

Interplay of Freedom of Scientific Research and Political Demands

Professor Sir Peter Knight FRS

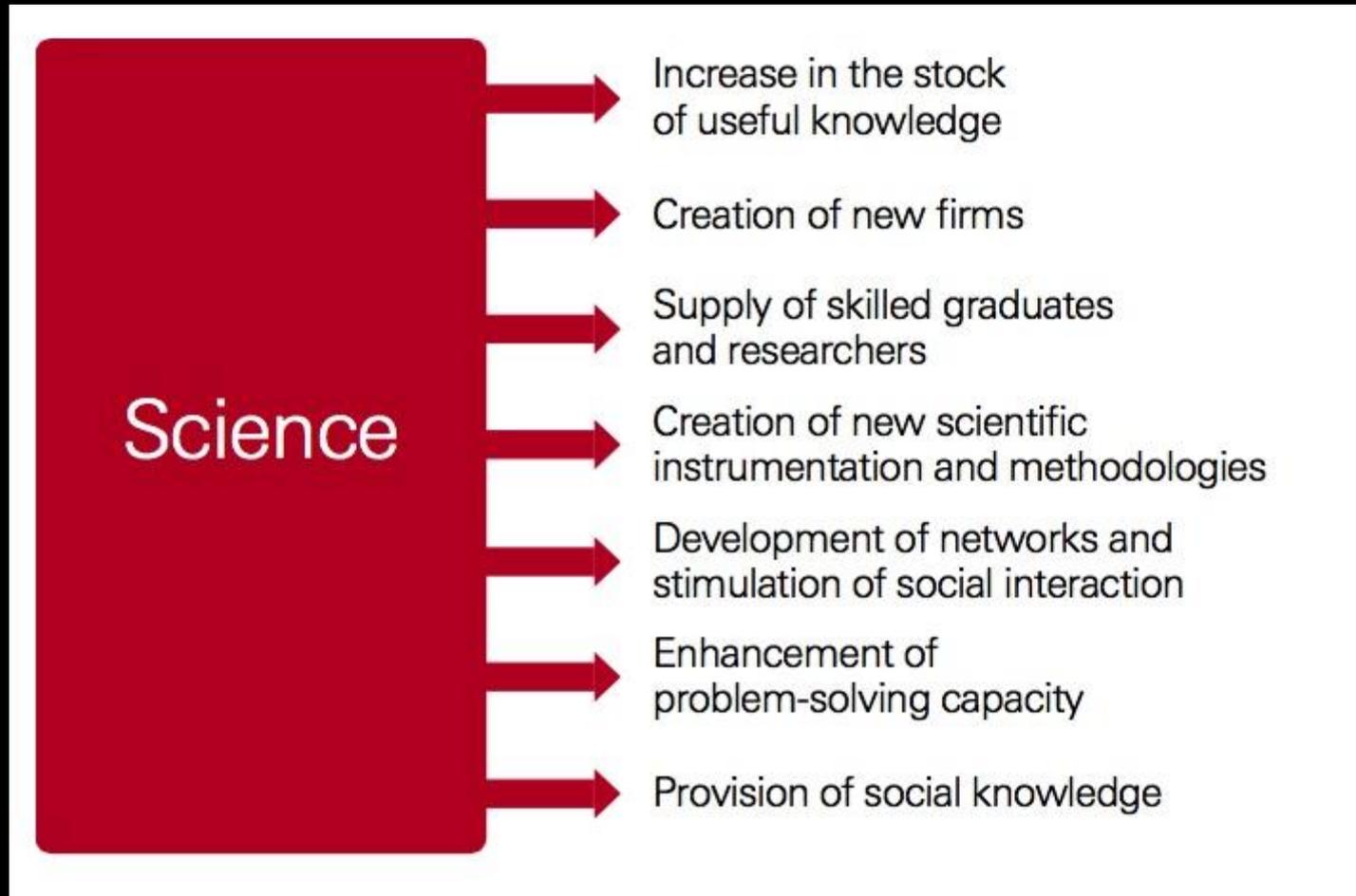
Imperial College London

London SW7 2AZ, UK

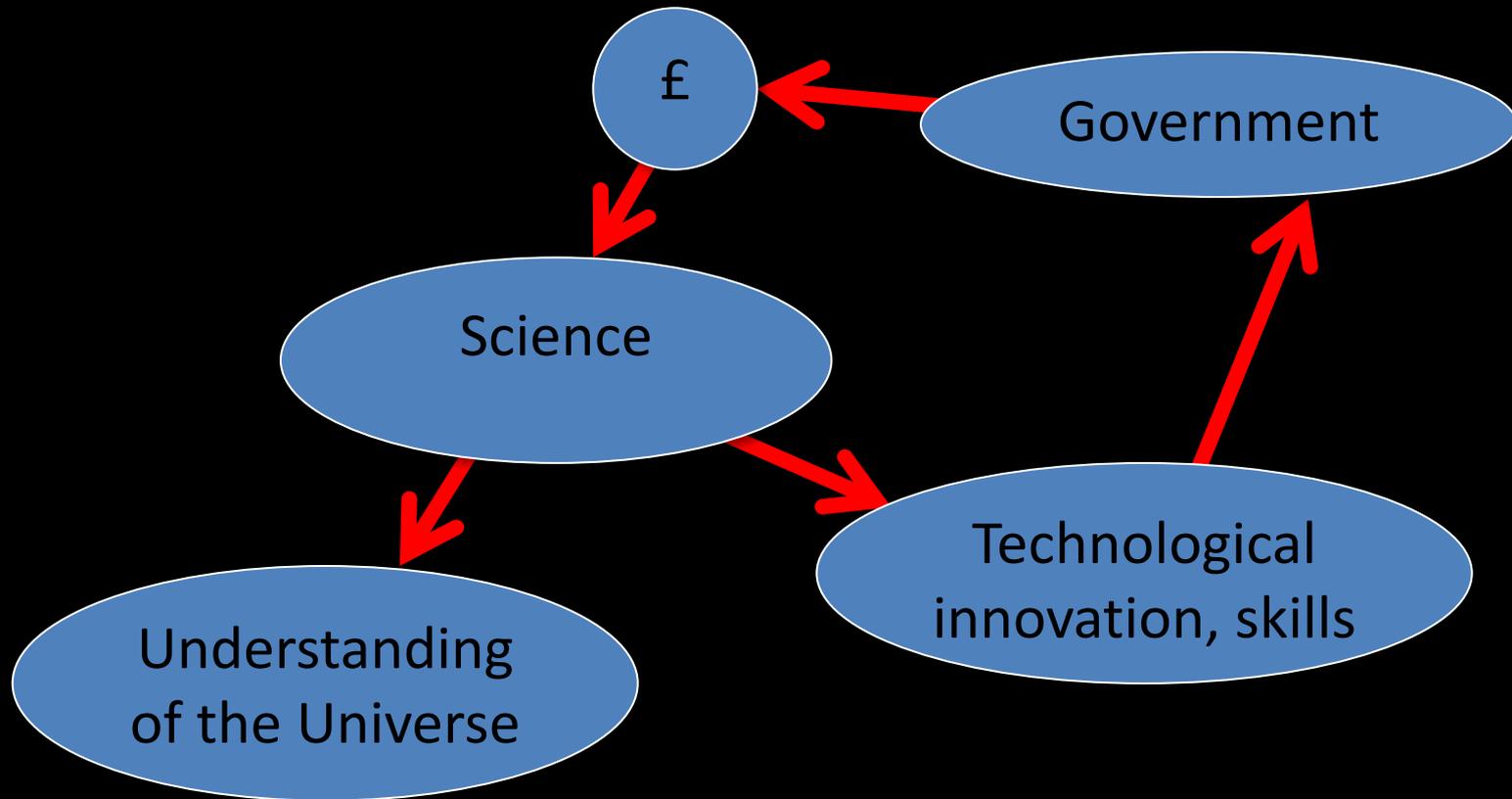
menu

- What motivates scientists
- What motivates governments
- Discovery, translation and exploitation
- Evidence-based policy
- The changing global landscape

What does science do?: the balance between acquiring new knowledge and applying it-*RS Sci Century*



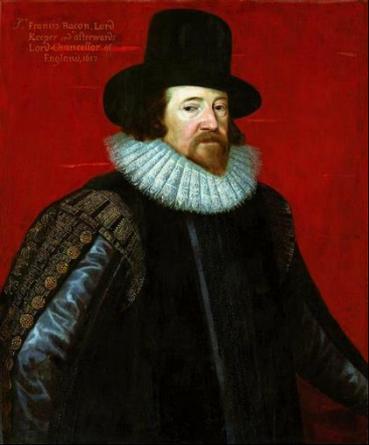
Why does government support science?



Coordination of research



- The UK Nurse Review
- “reform is needed to put science at the heart of government”
- Nurse admits this may be seen as “a deal with the devil”
- Risk of putting government at the heart of science....



Its not a new concern



- Francis Bacon argued that science improved learning and knowledge which “leads to the relief of man’s estate”
- Robert Hooke maintained that “discoveries concerning motion, light, gravity and the heavens helped to improve shipping, watches and engines for trade and carriage”
- On the other hand: Faraday's purported reply to Gladstone (then the UK’s finance minister) when asked of the practical value of electricity: “Why, sir, there is every probability that you will soon be able to tax it.”



The encroachment of academic freedom



- Soviet controls of science and Trofim Lysenko: 3,000 biologists imprisoned or killed
- Science as a servant of the state (J D Bernal)
- The defence of liberty to pursue science for its own sake and to advance knowledge (Michael Polanyi, 1936) and the Society for Freedom in Science
- Policy and evidence: tobacco and cancer; climate change; GM crops; effect of magnetic fields on health and MRI scanners; effect of RF from cell phones.....

