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The Changing Of UK STEM Higher Education In The Wake Of Brexit

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Introduction

The impact of science on today’s world has emerged in large part due to the work of universities in the UK. For the past several hundred years, the UK has forged the field into the acclaimed domain it is today, with UK universities nurturing the minds of notables like Sir Francis Bacon, Sir Isaac Newton, Niels Bohr, and Alan Turing. The prestige of the UK’s scientific program has drawn the best and brightest from all over the globe, leading to the island nation’s domination of modern science. Recent events, however, may threaten the continued success of the UK’s science, technology, engineering, and math (STEM) fields in higher education, all encompassed in the academic scientific community.

With the entirety of the UK set to leave the EU in April 2019, many challenges to science at UK universities arise. Brexit portends a limiting of the freedom of movement essential to maintaining the high quality of UK scientific performance as well as a shift in research funding sources as the UK tries to find money to supplant that anticipated to be lost from EU collaborations. This article explores the consequences that could follow various Brexit outcomes on the movement of people and funds that fuel the UK’s university scientific research.

Pre-Brexit, 1996–2016

From 1996 to 2016, the UK produced the third largest total amount of scientific documents and citations of any country in the world, following the United States and China; in particular, documents authored by at least one UK scientist were cited just under 61 million times in that period (Scimago Lab). Especially when considering the UK’s significantly smaller population size compared to the US and China, these statistics indicate that not only was the UK’s research workforce highly prolific but also the output was of a high enough quality

THE CHANGING OF UK STEM HIGHER EDUCATION IN THE WAKE OF BREXIT

Veronica McKinny

Scientific research, particularly at the university level, has long been a hallmark of UK economic and technological prosperity. This article analyzes how Brexit will change scientific research at UK universities by examining the flow of people and funds across borders and offers thoughts on researchers’ and Parliament’s role in supporting the future efficacy of the UK scientific domain.
to garner a hefty number of citations. With a substantial volume of insightful scientific articles produced each year, the UK continues to prove itself a powerhouse of innovation and research.

The outlook of scientific research in the UK post-Brexit, however, begins to change when examining the underlying details of these UK scientific documents. Yes, the UK produces copious cited articles. Yet, of these cited articles, about half of those published within the past decade are co-authored by at least one non-UK partner, of which more than 50% are EU partners (Frenk et al., 2016, pp. 14–15). This statistic is one sign of a strengthening partnership with both the global scientific community and the EU, as shown in Figure 1. When internationally collaborative articles encompass this percentage of UK article output, international partners must therefore be credited with enhancing UK scientific prestige.

The rise of collaboration with EU partners meshes clearly with the growth of the EU’s Framework Programmes, run by the European Commission to fund research, technological development, and innovation in EU member states and global partners. The most recently completed Framework Programme 7 (FP7) ran from 2007 to 2013 and contributed to research and development (R&D) by means of competitive grants. Over FP7’s seven-year period, the UK received €6.9 billion in FP7 funding, an amount second only to Germany’s; the UK also received €1.9 billion of non-competitive structural funds from the EU (Frenk et al., 2015, p. 13). Therefore, in total, €8.8 billion of the EU’s €47.5 billion R&D expenditure across the 28 member states (EU-28) during FP7’s run went to UK scientists (Frenk et al., 2015, p. 12). Because 71% of this funding went to UK universities (Frenk et al., 2015, p. 18), STEM higher education is clearly a large and important beneficiary of EU investment.

This success in garnering European support for scientific innovation is on track
to continue through the EU’s eighth major Framework Programme, the 2014–2020 program called Horizon 2020. In the most recent (2015) monitoring report for Horizon 2020, statistics show that the UK remains an influential player in the EU’s scientific landscape. For 2015 projects, the UK marked the largest share of participation in signed grants from Horizon 2020, with 13.1%. Organizations based in the UK also received the largest share of Horizon 2020 funds for 2015 projects, with 15.8% (European Commission, “Horizon 2020…,” pp. 210–11). The UK’s high receipt of funding and large participation continue a trend demonstrated in the first Horizon 2020 monitoring report (European Commission, “Horizon 2020…,” pp. 21–22). Indeed, this substantive participation in Horizon 2020 increased from the UK’s already notable involvement in the preceding FP7, marking the UK as a principal player in the EU scientific domain. In turn, collaborations and EU funding have a valuable impact on the nation’s research workforce and article output. The prolific success of citable UK scientific publications in the past few decades owes much to both collaboration with EU scientists and EU funding.

