

North & West Europe

Strong spending and recruitment keep countries in this region near the top of the world's output in the Index, and scientists from universities collaborate more with their neighbours.

ARTICLE COUNT (AC): 25,137
 FRACTIONAL COUNT (FC): 18,382
 WEIGHTED FRACTIONAL COUNT (WFC): 15,785

North & West Europe accounted for about 30% of the publications in the Nature Index based on the weighted fractional count (WFC), second only to North America. Moreover, this region scored highly on the Index's WFC in all four categories: first in physical sciences, second in life sciences and earth and environmental sciences, and third in chemistry.

Germany (number 3 in the global Index) put in the region's strongest performance, edging the runner-up United Kingdom (number 4 globally) by nearly 25% according to WFC. In addition, Germany ran away with the region's leading WFCs in chemistry and physical sciences, topping the second-placed United Kingdom by about 40% in the former and 60% in the latter. But the UK led the region in the life sciences, according to the Index, with a WFC about 10% higher than Germany. And both the UK and France surpassed Germany in earth and environmental sciences.

PURCHASING PRESTIGE

Germany's scientific strength is cemented by consistently high research spending — more than US\$100 billion annually and the world's fourth highest. Data from the Organization for Economic Co-operation and Development (OECD) show Germany's public and private research spending as 2.9% of GDP in 2013, which is a full percentage point higher than

the European average. "We are aware that this is not the case in all European countries, and this is a clear competitive advantage not only in Europe but also in comparison to the US," says Rolf Zettl, managing director of the Helmholtz Association, Germany's largest publicly funded scientific research organization.

"THEY LIKE TO HAVE THAT EUROPEAN FUNDING EVEN IF IT COMES WITH A LOT OF RED TAPE."

Several European countries increased public research spending during the financial downturn that began in 2007. "By keeping up the activity level they helped mitigate the fall in business R&D expenditure," says Gernot Hutschenreiter, head of country innovation policy reviews at the OECD. However, he adds, "this buffering is now over and public expenditure is either stable or falling." Even the German government's pledged 3% annual increases from 2016 until 2020 are a reduction from the current 5%.

In the UK, R&D spending was only 1.6% of GDP in 2013 — considerably lower than Germany and also France, which spent 2.2%. Alex Halliday, vice-president of the UK's Royal

Society, says, "I think government does understand that we have to spend more money in the future, but it's quite a hard thing to do at the same time as you are having to make massive cuts elsewhere." Still, the quality of UK science remains high and it leads the region in WFC for papers published in *Nature* and *Science* with 128, or 3.9% of its total WFC — compared to the global aggregate of 3.1%.

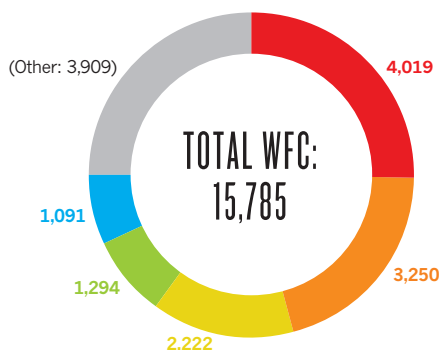
In part, Halliday attributes the UK's high-standard papers in the Index to its intensely competitive research auditing system, the Research Excellence Framework (REF), most recently published in 2014 and used to determine each university's funding allocation. Halliday, who returned to the United Kingdom after working in Switzerland and the United States, says, "I gradually became a convert because I began to see what it was achieving for the UK that other countries didn't have." He adds, "It has forced universities to think about how to build research strength in a very competitive way." UK excellence is often hampered by an ageing university infrastructure, and cannot compare to the kind of facilities available at the top universities in Switzerland, Halliday says.