The encroachment of academic freedom

- Decision making and evidence-based policy
- [Government Ministers] should certainly not seek selectively to pick pieces of evidence which support an already agreed policy, or even commission research in order to produce a justification for policy: so-called "policy-based evidence making". **“Where there is an absence of evidence, or even when the Government is knowingly contradicting the evidence—maybe for very good reason—this should be openly acknowledged”**: Paragraph 89, *House of Commons Science and Technology Committee: Scientific Advice, Risk and Evidence Based Policy Making*

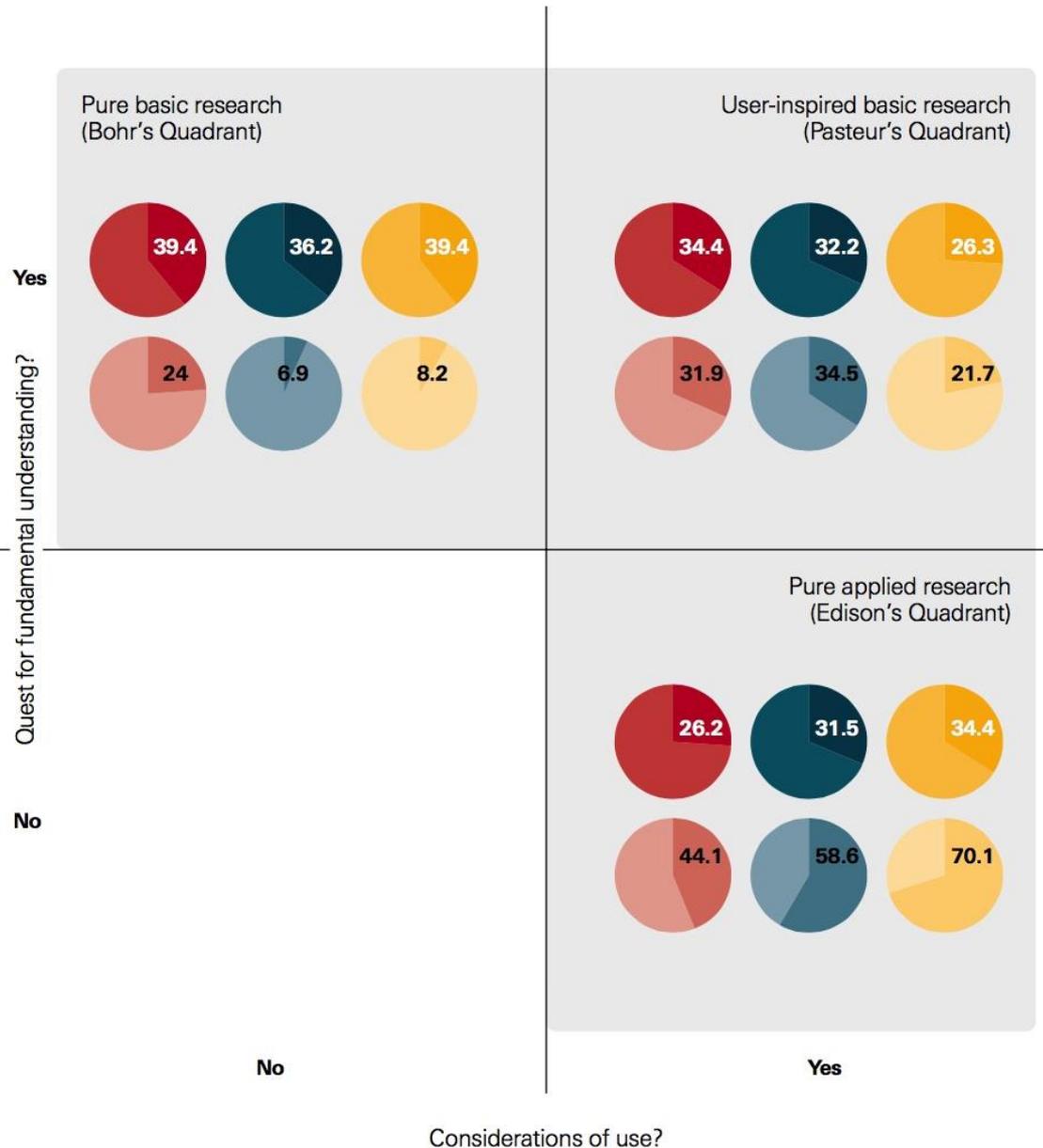
Donald Stokes:

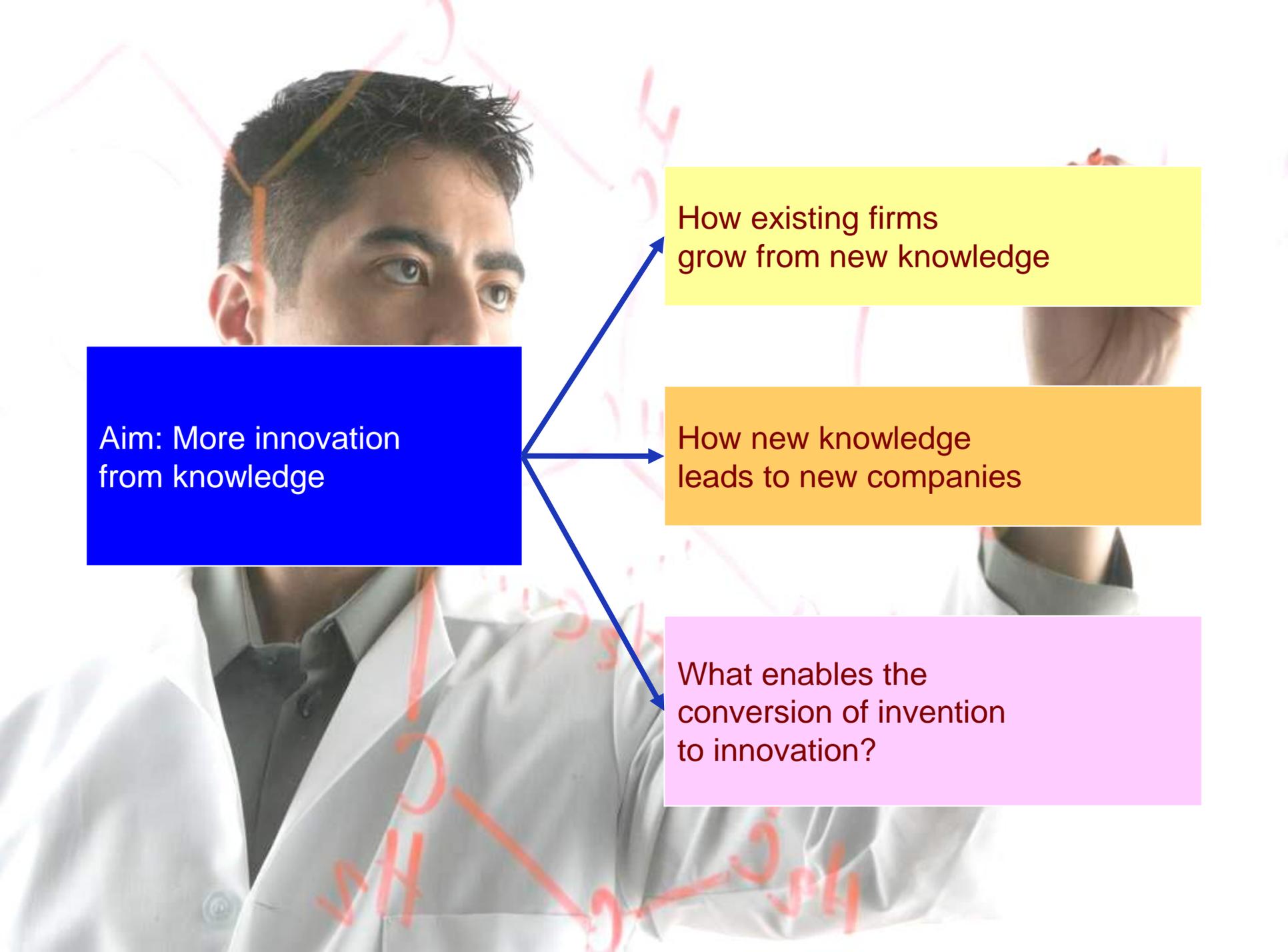
‘Pasteur’s Quadrant’, which he contrasts with the fundamental research of scientists like Niels Bohr or the purely applied research of Thomas Edison. Of basic research funded by Research Councils in 06/7, 60% fits into Pasteur’s Quadrant. This emphasis is also reflected in the results of a 2009 UK Innovation Research Centre survey of 22,000 academics – although results vary by discipline

Key

- Physics, Mathematics
- Biology, Chemistry, Veterinary science
- Social sciences
- Arts and Humanities
- Engineering, Materials science
- Health sciences

Figure 1.8 How UK academics classify their own work⁴²





Aim: More innovation
from knowledge

How existing firms
grow from new knowledge

How new knowledge
leads to new companies

What enables the
conversion of invention
to innovation?

Haldane



Department of Scientific and Industrial Research (DSIR) established in 1915 with an advisory council under the Privy Council and the Lord President. The idea was extended by the recommendation of Lord Haldane in 1918 that the Medical Research Council be re-established on similar lines.

R.B. Haldane was a Liberal (and later Labour) politician, lawyer and intellectual, who was twice Lord Chancellor.

Roosevelt

PRESIDENT ROOSEVELT'S LETTER

THE WHITE HOUSE
Washington, D. C.
November 17, 1944

DEAR DR. BUSH: The Office of Scientific Research and Development, of which you are the Director, represents a unique experiment of team-work and cooperation in coordinating scientific research and in applying existing scientific knowledge to the solution of the technical problems paramount in war. Its work has been conducted in the utmost secrecy and carried on without public recognition of any kind; but its tangible results can be found in the communiques coming in from the battlefronts all over the world. Some day the full story of its achievements can be told.

