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Getting to 2.4%: The importance of Business R&D and incentives

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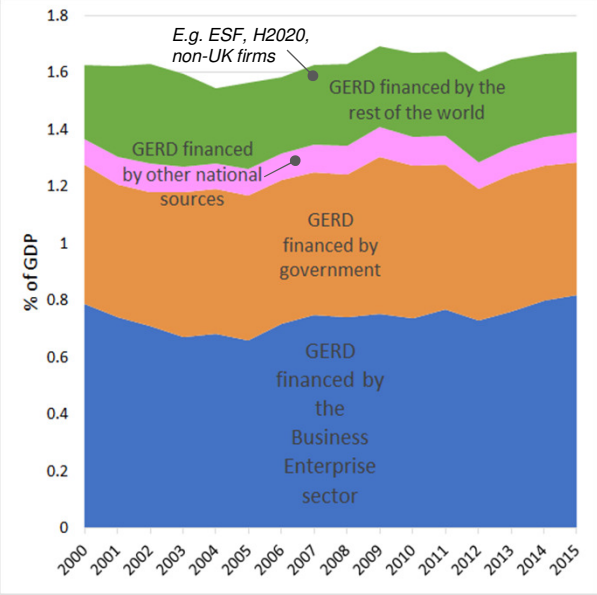
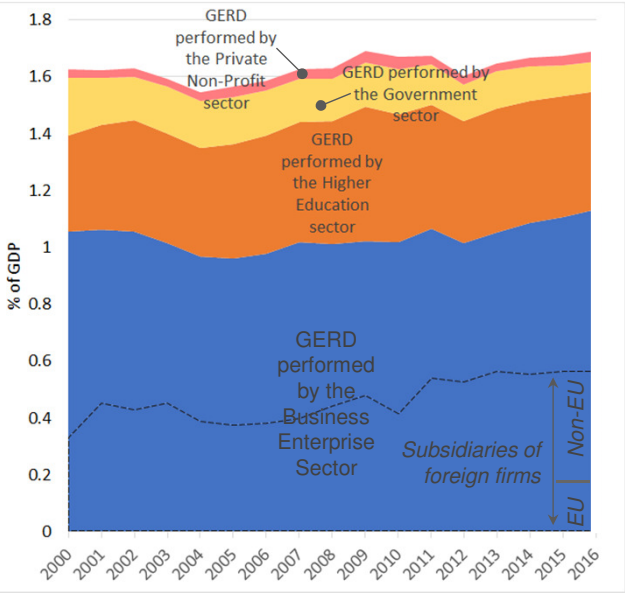
Nesta

Businesses are main funders – and performers – of R&D





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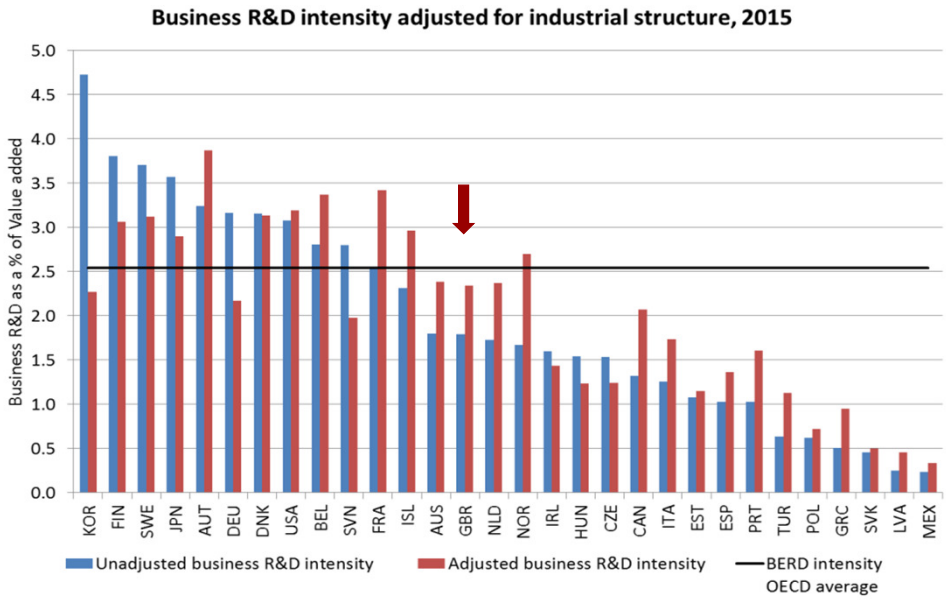
Source: OECD, MSTI database

UK BERD is below OECD – even when adjusted for industrial structure



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Innovation > R&D

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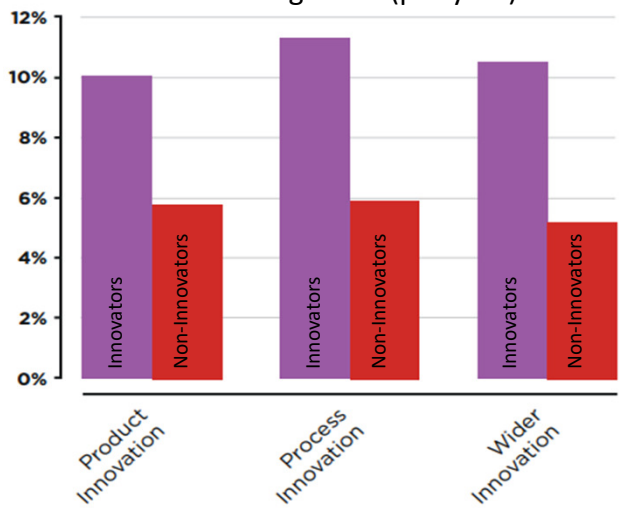
Innovation drives growth

Innovative firms grow twice as fast, both in employment and sales, as firms that fail to innovate

Revenue growth (per year)



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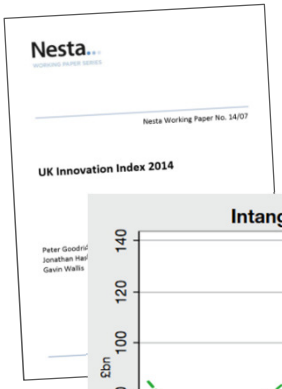
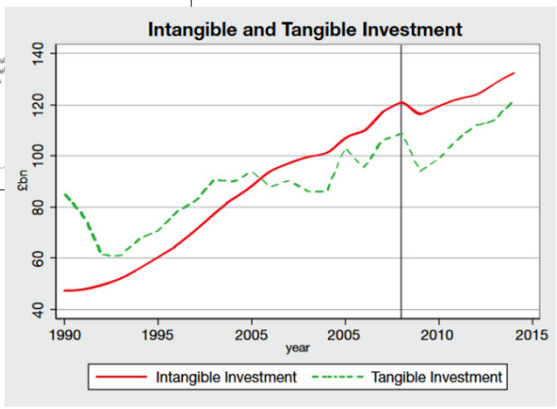
Source: https://www.nesta.org.uk/sites/default/files/business_growth_and_innovation.pdf

