: http://www.wellcome.ac.uk/stellent/groups/corporatesite/@sitestudioobjects/documents/web_document/wtx052110.pdf.
542 A classic case is the work of Hitch and McKean for the US department of defence; see: Hitch CJ and McKean RN (1960) *The economics of defense in the nuclear age*, available at: http://www.rand.org/content/dam/rand/pubs/reports/2005/R346.pdf.
543 See paragraph 2.33.
544 See paragraph 6.33, with regard to halting innovation trajectories. We discuss how notions of social selection may be introduced into commercial biotechnology innovation in Chapter 9.

that allows freedom and flexibility in science would guard against ignorance of the mechanisms of innovation and scientific creativity.

7.49 There is an assumption that for each nation state there should be one public agency concerned with the funding of each particular type of research. Sometimes of course this is not the case, such as where areas of research are fundable by many agencies. Within Europe there is, of course, an overlapping European structure but it, too, is centralised, although the strengthened European Research Council has provided a welcome competitive stimulus to Framework programmes, with benefits to the UK research effort.[546] To justify centralisation, agencies point to the need to take a strategic overview, and to eliminate unnecessary duplication. Yet the costs of monopoly need to be taken into account as well: there can easily be a lock-in of policies that work poorly, with feedback mechanisms acting slowly. Although there *is* competition between research councils in the UK, that competition takes the form of vying for funding from Government, and of reducing commitment to interdisciplinary areas by passing responsibilities to another council. The key issue is to get competition to work to generate better quality claims for the importance of different research programmes and, most importantly of all, better outcomes in terms of research and of impact.

The 'Haldane principle' and policy control of research councils

7.50 For much of the 20th Century it has been fully accepted that most Government-funded research should be carried out under the direction of particular Government departments. However, increasing proportions of Government-funded research have been funded by research councils (see paragraph 7.10) under the supervision of the ministry for business (currently the Department for Business, Innovation and Skills (BIS)). Discussion of the actual policies and practices of the research councils and BIS has been coloured by an assumption that the policy should follow what is called the 'Haldane principle', which "states that decisions on general research should be made by researchers, free from political and administrative pressures."[547] This definition of the essential principle has been accepted by Government,[548] although only in relation to research funded by research councils inasmuch as they accept that researchers are best placed to determine detailed priorities. (By definition the determination of technical priorities requires expert knowledge, so this limited construction of the principle would be unreasonable to dispute.) As adopted today, the Haldane principle makes a very limited point about the role of researchers in running research council research programmes and similarly has very limited, if any, bearing on research policy.[549]

7.51 No UK government has ever supported a doctrine that researchers should decide public macro-level research policy. The nearest approach to such a doctrine was in the period 1916-64 when a small fraction of Government-funded research was overseen by research councils reporting to a non-departmental minister. These research councils were made up of independent figures of high standing from the worlds of industry and science. However, Government has never

545 Stirling A (2011) Pluralising progress: from integrative transitions to transformative diversity *Environmental Innovation and Societal Transitions* **1**: 82-8.

546 Currently an industrial perspective dominates the EU policy framework for a European bio-economy. A broad concept is being promoted at the public-relations level, but a narrower one apparently drives the EU's R&D priorities. Schmid O, Padel S and Levidov L (2012) The bio-economy concept and knowledge base in a public goods and farmer perspective *Bio-based and applied economics* **1**: 47-64. However, there was a little room created for research outside the dominant paradigm. Birch K, Levidow L and Papaioannou P (2010) Sustainable capital? The neoliberalization of nature and knowledge in the European "knowledge-based bio-economy" *Sustainability* **2**: 2898-918.

547 Wakeham W (2008) *Review of UK physics*, available at: http://www.rcuk.ac.uk/documents/reviews/physics/review.pdf, p48. See generally Chapter 8 of that document for more information on the 'Haldane principle'.

548 See, for example, the 2010 written ministerial statement on the Haldane Principle to the House of Commons, by the Minister for Universities and Science, David Willetts: House of Commons Hansard (20 December 2010) *c138WS*, available at: http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm101220/wmstext/101220m0001.htm.