Vannevar Bush:

in a sense the first US Presidential Science Advisor

The Endless Frontier



- In a letter dated November 17, 1944, President Roosevelt requested my recommendations on the following points:
- (1) What can be done, consistent with military security, and with the prior approval of the military authorities, to make known to the world as soon as possible the contributions which have been made during our war effort to scientific knowledge?
- (2) With particular reference to the war of science against disease, what can be done now to organize a program for continuing in the future the work which has been done in medicine and related sciences?
- (3) What can the Government do now and in the future to aid research activities by public and private organizations?
- (4) Can an effective program be proposed for discovering and developing scientific talent in American youth so that the continuing future of scientific research in this country may be assured on a level comparable to what has been done during the war?

Statement of values?

“Without scientific progress no amount of achievement in other directions can insure our health, prosperity, and security as a nation in the modern world.”

Vannevar Bush,
Science: The Endless Frontier, 1945

He really did say insure and not ensure

Hailsham

- “Ever since 1915 it has been considered axiomatic that responsibility for industrial research and development is better exercised in conjunction with research in the medical, agricultural and other fields on what I have called the Haldane principle through an independent council of industrialists, scientists and other eminent persons and not directly by a Government Department itself. “
- David Edgerton, 2009

John Denham

- John Denham, then UK Innovation, Universities and Skills Minister, said that the 'fundamental elements of Haldane' remain valid: that researchers are best placed to determine detailed priorities; that the Government's role is to set the over-arching strategy; and that the research councils are 'guardians of the independence of science'
- (Speech to Royal Academy of Engineering, 19 February 2009).

Letter to *The Times*, August 27, 2007

Sir, Richard Horton, editor of *The Lancet*, says “the best science more and more depends on international collaborations. No single nation can stand alone successfully in its science policy.” I couldn’t agree more.

What I would disagree with is his assertion that UK policymakers are being driven by “short-term political concerns”. The Government fully recognises the importance of international collaboration on scientific research. In fact, recent figures show that nearly 40 per cent of UK scientific output over the past five years involved international collaboration – a 50 per cent increase compared with the previous five years.

Britain has a proud tradition of excellence in science and we must ensure that continues.

We need to be world class at both basic research and translating the outcomes of that research. However, there should be no suggestion that basic research will suffer as a result of the drive to achieve the more effective use of research for Britain. That the Government has doubled science spending in real terms in the last decade serves as testament to our commitment to scientific research.

JOHN DENHAM

Secretary of State for Innovation, Universities and Skills

Daresbury Laboratory



“We feel that at this time [Nov 07] bold moves are necessary, and indeed these have been proposed by the Executive...in particular:

- a) The closure of DL is unavoidable*
- b) Any future STFC spend at the Daresbury Campus should not lead to replication or extension of the activities that have been taking place at DL.”*

(STFC Science Board Minutes)

STFC’s plans for DL (following closure of SRS in 2008) were vetoed by DIUS.

UK Innovation and Research Strategy

Dec 2011 - key measures give some idea what is expected of science community

- Monitoring the UK's performance in terms of research outputs, and maintaining our reputation for excellence
- Delivering Government investment commitments in High-Performance Computing and e-infrastructure, graphene etc.
- Monitoring the proportion of UK research outputs that have an international co-author, the quality of these collaborations, and the volume of R&D investment leveraged from abroad
- Increasing the successful engagement of UK universities and business with EU funding programmes
- Increasing the number of high quality inward investment projects from overseas
- Increasing the availability of public data

Getting Government aligned with the science community...involve the Finance Minister!



“When money is short, we should ruthlessly prioritise those areas of public spending which are most likely to support economic growth, including [...] our science base and the skills and education of citizens.”

George Osborne, Spending Review 2010

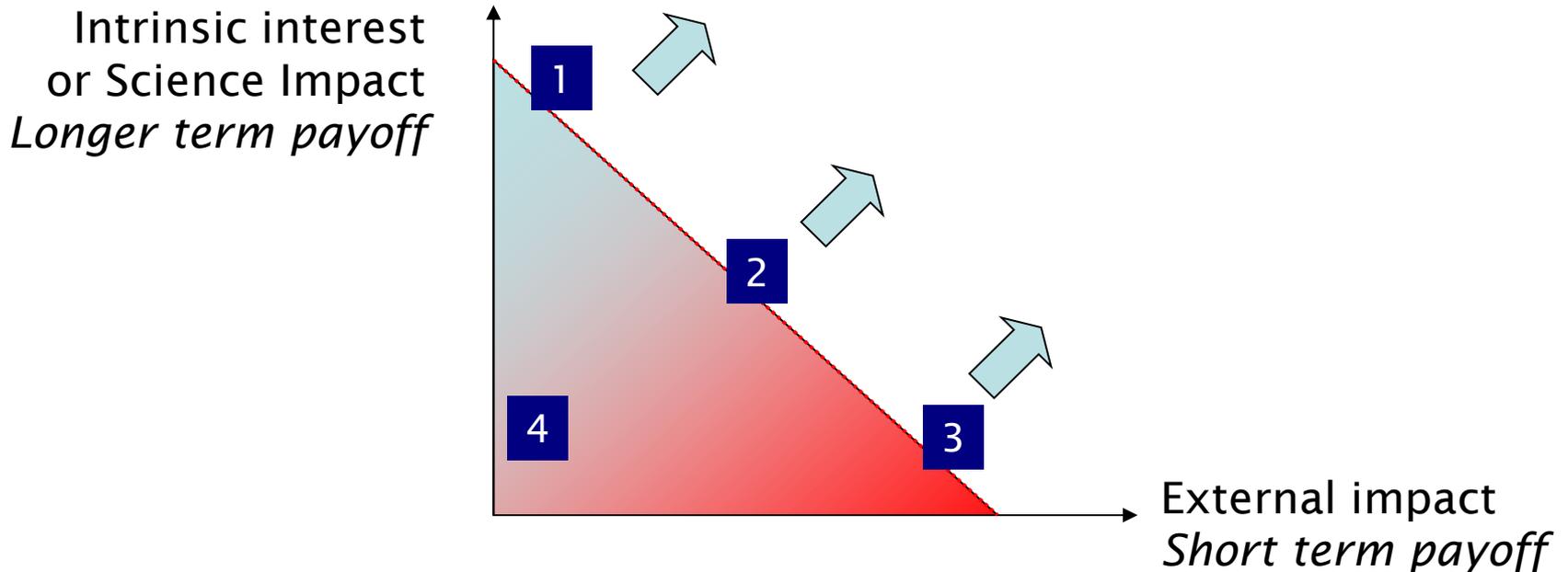
“My children are eight and ten years old. I don’t want them to read about how China has just built the world’s most advanced aircraft; how India is leading the globe in computer design; and have to say to my children: ‘That used to be Britain’.

I want Britain to be the home of the greatest scientists, the greatest engineers, the greatest businesses – a land of innovators.”

George Osborne, 3 October 2011

Proteins or protons?

- How to compare projects in very different areas?



- Viki Weisskopf's diagram [*Physics Today*, May 1967]
 - Good proposals lie at (or beyond) the boundary
 - Goal is to push the boundary upwards and to the right

World Class Science

Fund the *best* research, working for the community as a whole

Adventurous

not

“solid”

Doing new things

not

doing the same thing
with smaller errors

Influencing a project

not

tagging along

Focused on excellence

not

make sure we are doing
a bit of everything

A potential set of criteria

- Scientific impact and timeliness
 - Does it offer the potential for breakthroughs in its area?
 - “tear up the textbooks?”
- Economic impact
- Societal impact
 - Education, outreach, training/skills, match to public policy priorities
- Level of leadership or impact
- Breadth of community served
- Risk
- Match with the views of other research councils and communities
- Coherence and synergy across programme
 - does it enhance and/or exploit existing facilities or subscriptions
 - does it exploit our unique capabilities and/or skills base
- The European context, need for quid pro quo?
- The global context, India/China etc

Saying no

- Resources are limited
- We will need to say “no” to good science
 - This is a real shame
 - but we can’t borrow (or print) money



And if we’re going to say “no”

- Best to say “no” sooner
- Best to say “no” to whole projects

Thoughts on how to do more?

Peer review and advice

- Our long-term ability to generate more support depends on more than just good science. We must also show that
 - we can plan
 - we can prioritise
 - we can stop things (even when they are good)
 - we can be imaginative
 - we can “do more”
 - we are relevant
(economic impact, society, education...)

This is what many Science and Technology Strategies aim to do

Public perception of Universities?



Vice chancellors' group Universities UK (UUK) says most people under-estimate the value of universities.