But R&D is only one component of (intangible) innovation investment



Tangible and Intangible Investment, £bns



Asset	1990	1995	2000	2005	2010	2011
Purchased Software	2.5	5.2	7.3	10.4	10.4	11.0
Own-Account Software	4.8	5.8	9.9	11.9	12.9	13.2
Total Software	*7.3*	*11.0*	*17.2*	*22.3*	*23.4*	*24.3*
R&D	7.3	8.3	10.7	12.7	14.8	15.9
Design	6.7	7.0	9.5	11.6	12.8	12.9
Non-scientific R&D	0.2	0.3	0.4	0.3	0.9	0.9
Mineral Exploration	1.6	1.1	0.5	0.7	0.6	0.8
Financial Innovation	0.3	0.4	0.7	0.9	1.6	1.8
Artistic Originals	1.9	3.0	4.9	7.0	5.7	5.8
Total Innovative Property	*18.1*	*20.1*	*26.7*	*33.2*	*36.3*	*38.1*
Advertising	3.8	5.5	8.6	8.8	10.3	10.3
Market Research	1.0	1.3	1.7	2.8	3.2	3.7
Total Branding	*4.8*	*6.7*	*10.2*	*11.7*	*13.5*	*14.0*
Own-Account Organisational Capital	5.0	10.0	14.7	19.7	22.8	20.7
Purchased Organisational Capital	0.8	1.7	3.3	6.0	4.3	4.8
Total Organisational Capital	*5.9*	*11.7*	*18.1*	*25.7*	*27.0*	*25.5*
Training	11.8	14.4	19.9	25.2	27.4	25.0
Total Economic Competencies	*22.5*	*32.8*	*48.2*	*62.6*	*67.9*	*64.5*
TOTAL INTANGIBLES	47.9	63.9	92.1	118.1	127.6	126.8
Buildings	27.0	22.1	38.0	52.8	44.9	47.4
Plant & Machinery (excl IT)	25.7	28.4	37.3	30.2	30.4	30.4
Vehicles	9.0	9.4	9.1	10.9	13.6	4.4
IT Hardware	5.1	6.6	9.4	6.3	5.4	5.6
TOTAL TANGIBLES	66.9	66.5	93.8	100.1	94.4	87.9
MSGVA						
without intangibles	393.2	484.4	629.5	801.1	915.1	927.4
with NA intangibles	404.1	499.5	652.0	831.1	944.8	958.3
with all CHS intangibles	441.1	548.3	721.5	919.2	1042.7	1054.3

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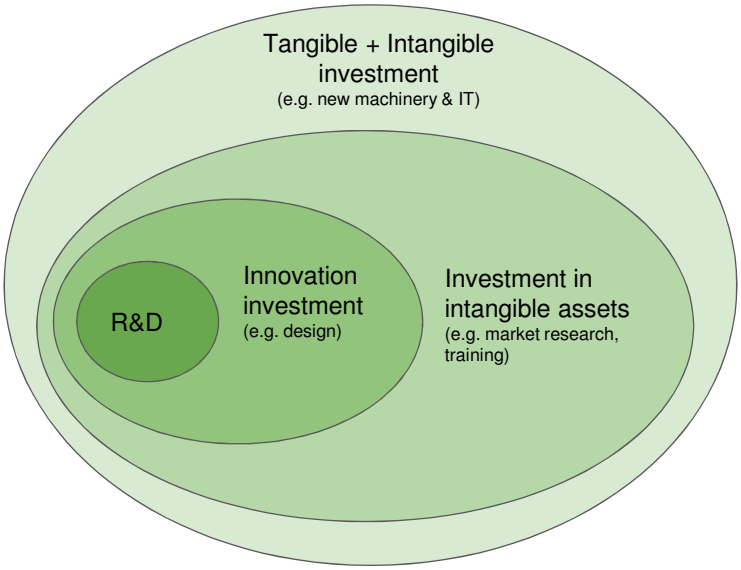
Sources: Goodridge, Haskel & Wallis / IPO (2016), UK Intangible Investment and Growth; Nesta (2014) Innovation Index

But R&D is only one component of (intangible) innovation investment



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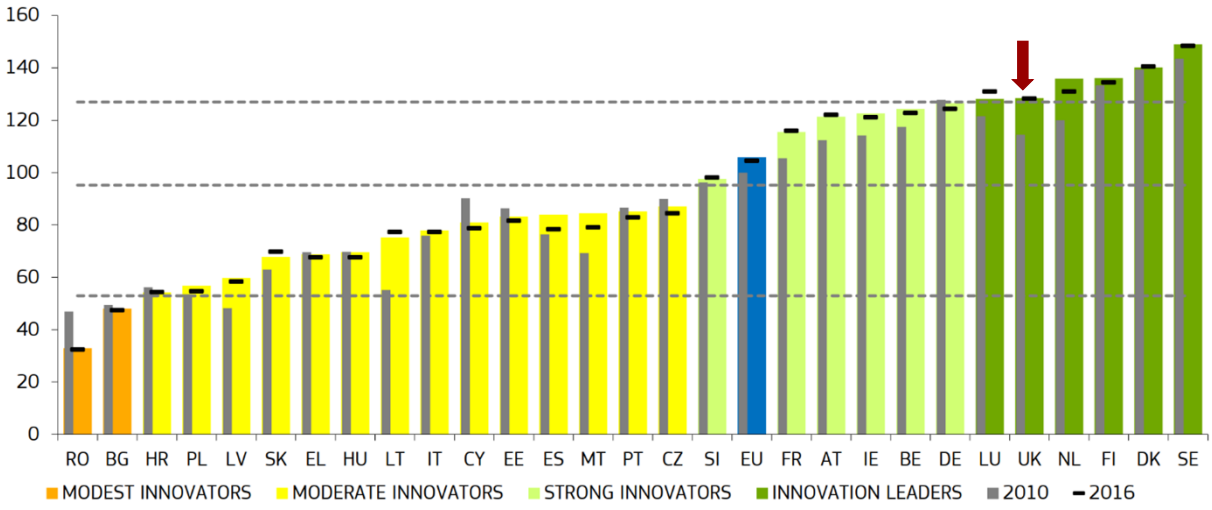
We compare well on broader innovation activities...



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European Innovation Scoreboard 2018
Performance of EU Member States' innovation systems

...But no real evidence that firms are substituting non-R&D innovation spend for BERD (as best as we can measure)

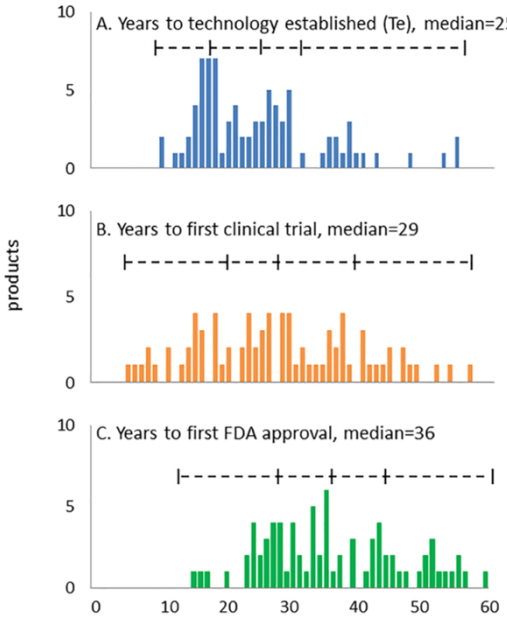
	National Accounts Intangibles	New Intangibles	Total Intangibles	Tangibles
Austria	3.1%	3.6%	6.7%	11.4%
Belgium	2.9%	5.2%	8.1%	11.7%
Czech Republic	2.5%	4.6%	7.1%	17.8%
Denmark	3.8%	4.1%	7.8%	9.9%
Finland	4.3%	4.4%	8.8%	6.9%
France	4.2%	4.5%	8.7%	7.4%
Germany	2.8%	3.0%	5.9%	9.7%
Greece	0.9%	2.8%	3.7%	8.8%
Hungary	2.0%	4.0%	5.9%	13.3%
Ireland	3.8%	4.7%	8.5%	9.2%
Italy	1.9%	3.4%	5.3%	10.0%
Netherlands	3.4%	5.1%	8.5%	8.3%
Portugal	1.7%	4.3%	6.0%	11.3%
Slovenia	2.5%	4.5%	7.0%	13.1%
Spain	2.1%	2.6%	4.6%	12.7%
Sweden	5.1%	5.3%	10.4%	9.4%
Slovakia	1.5%	3.6%	5.1%	17.2%
United Kingdom	3.4%	5.6%	9.0%	7.5%
United States	**4.2%**	**4.6%**	**8.8%**	**7.7%**
EU14	**3.1%**	**4.1%**	**7.2%**	**9.2%**
NMS	**2.2%**	**4.2%**	**6.4%**	**16.0%**