549 Department for Business, Innovation and Skills (2010) *The allocation of research science funding, 2011/12 to 2014/15: investing in world-class science and research*, available at: http://www.bis.gov.uk/assets/biscore/science/docs/a/10-1356-allocation-of-science-and-research-funding-2011-2015.pdf, p57.

suggested that decisions about specific research projects (namely those supported by research councils) should not be taken by researchers themselves and peer reviewers.[550]

7.52 In the absence of a clear, enacted principle, the question of who controls research policy, and with what aim, has continuing importance. Clearly expectations adopted by Government play a key role, but Government is not just politicians; it includes scientists, for instance, too.[551] It is highly suggestive, however, in view of our conclusions about the orientation of research policy towards economic growth,[552] that in recent years the research councils have been under the statutory control of BIS. Business therefore clearly plays a very powerful role within Government and research councils that may not be fully recognised, for example through the strong representation of business and industry 'users' of research within the policy structure. Representatives from business or industry are by far the main representatives of 'users' of research within the policy structure. At the time of writing, the TSB, for example, is made up primarily of business people; the councils of the research councils are made up of approximately equal numbers of academics and industry people, with the occasional representative of some other 'user'. The same pattern is usually repeated in many of the advisory panels, boards and groups associated with those organisations.[553]

7.53 Among the research councils, the concerns of other technology users and potential beneficiaries (and losers), and reflection on wider issues generally are addressed by sub-committees and panels constituted for that purpose. The Science and Technology Facilities Council has a largely private sector Economic Impact Advisory Panel, and an Advisory Panel for Science in Society. The experience of controversies around agricultural biotechnology convinced the BBSRC that it needed a forum to discuss societal issues surrounding its research, and it established the Bioscience for Society Strategy Panel which works closely with BBSRC's other Strategy Advisory Panels and reports regularly to the Council's Chief Executive. Its membership includes both academic social scientists and representatives of non-governmental organisations (e.g. the Soil Association). The MRC has an Ethics, Regulation and Public Involvement Committee, members of which include an academic biomedical ethicist. The EPSRC was somewhat later to act, but following a workshop in 2005 involving prominent scientists and social scientists, it established a Societal Issues Panel in 2007. This was to be an important body, reflected in its eminent membership, having the same status as the User Panel and the Technical Opportunities Panel (i.e. advising Council directly).[554]

7.54 There is some evidence that these panels have had a significant influence on the work of the research councils, although this influence is, by its nature, very difficult to ascertain.[555] It is possible to show that a number of more broadly focused activities that might not otherwise have taken place were initiated or commissioned by these panels: in the case of the EPSRC, one can point to a public dialogue about nanomedicine that had a direct influence on the way a funding

[550] The view that they *should* take such decisions has now been explicitly supported in a Written Ministerial Statement. See: House of Commons Hansard (20 December 2010) *c138WS*, available at: http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm101220/wmstext/101220m0001.htm.

[551] See Chapter 6, paragraph 6.57ff.

[552] See paragraph 7.10ff

[553] The membership of the TSB can be found at: http://www.innovateuk.org/aboutus/governingboard.ashx. Information on the general structure of the EPSRC can be found at: http://www.epsrc.ac.uk/about/governance/Pages/default.aspx. EPSRC 'strategic advisory team' membership can be found at: http://www.epsrc.ac.uk/about/governance/sats/Pages/default.aspx. The BBSRC general structure is outlined at: http://www.bbsrc.ac.uk/organisation/structures/structures-index.aspx, while information on its other boards and 'strategy panels' can be found at: http://www.bbsrc.ac.uk/organisation/structures/boards/boards-index.aspx and http://www.bbsrc.ac.uk/organisation/structures/panels/panels-index.aspx, respectively. The MRC's structure is explained at: http://www.mrc.ac.uk/About/Structure/index.htm and its advisory bodies, boards, panels and groups at: http://www.mrc.ac.uk/About/Structure/Advisorybodies/index.htm and http://www.mrc.ac.uk/Ourresearch/Boardpanelsgroups/index.htm.