These indicators of the UK’s incredibly strong performance in the scientific domain, as well as UK STEM’s increasing reliance on international partners like the EU, are echoed in the performance of the nation’s universities. UK institutions dominate the list of the top 50 university beneficiaries of Horizon 2020. In 2015, the UK held the top three spots and overall had the most universities at 15 (European Commission, “Horizon 2020…,” p. 20). The UK similarly performs exceedingly well in the National Taiwan University (NTU) ranking, which takes into account a university’s current and past scientific articles alongside metrics like the number of citations. In the 2017 NTU ranking report, the UK had five universities in the top 50 and 36 in the top 500, far outpacing the rest of Europe and once again behind only the leading United States and China (“NTU Ranking…”). Discernably, UK universities contribute considerably to the UK’s status as a global frontrunner of scientific innovation.

Similarly to how many UK scientific articles are co-authored by EU nationals, the EU plays a large role in the STEM-based success of UK universities. Figure 2 shows that, as of 2015, the UK university research workforce is highly international, where 28%
of academic staff and 51% of postgraduate students are non-UK citizens. EU nationals in particular comprise 16% of academic staff and 14% of postgraduate research students (Frenk et al., 2015, p. 8). With such a large portion of the research workforce coming from abroad, the ability to attract talent and funding from an international pool plays a large role in the success of UK universities. Dampening outside interest from joining the UK research workforce is therefore highly detrimental to 1) international collaborations and, in turn, the number of quality scientific articles the UK publishes, and 2) UK universities’ provision of high-level contributions to the scientific domain.

Brexit challenges this portrait of an internationally driven UK scientific empire. In June 2016, when the UK voted 52 to 48 to leave the EU, a prevailing platform of populism and nationalism signified to the world that the UK is not a welcoming destination for foreign individuals. This perception leaves the UK’s university STEM sector, whose success pulls from an international workforce, in a state of uncertainty. In addition, considerable research funding comes from participation in major EU innovation programs, many of which will be unavailable to UK scientists once they are no longer from an EU member state.

Brexit Negotiations and the Budget

In a period of uncertainty for the country as a whole, the position of Parliament has done little to assuage concerns regarding the continued eminence of UK STEM higher education. When Prime Minister Theresa May called for a snap election that took place in June 2017, UK political parties published manifestos detailing their visions for the UK during Brexit and beyond:

- The Labour Party, which wound up with 261 of the 650 members of Parliament, included in its manifesto that the UK should “ensure that the UK maintains [their] leading research role by seeking to stay part of Horizon 2020 and its successor programmes and by welcoming research staff to the UK” as well as maintain membership in similar European organizations like Euratom and the European Medicines Agency (The Labour Party).
- The Scottish National Party, which earned 35 seats in Parliament, pledged to seek replacement funding for that lost from the EU by placing members of Scottish Parliament in parliamentary budgeting committees as well as to negotiate the continuation of programs that allow Scottish students to study anywhere in Europe (Scottish National Party).
- The Liberal Democrats won 12 seats and stated, “the Leave vote has already started to affect existing and proposed research programs.” The party pledged to “reverse the damage to universities and academics by changing the country’s course away from a Hard Brexit” (Liberal Democrats).
- Yet, the party with the largest say in the Parliament at 316 seats, although not an absolute majority, is Prime Minister May’s Conservative Party. The Conservative manifesto never specifically addresses scientific research, although it does promise to secure entitlements of EU nationals in the UK and UK nationals in the EU, which would help continue collaborative scientific projects. The manifesto also indicates that “there may be specific European programs in which [the UK] might want to participate and if so, it will be reasonable that [Parliament] make a contribution” (The Conservative Party).

This hung Parliament—this Parliament without an absolute majority—is therefore most controlled by the party with the least clear intent to further academic and scientific interests. With the mammoth restructuring the Parliamentary budget must undergo to compensate for renegotiating vast numbers of trade deals, scientific research may not be high on Parliament’s list of funding priorities. Nevertheless, in light of both Brexit and general international trends, there are several indicators and warning signs as to why scientific development should be a focus of Parliament in finalizing Brexit talks.