Carol Corrado, Jonathan Haskel, Cecilia Jona-Lasinio, Massimiliano Iommi (2016) 'Intangible investment in the EU and US before and since the Great Recession and its contribution to productivity growth', *EIB Working Paper 2016 / 08*; http://www.eib.org/attachments/efs/economics_working_paper_2016_08_en.pdf

European Innovation Scoreboard 2018 https://ec.europa.eu/docsroom/documents/30706

United Kingdom	Performance relative to EU 2010 in 2010	Performance relative to EU 2010 in 2017	Relative to EU 2017 in 2017
SUMMARY INNOVATION INDEX	**114.5**	**128.5**	**121.5**
Human resources	170.5	180.6	151.4
New doctorate graduates	153.8	221.6	159.0
Population with tertiary education	164.2	175.4	154.6
Lifelong learning	197.9	137.5	134.7
Attractive research systems	**177.8**	**196.8**	**173.2**
International scientific co-publications	245.6	405.9	249.6
Most cited publications	144.0	156.1	150.3
Foreign doctorate students	202.7	183.0	165.3
Innovation-friendly environment	**111.4**	**123.4**	**92.2**
Broadband penetration	88.9	144.4	81.3
Opportunity-driven entrepreneurship	124.7	111.0	103.0
Finance and support	**123.3**	**115.8**	**107.6**
R&D expenditure in the public sector	84.1	64.6	67.0
Venture capital expenditures	173.7	181.5	148.7
Firm investments	**98.7**	**113.9**	**101.9**
R&D expenditure in the business sector	88.6	94.8	85.1
Non-R&D innovation expenditures	33.3	95.2	87.1
Enterprises providing ICT training	164.3	150.0	131.3
Innovators	**61.2**	**85.6**	**99.5**
SMEs product/process innovations	65.0	89.0	108.8
SMEs marketing/organisational innovations	69.8	118.7	143.3
SMEs innovating in-house	48.8	48.8	52.3
Linkages	**139.1**	**134.8**	**133.5**
Innovative SMEs collaborating with others	217.4	217.4	216.3
Public-private co-publications	123.1	127.3	126.1
Private co-funding of public R&D exp.	77.4	59.3	58.4
Intellectual assets	**78.5**	**82.3**	**81.5**
PCT patent applications	92.3	83.0	86.7
Trademark applications	89.1	102.0	90.2
Design applications	57.6	66.7	69.1
Employment impacts	**140.3**	**144.8**	**144.0**
Employment in knowledge-intensive activities	150.6	166.2	150.6
Employment fast-growing enterprises	132.9	129.5	138.5
Sales impacts	**86.3**	**128.3**	**123.2**
Medium and high tech product exports	98.5	107.3	101.3
Knowledge-intensive services exports	112.7	109.9	104.8
Sales of new-to-market/firm innovations	41.1	174.5	172.7

Time to market for much R&D is several decades



McNamee LM, Walsh MJ, Ledley FD (2017) 'Timelines of translational science: From technology initiation to FDA approval'. *PLoS ONE* 12(5): e0177371. https://doi.org/10.1371/journal.pone.0177371

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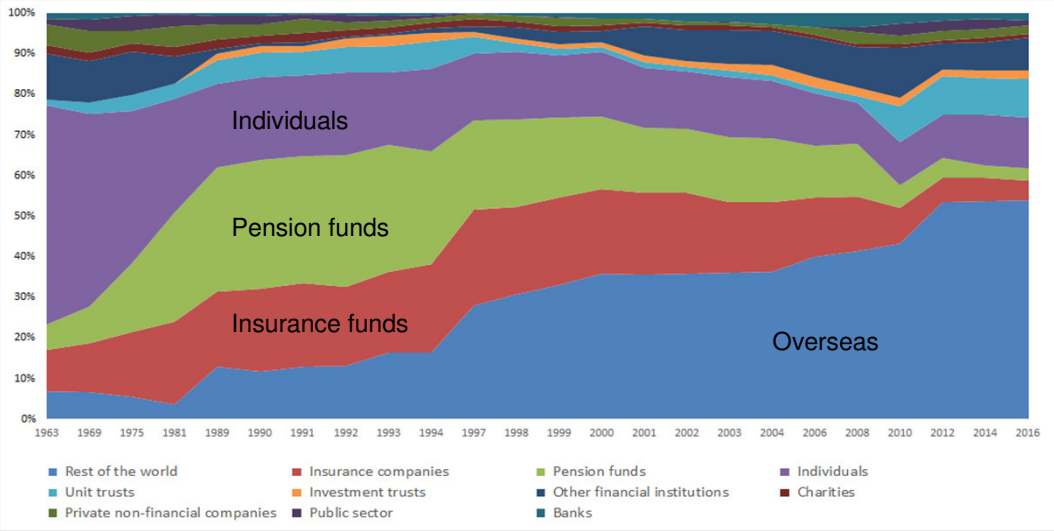
Ultimate ownership of UK public companies has changed dramatically



Percentage of total market value of UK quoted shares by sector of beneficial owner
(Pooled and excluded shareholdings allocated across the other sectors)

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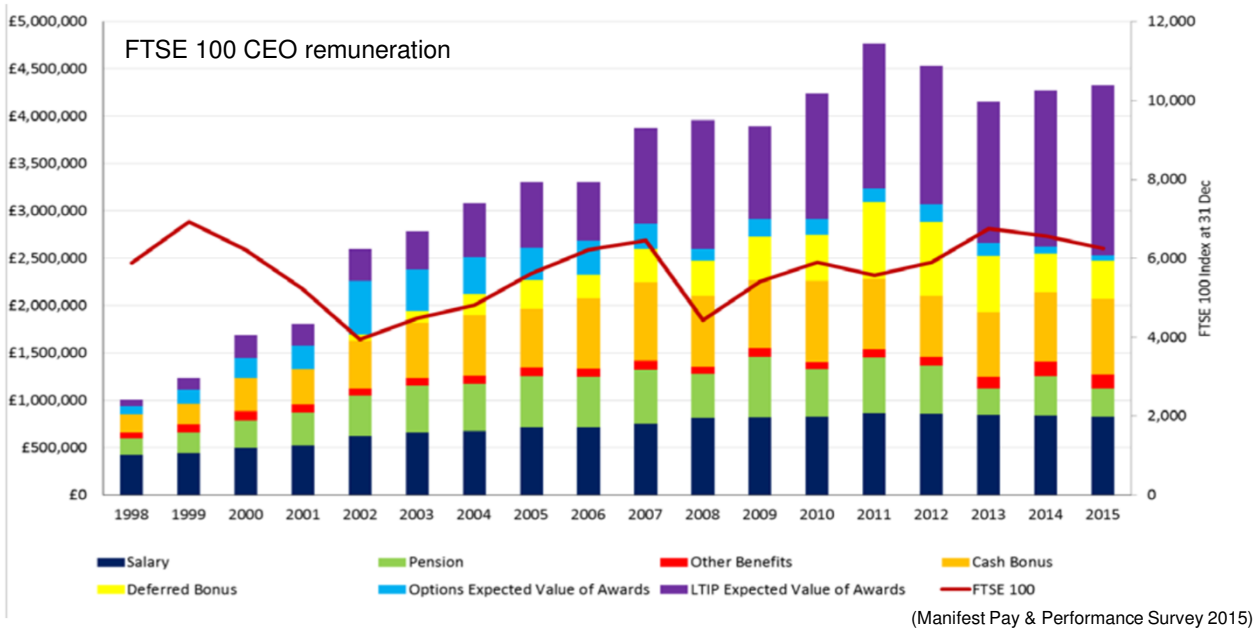
Source: ONS, https://www.ons.gov.uk/economy/investmentspensionsandtrusts/datasets/ownershipofukshares

