Debunking the myths about British science after an EU exit

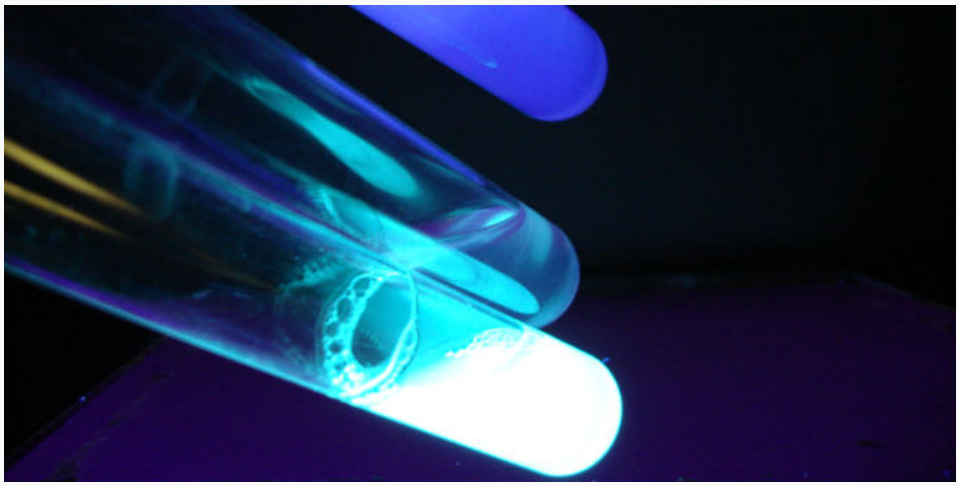
blogs.lse.ac.uk/brexit/2015/12/05/debunking-the-myths-about-british-science-after-an-eu-exit/

05/12/2015

In this extract from their evidence to the House of Lords Select Committee on Science and Technology, ***Dr Mike Galsworthy*** *(left) and* ***Dr Rob Davidson*** *explore the relationship between EU membership and the effectiveness of science, research and innovation in the UK.*

Collectively, the EU remains the world leader in terms of its global share of science researchers (22.2%), ahead of China (19.1%) and the US (16.7%), according to Unesco's Science Report (released last month). This would be a fairly moot bragging point, were it not for how the EU science programme has managed to network the European countries into a collaborative engine which serves as a hub of science in the wider world. This, in turn, has benefited UK science prowess demonstrably.

The EU is now a community of scientific talent which can flow between countries without visas or points systems and which can assemble bespoke constellations of cutting-edge labs, industry and small businesses to tackle challenges local and global. Across the 500m populace of the EU (plus the Associated Countries which buy into the EU science program), there is a capacity to pick'n'mix the best labs to do the job – and apply for funding from a single source. Given that the European Research Area produces a third of the world's research outputs, this communal spirit provides a powerful environment to combine leading players across borders to common advantage. So large is the programme that top teams in 170 other countries in the world are easily taken on board as secondary participants. This, in a nutshell, is how a collection of countries converts its critical mass into a critical research advantage, globally.



Fluorescent bacteria. Photo: njhdiver via a Flickr Creative Commons licence

Twenty-first century science often has to go big to go small and increase the resolution of our understandings and capacity. Developing new nano-materials or discovering ever-rarer particles often requires more expensive machinery to establish more extreme conditions. In health, identifying ever-smaller contributory effects (e.g. multiple interacting genes in disease development) requires ever larger sample sizes of patients. Increasingly complex models require larger collections of expertise and shared resources. This is more than an appealing narrative: The drive to big networked science is also borne out in the data on the rising internationalisation of science and the associated impact. Below we demonstrate how the international networks uniquely supported by EU funding have driven the UK into global pole position for productivity.

Increasing internationalisation

Since the 1980s, global research has become rapidly more international. The prevalence of scientific research papers co-authored by researchers from more than one country has risen sharply. However, some countries have seen this increase more than others. Since 1981, the UK has risen from 15% of its papers being international (and 85% domestic authors only) to over 50% international today. In fact, almost all the growth in UK output is in the form of international collaborations.