Switzerland (4th in the region by WFC and 8th globally) spends around 2.9% of GDP on research, and generally outperforms relative to its small size; its 2014 WFC for *Nature* and *Science* papers was 44. The Netherlands (6th in the region, 14th globally) spent a lower percentage,

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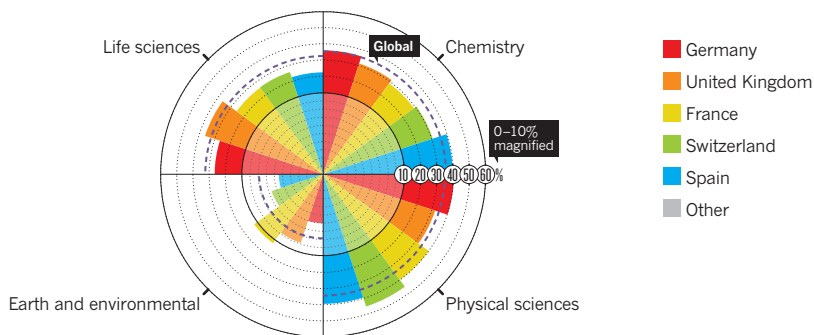
Countries' weighted fractional count (WFC)

Germany and the United Kingdom accounted for 46% of this region's output, and France made up another 15%.



Relative subject area distribution

Most of the top producers in this region published similar outputs in all categories except earth and environmental sciences.*



*Each slice represents the proportion each subject area contributes to a country's overall WFC. Subject areas can overlap, so the total percentage may exceed 100%.



Scientists supported by the French National Centre for Scientific Research (CNRS) explore subatomic physics.

1.98% of its GDP in 2013, but its WFC of 29 in *Nature* and *Science* ranks it in the top five. The country has concentrated funding on a small number of talented individuals, says molecular geneticist Hans Clevers, president of the Royal Netherlands Academy of Arts and Sciences. “There is a lot of emphasis on publication in top journals, but there are ongoing discussions asking if the country is emphasising the top 5% talent too much,” he says.

According to the Index, scientists in North & West Europe collaborate more with their immediate neighbours than any other region; 51% of all their international collaborations occurred within the region in 2014. When they do team up with researchers from further afield, it is usually with scientists in the United States. European Union (EU) funding partly explains the high collaboration level within the region. Although the EU research budget is only 5–7% of the total national budgets, Katrien Maes, chief policy officer of the League of European Research Universities, says universities see EU projects as a prestigious supplement to national funding. “They like to have that EU funding even if it is difficult to get and comes with a lot of red tape,” she says.

INSTITUTIONAL IMPACTS

By WFC rankings, all three top institutions in the Index for this region are national research organizations. The French National Centre for

Scientific Research (CNRS) takes the region’s top spot. Its overall WFC in the Nature Index is 762, which is third globally — behind the Chinese Academy of Sciences at 1,308 and Harvard University at 865. Regionally, Germany’s Max Planck Society and the Helmholtz Association of German Research Centres follow CNRS.

“MAX PLANCK LOOKS FOR THE SMARTEST SCIENTISTS AND PROVIDES THEM WITH PARADISE.”

CNRS employs more than 11,000 research staff with civil servant status and runs 10 fully funded labs. The 2014 annual budget of more than US\$3.5 billion represents a quarter of French public civilian research spending. Publications skew toward the physical sciences, with 41% in this field, compared to the global aggregate of about 35%. A 2014 OECD report called into question the “stultifying pre-eminence” of the CNRS in French research and labelled it a major handicap. The report noted slow reform of a bureaucratic system. “France is still in a transition and there is a kind of hybrid model now, which is very complex, and this creates difficulties,” says Hutschenreiter. Funding pressures are also an issue, and French

scientists protested a 1% cut to government’s 2015 research budget.