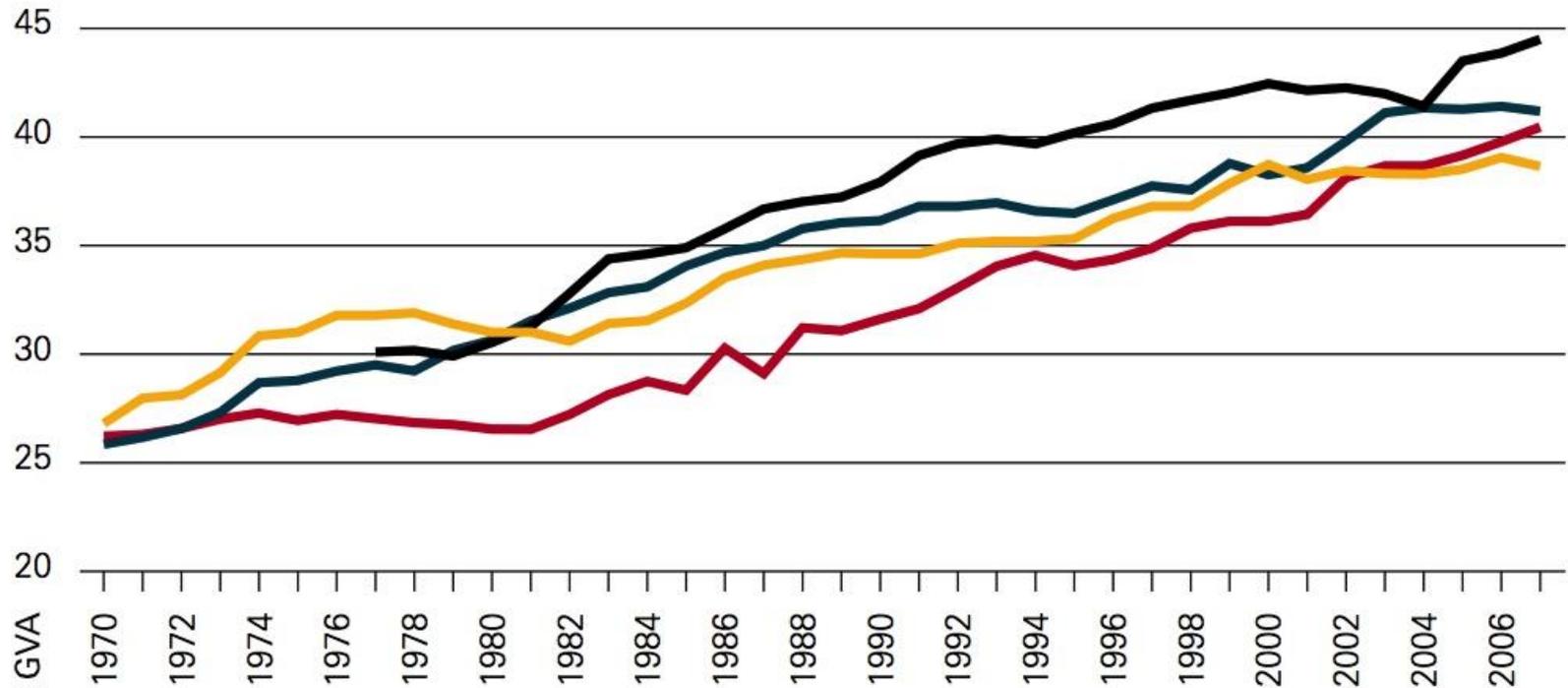
It commissioned a survey looking at people's perceptions and said it found people "vastly underrated" the economic impact of universities.

A fifth of those asked put the economic contribution of the sector at £100m a year, while a further 10% said it was zero.

In reality, UUK says, universities contribute around £31bn each year to the nation's economy directly and £59bn indirectly.

Knowledge-based industry: *RS Sci cent*

Figure 1.3 Knowledge-intensive services and high-tech manufacturing as percentage gross value added (GVA), 1970-2007¹⁴



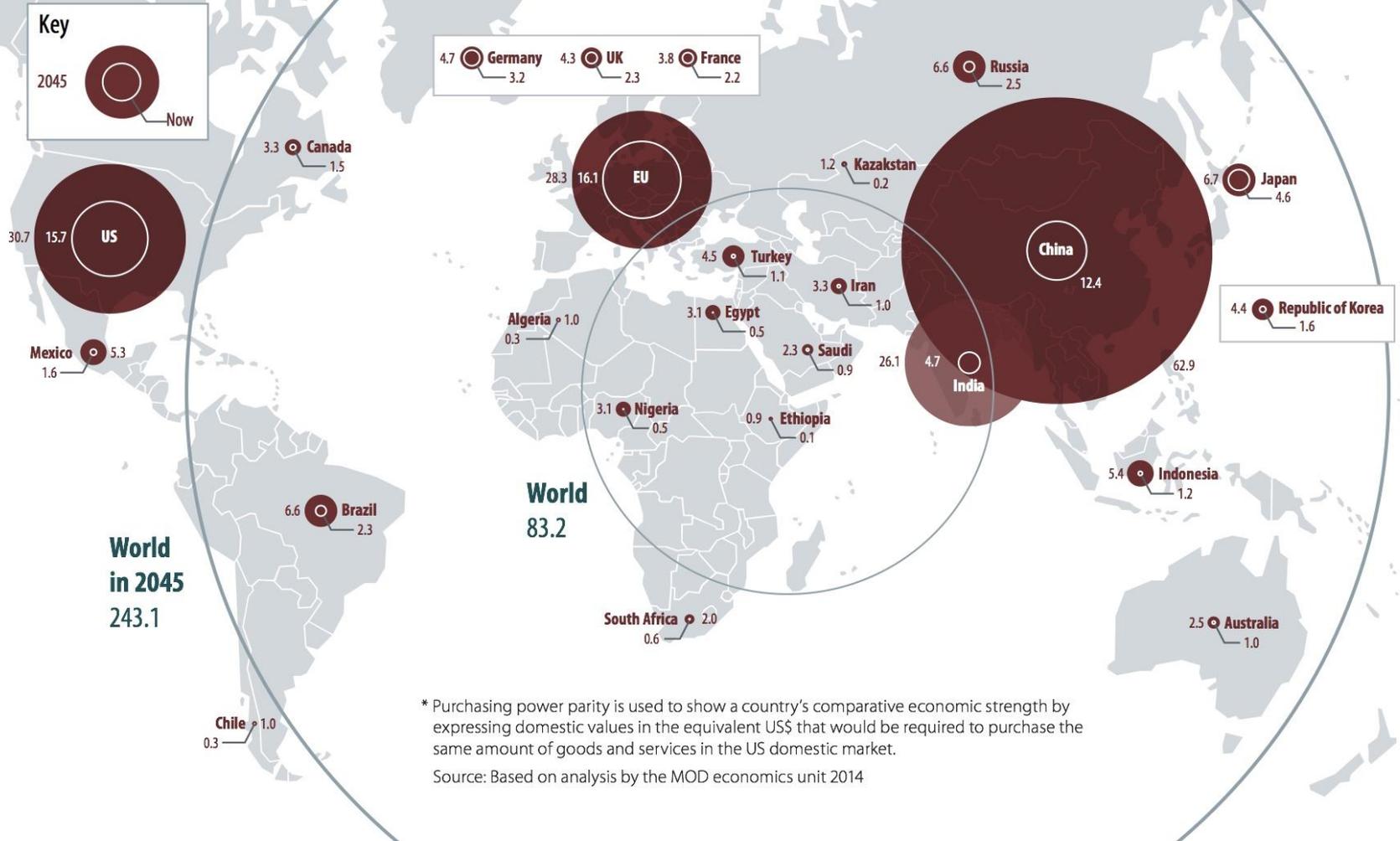
Key

- UK
- Germany
- France
- USA

The changing world

Economic growth

Gross Domestic Product (adjusted for purchasing power parity)*, expressed in US\$ trillion at 2012 values.



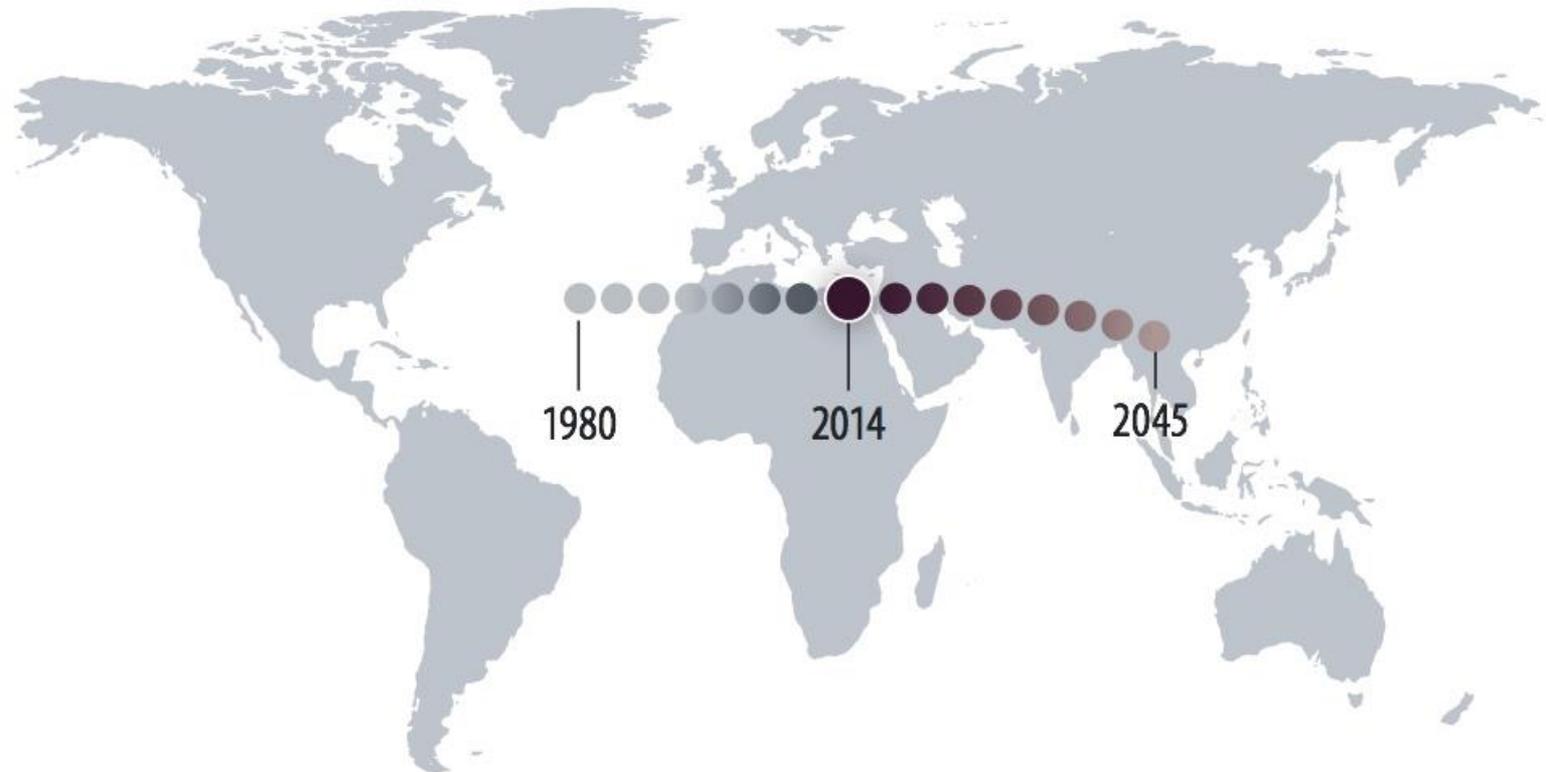
* Purchasing power parity is used to show a country's comparative economic strength by expressing domestic values in the equivalent US\$ that would be required to purchase the same amount of goods and services in the US domestic market.