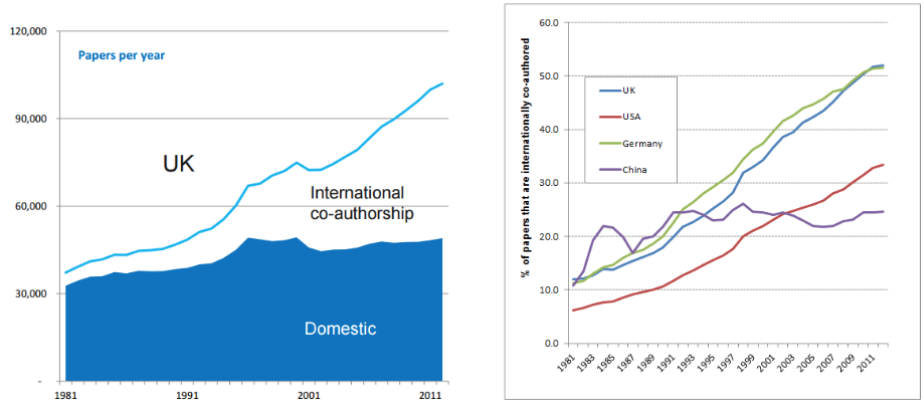


Figure 1: a) The UK's increasing output is largely driven by an increase in internationally co-authored papers and b) UK rise in international papers compared with other countries. Reproduced with kind permission from Dr Jonathan Adams

This rate of increase can be compared to the US, which has seen a rise in internationally co-authored papers from 6% in the 1980s to 33% currently.

Internationalisation and impact

Multiple sources have identified international co-authored papers as having substantially higher impact than domestic-only papers.

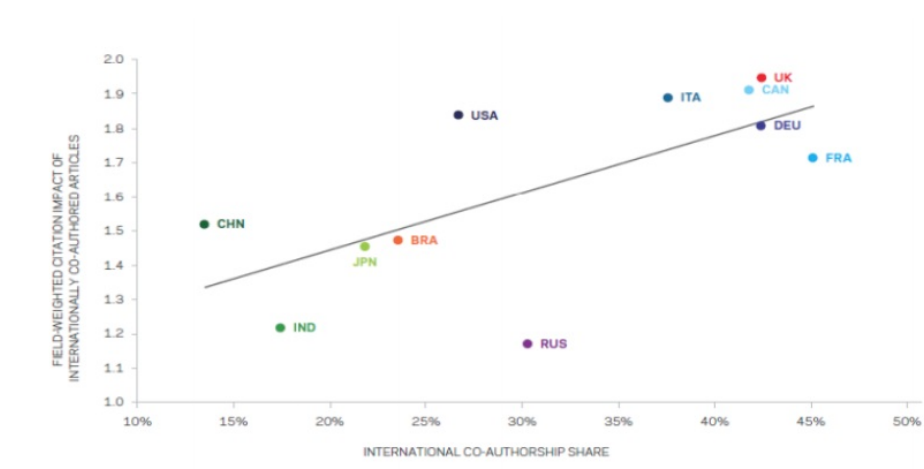


Figure 2: Correlation of international co-authorship share and field-weighted citation. Reproduced with kind permission from Dr Jonathan Adams .

The UK's strong lead over the US on proportion of international output interacts with the added impact of international output – resulting in the UK science base now measuring as more productive than that of the US. This is despite the US's domestic-only papers showing more citation impact than UK domestic-only papers. International

collaborations give the UK the research quality edge.