Incentives often dwarf salaries

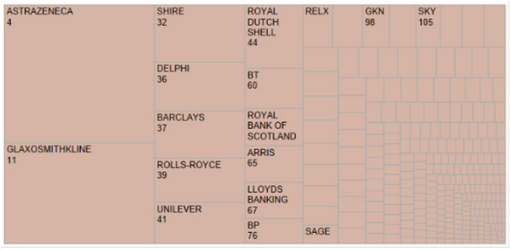


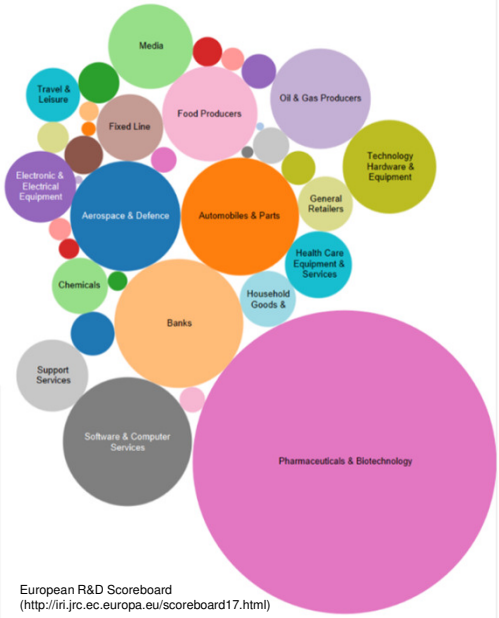
(Manifest Pay & Performance Survey 2015)

Power laws apply!

	Total Expenditure (£ million)	Funded by UK Government (£ million)	Percentage of Total
TOTAL OF ALL ENTERPRISES	**22,224**	**1,734**	100%
Enterprise groups with the largest expenditure on R&D			
Top 5	4,514	..	20%
Top 10	6,312	..	28%
Top 15	7,389	721	33%
Top 20	8,185	736	37%
Top 50	11,147	950	50%
Top 100	13,568	1,146	61%

Source: Office for National Statistics





European R&D Scoreboard (http://iri.jrc.ec.europa.eu/scoreboard17.html)

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Innovation Related Metrics Used In FTSE350 Incentive Schemes

Category	Sub-category of incentive	Occurrence
New Business	New Product: includes target relating to the producing new products or identifying new revenue streams for the business.	9.3%
	Pipeline: includes targets relating to achieving specific goals e.g. progress on implementing a new drug	18.1%
	New customers: includes targets such as the number of new clients as a result of innovation	1.3%
Existing Business	Brand development: includes targets such as rebranding in order to increase customers/product exposure	3.0%
	Operational improvement: includes targets relating to improving the operations of the business e.g. cost saving, improving company processes.	13.9%
	Infrastructure improvement: includes target relating to implementation of new IT systems, reorganising the business, etc	13.9
	Integration: includes targets relating to integration of new businesses following mergers or acquisitions.	7.2%
	Environmental: includes targets relating to improving process with a view to improving the company's environmental impact	0.4%
	Health & Safety: includes targets relating to improving company process with a view to improving health & safety	0.4%
Culture	Employee development: includes target relating to the development of staff to either drive growth	3.4%
	Strategic development: includes targets relating to the refreshment of company strategy to drive growth	12.7%
	Cultural initiatives: includes target relating to improving company culture towards innovation	9.3%
Financial	Input: includes target relating to financial input into innovations, e.g. R&D expenditure	2.1%
	Output: includes targets relate to revenue or new business generated as a result of innovation.	5.1%

Source: Nesta / Manifest (forthcoming)

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Most Common Metrics In Annual Bonuses

Annual Bonus Non-Financial Performance Conditions

Performance Condition	Occurrence	Average Weighting (if used)
Personal	52.7%	22.7%
Strategy	33.2%	15.6%
Customer	14.4%	14.2%
Other	13.7%	16.4%
Health & Safety	12.0%	9.5%
Employee	4.1%	8.3%
Production	3.1%	20.0%
Sustainability	1.0%	10.8%
Environmental	0.7%	3.5%
Reserves	0.3%	12.5%

Annual Bonus Financial Performance Conditions

Performance Condition	Occurrence	Average Weighting
Profit	58.6%	48.7%
Cash Flow	24.3%	21.8%
Profitability Ratios	18.8%	28.1%
Revenue	18.5%	26.6%
Other	15.1%	23.0%
EPS	14.4%	42.4%
EBITDA	13.7%	47.9%
Balance Sheet	8.6%	26.8%
Costs	6.5%	12.7%
Cash	4.5%	17.2%
Margin	4.1%	19.3%
KPIs	3.4%	14.5%
Investments	1.4%	14.2%
TSR	1.4%	35.0%
Capital	1.0%	16.3%
Capital Adequacy	1.0%	16.3%
Capital Expenditure	1.0%	8.7%
Economic Profit	0.3%	100%
Total Assets	0.3%	-

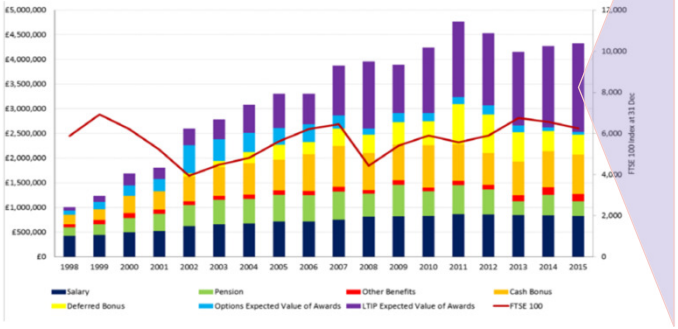
Most Common Metrics In Annual Bonuses

Are these measures more likely to be improved over the course of a year by <u>increasing</u> R&D spend, or by <u>cutting</u> it?