Over the course of FP7’s 2007 to 2013 run,
the €8.8 billion of EU research funding given to the UK made up only a slim 3% portion of the €226.3 billion that the UK spent on R&D, as shown in Figure 3 (Frenk et al., 2015, p. 17). This shockingly small percentage suggests that the EU contributes insignificantly to the overall picture of UK STEM higher education proficiency, thereby meriting Parliamentary budgetary discussions to ignore the loss of EU R&D funding. However, of that 3% sum, 71%, or €6.3 billion, went to academia. In further examining how funding was distributed across sectors, Frenk and colleagues (2015, pp. 17–18) found that business and industry received 64%, or €144.8 billion, of total expenditure, whereas merely 26%, or €54.3 billion, went to academic institutions. Therefore, around 11% of funding for STEM research at UK universities came from the EU between 2007 and 2013. Although the 3% of total UK R&D might be easily replaceable and, therefore, reasonably ignored, this 11% EU contribution to academic funding cannot be readily dismissed. The EU played a critical role in the funding of scientific research at UK universities throughout the duration of FP7 and, as previously demonstrated, has continued its critical role through Horizon 2020. By revoking the continued ability to benefit so significantly from future EU Framework Programmes, Brexit leaves UK STEM higher education in a state of deficient funding, shifting dependency to Parliament. Unfortunately, because the outsized role the EU plays in funding academic innovation is hidden under the guise of a trivial 3% share, it risks going unnoticed by Parliament in their budgetary restructuring, threatening the continued success and prestige of UK universities.

From 1995 to 2012, the money UK universities received for R&D compared to other institutional groups stayed relatively stagnant. The UK Office for National Statistics data suggest UK universities’ R&D funding increased only at the rate of the whole R&D sector. As shown in Figure 4, each sector’s share of government expenditure on research and development (GERD) remained fairly stable over time. During that period, higher education received a minimum of 14.4% and a maximum of 21.5% of total GERD (standard deviation of 1.88) (Office for National Statistics, 2012). As such, academic spending has not really changed over the course of the past few years. Academia, however, will suffer greatly from Brexit. If the UK Parliament continues

![Figure 3
Distribution of R&D Source Funding, 2008–2014](image)

its current trend after UK universities lose EU funding, then research at UK universities will suffer an institutional funding squeeze.

This alarming loss of funding that Brexit triggers is exacerbated by the fact that the overall UK government R&D spending has been, in relative terms, falling drastically on the world innovation stage. The UK supports R&D with only a small portion of its GDP. According to the most recent data available from the World Bank, in 2015, only 1.7% of the UK’s total GDP was spent on R&D, including both public and private current and capital expenditures. This amount placed the UK eighteenth, significantly behind its biggest EU competitors, Germany and France, and its biggest global competitors, the US and China (The World Bank, “Research…”). Moreover, from 1996 to 2015, the UK showed little significant increase in GDP expenditure on R&D, as shown in Figure 5 (The World Bank, “Research…”). This fall comes alongside a relatively consistent growth rate in overall UK GDP—the country averaged a growth of 1.7% to 2.5% each year with the exception of a 4.9% fall during the 2009 recession (The World Bank, “GDP…”). As such, the UK is making the task of keeping up with the rest of the world in scientific research, let alone continuing its respected position as a trailblazer, more difficult, putting its academic dominance, already threatened by the loss of EU money, even more at risk.

The slipping ranking on the global R&D stage has been noticed by the House of Commons Science and Technology Committee, which has been calling for increased spending since as early as 2015, yet little has been done (Blackwood et al.). Because R&D encompasses such a small percentage of the total budget under Parliament control, it is sidelined by major discussions concerning bigger expenditures like the National Health Service. Yet, not expanding R&D expenditure, while damaging to the industrial and governmental sectors, will have the most noticeable effect on STEM research at universities. With the future of UK scientific research already so fragile,
and with the current power in Parliament so blasé about supporting scientific development, Brexit’s effect on UK universities has the potential to be profoundly devastating. And it is not only a funding problem.