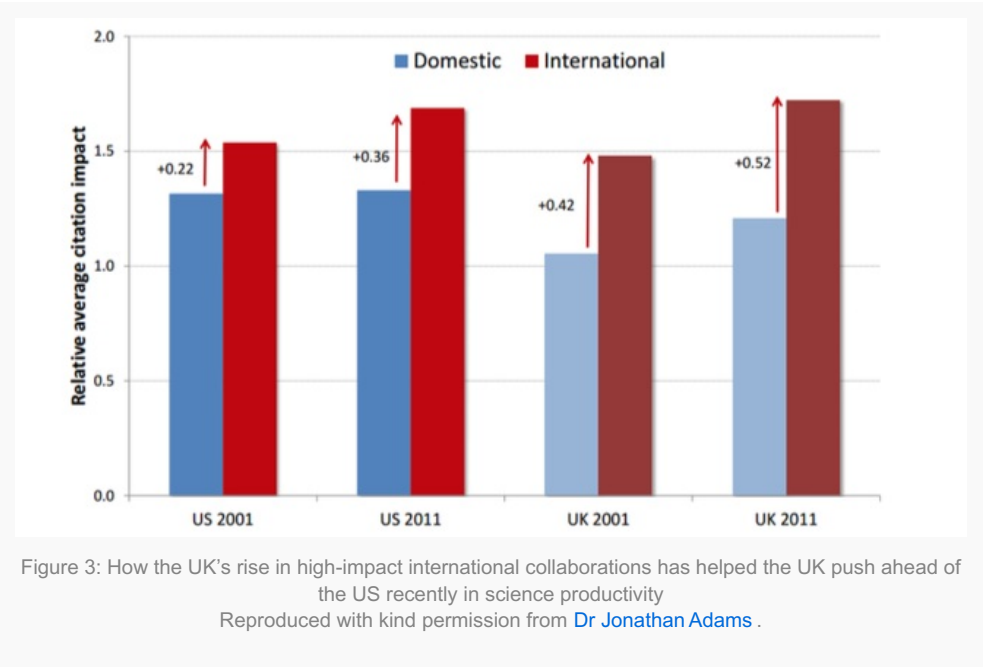


Figure 3: How the UK's rise in high-impact international collaborations has helped the UK push ahead of the US recently in science productivity
Reproduced with kind permission from Dr Jonathan Adams .

How much of this increase in internationality can be attributed to participation in the EU science programme? Approximately 10% of UK public funding for science came from the EU during 2007-2014, this amount has been rising sharply recently and, pertinently, Horizon 2020 funds are predominantly for international collaborations. Of the UK's international collaborations, 80% include an EU partner. Therefore, it is not too adventurous a conclusion to state that participation in the EU science programme looks highly likely to have helped the UK science base become more productive than the US.

Other benefits of a pan-European science programme to EU and UK productivity

- Beyond the cross-border collaborations themselves providing more impact than domestic-only work, there are multiple additional properties of a pan-European science programme that confer increased science capacity and productivity to its members:
- The presence of a pan-European fund helps prevent duplication of activity.
- The spread of good practice is facilitated 1) by collaboration and researcher interactions and 2) by adoption of successful policies from one country (e.g. open access, open data) into a funding body present in multiple countries.
- Such a large comprehensive programme covering the gamut of research and innovation areas sets a common framework for funding categorisation and comparisons; a spine against which national funding schemes can be benchmarked.
- A single one-stop shop for international collaborations removes a vast amount of bureaucracy that would be incurred otherwise. Without the EU common pot of funds and common administration, a UK lab looking to partner with, for example, teams in four other countries would encounter serious trouble in finding full funding. The UK government (or any other) would be unlikely to fund a five-way collaboration on which the UK partner undertook 20% of the work. Similarly, all five partners attempting to obtain matched funds from their governments means five times the administrative loads, aligning five timelines of funding applications and work, and five times the jeopardy in getting the monies through. If each of the five applications had a 20% chance of success, then the overall chance of getting funding for all five partners would be 0.25 = 0.00032. The EU, however, regularly funds teams of many partners. This is because the governments of the EU members and associated countries have committed money to a common administration that can choose to fund constellations of labs, regardless of team composition, based solely on competitiveness of the

proposal.

“Brexit” and free money for science

> *“Our current assessment is that leaving the EU would be likely to impose substantial costs on the UK economy and would be a very risky gamble.”*
> *Analysis by economists at the Centre for Economic Performance (CEP)*

Stocktaking the current benefits of EU membership to UK science is not enough. This House of Lords inquiry will be used to inform the debate on whether to stay in the EU or leave. To adequately address the role of UK science in the debate, we must compare realistic models of UK science continuing within the EU against realistic models of UK science moving to a position outside the EU.
As an analogy: When evaluating the utility of any new drug or treatment, the medicine at hand must be compared not only with a placebo, but also with the best competing medicines on the market. In the case of EU membership, we must compare the current trajectory within the EU against more than flat-cash reimbursement of EU funds through UK funding mechanisms (placebo). We must compare UK science in continued EU membership with the most seductive alternatives being offered on the market.

To summarise those alternatives; we, have widely encountered two notions:
Firstly, that because the UK is a net contributor to the EU budget, then the UK could leave the EU and the surplus money gained from the transition could be channelled into research and innovation. In short, leaving the EU frees up money for UK science.
Secondly, that because non-EU countries such as Norway and Israel can have full participation in EU science programmes such as Framework 7 and Horizon 2020, therefore there is no threat to the UK’s relationship to the EU science programmes continuing as is. On leaving, we simply buy back into EU science programme participation as the other countries do.