[554] In 2011, the EPSRC reorganised its advisory structure, replacing its three advisory panels by a single 'strategic advisory network' but retaining some members of the Societal Issues Panel. See: EPSRC (2011) *Strategic Advisory Network*, available at: http://www.epsrc.ac.uk/about/governance/san/Pages/default.aspx

[555] See paragraph 5.12 for reflections on evaluation of qualitative influences more generally.

program was specified.[556] BBSRC and EPSRC jointly commissioned a dialogue around synthetic biology, the results of which were published in 2010 and noted as helpful in the 2012 *Synthetic biology roadmap*,[557] although the real impact on policy awaits further elaboration of themes under the current rubric of responsible innovation. The MRC displays an interest in engagement on its website.[558] BIS has a science and society strategy and also runs the 'Sciencewise Expert Resource Centre for Public Dialogue in Science and Innovation'.[559]

7.55 In discussion of engagement and responsible innovation, the argument is made that engagement is essential at an early stage of development. But what is usually meant is wider engagement, often of a limited sort, in the research policies of parts of governments or the EU. Candour is needed as to just how likely an intervention at this level will in fact change outcomes. The likelihood is that it would do very little. The reality is that key agendas are set elsewhere, such as in industry, and that any particular research council will have minimal influence. In other words, if the desired outcome is a real democratic debate and input into technological decisions, the measures needed to be enacted will be much more radical than anything currently practised. However, 'upstream' engagement can be very valuable to the extent that it can influence positively the quality of claims made by researchers for their research and set the context within which researchers construct justifications for their research. Our conclusion in that **research policy should be framed not by received assumptions but through continuous engagement with a broad range of societal interests and with the involvement of social actors who can bring understanding of these interests to the joint enterprise of constructing a public frame for research policy decisions**.

7.56 There were, in fact, good reasons for Lord Haldane's suggestion that some research that could affect a range of Government departments might be directed by semi-independent figures under a non-departmental minister. There might also be a good case for separating different kinds of research into different bodies, to avoid focusing on economic growth as the central theme of research policy. To achieve this, **consideration should be given to bringing Government research policy and funding bodies under a senior minister (i.e. of Cabinet rank) free from departmental responsibilities to ensure that research properly reflects all the objectives of Government, rather than those of a particular department**. Furthermore, in order to increase openness about the way in which biotechnology policy relates to social values, **there should be a clearly defined, written and published Governmental research policy against which detailed elements of departmental and other public research policies (such as the approach and methods of funding bodies) may be assessed**; this should not be produced, as it was formerly, by the Treasury.

Governance of charities

7.57 In contrast to the business focus of Government, membership of committees and boards within major charities that fund research is overwhelmingly comprised of academics[560] although subcommittees that focus on more technical problems such as drug discovery and technology transfer have a larger number of private sector members. The agenda for charity research funders is clearly focused on a particular social objective (the alleviation of ill health, for example, in contrast to economic growth) and that is bound up with a positive ethical mission.

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[556] See, for example, Engineering and Physical Sciences Research Council (2009) *Nanotechnology programme*, available at: http://www.epsrc.ac.uk/SiteCollectionDocuments/other/LandscapeNano.pdf, p2 and HM Government (2010) *UK nanotechnologies strategy: small technologies, great opportunities*, available at: http://www.bis.gov.uk/assets/goscience/docs/u/10-825-uk-nanotechnologies-strategy, p35.

[557] See paragraphs 6.33 to 6.35.

[558] MRC (2012) *Public engagement opportunities for MRC research students/scientists*, available at: http://www.mrc.ac.uk/Sciencesociety/Publicengagement/index.htm.

[559] For the 'science and society strategy' see: Department for Business, Innovation and Skills (2012) *Science and society*, available at: http://www.bis.gov.uk/policies/science/science-and-society; for BIS's work in public dialogue see: Department for Business, Innovation and Skills (2012) *Public dialogue and policy making*, available at: http://www.bis.gov.uk/policies/science/science-and-society/communication-and-engagement/public-engagement-with-science/public-dialogue-and-policy-making.