Annual Bonus Financial Performance Conditions

Performance Condition	Occurrence	Average Weighting	Link R&D spend
Profit	58.6%	48.7%	-
Cash Flow	24.3%	21.8%	-
Profitability Ratios	18.8%	28.1%	-
Revenue	18.5%	26.6%	-
Other	15.1%	23.0%	?
EPS	14.4%	42.4%	-
EBITDA	13.7%	47.9%	-
Balance Sheet	8.6%	26.8%	-
Costs	6.5%	12.7%	-
Cash	4.5%	17.2%	-
Margin	4.1%	19.3%	?
KPIs	3.4%	14.5%	?
Investments	1.4%	14.2%	+
TSR	1.4%	35.0%	-
Capital	1.0%	16.3%	-
Capital Adequacy	1.0%	16.3%	-
Capital Expenditure	1.0%	8.7%	+/-
Economic Profit	0.3%	100%	-
Total Assets	0.3%	-	+/-

Most Common Metrics In LTIPs



Metric	Occurrence	Average Weighting
TSR (total shareholder return)	73.2%	44.4%
EPS (earnings per share)	60.7%	54.6%
Profitability Ratios	32.0%	45.2%
Strategy	13.2%	46.3%
Cash Flow	12.1%	40.2%
Revenue	8.5%	28.2%
Balance Sheet	7.4%	50.1%
Profit	6.6%	47.3%
EBITDA	3.7%	44.3%
Customer	2.9%	12.6%
Other Financial Metric	2.6%	66.1%
Capital	2.2%	57.2%
Personal	2.2%	33.1%
Economic Profit	1.5%	29.2%
Costs	1.5%	16.3%
Cash	1.1%	29.4%
Investments	1.1%	33.3%
Share Price	1.1%	75.0%
Production	1.1%	26.3%
Employee	1.1%	6.7%
Margin	0.7%	27.8%
KPIs	0.7%	16.3%
Total Assets	0.4%	25.0%
Capital Adequacy	0.4%	25.0%
Market Cap	0.4%	100.0%
Health & Safety	0.4%	5.0%

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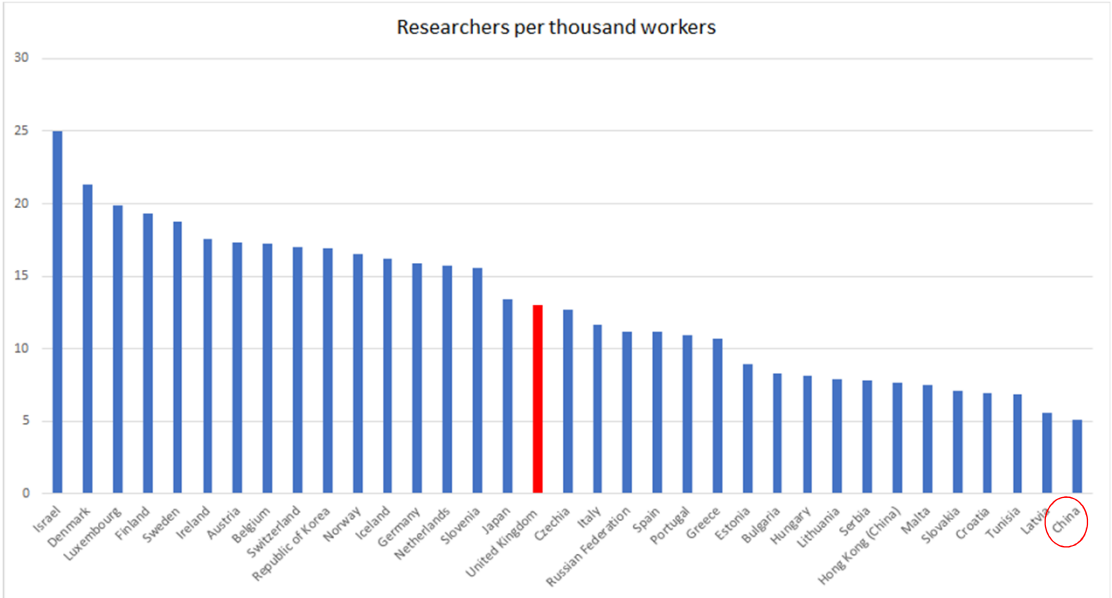
We have quite a lot of human capital...



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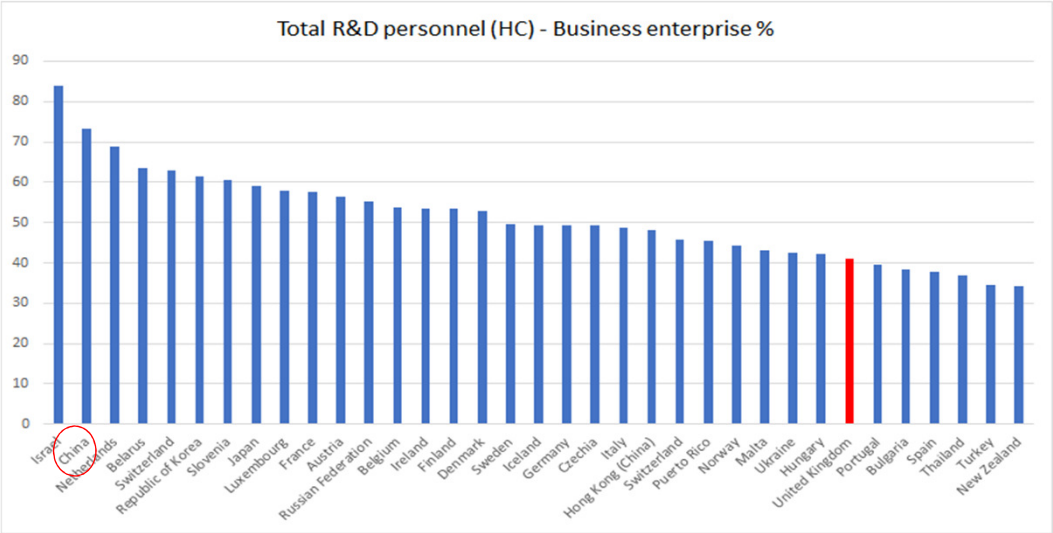
Source: UNESCO Institute for Statistics, June 2018 http://data.uis.unesco.org/Index.aspx?DataSetCode=SCN_DS&lang=en#

...But it is disproportionately concentrated in academia not business



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http://data.uis.unesco.org/Index.aspx?DataSetCode=SCN_DS&lang=en#

Conclusions & suggestions

- Non-R&D innovation is (probably?) not substituting for R&D - but we still need much better measures of the former.
- Also need better evidence of effectiveness of innovation schemes (which could be achieved via more experimentalism in government)
- Recognise that SMEs will play little role in getting to 2.4%.
- Incentives dwarf basic salaries in the big R&D firms, so need much closer attention to whether these *really* incentivise R&D.
- Raise awareness among analysts & fund-managers (cf. sustainability), and ensure that R&D- (or broader innovation-) metrics are part of their analysis.
- Focus on academia / industry permeability to improve flow of tacit knowledge

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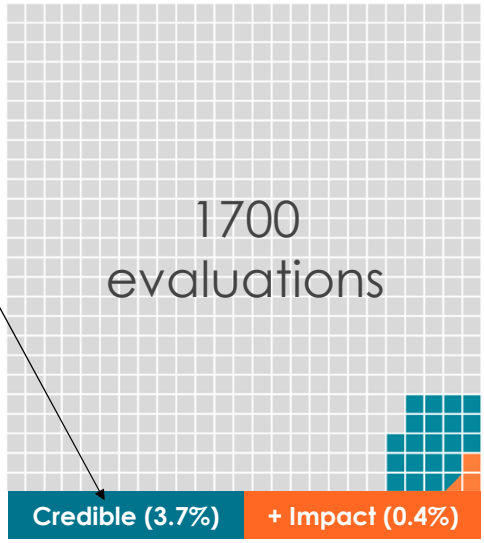
Weak evidence about what works