Combined, the claims amount to an appealing package: On leaving the EU, the UK could continue reaping all the benefits of full membership on the EU science programme whilst having significant extra cash-in-hand to boost public investment in R&I at the national level.

Both these notions are dangerously – and demonstrably – misinformed.

The availability of money on a departure from the EU

There is a claim by the campaign Vote Leave (which use the slogan “Vote Leave – take control”) that a Brexit will free up money for R&I investment11. This claim is based on the UK being a “net contributor” to the EU budget as a whole. The size of that net contribution varies, but according to analysis by economist Roger Bootle in his 2014 book “The trouble with Europe” (which, incidentally, contains no analysis of EU research and innovation in its 201 pages), the UK paid a net £9.6bn into the EU in 2012, about 0.6% of nominal GDP.

Models of impact to the UK economy on Brexit vary. The Centre for Economic Performance (CEP) calculated the UK could suffer income falls of between 6.3% to 9.5% of GDP under a pessimistic scenario. CEP calculate loses of 2.2% GDP under an “optimistic scenario” (a free trade agreement with the EU). The think tank Open Europe calculate UK GDP could be 2.2% lower in 2030 if Britain leaves the EU and fails to strike a deal with the EU. In a best-case scenario (liberal trade arrangements with EU and globally, with large-scale deregulation at home), Britain could be better off by 1.6% of GDP in 2030.

Importantly, even the more optimistic assessments of the UK’s economic performance following a Brexit (such as

the “best case” +1.6% GDP increase by 2030 by Open Europe) all analyses model an immediate loss in GDP for the transition years following a Brexit. The size of that loss is substantially larger than the current net contribution of the UK to the EU budget. The triviality of the UK net contribution relative to the greater economic forces around transitioning out of EU membership have been noted by Bootle: “These are not the sort of sums on which the fate of great nations depends – nor on which momentous decisions about EU membership should be made.”

Therefore the attempt to financially gain in the short term via a Brexit is akin to killing the goose that lays the golden egg. It is a sure-fire short term loss, wiping any free money for R&I investment until at least a decade down the line – according to the most optimistic scenarios. This strongly counters any claim that voting to leave the EU provides immediate funds for a shot in the arm of national science. The extra money simply will not be there for science as the UK economy is hit by huge transition costs. Even if it were the case that there were free cash-in-hand on a Brexit, the individuals offering this money to science (as part of their campaign) would have no power over its allocation. None of them have any track record in science policy or impact on national science budget allocations. They are simply in no position to offer money to national R&I – even if that money were available.

It is worth taking a moment to consider where the UK’s net contribution actually goes. The UK net contribution (and similarly, the net contributions of the other wealthier countries in the EU, such as Germany – which contributes the most) has risen in recent years due to the EU’s expansion eastwards, taking in new member states that are less developed than western Europe. Regional development funds are being used to support their development. A huge transition from the FP7 to the Horizon 2020 timeframes concerns the use of regional development funds alongside the science programmes to support research and innovation capacity building. So while eastern (and southern) Europe’s under-competitiveness does not interfere with the EU’s criterion of funding “excellence” in science (a decision which benefits the UK greatly), nevertheless, it is important that those EU countries which came into the competitive funding environment late receive adequate support to be competitive. Otherwise brain drain and disillusionment will drop capacity in those regions and for the EU overall.

Therefore, the new focus of the Commission to dedicate regional development funds to R&I means that the whole EU ecosystem of science is strengthened in all parts. The UK, as the EU science programme’s leading player – benefits strongly in the long run when it can participate in and lead (more than any other country) ever more capable teams from an ever stronger region. Much of the “net contribution” being promised by Vote Leave to UK R&I is currently deployed to strengthen the pan-EU science hub that boosts the UK’s global leadership in science. Therefore those monies are already being strategically invested in the UK’s R&I future. Ultimately, we see further by standing on the shoulders of a giant.

