

Solving the UK's problems of productivity growth and regional economic disparities: the role of the chemicals industry

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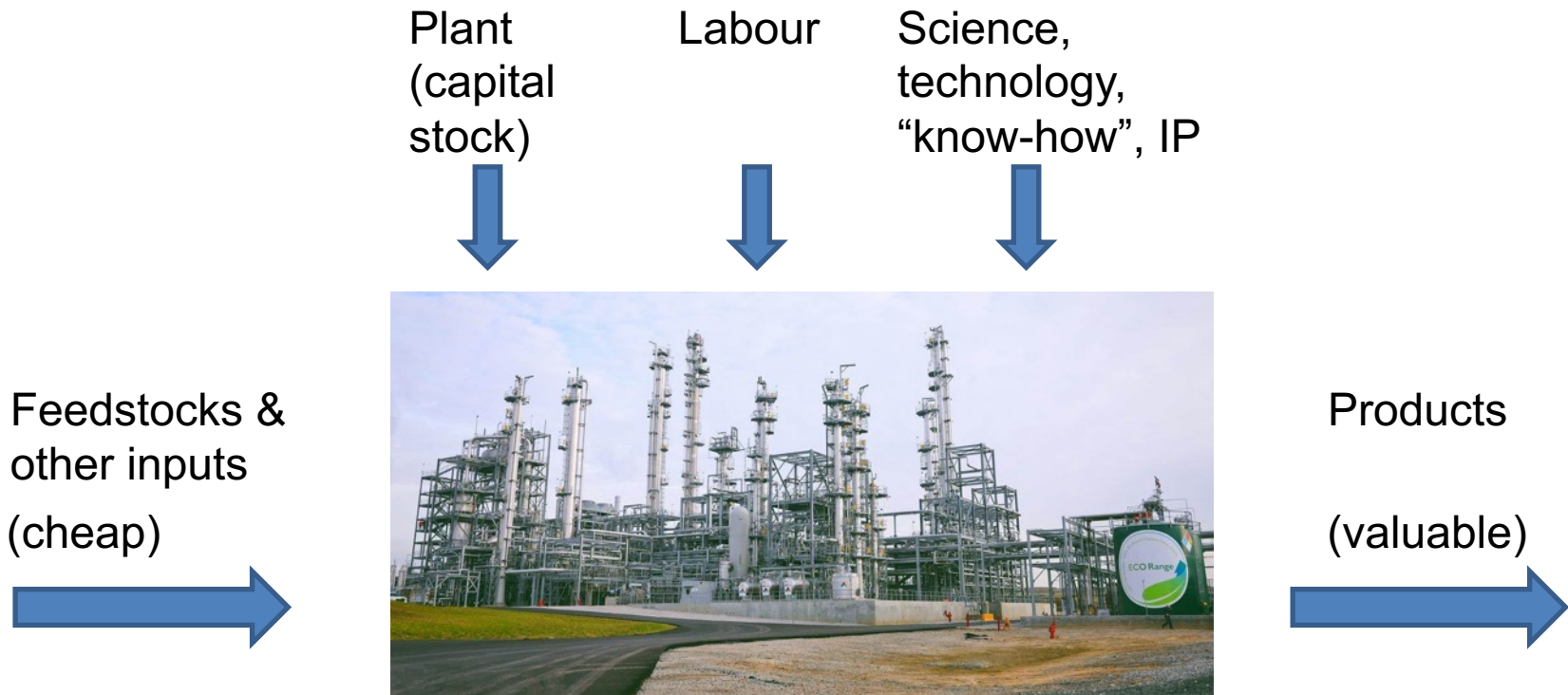
How do we create value?

*The Alchymist, In Search of the
Philosopher's Stone, Discovers
Phosphorus, and prays for the
successful Conclusion of his
operation, as was the custom of
the Ancient Chymical
Astrologers.*

Joseph Wright of Derby



How (and where) do we create value?



The Solow growth model including technological progress

$$Y(t) = F[K(t), L(t), A(t)]$$

Output Capital stock Employment “Level of technology”

The diagram shows the equation $Y(t) = F[K(t), L(t), A(t)]$ with four blue arrows pointing from labels below to variables in the equation: from 'Output' to $Y(t)$, from 'Capital stock' to $K(t)$, from 'Employment' to $L(t)$, and from '“Level of technology”' to $A(t)$.

Growth Accounting

- Control the measured economic growth for changes in capital stock and labour inputs
- What's left is called **“total factor productivity”**
- Interpreted by economists as a measure of “*innovation*”
- c.f. **“Labour productivity”** - output per hour of labour

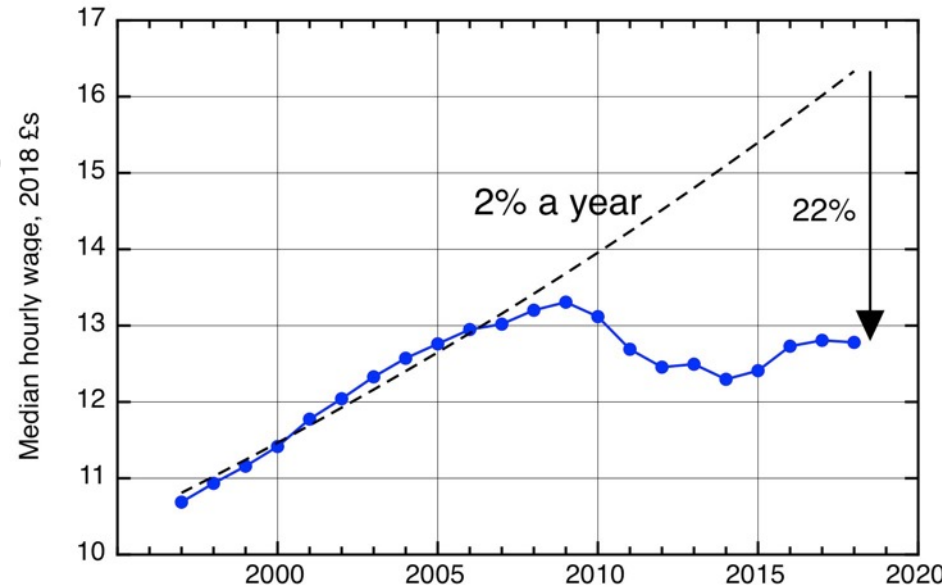
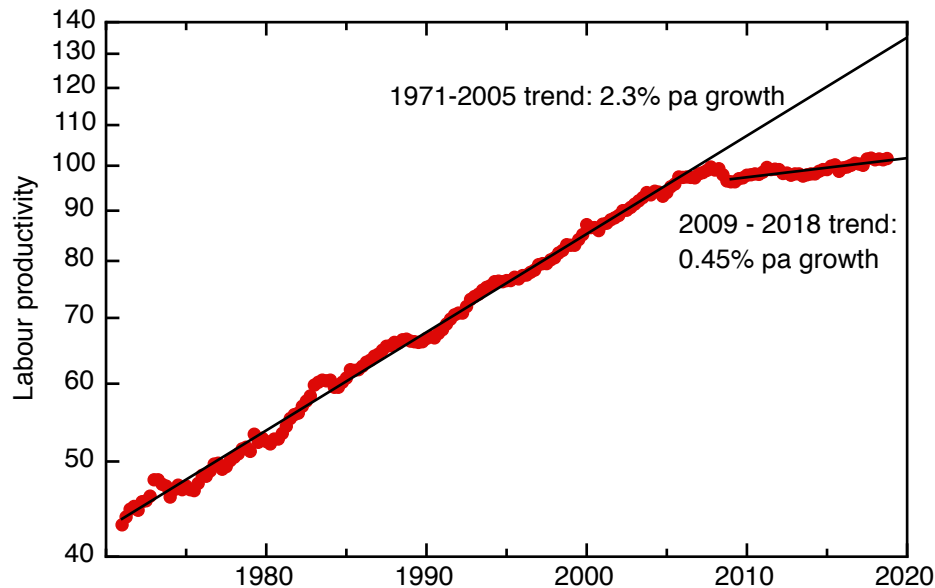
Outline

- The UK's productivity and regional imbalance problems
- Sources of productivity growth in the UK economy – how important are chemicals and pharmaceuticals?
- What should industrial policy focus on?
- The chemicals industry in a net-zero world
- (Why) Is R&D productivity falling?
- An industrial strategy for the chemicals industry

The UK's productivity and regional imbalance problems

Economic growth has stalled – and this is reflected in stagnating living standards