Source: Based on analysis by the MOD economics unit 2014

The changing world

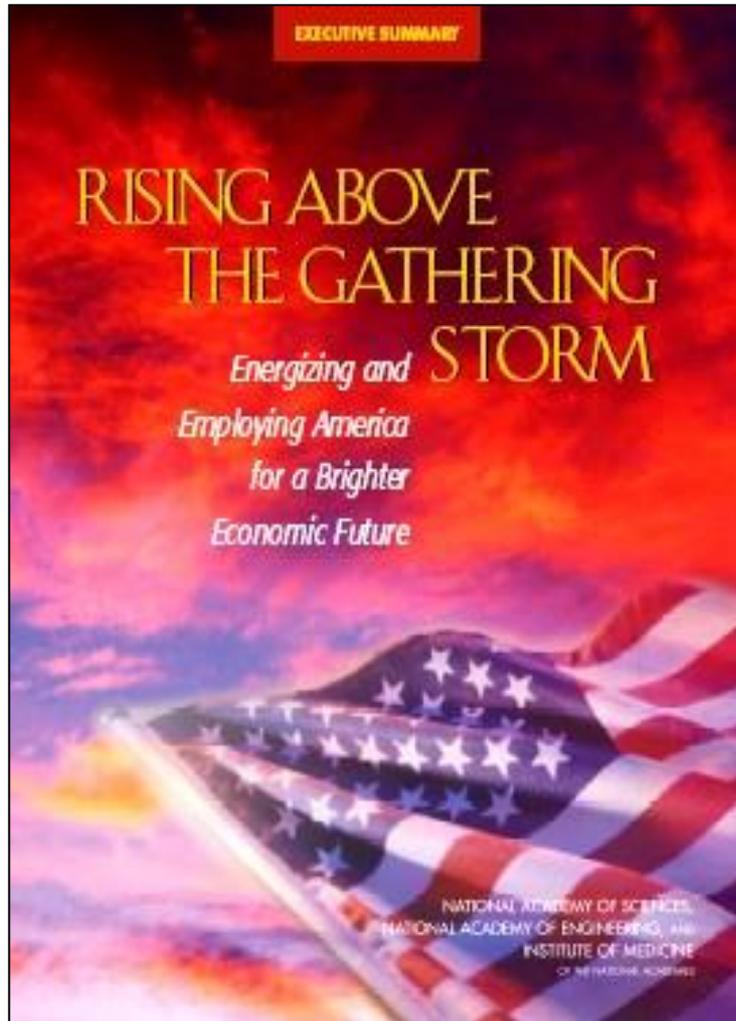
Global economic centre of gravity shifting

The steady rise of emerging economies in Asia will cause the world's economic centre of gravity – the average location of economic activity by GDP – to continue its move eastwards.



Source: Quah, D. (2011), 'The Global Economy's Shifting Centre of Gravity' (adapted by DCDC)

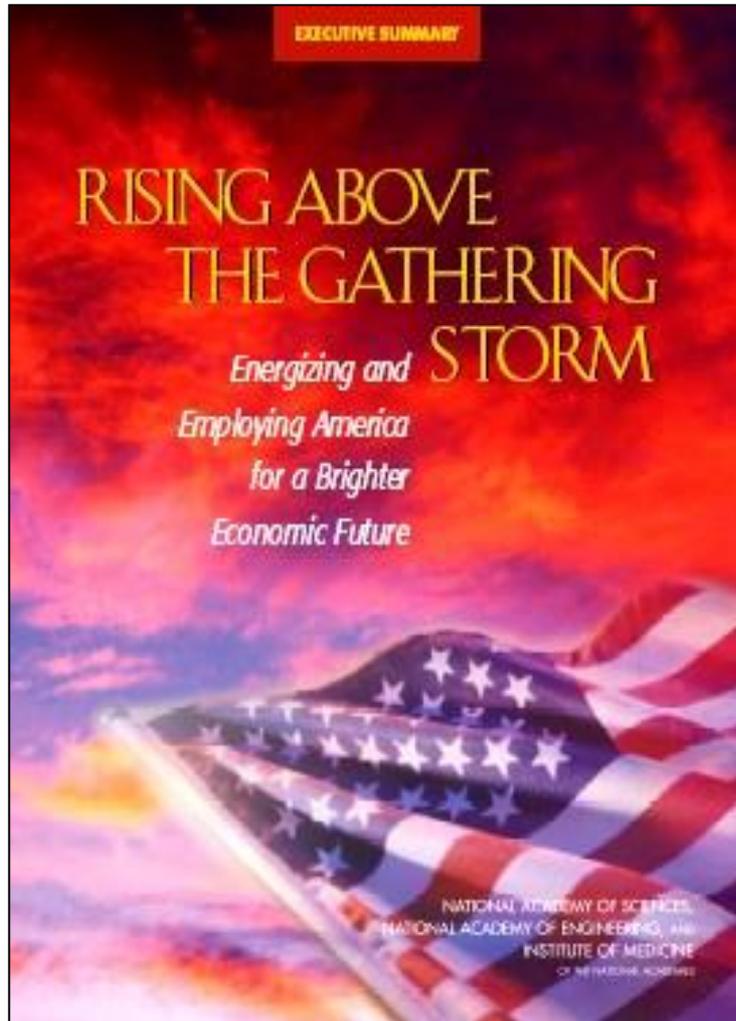
National Responses to the Global Marketplace



“In a world where advanced knowledge is widespread and low-cost labour is readily available, U.S. advantages in science and technology have begun to erode. A comprehensive and coordinated federal effort is urgently needed to bolster U.S. competitiveness and pre-eminence in these areas. “

This led to a congressionally requested report

National Responses to the Global Marketplace



Report makes four recommendations along with 20 implementation actions that federal policy-makers should take to create high-quality jobs and focus new science and technology efforts on meeting the nation's needs

Increase America's talent pool by vastly improving K-12 mathematics and science education;

Sustain and strengthen the nation's commitment to long-term basic research;

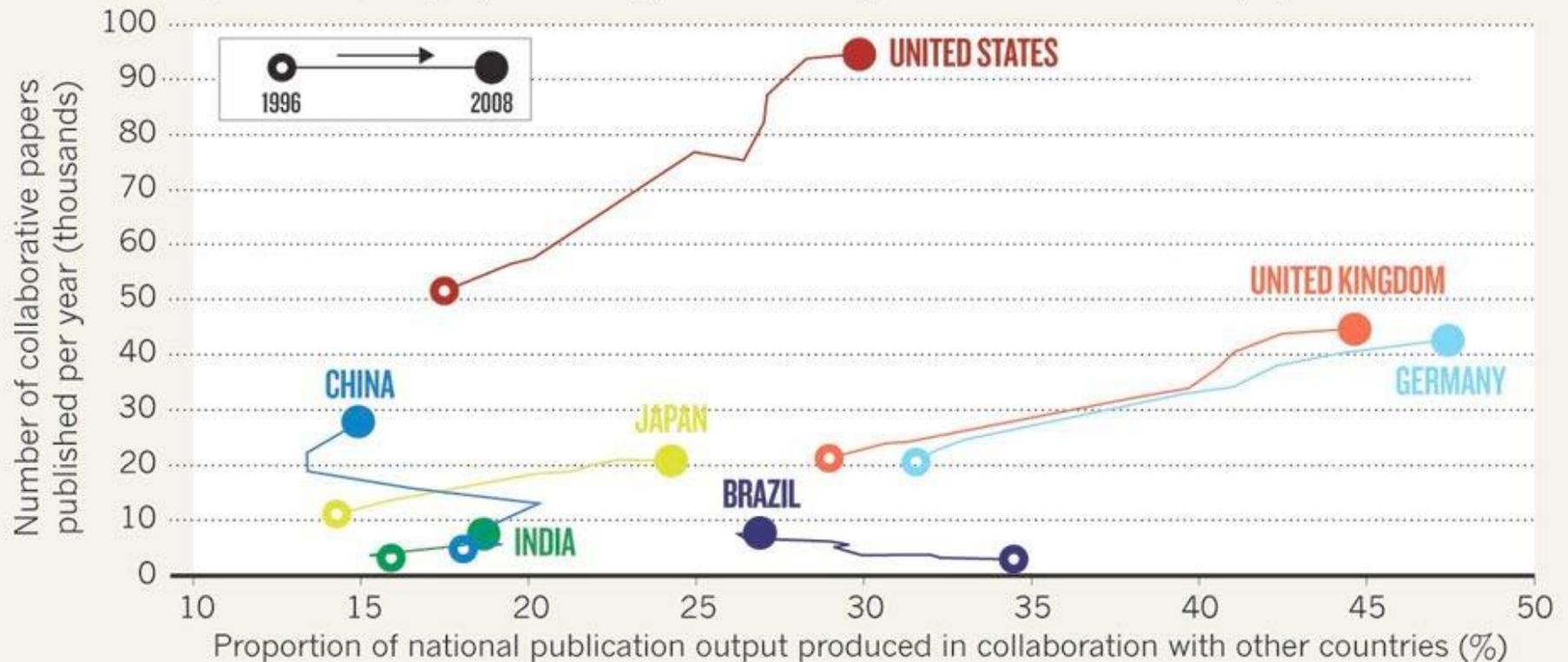
Develop, recruit, and retain top students, scientists, and engineers from both the U.S. and abroad; and