A case study of Switzerland as a model for UK science outside the EU

Fortunately, this discussion is not purely hypothetical, but rather based largely on the precedent of Switzerland’s relationship with the EU science programme. Given Switzerland’s high competence in science, geographical location in Europe, non-EU status and political difficulties with issues of EU immigration – Switzerland is a helpful model for the UK’s re-negotiation of science programme membership following a Brexit:

Synopsis of the Swiss-EU science story

1. Switzerland is not a member of the EU but since 1992 has obtained full access to Framework Programmes, as part of agreements that also guarantee free movement of persons, contributing to the FP budget alongside other EU members.
2. In 2014, a popular vote to limit mass migration was passed by a margin of 50.3 to 49.7%
3. The Swiss government was then unable to commit to ratification of a free movement accord with Croatia.
4. Switzerland was suspended from access to Horizon 2020.
5. The Swiss government was forced to replicate at national level a temporary programme to replace immediate access to the ERC programme and subsequently negotiated limited access to H2020, with much reduced access to programmes, exclusion from the new SME Instrument and loss of ability to coordinate collaborative research within

H2020. This is reliant on continued freedom of movement. Switzerland also funds Swiss participants in EU collaborative programmes directly at national level, requiring parallel domestic administration and an agreement to accept all funding decisions made in Brussels, effectively losing control of its national science budget.
6. The Swiss were also not included on Erasmus+. They chose to ensure continuation of the scheme by paying nationally both for students leaving and for those coming in (i.e. paying double what they would as a member of the international programme).
7. Negotiated access to H2020 will end in 2016, when Switzerland must either ratify the Croatia treaty or lose access to H2020 plus risk its bilateral trade agreements with the EU.
8. Switzerland must contribute to H2020 based on GDP and population and has no role in developing funding topics.

This case study of Switzerland represents an instructive set of circumstances for the UK with regard to Horizon 2020 access post-Brexit. Switzerland's current participation is dependent on free movement. Should the UK leave the EU and restrict freedom of movement, it will have no access to Horizon 2020 beyond third country status (Afghanistan, Argentina etc.). However, as detailed further on, the sheer size of the UK causes problems for re-joining the EU programme after rejecting the EU.

The UK must consider that a withdrawal from the EU, followed by Horizon 2020 'buy in' such as that of the Swiss model, will require continued EU budget contribution. Switzerland makes a contribution to the Horizon 2020 budget based on its GDP and its population, but the UK may have to pay more than its current contribution and/or accept limited involvement, due to its size, so as not to be so overtly disruptive (without the counter-balance of net contribution investment into less competitive regions). It will also have to follow Switzerland in creating domestic administration structures for programmes where it will fund UK participation in Horizon 2020 collaboration from domestic budgets. This has the double disadvantage of replicating a complete administration structure in the UK that operates on EU financial and legal rules without any role in creating those rules, and it must agree to a single evaluation decision made in Brussels to avoid damaging the partner-worthiness of UK participants with an additional UK level of evaluation.

The requirement to agree to implement funding decisions made in Brussels will ensure that the UK cannot control budget allocated to such collaborations. This creates a scenario in conflict with claims by anti-EU groups. The UK will still be contributing to EU science financially, it will have no control over domestic budget for collaborative research and it will have to sustain a parallel administration structure. This combination of factors means that the UK cannot make a simple financial calculation on financial contribution to EU science nor estimate how much it would retain to fund UK research post-Brexit.