UK labour productivity since 1970

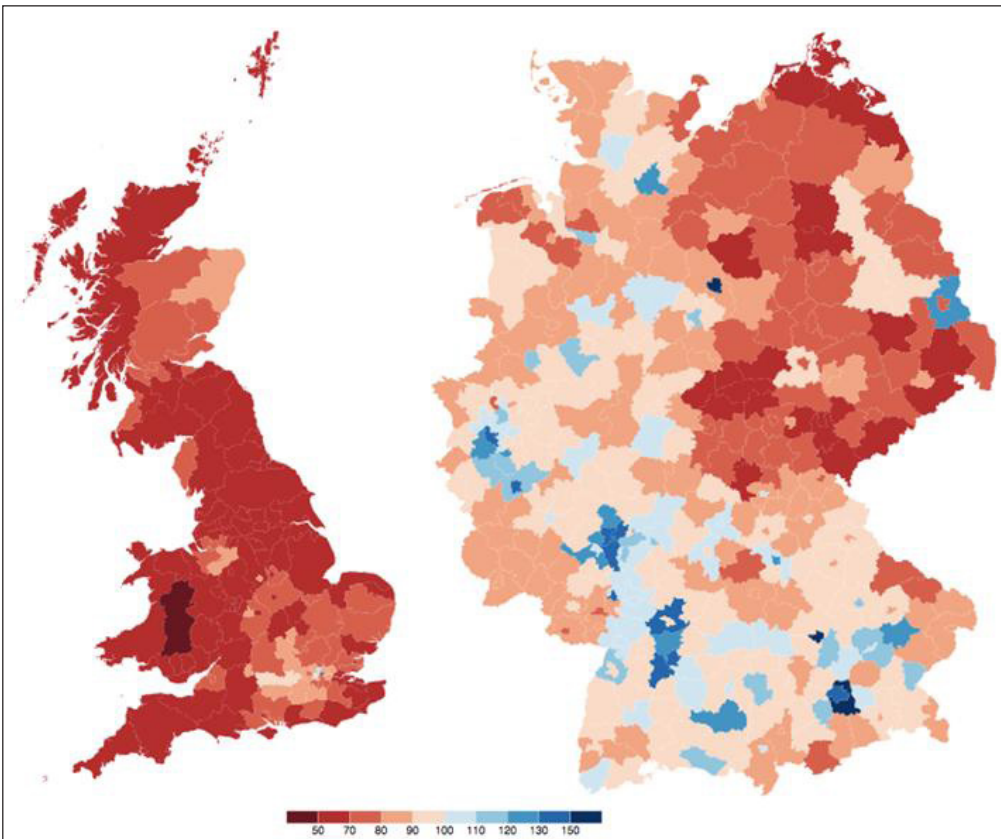


UK average real wages

Data: ONS

(All data pre-COVID, of course)

Most of the UK is below average in wealth and productivity

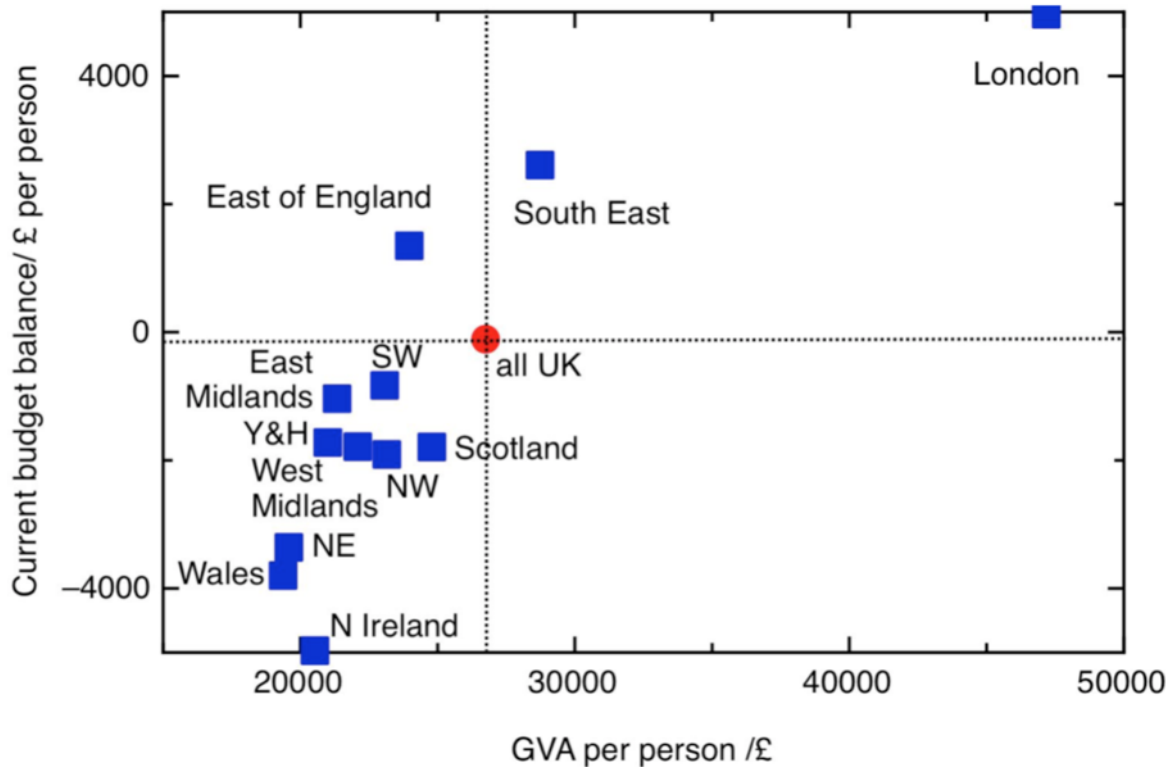


Outside the SE, productivity levels are comparable with E. Germany or S. Italy

GVA per hour at NUTS 3 region level in 2014

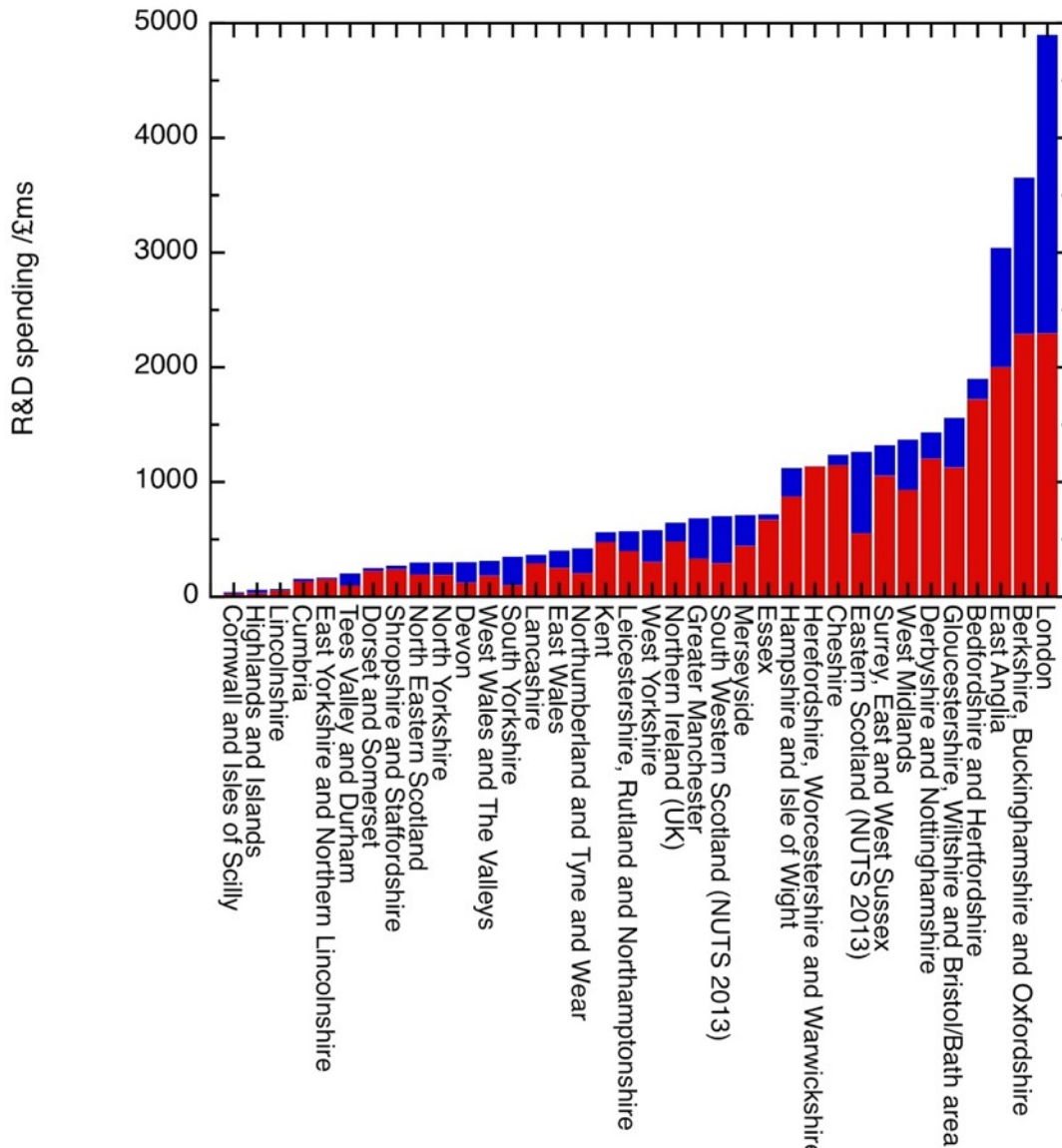
Bernick, S., Davies, R., and Valero, A. (2017) 'Industry in Britain – An Atlas', Centre for Economic Performance Special Paper No.34

Only three regions of the UK contribute to government more than they receive.