[560] We reviewed the five largest UK medical charities by expenditure on research (according to the Association of Medical Research Charities): the Wellcome Trust, Cancer Research UK, the British Heart Foundation, Arthritis Research UK and Breakthrough Breast Cancer.

Thus, while there is a strong emphasis on the ethical conduct of research there is understandably less critical reflection on the overall objectives of the charity as its *raison d'être*.

7.58 All the major charities express an explicit position on the ethical aspects of the research they fund, although none mention 'social' impact specifically. In almost all cases, however, their requirements are couched in terms of adherence to pre-existing ethical and regulatory requirements (such as research ethics committee approval). The Wellcome Trust is an exception here: it publishes a large number of specific policies on various areas of research and, although the majority of the grant requirements relate to ethical and legal review by third parties, the Wellcome Trust has established a Standing Advisory Group on Ethics to consider and advise it on any major ethical issues associated with applications for funding that cannot be addressed through the standard procedures of local ethical review, such as the Home Office Inspectorate (for animal experiments) or research ethics committees (in the case of studies involving human subjects).

Conclusion

7.59 To capture the potential benefits from new discoveries and inventions in the biosciences is a difficult task and one that necessarily involves consideration of the exceptional levels of uncertainty and complexity, as well as the serious ethical and social issues that are involved. A central theme of this Report has been the need to realise that the way issues are framed is a critical influence on how decisions are made. An important purpose of this Chapter, therefore, has been to interrogate the kind of frames within which research policy is debated. The discourse on research policy has, however, shown difficulty engaging seriously with complex economic issues, let alone the closely related ethical and social issues. Part of the reason is doubtless that the main focus of discussion is on publicly-funded research policy, where the central concern is getting money from Government, and where it is felt that a focus on the economic benefits of research is what is required. Our examination suggests that, at least in the UK case, the principles informing Government research policy need to be better developed and made explicit, as a part of the publicly-determined frame for more detailed policy decisions.

7.60 In the absence of such principles, research policy is in danger of being determined through closed engagement between scientific, political and industrial elites, and, in the absence of unambiguous evidence, being framed by self-reinforcing but unexamined assumptions according to sectional values (such as economic growth, scientific excellence, shareholder value). These may participate in, but certainly do not exhaust, the social function of research policy. Government and research councils are trying to address this through efforts at broader engagement, some of which are now firmly institutionalised. However, this does not appear to be reflected in policy discourse at the highest level, which remains framed by traditional assumptions rather than social values, articulated principally within the economic growth paradigm and identified with particular technological trajectories.[561] To be clear, it is not merely that the concentration on economic growth obscures other values that are highly relevant, but that the basis for expecting economic growth from investment in biotechnologies is weak. In any case, the sort of engagement that is carried out, though valuable, tends only to inform decision making with one further dimension of proxy evidence, rather than to alter the nature or frame of decision making. More radical measures are therefore required.

7.61 The conventional framing of research policy is predisposed to expect benefits and to assume that securing them is a matter of funding the right area, one that therefore asks only what areas of research to support. Asking questions about who controls research, how research agencies come up with research priorities, whether they are consistent with our understanding of uncertainty, whether they are informed by past experience of such policies and whether they

[561] Evidence can be found in policy statements and speeches by Government Ministers, including those of the Prime Minister. See, for example, the 1 August speech on global health policy by the Prime Minister, available at: http://www.number10.gov.uk/news/global-health-policy.

aim to achieve or reflect consensus, suggests that it might be more appropriate to think of research policy as a process of encouraging the generation of new ideas and then of applying more reflective and broad-based ways of filtering and steering the development of those ideas. Funding conditions thereby act as one of a number of evolutionary constraints on technology development, rather than as an excuse to 'drive through' a chosen technology, riding roughshod over the uncertainties that must be confronted, including the uncertainty that a rejected alternative might, by an alternative path, have offered a more socially desirable outcome.