Ensure that the United States is the premier place in the world for innovation.

need for international presence

A WORLD OF COLLABORATION

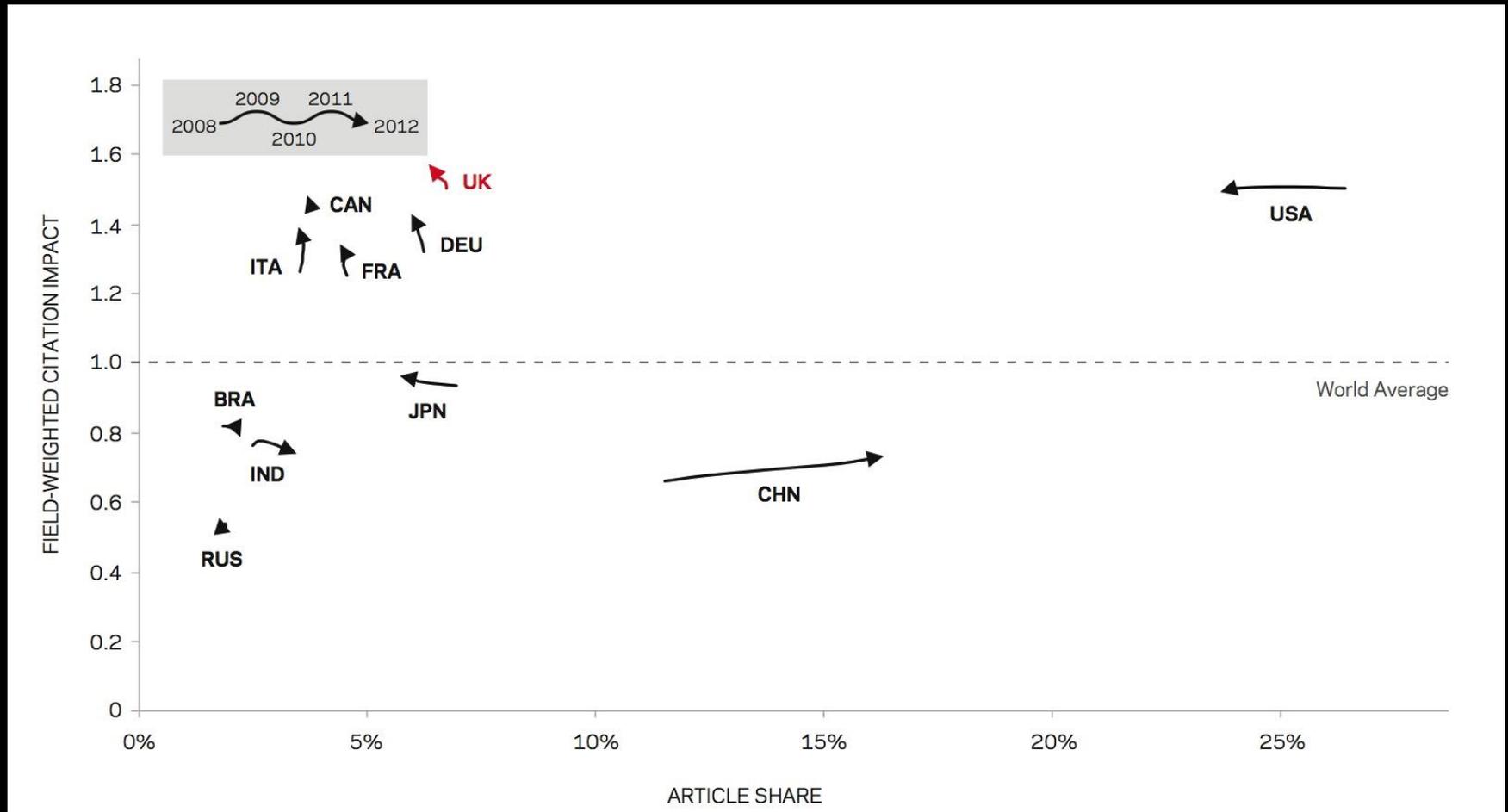
In developed countries, collaborative papers increased as a proportion of national output. In some fast-developing countries, the proportion dropped even though the absolute number of papers rose.