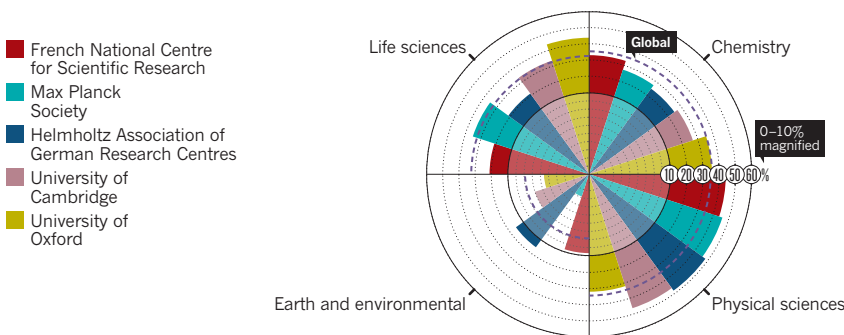
Nearly 30% of Germany’s overall WFC comes from papers published by scientists at the Max Planck Society and Helmholtz Association. The centres are run independently, with full scientific autonomy. The Max Planck Society consists of 83 facilities and in 2014 employed a total of 5,516 scientists, with an overall budget of more than US\$1.75 billion, coming jointly from federal and state budgets. Since its founding in 1948, the MPS has produced 18 Nobel Prize winners and this reflects the society’s ethos of researcher-centred excellence. “The Max Planck position is to look for the smartest and brightest scientists worldwide and provide them with paradise,” says Zettl. The Max Planck has 2,950 papers in the Nature Index, which represents at least half a paper per scientist. It shows particular strengths in physical sciences, with 46% of all its overall WFC in the Index in this area and 4.7% of its publications in *Nature* or *Science* — considerably higher than the 2.6% for the CNRS.

The newer and lesser-known Helmholtz Association was founded in 2001 from a collection of 18 independent research centres. The Helmholtz association has a WFC of 440, with 49% in the physical sciences — perhaps to be expected given its inclusion of Germany’s Deutsches Elektronen-Synchrotron (DESY) located in Hamburg and Zeuthen, near Berlin. As well as exploring particle physics, the facilities’ three large particle accelerators provide extremely powerful X-ray radiation used to study new materials and biomolecular processes. Helmholtz is also strong in earth and environmental sciences: 16% of its WFC is in these fields, almost double the global aggregate.

The Helmholtz Association provides programme-centred strategic research on pressing problems in energy, the environment, health and transport. Its nearly US\$3 billion 2015 budget comes mainly from the federal government with a 10% contribution from local states, plus more than US\$1 billion from

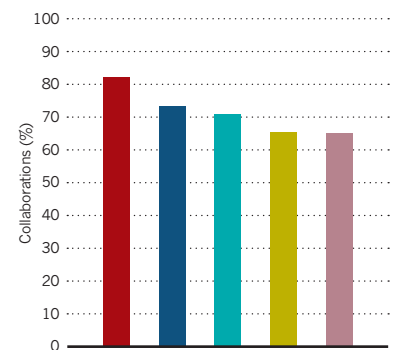
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Top 5 institutions’ relative subject area distribution
The region’s top institution, the French Centre for Scientific Research, published 77% of its WFC in chemistry and physical sciences.*



*Each slice represents the proportion each subject area contributes to an institution’s overall WFC. Subject areas can overlap, so the total percentage may exceed 100%.

Top 5 institutions’ collaborativeness
The percentage of collaboration by this region’s leading institutions resembled the order of output.*



*Each bar represents the proportion of an institution’s overall output in the index (AC) stemming from domestic and international collaborations.

ANGEL VILALBA/GETTY

additional research grants from other sources, such as EU programmes.

UK UNIVERSITIES EXCEL

For the rest of the region's top-10 institutions, the UK's university sector dominates, including the University of Cambridge, the University of Oxford, Imperial College London and University College London (UCL). Switzerland's top universities, the Swiss Federal Institutes of Technology in Zurich (ETH Zurich) and Lausanne (EPFL), take the other spots. Maes says the strength of these institutions is linked to their autonomy, particularly in relation to academic recruitment. "Research is a global competition and our universities are in the search for talent," she says.

Cambridge and Oxford are the oldest universities in the English-speaking world, established in 1209 and 1096, respectively. Based on the WFC of all institutions globally, Cambridge is ranked 9th in the Index and Oxford 11th, with WFCs of 403 and 356. Papers published in *Nature* and *Science* account for 5.0% of Oxford's WFC and 4.5% of Cambridge's — both significantly higher than the global aggregate of 3.1%.

The subject spread of Cambridge publications is close to the global aggregate with a slightly stronger performance in the physical sciences. One 2014 article in the Index came from Cambridge materials scientist, Jason Robinson, and colleagues. This article in *Nature Communications* describes a breakthrough in the field of spintronics, a technology that could help create super-fast computers, processing data using the electron property 'spin' rather than charge. The paper provides the first evidence that superconducting materials, which carry current without losing energy, can be made into data processing devices using a layered magnetic material containing the element holmium. Robinson says one of Cambridge's strengths is the sense of a collective way of working. He says, "When I first arrived there wasn't as much interaction between departments, but now I feel there is a lot of collaboration going on."



