

**The Foundation for Science and Technology
Script for a debate held on 16th November, 2016 at The Royal Society**

**The opportunities for and threats to the research and innovation communities
from Brexit**

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Our world seems to be reacting to the inequalities brought about by globalization by retreating into nationalism and protectionism. This is not new. According to a recent article in the New York Times by Ruchir Sharma, the chief global strategist at Morgan Stanley, the outbreak of World War I ended four decades of rising migration and trade, with huge flows of goods, money and people across borders, in which millions benefited. As today, it was the elite that gained the most, and it stirred fierce resentment among those left behind. After the economy crashed in 1929, the US Congress passed a sweeping tariff act. Trade, which was 30% of the world's economy slowed to less than 10% in 1933. Immigration in the US declined from more than a million annually to a few tens of thousands. Similar reactions took place in other countries.

However, these reactions prolonged the depression and economic stagnation and led to the rise of nationalism and totalitarian regimes. Global trade did not fully recover until the 1970s and capital mobility did not recover until the 1990s. Today, especially since the financial crisis of 2008, globalization is on the retreat again, with increased calls for restrictions to mobility and trade and a rise in nationalism.

There is considerable debate about the way forward for the UK after Brexit. A chief reason for Brexit was the feeling of many that they did not share in the economic prosperity of globalization and membership of the EU. Rather they faced stagnating wages and increased pressure on resources, infrastructure and costs. Virtually all economists from both the left and right agree that retreating into protectionism would simply repeat the mistakes of the past and cause all of us to be worse off. Fortunately, the UK continues to believe in free trade. However, if we have free trade and also restrict mobility, and at the same time want to ensure people a decent minimum wage and standard of living, we will not be able to compete purely based on traditional industry. I believe the government understands this, and has launched a new industrial strategy. Such a strategy will be successful only if it spurs growth by increasing productivity, which will require innovation. So science and technology has to be at the heart of any industrial strategy. Fortunately for us, the UK is one of the leaders in research and innovation by almost every measure.

The older industries, both in the UK and the US were based on proximity to raw materials and what at the time was world-leading technology. Many of these industries are not particularly competitive today in a global economy. It is doubtful that steel mills and coal will return on a large scale to either Pennsylvania or the North of England. Even if they were to do so, automation and other efficiencies will ensure that they will not create the large number of well-paying jobs that they did in the past.

In the US, much of the innovation and the resulting economic growth has occurred in the North-East Washington-Boston corridor or on the West Coast. This has left the vast hinterland of the US behind, so the result of the US election is not surprising in hindsight. In the UK, much of the new economy is concentrated in areas like London and Cambridge. Newer, knowledge-based industry relies on easy and rapid acquisition of information to have a competitive advantage. In a laissez faire environment, the growth of these clusters will continue at the expense of other areas, and is a natural consequence of economics.

A key aspect of this is the so-called agglomeration effect. Small and large companies want to be in an environment where there is complementary expertise and industry all around them. There is a reason that AstraZeneca moved its research headquarters from the North of England. The three places on their short list were the Bay Area and Boston in the USA, and Cambridge. Fortunately for the UK, they chose Cambridge. The move to Cambridge would not make sense on the basis of cost alone: housing costs for their employees, as well as running costs would be much higher in Cambridge. However, the life sciences cluster in Cambridge meant they would be plugged into first-rate research and innovation, be able to recruit skilled employees and benefit from a "first mover's advantage."

Given the geographical inequalities it generates, such a laissez faire approach is not sustainable politically. How then should a strategy ensure that different parts of the country are not left behind? I believe it would be a mistake to try to artificially prop up designated parts of the country with targeted investments that may simply favour existing areas of industry that are in decline. Sometimes, it is possible for cities to reverse decline by investing in completely new areas. For example, Pittsburgh, previously in decline due to the loss of its steel industry, is now rejuvenating itself thanks to investment in new technologies, facilitated by having two top universities, including Carnegie-Mellon, a world leader in computer science and robotics. It is currently working with Uber to test driverless cars on its streets.

In general, it is not possible to predict how to reverse decline by a shift to new areas. Rather than trying to predict winners, the government should put most of its resources to infrastructure that improves opportunities for growth. A major part of this involves reducing the isolation and improving the connectivity of the entire country. High speed connectivity – both virtual through the internet and real through transport – will ensure that places that are currently left behind will quickly connect up with the highest growth areas nearby. The UK has large centres that are, or could be, the nucleus for future growth. For example, the Manchester-Sheffield-Leeds area could be a hub which if appropriately connected with each other and surrounding areas could lift up not only themselves but also areas such as Grimsby and Hull. Similarly, large parts of East Anglia could be connected up to Norwich and further to Cambridge. High-speed links will ensure that their residents will be able to work where the jobs are being created. More importantly, it reduces barriers for local industries to develop since they will no longer be isolated.