Another Challenge of Brexit: Freedom of Movement

One of the benefits of membership in the EU is the freedom of movement of EU citizens across open borders. This benefit enables residents of the EU-28 to travel seamlessly between EU countries, allowing workers to get jobs and students to pursue degrees in other EU member states. Horizon 2020 and other similar programs (e.g., the affiliated Marie Skłodowska-Curie Actions) not only fund research but also further facilitate the travel of scientists and offer limited participation to non-EU members. One of the necessities for these programs to function, even for non-EU-28 participants like Switzerland and the Netherlands, is the existence of those borders open to free movement, something that Brexit threatens (Burns). Indeed, Frenk and colleagues (2016, p. 5) note in their analysis of UK scientific researcher mobility that “any change to the UK’s adherence to the EU free movement of workers principle could adversely affect the UK’s eligibility to take part in EU research funding schemes, as has been seen in Switzerland.” Since one of the major emphases of Brexit is to reduce the flow of people across UK borders, post-Brexit scientific international collaboration would be hurt by the lack of a truly open border.

Depending on the exact terms of the divorce bill, it may become difficult for professors and students at all levels to gain entry into the UK for collaborative projects, fellowships, and studies. If gaining the proper documentation becomes too onerous, the number of students and visiting professors likely will noticeably decrease. A backlash against Brexit has already been seen in the UK’s permanent academic STEM research staff. Michael Arthur, Provost and President of University College London, a premiere research institution, revealed in September 2017 that “95 [percent] of the university’s senior European researchers had been approached with job offers by other European universities” (Warrell). It is likely that other universities have experienced similar poaching. For sake of argument, assume this 95% of European professors in the UK offered jobs by other European universities is universally applied across the UK university network. Since, as

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**Figure 5**

Percent of GDP Contributed to R&D, 1996–2015

<table>
<thead>
<tr>
<th>Country</th>
<th>1996</th>
<th>2015</th>
<th>Change Over Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>2.133</td>
<td>2.877</td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td>2.442</td>
<td>2.794</td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>2.209</td>
<td>2.231</td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>0.563</td>
<td>2.066</td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1.605</td>
<td>1.703</td>
<td></td>
</tr>
</tbody>
</table>

previously discussed, 16% of academic staff in STEM research are from the EU (Frenk et al., 2016, p. 8), this would mean that on the order of 15% of STEM faculty in the UK have been offered jobs at EU universities. While not all of these offers will be accepted, and although this assumption is likely a bit high, if the new immigration policies enacted in the wake of Brexit substantially hinder the mobility researchers currently enjoy, a conceivable result is the exodus of a sizeable chunk of talented international minds from the UK, a modern brain drain.

A matching fall in EU applications to bachelor’s degree programs was expected in anticipation of Brexit, and unsurprisingly applications from the EU in this domain fell 7.43% in 2017 (Weale and Barr). However, this downward trend does not appear to have continued into the 2018 application pool. As of the October 2017 deadline for applications to 2018 programs, there was actually a rebound, a 6% increase in applications from the EU for bachelor’s degree courses (UCAS, “Number…”). This rise came after the April pledge from the UK government and the Universities and Colleges Admissions Service that EU students who begin their studies in the UK during the 2017–2018 academic year will be eligible for EU costs and grants throughout the entirety of their bachelor’s degree course and that these organizations are working to confirm the same arrangement for students entering in the 2018–2019 academic year (UCAS, “Advising…”). Unless more funding becomes guaranteed after the UK officially leaves, and unless the new immigration laws allow for ease of mobility, it is likely that the number of undergraduate students from the EU will again decrease for the 2019 application pool and beyond.

The rise in EU applications during 2018 masks another crucial symptom of the Brexit plague. With the fierce rise of nationalism that led to the Brexit vote comes the promulgation of an unkind message far and wide—that Britain is not a welcome place for foreigners. As such, many foreign students and professors have shied away from applying for positions in specific locations where they fear they will not receive a warm welcome. Many UK universities beyond London or outside the historical prestige bestowed on universities like Oxford and Cambridge have seen declines in rankings. The Times Higher Education (THE) rankings, a system that measures universities based on research strength, showed that just over half of the 31 UK institutions appearing in the 2018 top 200 universities slipped in rankings, which Phil Baty, editorial director of the THE rankings, partly ascribes to Brexit inhibiting international talent from attending schools outside London and outside the most elite, prestigious, and historic institutions in the UK (Bothwell and Grove). Whether or not this development can be attributed to Brexit, to internal quarrels about chancellor pay, to the rise of Asian universities on the global scale, or to other internal aches, and whether or not this trend will endure in the post-Brexit era, many in the media openly lament that the UK’s non-elite schools are dropping in quality (Warrell). With the problems that Brexit will create for attracting talent in the future, it is conceivable that many UK universities will suffer a more precipitous drop in ranking and consequently witness a diminution of scientific research success in the coming years.