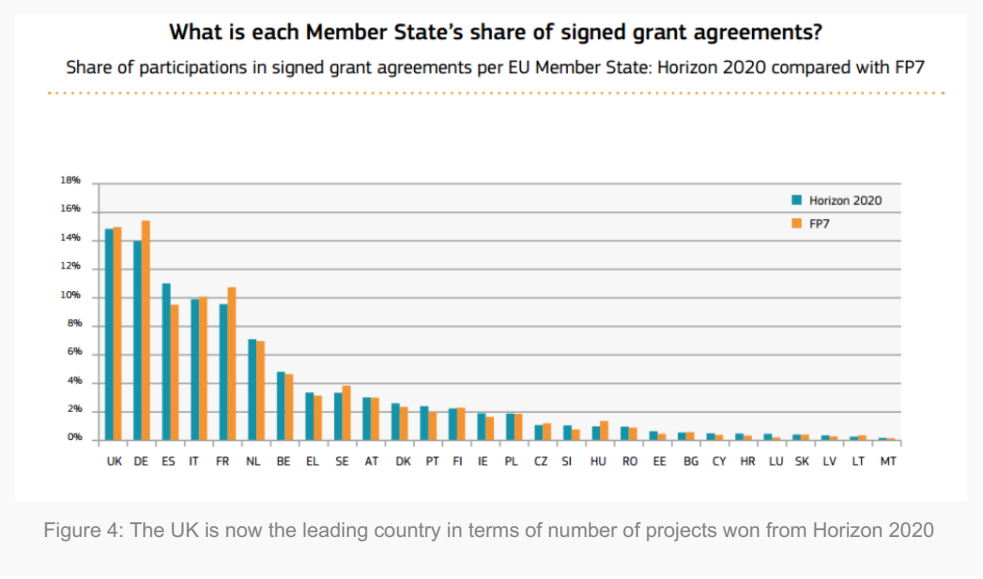


Figure 4: The UK is now the leading country in terms of number of projects won from Horizon 2020

Important considerations pertaining exclusively to the UK's relationship with the science programmes must be

addressed upfront. Unlike Switzerland, Norway, Turkey or any of the non-EU countries that hope to become full Associated Countries on the EU science programme – the UK has a lot more to lose. The UK is currently a full member of the EU, meaning that it has a political say in the development of the science programme. It is also the leading player on the EU science programme, winning more grants than any other country during Horizon 2020 so far. That means it has overtaken Germany, which was the leading country on FP7 (see Figure 4 above).
This combination of the political input (and the UK has, due to its population size, the third largest delegation to the European Parliament), and the UK's science prowess means that the UK has the kind of status and power on the programme that no non-EU participating country has. These other countries are easily absorbed into the overall programme at a cost. Whether they are EU members or not, they would not command much of a political say on overarching science direction and management. This commanding position for the UK means that, on Brexit, a buy-back into the programme as a full Associated Member would have several major flaws:

- The largest player on the programme would have no political say about its formation.
- Playing by the same rules as others means a 12% contribution of funds for 16% gain of competitive funds – a very damaging ratio to the other countries given the UK's size, given also that it is no longer a net contributor to an EU budget and therefore not supporting the R&I of other EU countries.
- The threat of the UK changing its immigration policies at any stage offers major disruption to the programme, which must respond according to the precedent with Switzerland.

In conclusion, the UK acquiring full Associated Country status on Brexit is not an option. The EU has already introduced and used the concept of Partial Association with Switzerland and would do the same with the UK, tailoring a deal to maximise its own interests.

The impact on Swiss science of a partial access deal

Although it is early days in Horizon 2020, nevertheless, data available clearly show the disruption caused to Swiss science performance on the EU program (Figure 5). The uncertainty and renegotiations, despite clawing back participation on areas of the program critical to Switzerland's interests, has taken a marked toll.

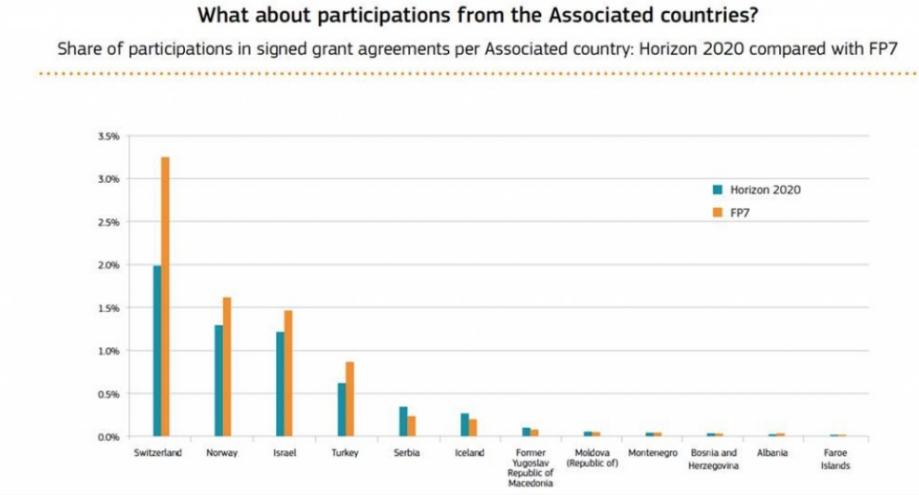


Figure 5: Comparison of participation levels during FP7 and the latest figures from H2020. Switzerland indicates a 40% drop in participation.