Level 5	Randomised Controlled Trials (RCTs) – comparison group created through random assignment of treatment
Level 4	Quasi-randomness in treatment used to identify comparator group
Level 3	Matching use to identify comparator group, with good controls and before and after measures
Level 2	Comparisons made with unsupported businesses but without strong controls for relevant differences
Level 1	Evaluations lacks comparison to a matched untreated group or before and after measures

Source: Adapted from LG WWC Scoring Criteria, http://www.whatworksgrowth.org/resources/the-scientific-maryland-scale/

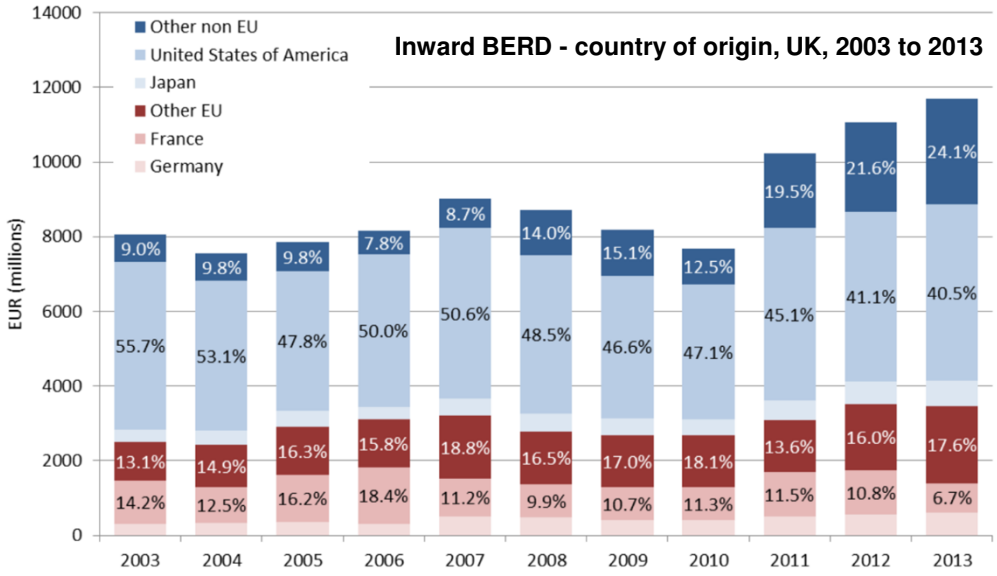
IGL Innovation Growth Lab

Innovation schemes



Source: Systematic reviews conducted by the What Works Centre for Local Economic Growth at the LSE (Credible: Level 3 Maryland Scale, Positive impact on employment)

Maybe it's not all about Brexit…



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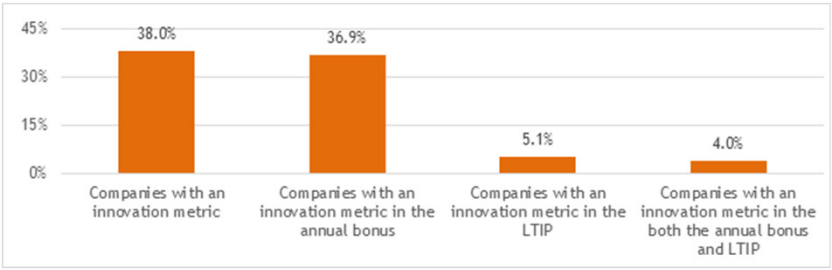
Source: ONS data, cited byFrédérique Lang and Parimal Patel (2016), Internationalisation of business investments in R&D and analysis of their economic impact (BERD Flows)

nesta (Bubble size = Total expenditure PPP$) http://uis.unesco.org/apps/visualisations/research-and-development-spending/

Figure 2: Proportion of the FTSE350 with Innovation Performance Metrics



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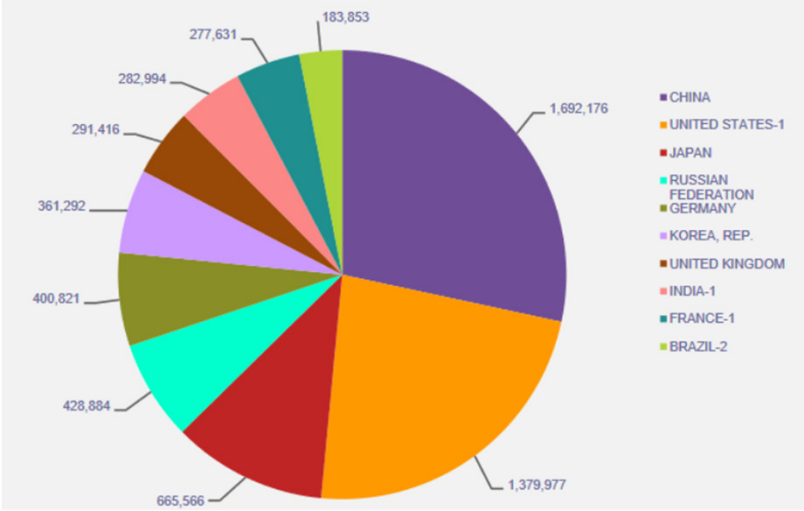

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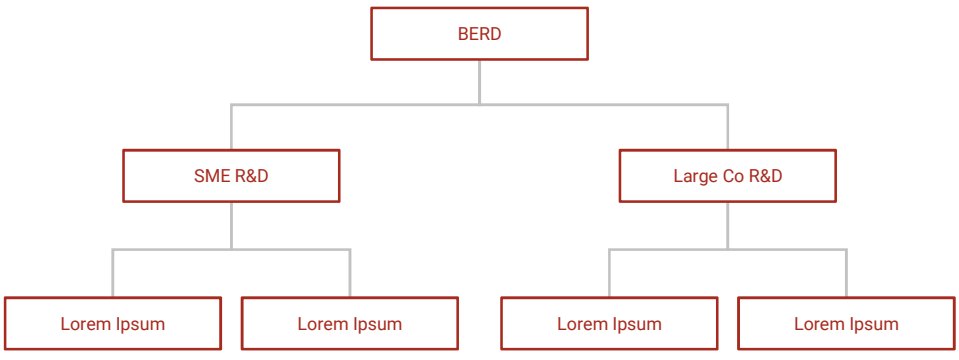
Source: UNESCO Institute for Statistics, June 2018
http://uis.unesco.org/sites/default/files/documents/fs49-human-resources-rd-2018-en.pdf



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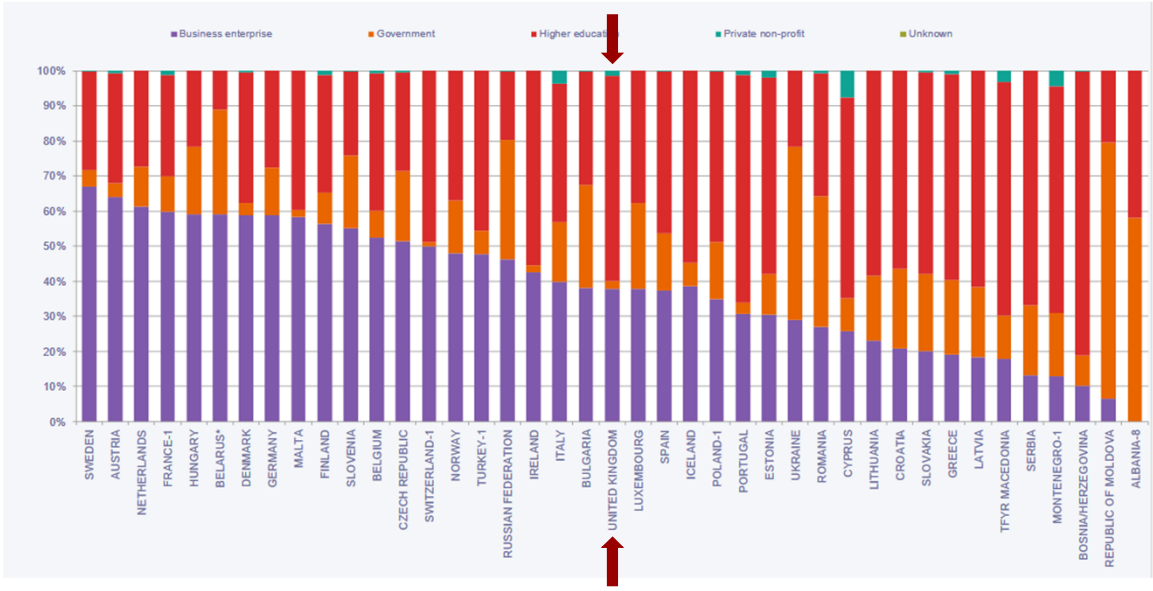
A breakdown of researchers in Europe