The difference between government revenue and current expenditure for NUTS1 regions, plotted against their regional productivity (GVA per person), both expressed per head of population. ONS data.

R&D spending is highly concentrated in London, E & SE



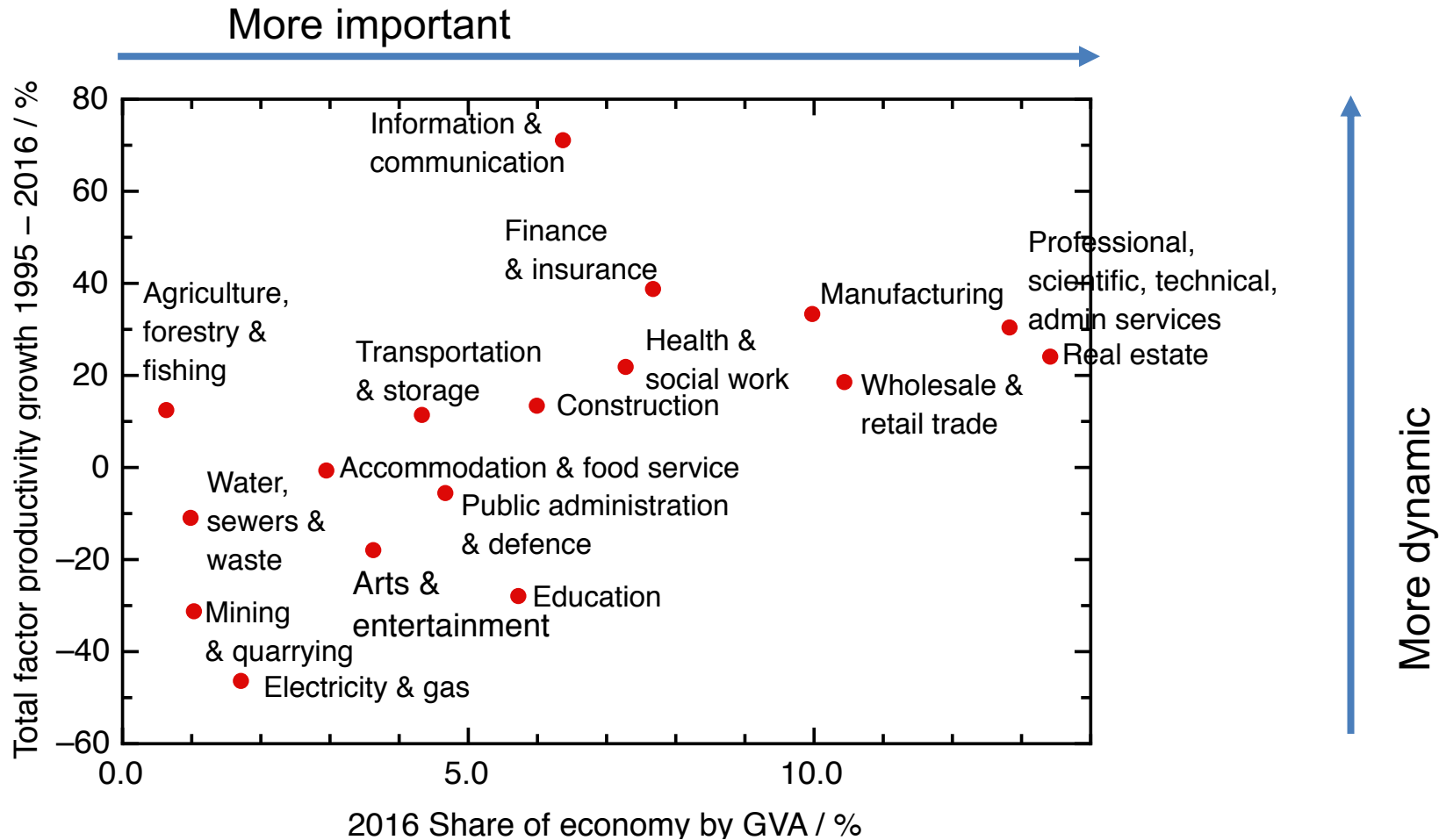
Public sector funding is more concentrated than private sector funding.

London, together with the two subregions containing Oxford and Cambridge, account for 46% of all public and charitable spending on R&D, with 21% of the UK's population.

Business and public sector R&D by NUTS2 region (except for London, presented at NUTS1 level). 2016 data, Eurostat.

Sources of productivity growth in the UK economy

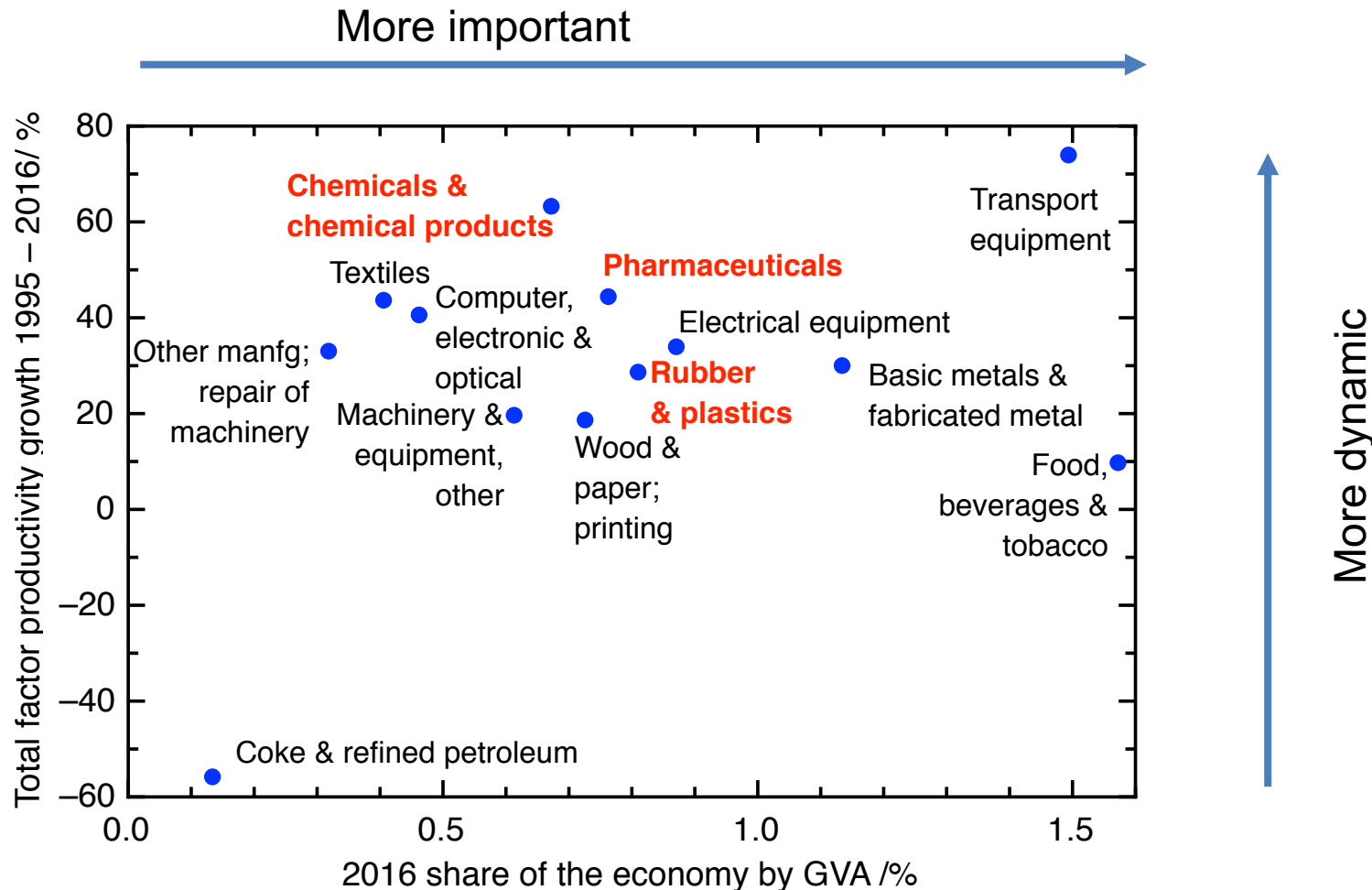
A map of the UK economy



The UK's economic sectors, mapped by their contribution to the economy and historical total factor productivity performance..