R and D spend as % of GDP

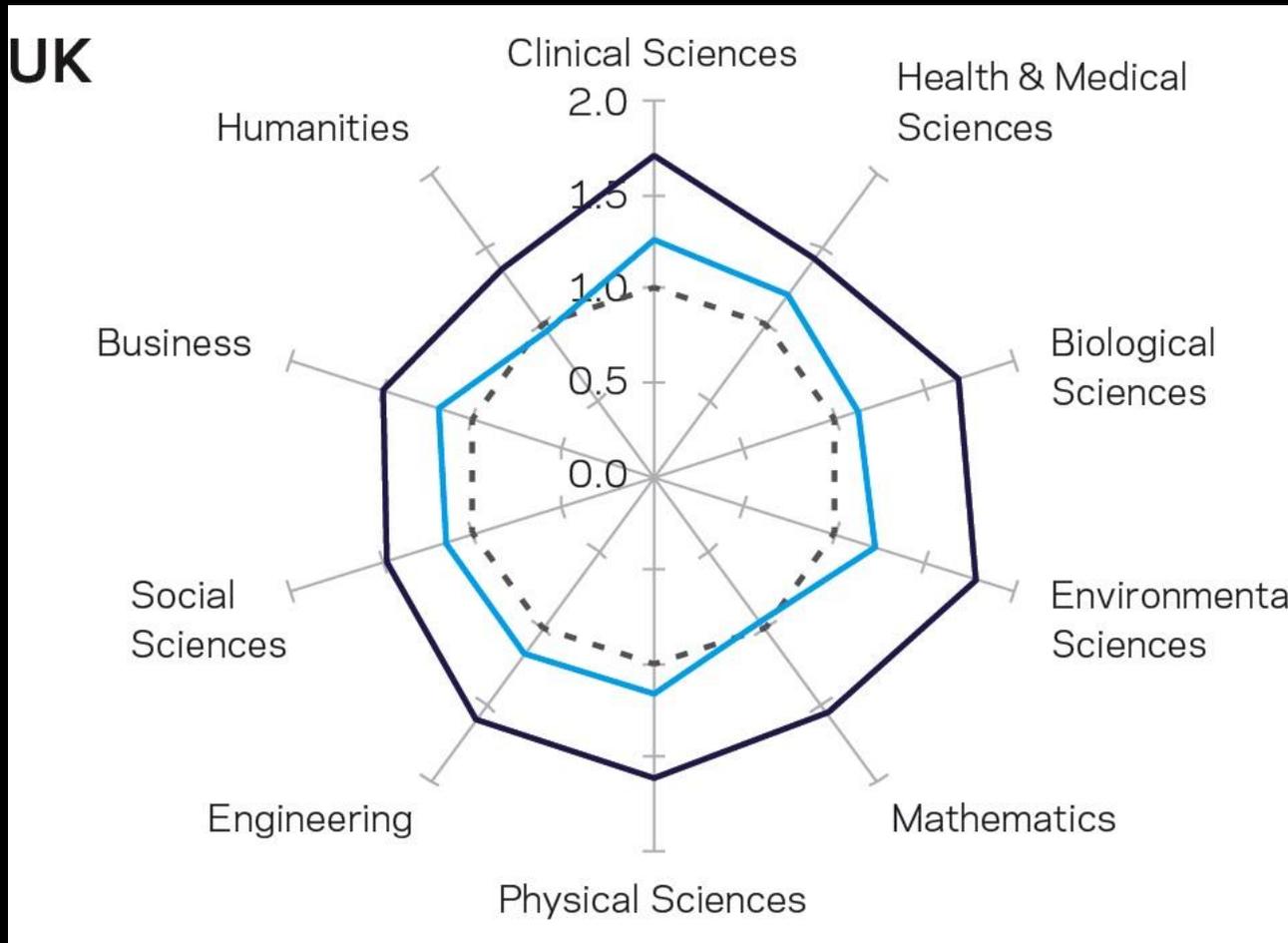


Nations and impact of output

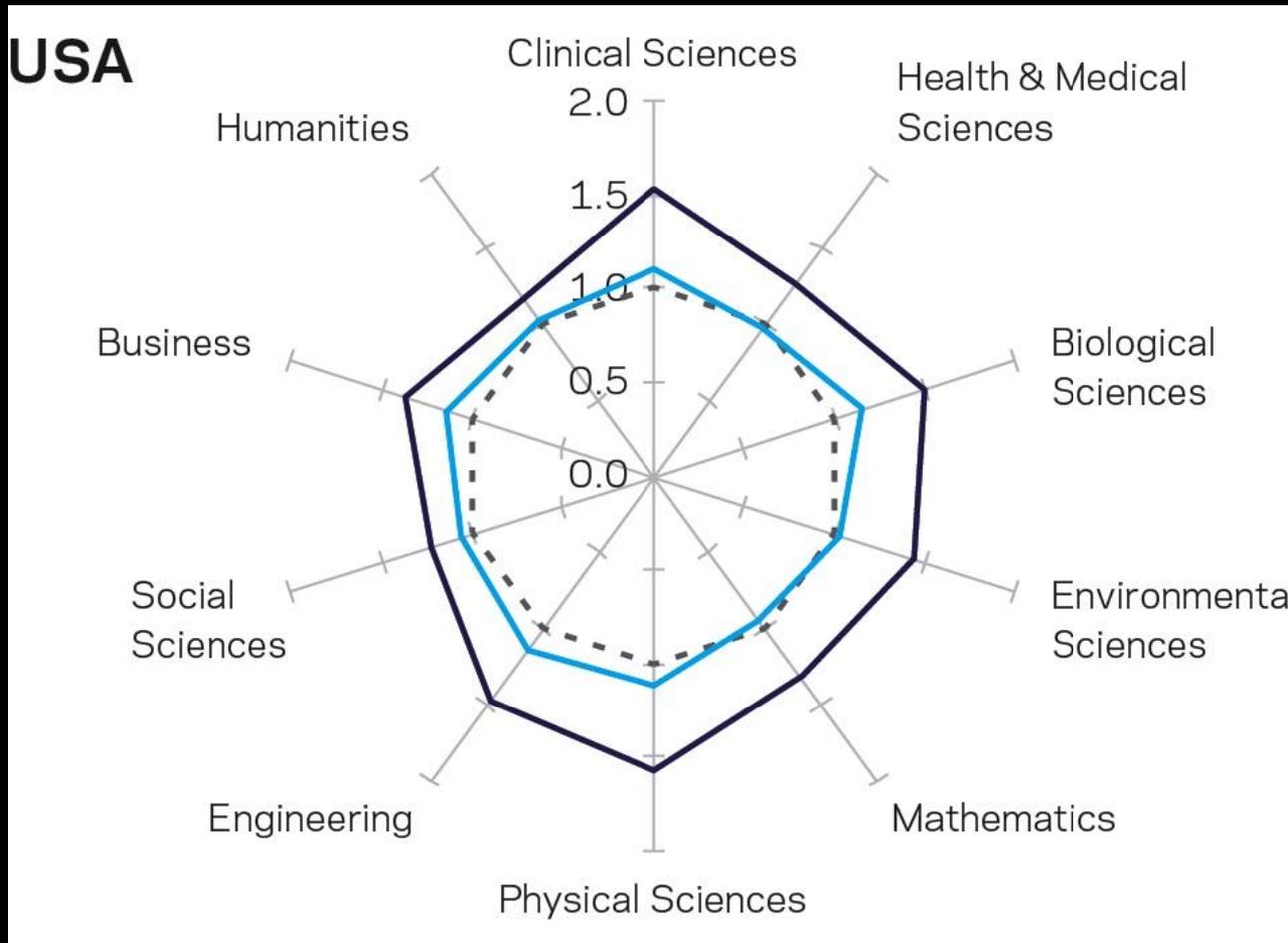


Field-weighted citation impact – ratio of total citations actually received to the total citations that would be expected based on the average of the subject field.

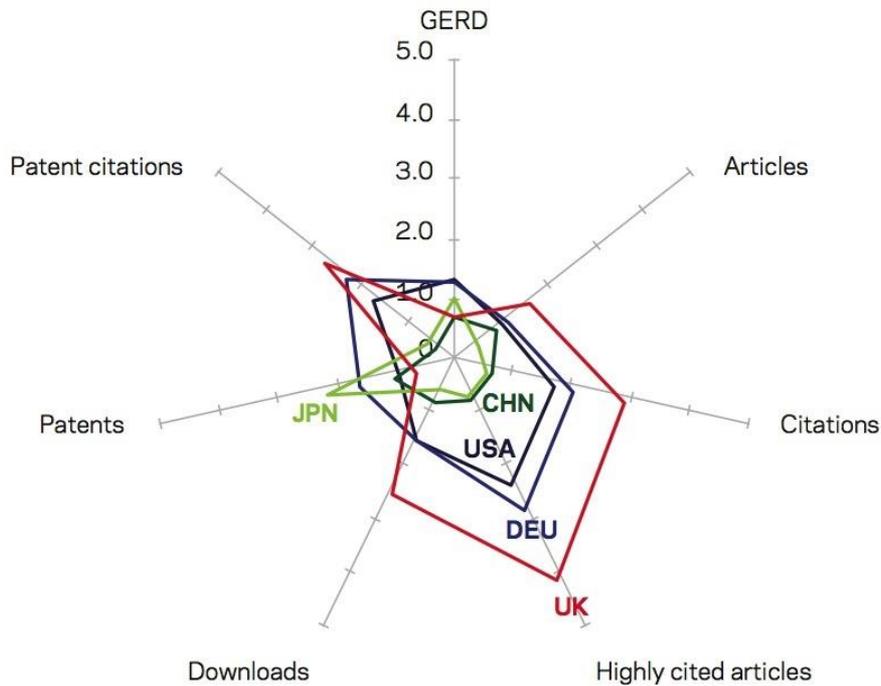
Field-weighted citation impact (FWCI) and field-weighted download impact (FWDI) for selected countries across ten research fields in 2012. For all research fields, a field-weighted citation or download impact of 1.0 equals world average in that particular research field.



Field-weighted citation impact (FWCI) and field-weighted download impact (FWDI) for selected countries across ten research fields in 2012. For all research fields, a field-weighted citation or download impact of 1.0 equals world average in that particular research field.



Share of outputs



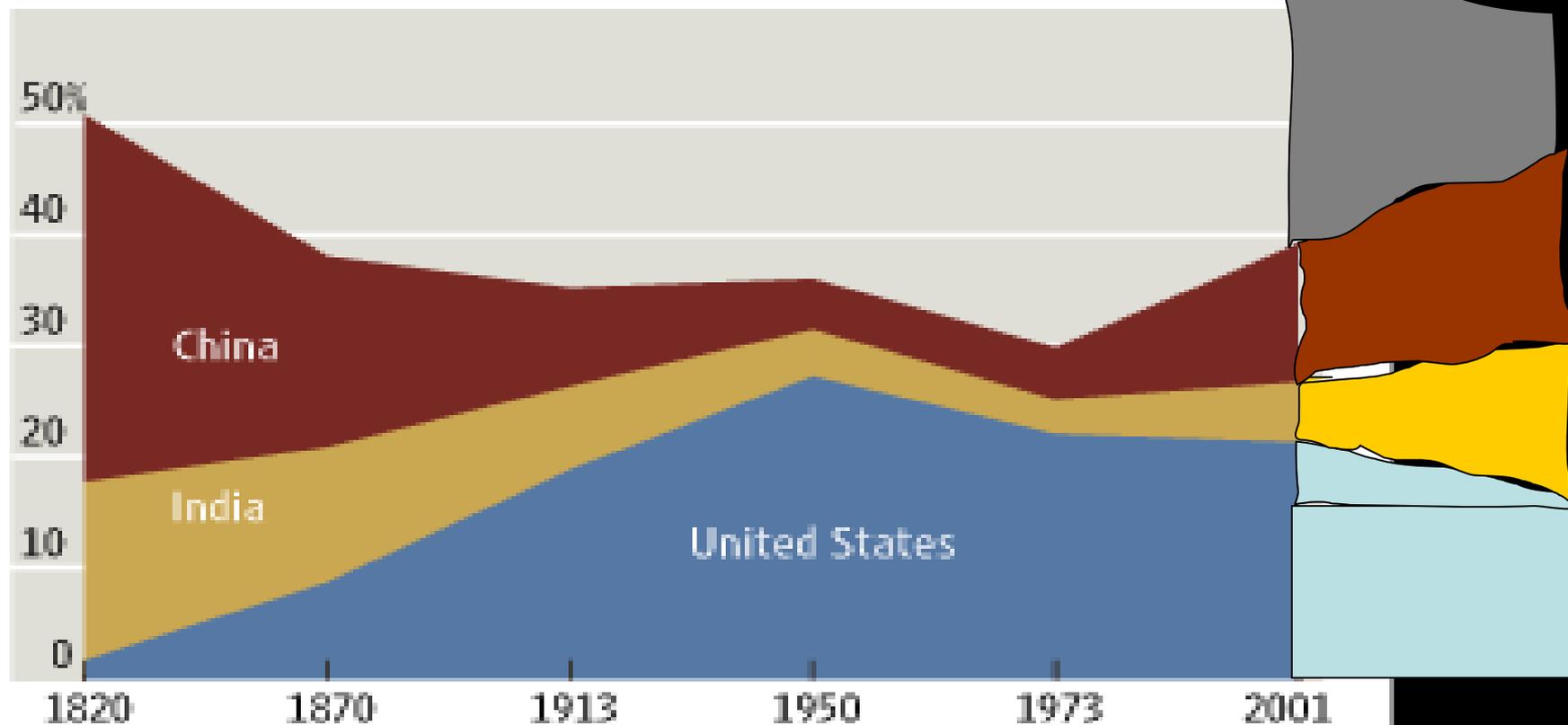
Panel B: Relative share of key input and output indicators per researcher.

All data are expressed as world share divided by world share of researchers, giving a relative index where a value of 1.0 implies that, per researcher, the indicator is equal to the world average.