Percentage of researchers by sector of employment (FTE), 2016 or latest year available



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Source: UNESCO Institute for Statistics, June 2018
http://uis.unesco.org/sites/default/files/documents/fs49-human-resources-rd-2018-en.pdf

...But it is *probably* not the case that firms are substituting non-R&D innovation spend for BERD (as best as we can measure)

European Innovation Scoreboard 2018

https://ec.europa.eu/docsroom/documents/30706

Dark green: normalised performance above 120% of EU; light green: normalised performance between 90% and 120% of EU; yellow: normalised performance between 50% and 90% of EU; orange: normalised performance below 50% of EU. Normalised performance uses the data after a possible imputation of missing data and transformation of the data.

Data in red show a decline in performance compared to 2010.

United Kingdom	Performance relative to EU 2010 in 2010	Performance relative to EU 2010 in 2017	Relative to EU 2017 in 2017
SUMMARY INNOVATION INDEX	**114.5**	**128.5**	**121.5**
Human resources	170.5	180.6	151.4
New doctorate graduates	153.8	221.6	159.0
Population with tertiary education	164.2	175.4	154.6
Lifelong learning	197.9	137.5	134.7
Attractive research systems	**177.8**	**196.8**	**173.2**
International scientific co-publications	245.6	405.9	249.6
Most cited publications	144.0	156.1	150.3
Foreign doctorate students	202.7	183.0	165.3
Innovation-friendly environment	**111.4**	**123.4**	**92.2**
Broadband penetration	88.9	144.4	81.3
Opportunity-driven entrepreneurship	124.7	111.0	103.0
Finance and support	**123.3**	**115.8**	**107.6**
R&D expenditure in the public sector	84.1	64.6	67.0
Venture capital expenditures	173.7	181.5	148.7
Firm investments	**98.7**	**113.9**	**101.9**
R&D expenditure in the business sector	88.6	94.8	85.1
Non-R&D innovation expenditures	33.3	95.2	87.1
Enterprises providing ICT training	164.5	150.0	131.3
Innovators	**61.2**	**85.6**	**99.5**
SMEs product/process innovations	65.0	89.0	108.8
SMEs marketing/organisational innovations	69.8	118.7	143.3
SMEs innovating in-house	48.8	48.8	52.3
Linkages	**139.1**	**134.8**	**135.5**
Innovative SMEs collaborating with others	217.4	217.4	216.3
Public-private co-publications	123.1	127.3	126.1
Private co-funding of public R&D exp.	77.4	59.3	58.4
Intellectual assets	**78.5**	**82.3**	**81.5**
PCT patent applications	92.3	83.0	86.7
Trademark applications	89.1	102.0	90.2
Design applications	57.6	66.7	69.1
Employment impacts	**140.3**	**144.8**	**144.0**
Employment in knowledge-intensive activities	150.6	166.2	150.6
Employment fast-growing enterprises	132.9	129.5	138.5
Sales impacts	**86.3**	**128.3**	**123.2**
Medium and high tech product exports	98.5	107.3	101.3
Knowledge-intensive services exports	112.7	109.9	104.8
Sales of new-to-market/firm innovations	41.1	174.5	172.7

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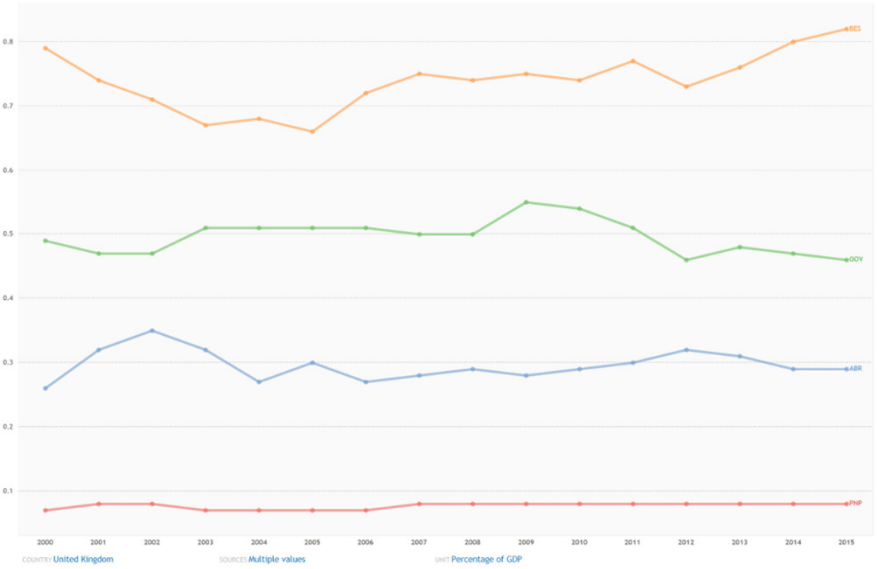
Business R&D (BERD) is the major component of UK R&D



Business Expenditure

Government Expenditure

Expenditure originating abroad

Private non-profit expenditure

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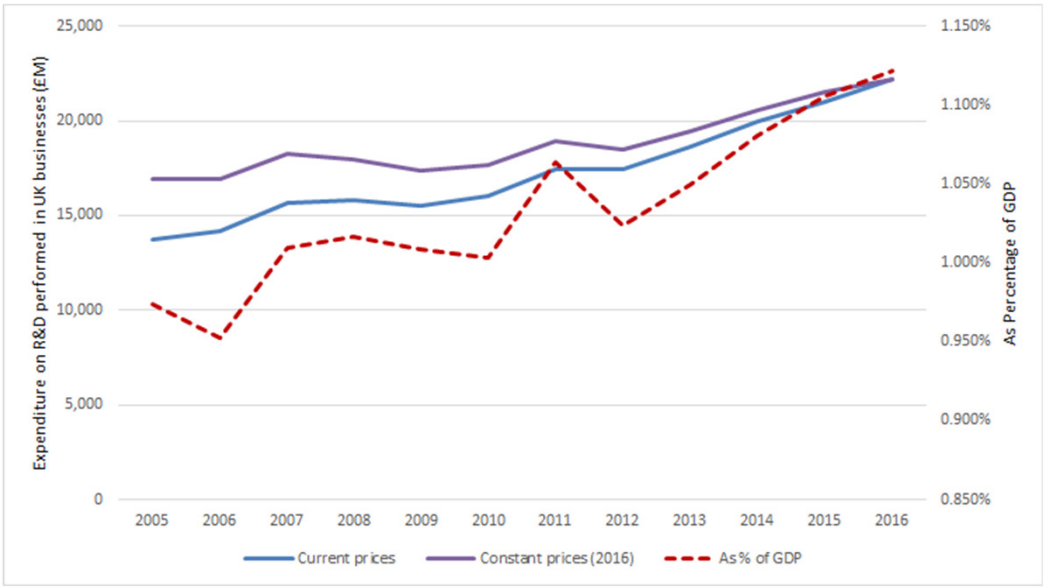
EC Research and Innovation Observatory: https://rio.jrc.ec.europa.eu/en/country-analysis/United%20Kingdom/key-indicators/26155