The University of Cambridge ranked ninth among the world's top institutions in the Nature Index.

“RESEARCH IS A GLOBAL COMPETITION AND OUR UNIVERSITIES ARE IN THE SEARCH FOR TALENT.”

Oxford shows a stronger performance in the life sciences, with 43% of its WFC in this area, compared to a regional aggregate of the WFC of about 30%. Overall the university has the highest research income of any UK university. It has been particularly successful in bringing in funding for new research centres, particularly at the interface between physical sciences and biomedicine, such as Oxford's Institute for Biomedical Engineering, where engineers and clinicians work together to develop medical devices and technologies in areas including medical imaging and regenerative medicine. "That interface is going to generate new tools, new devices, new technology, new drugs, and

that's where we need to invest in the future," says Halliday. Oxford is also strong in bioinformatics and statistical genetics, illustrated by a *Nature Communication* in the Index, from a large interdisciplinary team led by Ian Tomlinson from Oxford's Wellcome Trust Centre for Human Genetics. The communication reports the whole genome sequencing of bladder cancers and uncovered genetic mutations that provide potential drug targets as well as markers for diagnosis. These results are part of a wider genomics collaboration, with the technology company Illumina, studying the genomes of 500 patients with hard-to-treat diseases.

Unlike most Swiss universities top institution ETH Zurich receives 80% of its budget of more than US\$1.6 billion from the federal government to support 5,000 scientific staff. ETH shows strength in physical science and chemistry, which make up about 40% and 37% of all publications. Although only 22% of its 2014 WFC was in life sciences, that is an increase from the 2013 level of 16%. In 2012 ETH opened a new department of health science and technology, which takes a systemic and multidisciplinary approach to health, from the molecular scale to social context.

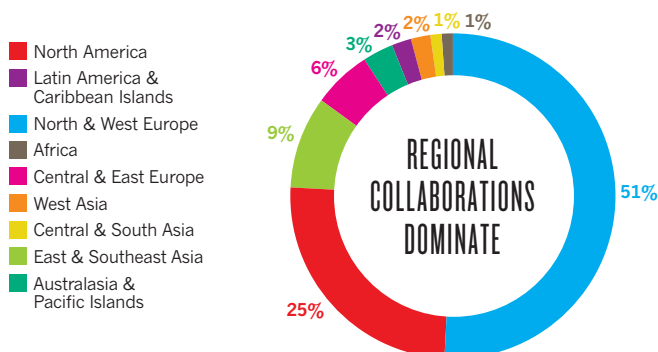
ETH's strength in chemistry is not surprising given the county's Basel-based pharmaceutical industry, in particular, Roche, which is eighth in the region's institutions publishing in *Nature* and *Science*. In 2014, Roche outspent all other pharmaceutical companies with a global R&D budget of US\$9 billion, and is the only company represented in the top-10 of any region. The company has many collaborations with leading academic institutions, and it "strongly encourages our scientists to share their findings in both peer-reviewed publications and presentations at congresses," says John Reed, head of pharma research and early development.

This region's educational and research institutes and industry promise a strong output of scientific research for years to come. ■

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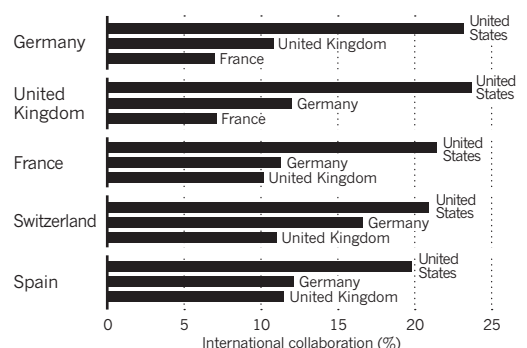
International collaborations

When scientists in this region collaborate, it is usually with scientists from other countries in the region.



Top 3 country collaborations

When collaborating outside the region, scientists largely work with colleagues from the United States.*



*Bars represent international collaboration rates between countries as a proportion of the total output (WFC) stemming from international collaborative efforts.