Data from EU KLEMS Growth and Productivity Accounts database

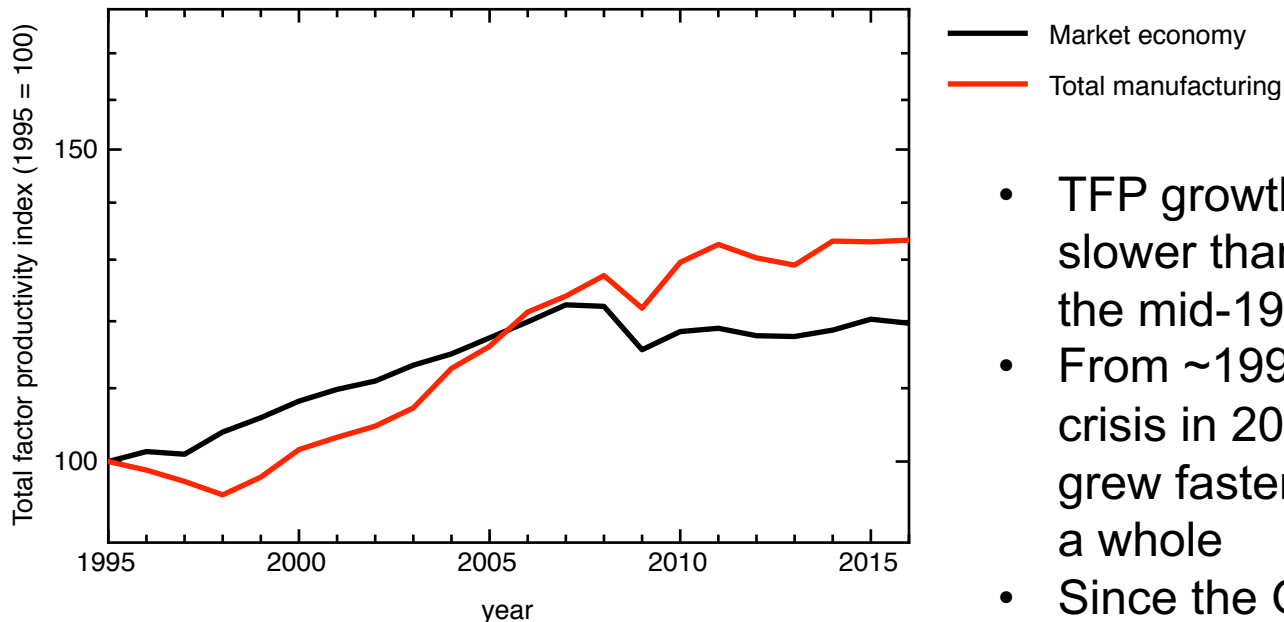
Total factor productivity growth in manufacturing sub-sectors



Manufacturing subsectors in the UK', mapped by their contribution to the economy and historical total factor productivity performance..

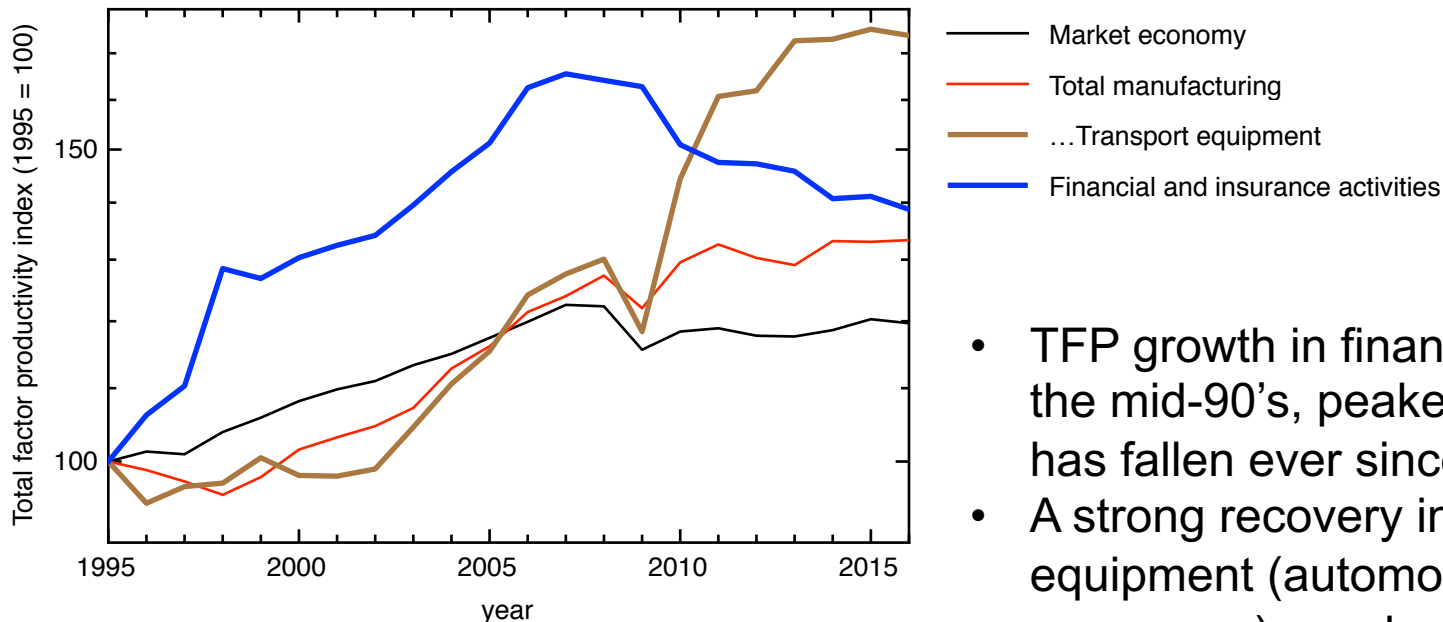
Data from EU KLEMS Growth and Productivity Accounts database

Total factor productivity growth – manufacturing



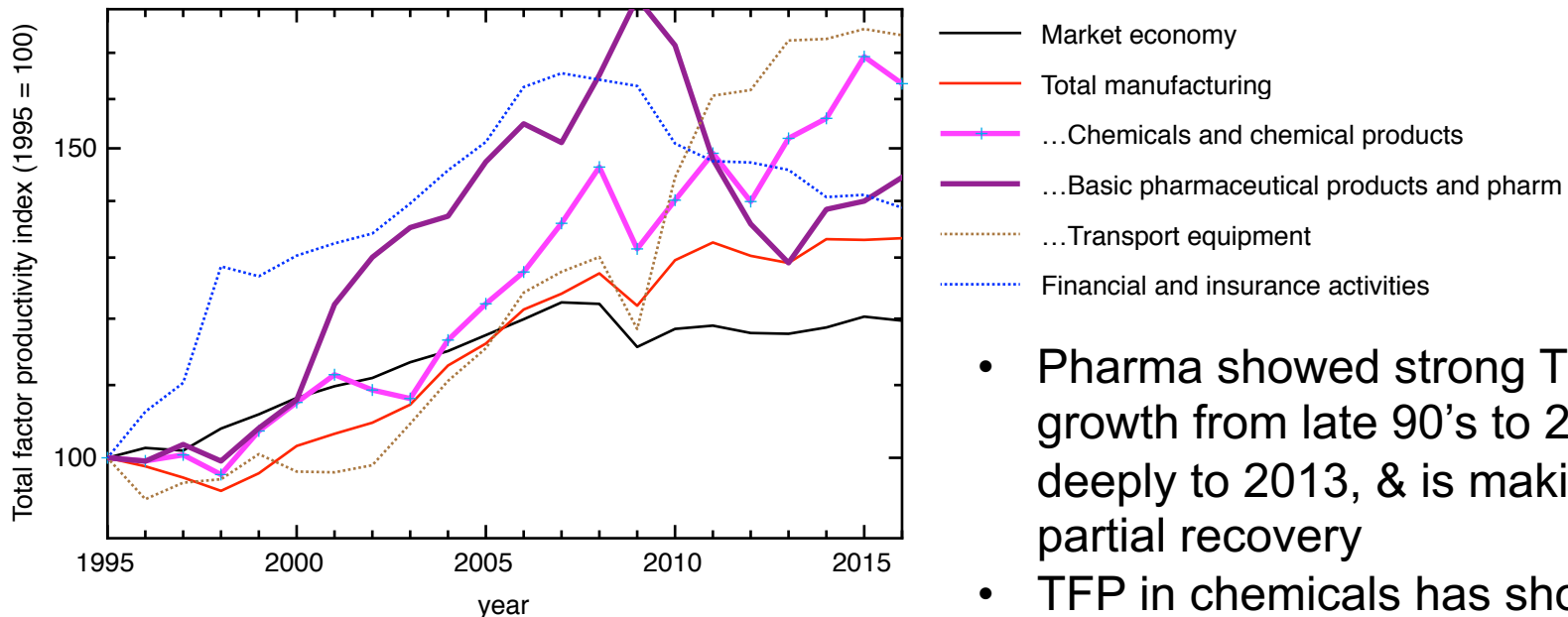
- TFP growth in manufacturing was slower than the whole economy in the mid-1990's
- From ~1998 to the global financial crisis in 2008 manufacturing TFP grew faster than the economy as a whole
- Since the GFC TFP of both manufacturing & whole economy have stagnated