In addition to connectivity, the other important requirement is the creation of large local pools of skilled workers. Creating this will require a large and sustained investment in education. All governments have paid lip service to education, but education for the future will need to be flexible and broad based to prepare people for the rapidly changing and often disruptive economies of the future.

These measures will take time. If we are to prosper enough to be able to implement them over a sustained period, there are some pressing measures to ensure that the UK remains at the forefront of science and technology. They involve mobility, funding and regulations.

Mobility

A major reason for the success of UK science and technology is that it has been open and welcoming to the best talent from around the world. Five of the last 15 Nobel Laureates were foreign born. In fact, three of the last five Presidents of the Royal Society were born abroad, and a sixth was the son of immigrants. Science today is global and depends on a free flow of people, who bring in new ideas and expertise. Our own young scientists also benefit enormously by going abroad for training, so migration works both ways.

Today, 30% of our academic research staff and a similar proportion of both CEOs and skilled workers in startup companies are from abroad. We are second only to the US as a destination for global talent. Their presence ensures that we remain first rate, and importantly, produces a first-rate environment for training home-grown talent. Losing them would be a disaster for our economy. We need to take immediate steps to reassure those who are here that they remain welcome. Currently an EU citizen working here has to fill out a 90-page form with lots of onerous and unnecessary reporting to gain the right to remain. In the future, rather than making things worse by having EU citizens go through the same long and cumbersome procedures that others currently do to gain the right to work here, we need to improve the situation for everyone by streamlining procedures so they are fair, transparent and efficient. Reducing the barriers to mobility will enhance our competitiveness and send a strong message that the UK will always welcome talent from around the world.

It is worth remembering that immigration was only the second most important reason why people voted for Brexit, and even so, it was control over migration that people wanted not the complete absence of it. A majority of the British, including leading Brexiteers, are not against movement of skilled labour into the country. The recent rhetoric around migration has been both unhelpful and unnecessary and the government needs to send a strong message to counter it.

Finally, counting students as part of migration figures is both unreasonable and a poor strategy. Only a small fraction of them stay on (mostly to our benefit) and they can be counted at that time. The rest return to their home countries and are valuable links with the UK. They become future leaders and are more likely to look at the UK as natural partners for trade and investment. By putting up unnecessary barriers to students and restricting opportunities for them, we are in danger of turning away entire generations of future partners who would be well disposed towards us.

Funding

The UK will not be perceived as an attractive global destination for talent and investment if we reduce our investment in research. We are already at the low end of the OECD countries in investment as a fraction of our GDP. Given that we are nevertheless so productive, increased investment in research would provided an excellent return. From 2005-2010, investment in science was maintained in flat cash terms due to the austerity budget, so in real terms there was a decline due to inflation. We were nevertheless able to be competitive because during this time we increased our support from the EU. Loss of these funds would be a serious problem for our research enterprise.

With our departure from the EU, it is essential that our funding be at least maintained. Science is a small fraction of overall expenditure. Moreover, private investment in research is well correlated with public spending so there is a multiplier effect. In considering how to restore funds, it is worth pointing out that our funding from the EU was valuable not just for monetary reasons. It was the basis of collaborations and partnerships that greatly expanded the influence of UK-based researchers. It allowed us to have a say in the future of large facilities and future scientific directions. So a more appropriate way would be for the UK to use its contributions to buy into multinational programmes. One obvious way would be to contribute to EU programmes such as Horizon 2020 including ERC, but another would be to create an equivalent pot that would allow us to collaborate beyond Europe internationally and have our own ERC equivalent, perhaps through the new UKRI body.

Over the long run, if we are to remain competitive, we need to move towards the OECD average in investment. Although we are efficient, we cannot hope to permanently maintain our advantage while underinvesting in science.

Regulations

The UK has benefited from a common regulatory policy within the EU, which is useful for collaborations across the continent, e.g. involving animal research, genetics, etc. However, the UK has excelled in enlightened regulatory policy for new technologies that takes into account a proper consideration of both risks and benefits. For example, long before it was acceptable in most countries, the UK pioneered IVF babies. Recently we have the example of the so-called "three-parent" baby for eliminating mitochondrial defects. We were also more rational about stem cells, resulting in leading scientists coming to work here from the USA. We are currently more forward-looking about areas like genome editing.

The UK potentially has great advantages in new areas where regulations, ethics, liability and technology intersect. Some examples are the use of large sets of personal data to drive discovery and innovation in health. In the NHS we have a single payer health care system with a very large patient data base. Proper regulations could also help other areas such as driverless vehicles and robotics. The UK's experience in setting standards will also help to define new technologies and give us a competitive advantage.

In summary, although most of us in the scientific community were for remaining in the EU, we recognize the social conditions that resulted in the referendum vote. It should nevertheless be possible to flourish outside the EU with the benefits spread throughout different parts and sections of the country, but to do so will require that we make the right decisions as we go forward.