BERD has been increasing since 2005, but slowly



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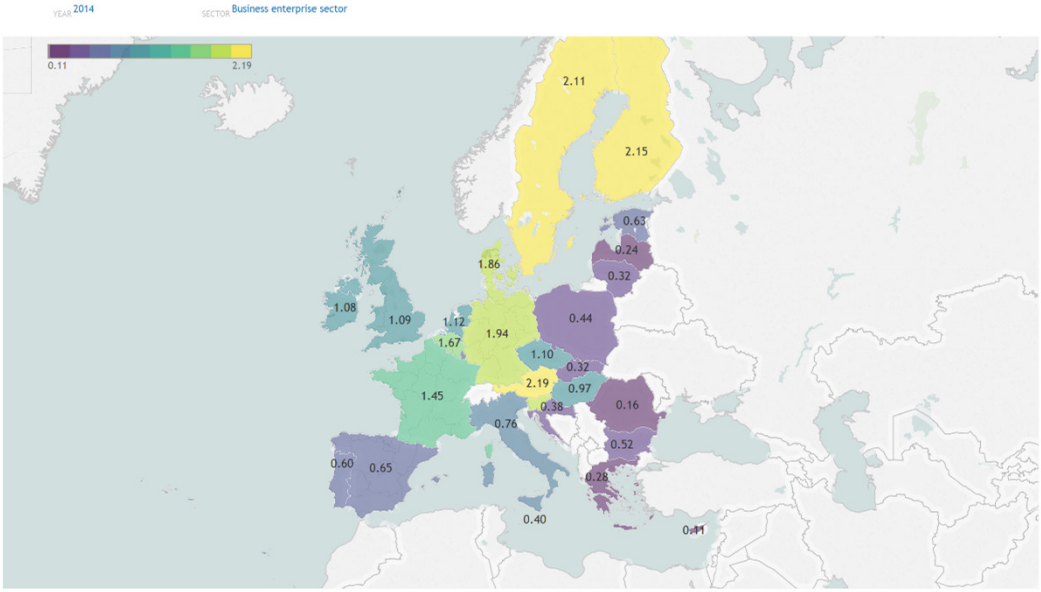
ONS, Research and Development in UK Businesses, 2016

UK BERD is not great by EU standards



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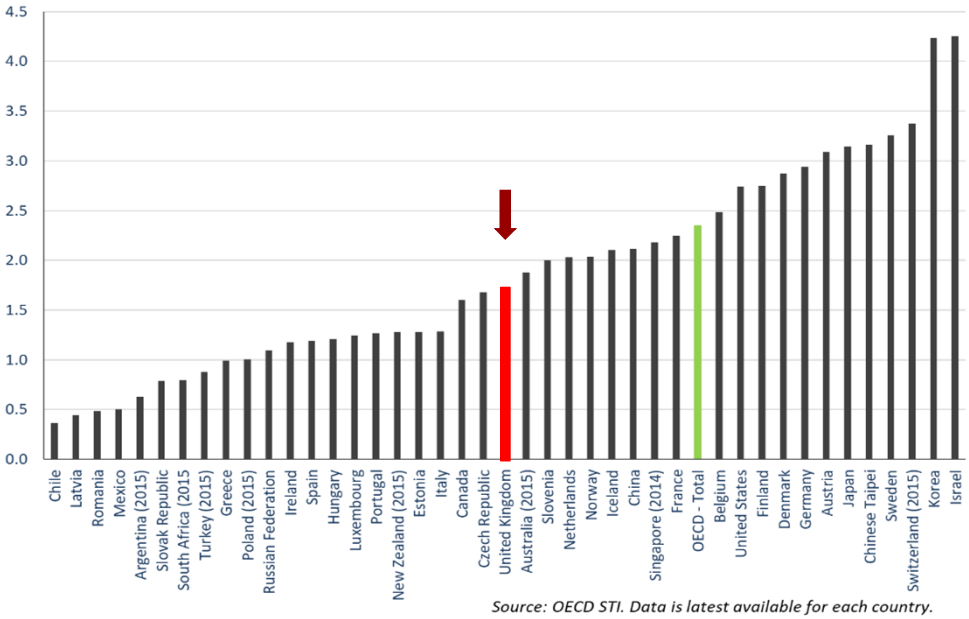
UK BERD is below OECD average...



Source: OECD STI. Data is latest available for each country.

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Time to market for much R&D is several decades

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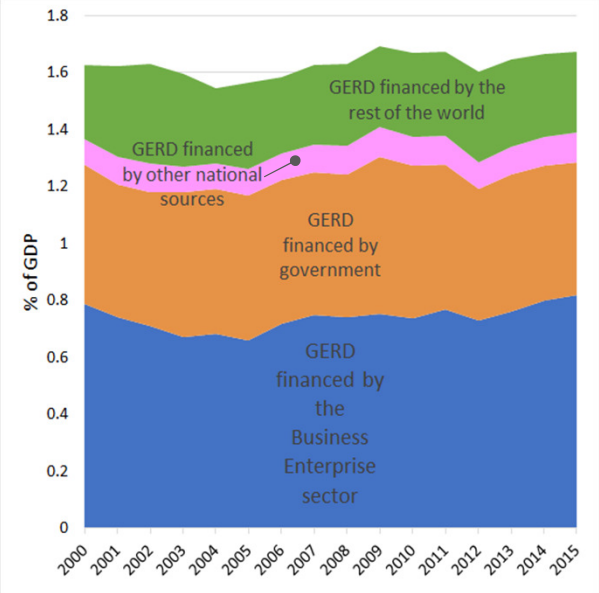
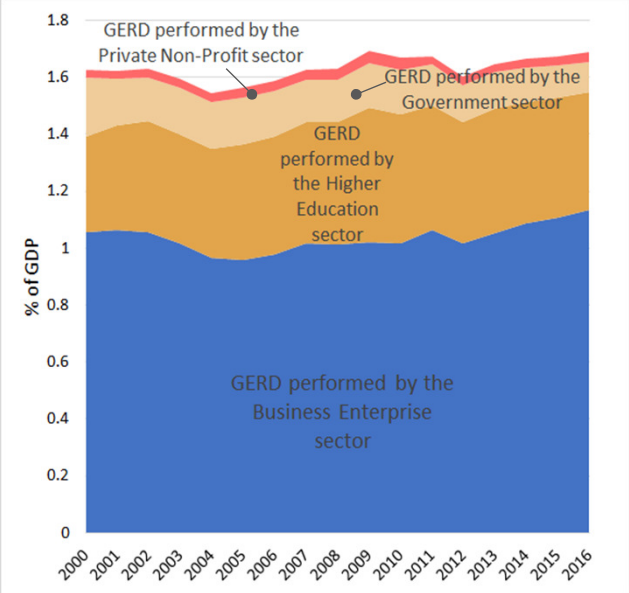
Businesses are main funders – and performers – of UK R&D





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Source: OECD, MSTI database