Apart from the shifting academic research workforce coming to UK universities, Brexit will also affect the ability of UK researchers to travel to EU laboratories and universities. Frenk and colleagues found that, between 1996 and 2011, nearly 70% of UK researchers had worked abroad and subsequently published articles with affiliated non-UK institutions. Furthermore, the study found that 21% of scientific researchers based in the UK had worked abroad for two or more years during the same period (Frenk et al., 2016, p. 9). Additionally, the Organisation for Economic Co-operation and Development notes that “scientists who undertake research abroad and return to the economy in which they first published contribute to raising the overall quality of domestic research by 20 [percent] on average” (OECD). The numerous scientists from UK institutions who do go abroad to conduct research therefore palpably increase the quality of UK research. With so many international collaborations, so much access to foreign laboratories, and so much
benefit to the quality of domestic research thanks to UK researchers working abroad, making travel to the EU from the UK tedious and paperwork-laden would harm current and future collaborations. This is especially important when considering the UK’s top international collaborative partners. While the US tops the list by far, the top five round out with EU-28 countries—Germany, France, Italy, and the Netherlands (Frenk et al., 2016, p. 11). Brexit’s potential to hinder the ability of UK researchers to work easily in Europe may be just as damaging to UK scientific research as is the limiting of international talent at UK universities.

**Conclusion**

For the myriad reasons explored in this article, Brexit has the potential to significantly disrupt the scientific prowess UK universities have enjoyed for so long. Funding for R&D was already in trouble before Brexit, and academic institutions in particular are set to lose a critical portion of their funding on exiting the EU. Additionally, changes in immigration laws likely to be included in the final divorce bill could significantly impede the flow of students and faculty across UK borders, hinder the formation of new international collaborations, and stem the level of talent working on UK-affiliated science. Nevertheless, with the aid of existing and strong international interaction, and with some persuading in Parliament, the academic STEM community could continue to achieve its standard of excellence.

The scientific community in the UK has already begun to show the creativity of thought affiliated with the field and develop interesting work-arounds to avoid the damages of Brexit. In early 2018, Imperial College London, a globally renowned scientific institute, announced the launch of a new joint laboratory in London for mathematics in conjunction with France’s governmental body for research, the Centre National de la Recherche Scientifique (CNRS). As a result, any researchers from UK institutions working at the new Unité Mixte Internationale Abraham de Moivre “will have the same funding status as those in France, even after the UK’s withdrawal from the EU” (Coughlan). This novel partnership, which came about from the connections that Imperial College already has through its 900 French staff and student members, is heralded by Imperial College President Alice Gast as a way to reinforce “Imperial’s exceptionally strong academic ties with France, as well as Imperial’s determination to deepen collaborations with European partners” (Coughlan). By bolstering relationships that are already strong, UK scientists at Imperial College have found ways to continue collaborating in the face of Brexit.

Solutions to the problems Brexit poses that are similar to those developed by the CNRS and Imperial College may be easier for universities in the London halo or for Oxbridge, where their prestige and endowments will continue to attract international talent regardless of nearly any event. However, using Imperial College’s approach as a model, universities throughout the UK can leverage their existing relationships to tailor means for funding and collaboration to their own situations. Furthering collaborations with other countries through established programs like the Gates, Marshall, and Rhodes, which attract bright international students to study in the UK, and developing other similar programs will also help counter the negative effects of Brexit.

The last piece of the puzzle, then, is what the UK government can do to ensure the success of academia, which contributes 2.9% of the country’s GDP each year (Jarvis and Hurley). In June 2017, Universities UK, a charity that prides itself as the “voice of universities” to Parliament, laid out priorities for the government during Brexit negotiations aimed at maximizing university success. Encompassing short-term transitional arrangements, exit negotiations, and domestic policy changes, these elements would refine UK immigration regimes to allow foreign scientists in the UK and UK scientists in the EU to maintain current citizenship rights, increase domestic funding to spur academic innovation, and continue UK access to European programs (Jarvis and Hurley). If the UK scientists can successfully lobby Parliament for these changes, then the scientific community in the UK will be on a good path. With hope in the ineffable spirit of humankind, the unwavering curiosity of the groundbreakers, and the
steadfast dedication to the improvement of life that is inherent to the STEM field, I believe the scientists of UK universities will “MacGyver” their way to innovation and discovery, so as to carry on as they always have.

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