Swiss participation in H2020 and financial benefit has declined significantly, despite negotiated access. The above graph suggests a drop in participation by over 40% for Switzerland – highlighting the cost of renegotiation confusion even for a highly-competitive scientific community. Swiss sources (private communication) report a declined trust in Swiss research partners and rapid reduction in their engagement in collaboration – the Swiss science sector is reliant on immigration and its innovative performance is likely to decline, particularly if it must completely exit

Horizon 2020 membership in 2016.

Retaining EU membership: Is the EU headed in the right direction for UK science?

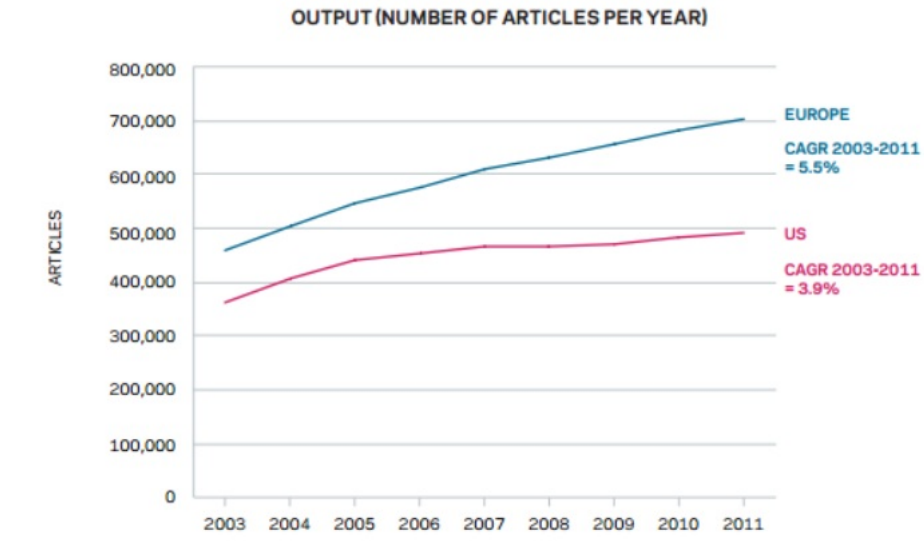


Figure 1 — *European and US output per year, 2003-11, with compound annual growth rate (CAGR).*

Outputs included are articles, reviews and conference papers indexed in sources covered by Scopus, primarily journals, conference proceedings, book series, and trade publications.

Figure 6: Retaining EU membership: Is the EU headed in the right direction for UK science? Figure copied from Science Europe & SciVal report (2013). “Europe” denotes all countries that paid into the FP7 science programme (ie. 27 member states plus 14 associated countries)

The UK is currently in the driving seat of a global hub of research excellence that is larger than the US in output size, growing faster than the US (see diagram above), and with a far higher rate of international collaborations at a time when the impact of international collaborations are bringing increasingly high impact.

From Eurocracy to leadership

However, the benefits of the UK remaining within the structure of the EU go beyond the clear internationalisation-impact dynamic. The increasing competence of the EU in science management is beginning to be felt. Whether one considers the bold commitment to increasing science investment despite shrinking overall budgets, a holistic and well-articulated vision for science, closer democratic accountability for the budgeting and priority-setting within science, success in linking universities with small businesses, open data, bold infrastructure, the European Research Council and plans for a similar innovation council, or newfound transparency around its science programme outputs – it is clear the EU has discovered an appetite for science leadership. The body has transitioned from a painful bureaucratic funder poorly copying a US lead into a true leader confidently setting its own agenda. UK politicians even act as a barrier to UK science’s capacity to fully harness the benefits of the EU. The low participation rate of UK SMEs on Horizon 2020 relative to our universities is directly attributable to very poor advertising through channels such as BIS and Innovate UK.

Any pride that British politicians may feel about the quality of British science in comparison to other countries in the EU should have their mood strongly tempered by the realisation that in the eyes of many British scientists, the EU is stealing a march on the UK in science policy leadership. New directions and capacities that our UK scientists argue for are now rapidly adopted within EU thinking, whilst in the UK, common knowledge about core needs (e.g. a funding increase to a 3% target) often circulates perennially with inaction by the parties in power and their appointees.

This post represents the views of the authors and not those of the BrexitVote blog, nor the LSE.

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