Total factor productivity growth – fast growing sectors



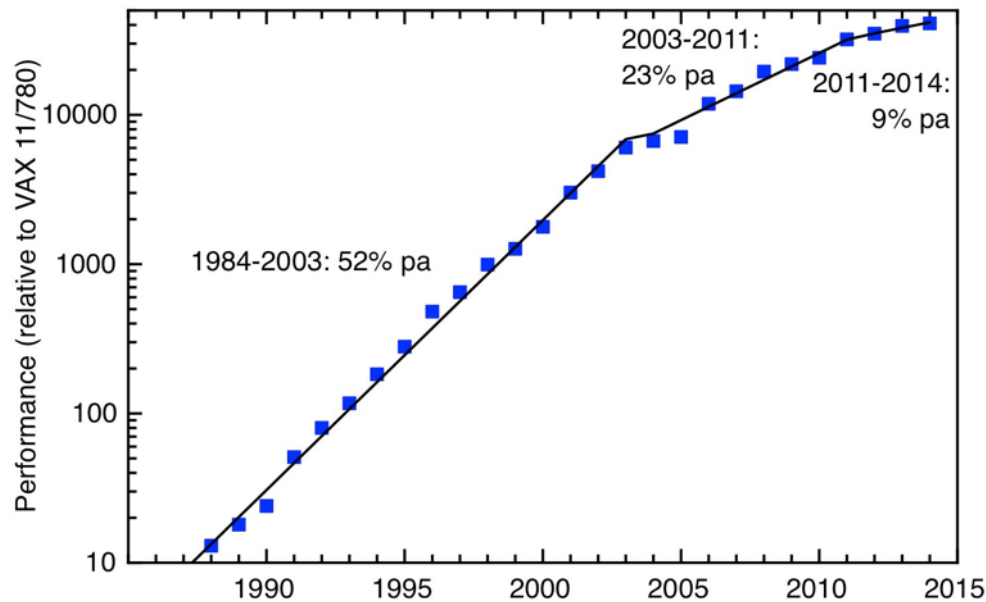
- TFP growth in finance boomed in the mid-90's, peaked in 2007, and has fallen ever since
- A strong recovery in transport equipment (automotive & aerospace) accelerated from 2009 but shows signs of plateauing

Total factor productivity growth – pharma & chemicals



- Pharma showed strong TFP growth from late 90's to 2009, fell deeply to 2013, & is making a partial recovery
- TFP in chemicals has shown steady increases over the whole period

Growth doesn't happen in a balanced way across an economy, because technological progress is uneven



Not all technology is accelerating...

Since 1988 computer (CPU) power has increased by more than 3 orders of magnitude...

...but this is still the train to Manchester



The growth in processor performance since 1988. Data from figure 1.1 in [Computer Architecture: A Quantitative Approach \(6th edn\)](#) by Hennessy & Patterson.

Baumol's “cost disease”

- Since the 18th century, steel making has achieved much higher productivity...
- But it takes much the same amount of labour to perform an opera to a live audience
- The result is that going to the opera has become much more expensive relative to buying nails.
- In general labour intensive services (e.g. arts, education, healthcare) become more expensive relative to manufactured goods

Baumol's “cost disease” is not a disease!

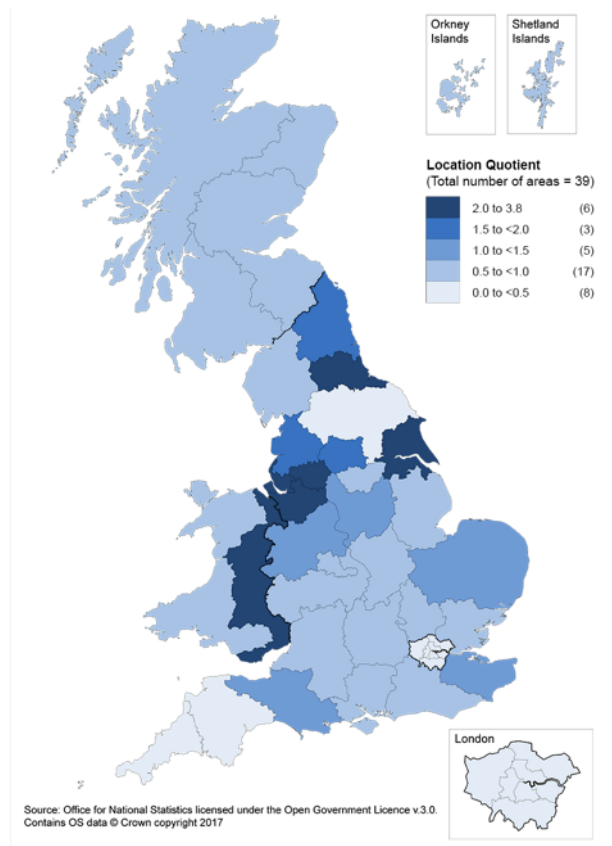
- Wrong response is to think all that matters is improving productivity in services...
- Because it's the greater purchasing power that productivity improvements in goods gives us that allows us to afford more services, even at their higher (relative) prices
- It's the sectors with high productivity growth that pull along the whole economy

What should industrial policy focus on?

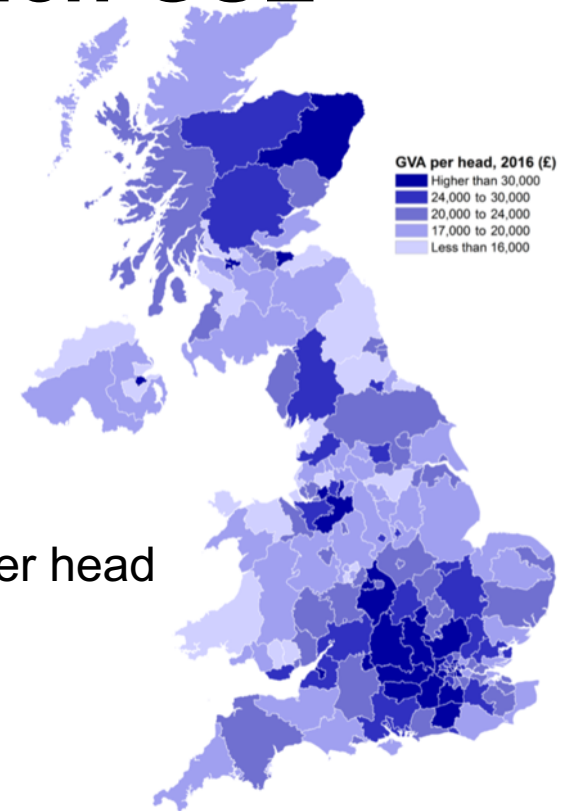
- “Vertical” industrial strategy - based around the specific needs of industry sectors – was out of fashion in the 80’s, 90’s & 00’s. This was a mistake.
- We’ve seen some return to sector-based industrial strategy since the global financial crisis – but the chemicals industry has been sidelined.
- What best fixes the UK’s problems of stagnant productivity and regional economic disparities?
 - Sectors with the high potential for productivity growth
 - Sectors that contribute to high productivity in economically underperforming parts of the country
- The chemicals industry qualifies on both counts.