So what

Output and Outlook

Share of World GDP, 1820-2001



Source: Angus Maddison, "The World Economy: Historical Statistics," OECD, 2003

Cross Disciplinary working – new models

RCUK Strategic Themes*

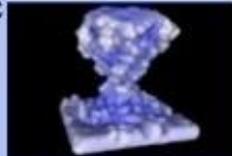
ENERGY
£319M

EPSRC lead
BBSRC
ESRC
NERC
STFC



**NANOSCIENCE
THROUGH
ENGINEERING TO
APPLICATION**
£51M

EPSRC lead
BBSRC
ESRC
NERC
STFC
MRC



**LIVING WITH
ENVIRONMENTAL
CHANGE** £363M

EPSRC
BBSRC
ESRC
NERC lead
STFC
MRC
AHRC



**AGEING: LIFE
LONG HEALTH &
WELLBEING**
£486M

EPSRC
BBSRC
ESRC
NERC
STFC
MRC lead
AHRC



**DIGITAL
ECONOMY**
£53M

EPSRC lead
AHRC
ESRC
MRC



**GLOBAL
UNCERTAINTIES**
£114M

EPSRC
BBSRC
ESRC lead
NERC
STFC
MRC
AHRC



Values are investment over CSR period

An aside

- An example of how I was able to link government desires with scientific aspirations

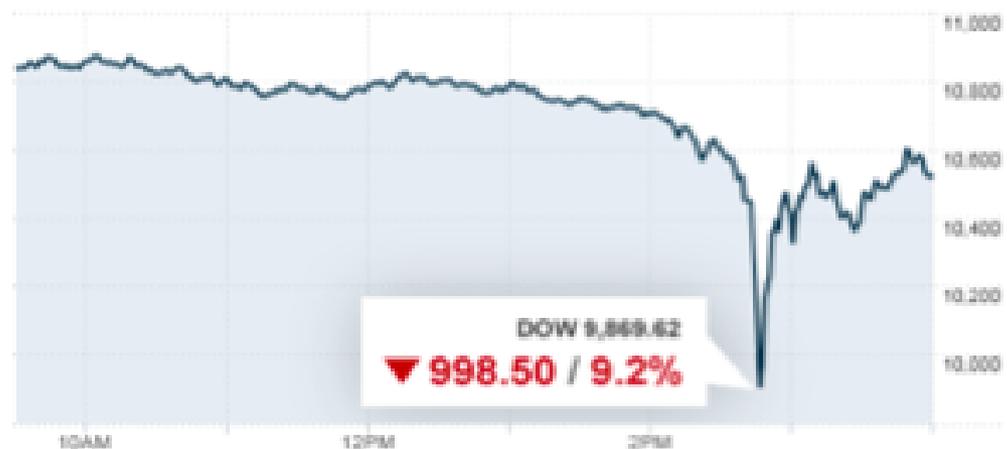
On May 6 2010, around £650bn evaporated from the US equities market for a few minutes. The flash crash was initiated by a \$4.1bn sale via a computer based order execution program. This triggered a high level of automated selling by other traders pushing prices down very quickly in an already twitchy market. Market failed spectacularly: key shares were executed at absurd prices-share prices of Accenture fell from nearly \$40 to one cent.



Government
Office for

Science

The Risk becomes a Financial threat



"What took a few days in August 2007 can unfold in a few minutes today given the amount of high frequency trading that now exists."

Andrew Lo Director of the MIT lab of financial engineering.

- The U.S. equity markets experienced the worst price decline and reversal since 1929 on May 6 2010. This has since been dubbed the "flash crash".
- The cost of the Flash Crash: confidence has been shattered and roughly \$70bn has been pulled out of US equity funds since May 6.

So what? Some applications in finance need accurate clock synchronisation: microtrading

- CSAC provides ability to pass data reliably and securely via precision time stamping & data authentication.
- In high frequency trading (transactions completed in microseconds) the network must be synchronised at all nodes (e.g. every switch, router, server, processor, GPS receiver etc.) with accuracy of order hundred nanoseconds. Otherwise timestamps will be inaccurate - it may appear that trades occurred before they have actually been executed.
- Such networks are synchronized to GPS time and susceptible to GPS outage.
- GPS used widely as a timing source in every industrial sector. Traceability to UTC achievable to 10's of nanoseconds.
- Major vulnerability to Global Navigation Satellite System-based timing solution is lack of resilience to interference, malicious or inadvertent.
- (UTC=Coordinated Universal Time, successor to GMT in 1961)

New UK public investment

- The UK National Quantum Technologies Programme.
- A five-year programme to exploit the potential of quantum science and develop **a range of emerging technologies**.
- Industry and academia working together to create opportunities for jobs & wealth creation.
- Spend started mid-2014; total now at €500M



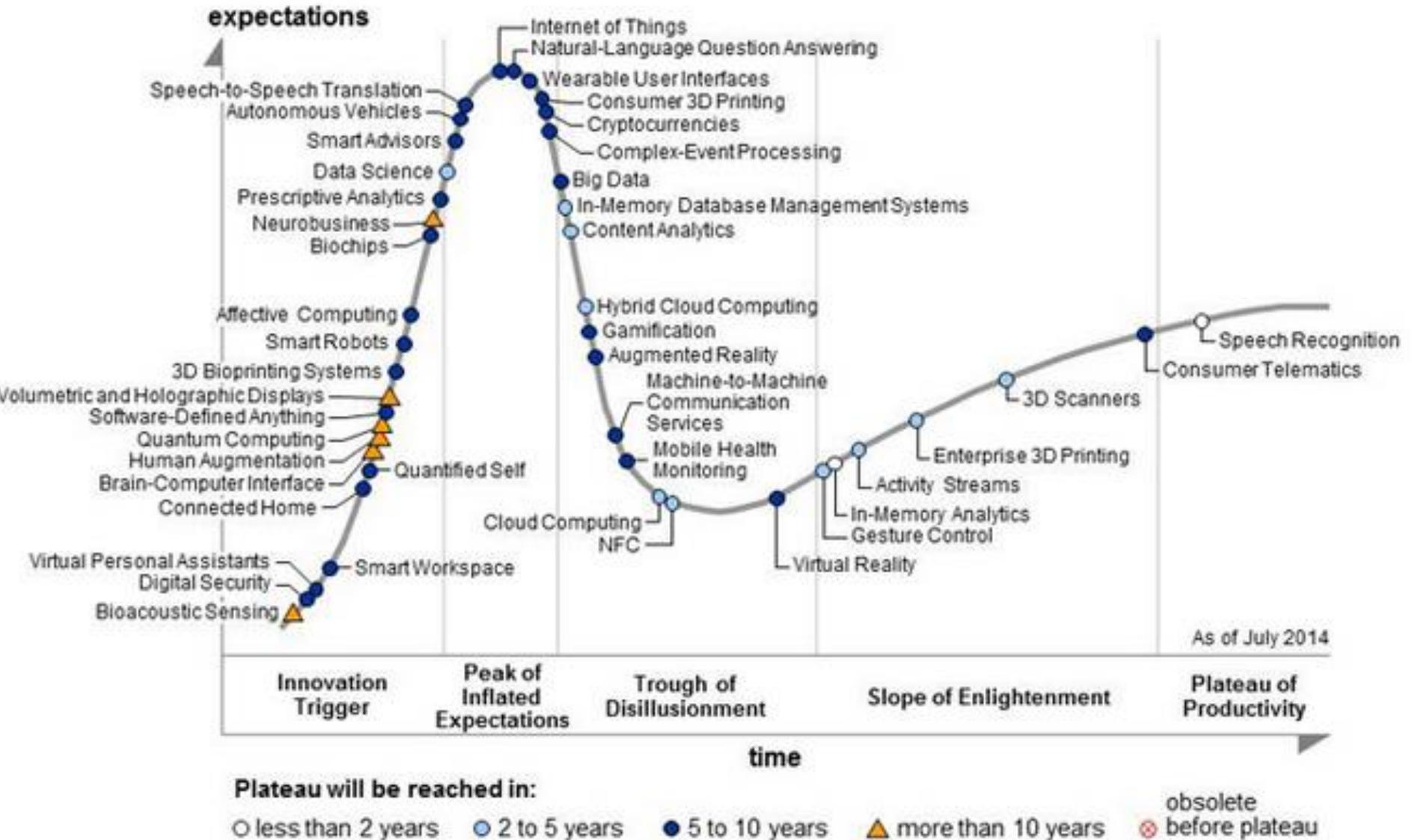
Autumn statement 2013

£270M

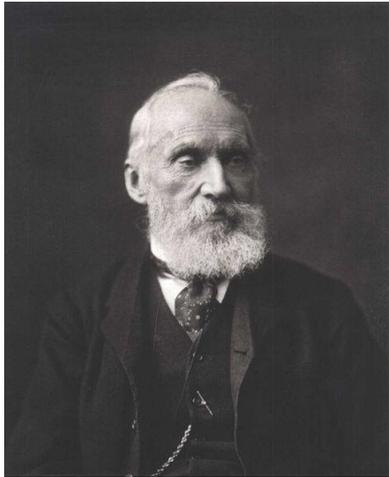
UK Government investment in quantum technologies research

Quantifying returns

- Realising vision will take time.



Finale: Technological prediction and innovation



“I can state flatly that heavier than air flying machines are impossible.”

“X-rays will prove to be a hoax.”

“Radio has no future.”

Lord Kelvin (1824-1907)

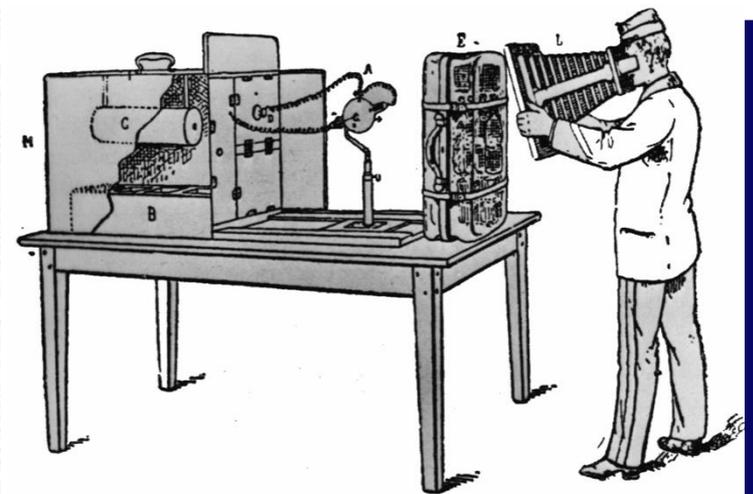


FIG. 155.—Hand of Professor Rt. Hon. Lord Kelvin.

From: Light, Visible and Invisible, 1923

<http://www.uh.edu/engines/epi1568.htm>

.....It is an actual X-ray of Lord Kelvin's hand!



Seguy's portable x-ray machine, 1897

From: Alan Sutton, A Victorian World of Science, Adam Hilger Ltd, 1986 p 54

Thanks for listening