The chemicals industry is concentrated outside the rich GSE

Location
quotients for
chemicals
industry (SIC
20), 2015



GVA per head
2016



The chemicals industry in a net-zero world

What's not included in the GVA figures

Some costs aren't measured in money, & are born by the rest of society

Feedstocks & other inputs



Products



↑
Products contributing to new zero carbon & lower impact technologies

↓
Unsustainable feedstocks deplete natural capital

↓
Costs of pollution & accidents born by nearby communities & ecosystems

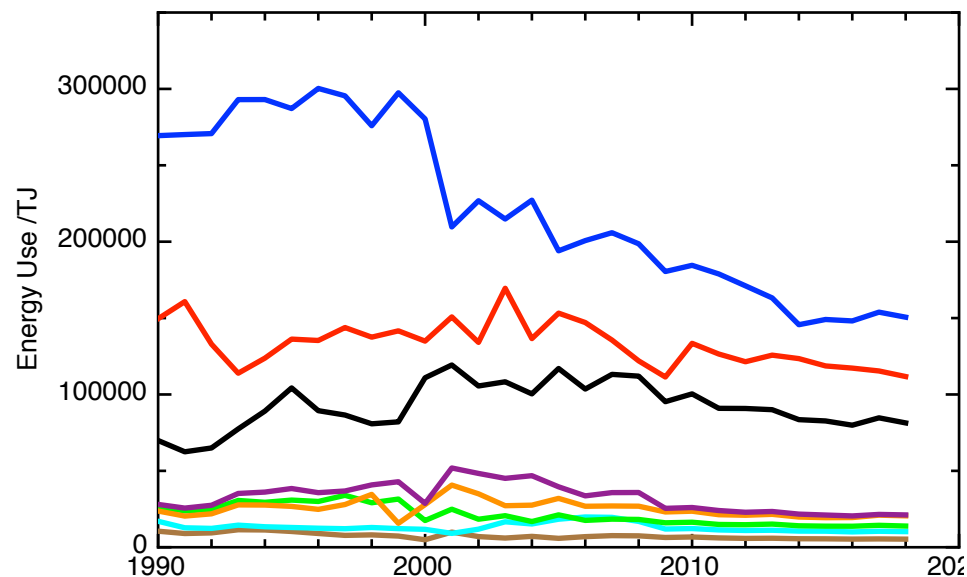
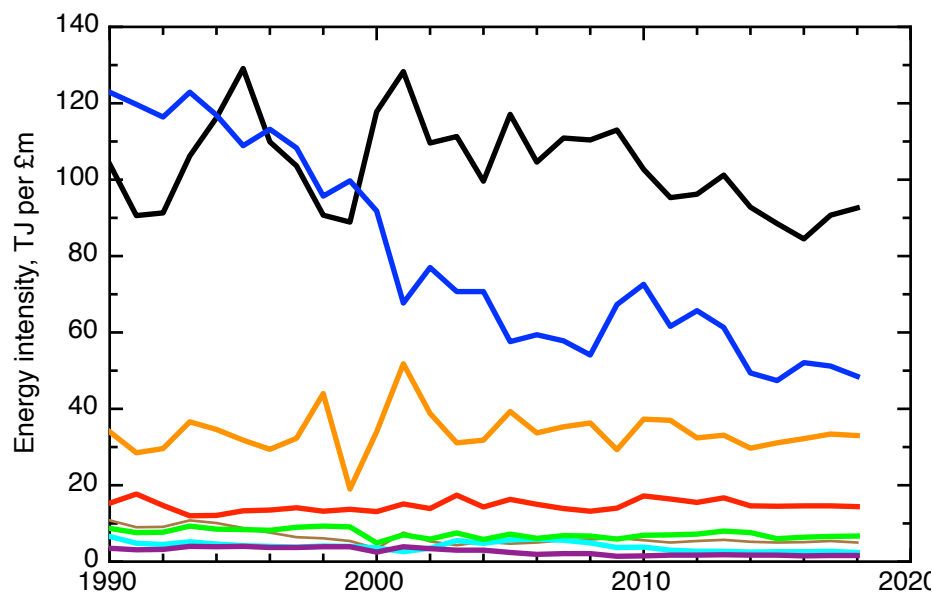
↓
High energy use produces carbon emissions & climate change

↓
Environmental impact of improper disposal of products at end of life

The chemicals industry is a big energy user!

- Industrial gases, inorganic chemicals, f
- Petrochemicals
- Paints, varnishes & ink
- Cleaning & toilet preparations
- Other chemical products & man-made fibre
- Dyestuffs & agro-chemicals
- Pharmaceutical products & preparations
- Rubber & plastics products

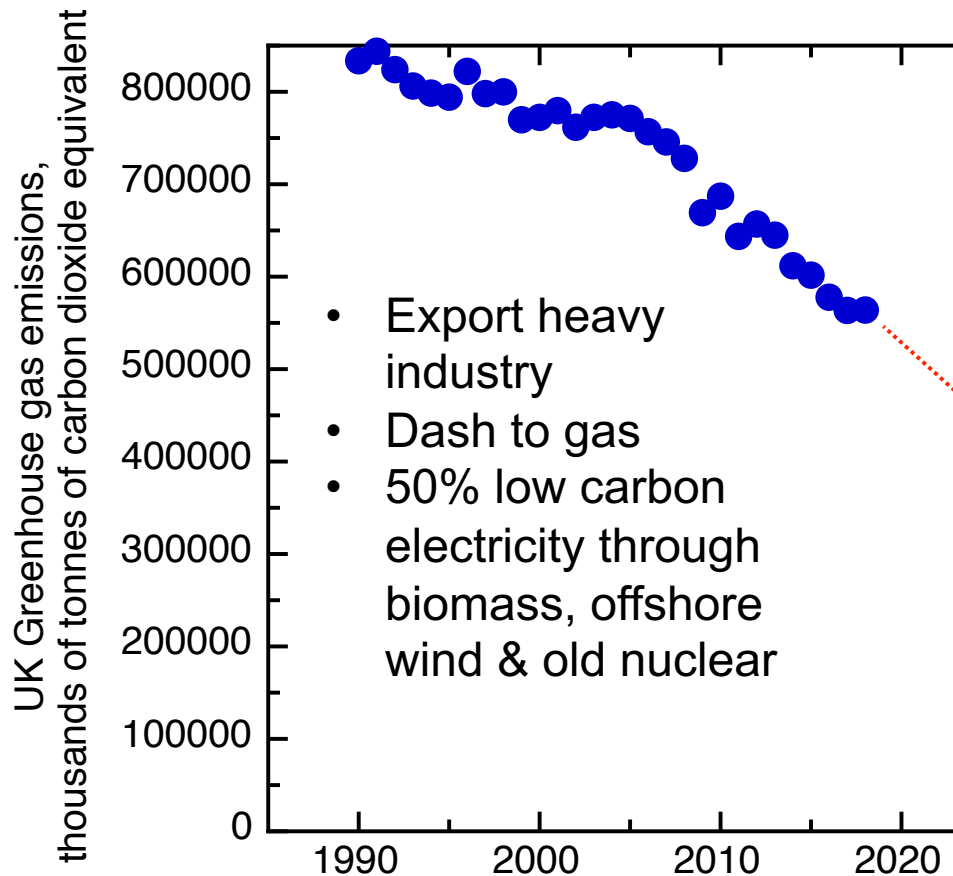
Energy Intensity



Energy use

Emissions: 20% of manufacturing, 3% of total

Towards net zero: the UK's domestic greenhouse gas emissions



- Export heavy industry
- Dash to gas
- 50% low carbon electricity through biomass, offshore wind & old nuclear

Fully decarbonize & expand electricity generation:

- More offshore wind
- New nuclear (?)
- CCS (?)

Storage

- Batteries
- Hydrogen (?)

Decarbonize industry:

- Hydrogen (?)

Decarbonize transport

- Electric vehicles
- Synthetic aviation fuel (?)

Decarbonise housing

- Net zero dwellings
- Hydrogen (?)

The net zero agenda is (largely) a chemicals industry agenda

Fully decarbonize & expand electricity generation:

- More offshore wind
- New nuclear (?)
- Carbon capture & storage (?)

Electricity storage

- Batteries
- Hydrogen (?)

Decarbonize industry:

- Hydrogen (?)

Decarbonize transport

- Electric vehicles/ batteries
- Hydrogen/ fuel cells (?)
- Synthetic aviation fuel (?)

Decarbonise housing

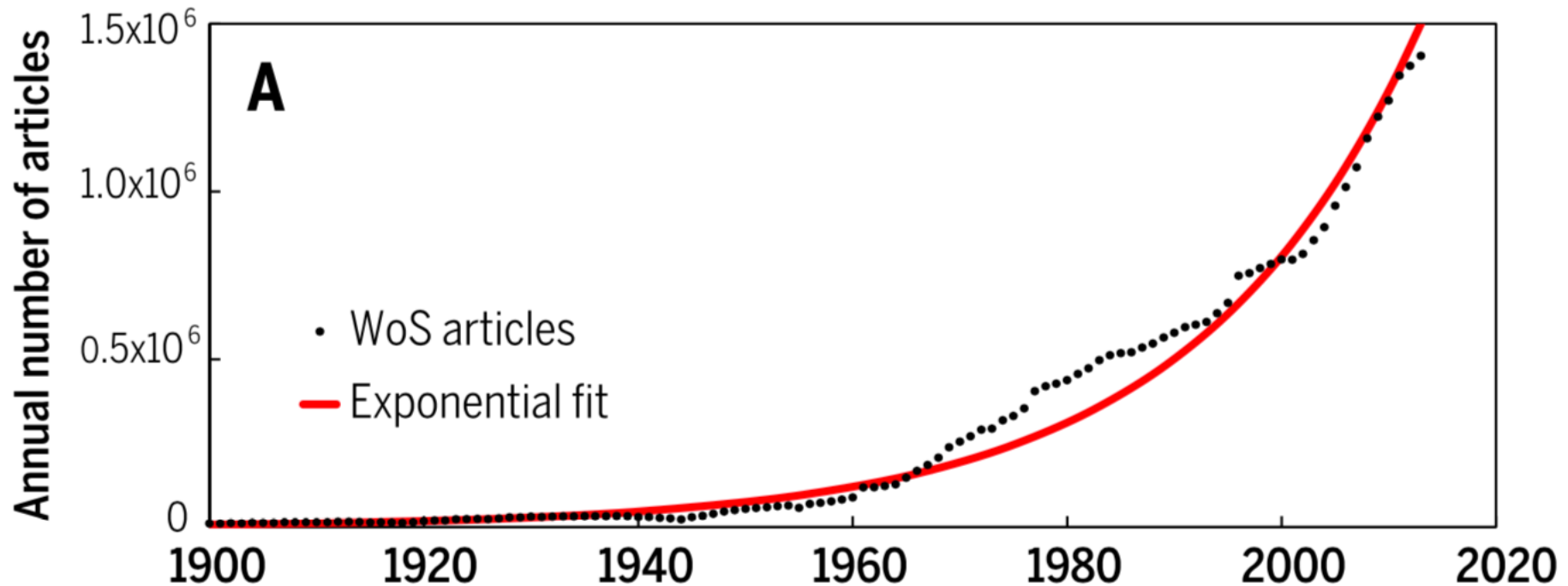
- Net zero dwellings
- Hydrogen (?)

What's going to drive the chemicals industry

- Markets – and marketing
- The priorities of the massive economic system change that net zero demands
- Government interventions:
 - Regulation
 - Market making
 - Industrial strategy
- The global environment

(Why) Is R&D productivity falling?

By some measures, the output of the world's scientific enterprise is increasing



Fortunato, S., Bergstrom, C. T., Börner, K., Evans, J. A., Helbing, D., Milojević, S., et al. (2018). Science of science. *Science (New York, NY)*, 359(6379), eaao0185–9. <http://doi.org/10.1126/science.aao0185>

But are we seeing diminishing returns?

Are Ideas Getting Harder to Find?

Nicholas Bloom

Stanford University and NBER

Charles I. Jones

Stanford University and NBER

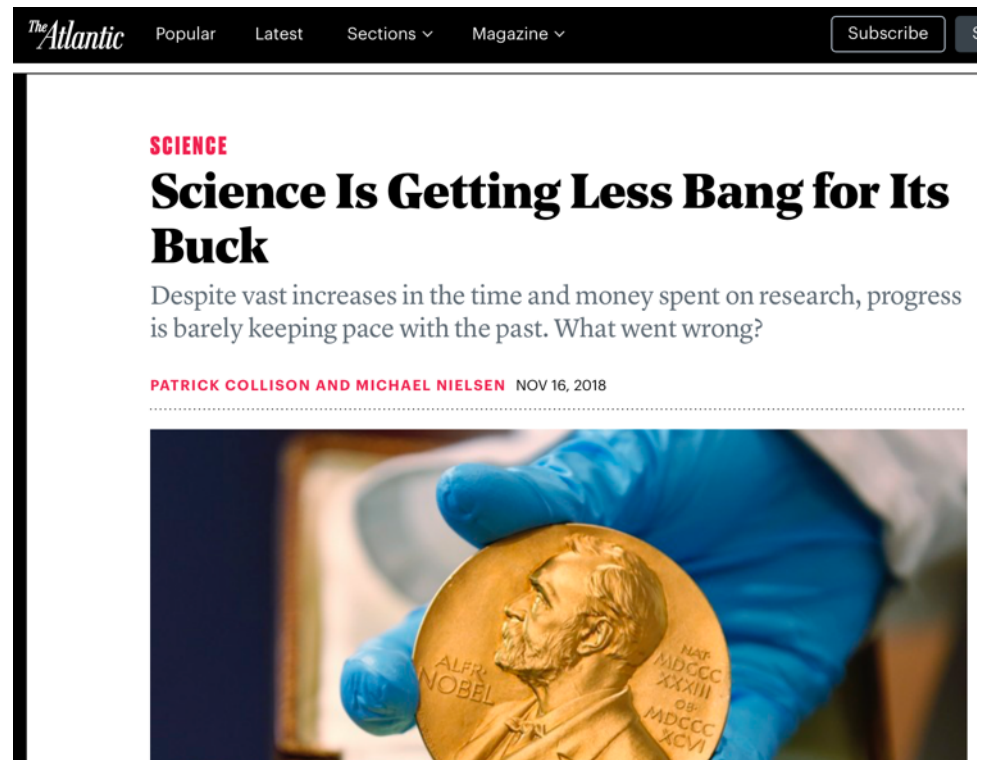
John Van Reenen

MIT and NBER

Michael Webb*

Stanford University

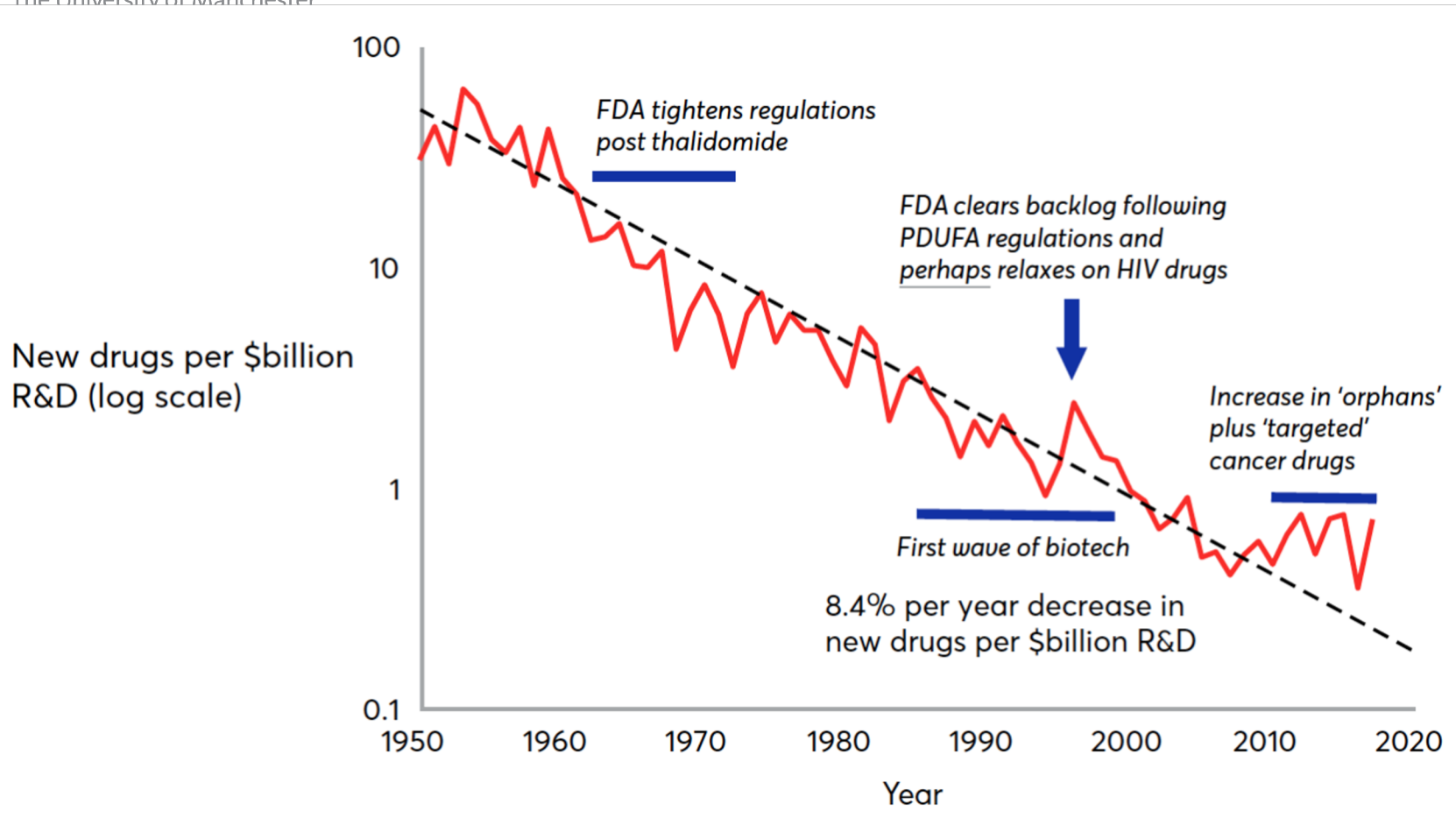
March 5, 2018 — Version 2.0



Exponentially falling R&D productivity in pharma

MANCHESTER
1824

The University of Manchester



Eroom's law: the number of new molecules approved by the US Food and Drug Administration (pharma and biotech) per US\$bn global R&D spending. (after Jack Scannell).

Can we drive up productivity in the R&D the chemicals industry needs?

The way we do research...



Andy Cooper – lab automation

The kind of research we do...

THE NEW
ATLANTIS
A JOURNAL OF TECHNOLOGY & SOCIETY

Saving Science

*Science isn't self-correcting, it's self-destructing.
To save the enterprise, argues Daniel Sarewitz,
scientists must come out of the lab and into the real world.*

Dan Sarewitz on academic pathologies

An industrial strategy for the chemicals industry



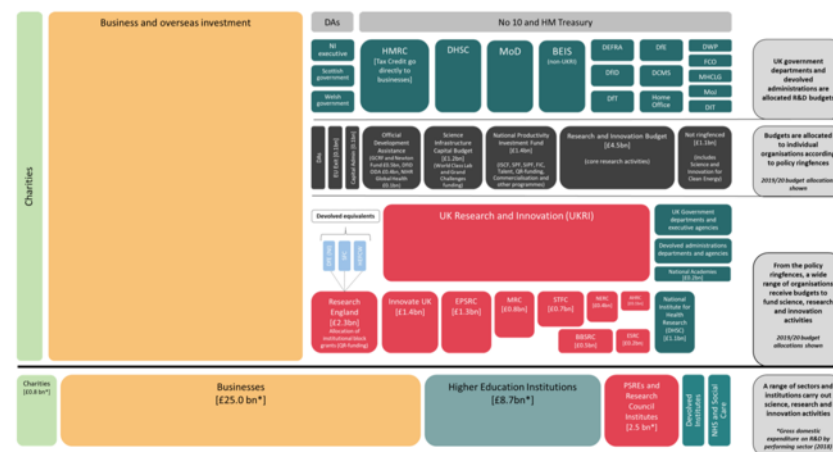
An industrial strategy for the chemicals industry

Productivity

- Towards the 2.4% R&D intensity target
- A science & innovation system that works
- Translational research & business/ academia links
- Regulation

UK Research and Development Roadmap

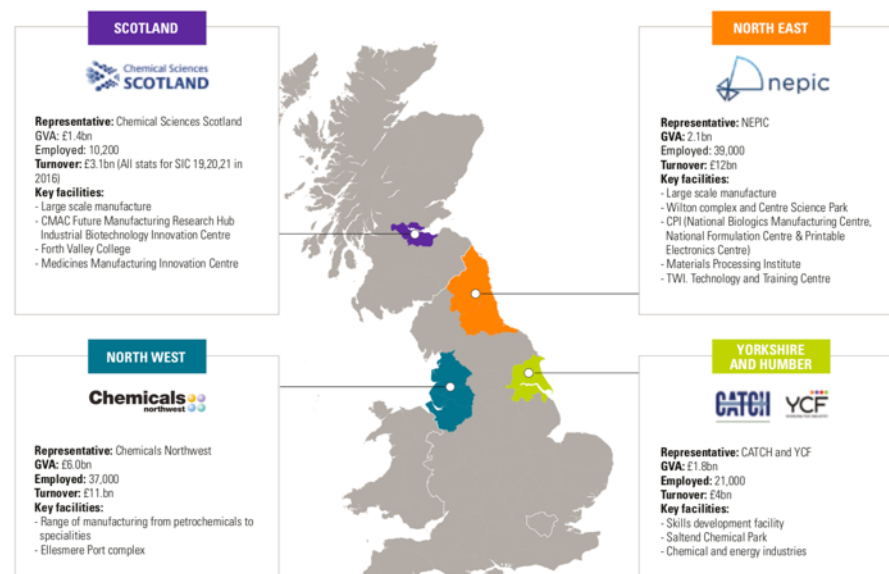
July 2020



An industrial strategy for the chemicals industry

Regional Growth

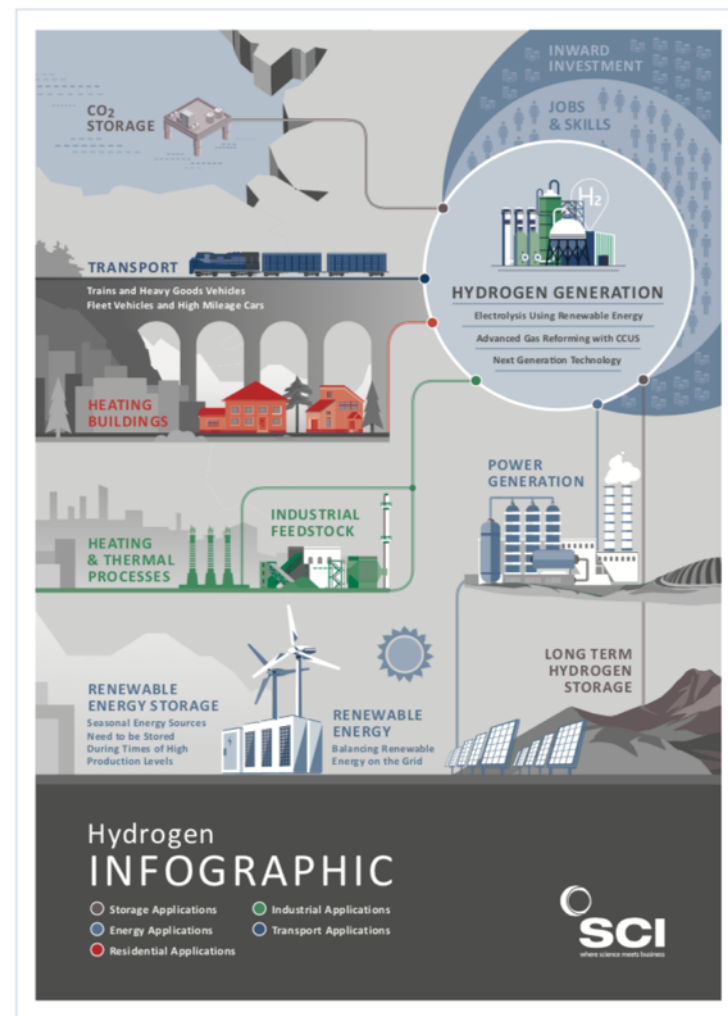
- Preserving and growing clusters
- Regional innovation systems
- Skills at all levels



An industrial strategy for the chemicals industry

Net Zero Challenges

- Recognising the scale of the economic transformation
- Setting the direction and getting on with it!
- Research and implementation need to be simultaneous, not sequential



Some concluding thoughts...

“Think global, act local”

The industry is a global industry

- But its activities take place in specific places
- Q is, why does this activity need to take place here?

Climate change is a global problem

- national governments have to lead
- And yet technological choices will be made emergently across the world

Thanks!

- For more on these issues:

“The Biomedical Bubble: Why UK research and innovation needs a greater diversity of priorities, politics, places and people”

Richard Jones & James Wilsdon, NESTA (2018)

<https://www.nesta.org.uk/report/biomedical-bubble/>

“A Resurgence of the Regions: rebuilding innovation capacity across the UK”.

R.A.L. Jones, preprint (2019)

<http://www.softmachines.org/wordpress/?p=2340>

“The Missing Four Billion: Making R&D work for the whole UK”

Tom Forth & Richard Jones, NESTA (2020)

<https://www.nesta.org.uk/report/the-missing-4-billion/>