We Have to **Refocus Excellence**

How can we better use the potential for excellence we have in Germany to further advance German cutting-edge research vis-à-vis international competition? Cutting-edge research and good basic education are not a contradiction – even if, in the opinion of our author, the President of the Max Planck Society, the two still do represent conflicting priorities in Germany.

TEXT **MARTIN STRATMANN**

Education is the foundation upon which research is built. A successful education and science system must thus fulfill two tasks: First, it must guarantee access to the best possible university education for the broad public. Second, it must ensure that particularly gifted students and aspiring scientists find themselves in an environment that allows their skills to flourish to the benefit of society. This results in the proliferation of cutting-edge research.

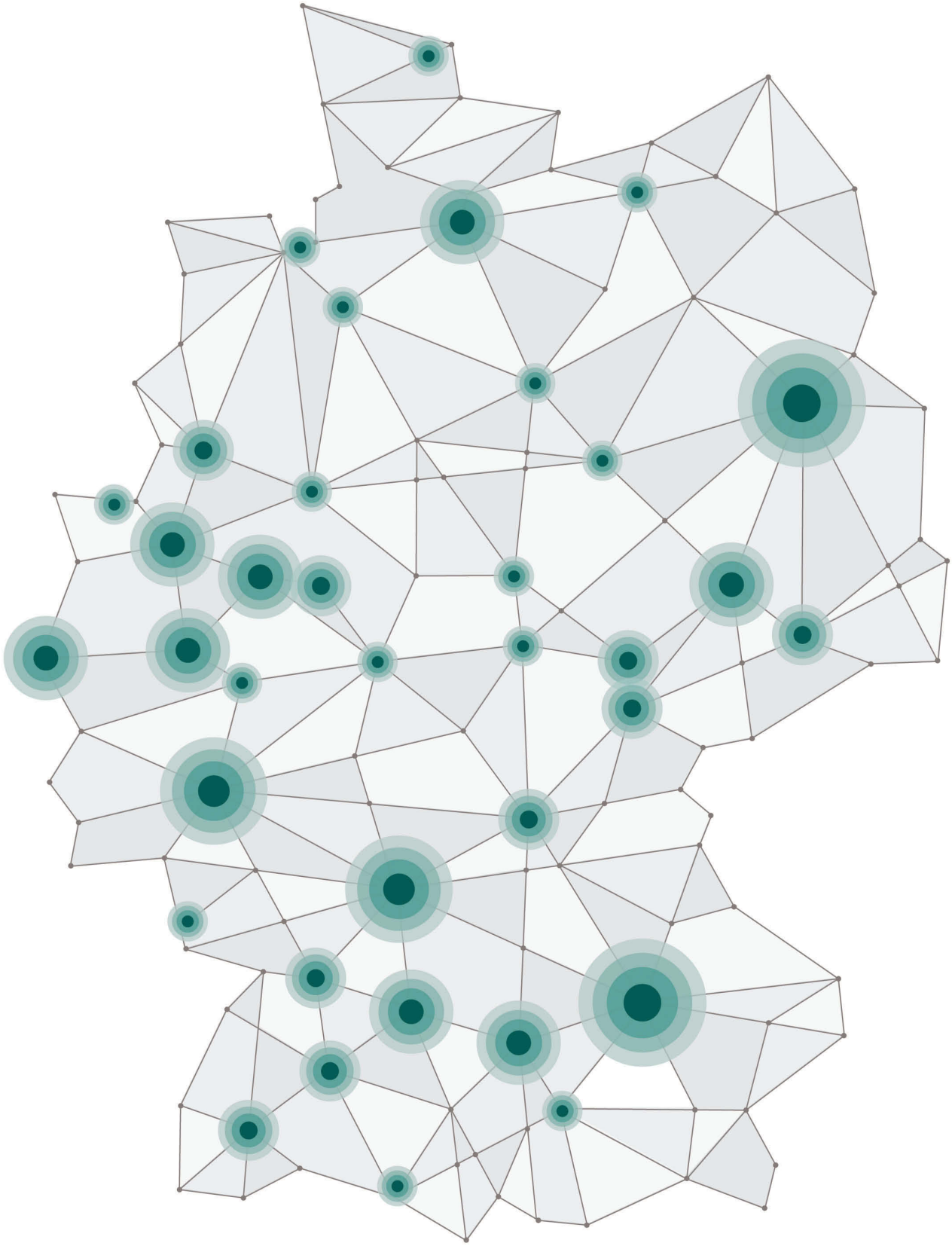
Conflicting priorities between a broad base and excellence must be dealt with productively

Broad base and excellence – this is a concept we're familiar with from the realm of sports, and we as a society have accepted it as such. Recreational sports and high-level competitive sports are not opposites, they are mutually dependent. Leading Germany to a gold medal in rowing in the men's eight competition isn't something that can be achieved under the conditions experienced in recreational sports. It requires dedicated training centers, which, in turn, rely on the pool of talent coming out of recreational sports.

Broad base and excellence – every science system is familiar with these conflicting priorities, as well, and must deal with them productively in order to be successful. And just as in sports, that requires structural diversity and differentiation.

Access to university education for the broad public is something that countries like the United States realized very early on with the vertical diversification of its university system: almost 80 percent of universities and colleges have almost no right to award doctorates, while slightly more than 20 percent of universities have this right. Of these rough-

A network of the best: In Germany, scientific excellence – in this image, the top one percent of the most frequently cited scientists – is spread across a wide area. This has positive consequences: output is generated in numerous locations, and scientific education is very good in many places, also by international comparison. To create visibility, Martin Stratmann recommends bundling the geographically dispersed excellence into cross-regional networks, and embedding the hubs of these networks in the locations where excellent science is practiced in Germany.



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ly 1,000 universities in the US, a small group of research universities emerges where the vast majority of Ph.D.'s are completed and that simply do not provide a broad-based university education. This elite cluster manages to provide exclusive teaching while successfully concentrating on excellent research and attracts students and scientists from across the entire globe. But in the overall system of 4,600 institutions, this cluster makes up just slightly more than two percent.

The German system, too, has faced the challenge since the 1960s, if not before, of opening up access to a university education for a huge number of students while still remaining internationally competitive in terms of research performance.

Unlike the US, Germany extended access to a university education through a massive horizontal expansion of the university system. A large number of universities were created based on the same model, with the result that there are now more than 100 universities that are entitled to confer doctorates, all structured much the same and all having to cope with accepting large numbers of students.

What Germany failed to do is ensure broader access to a university education through greater diversity of the institutions, and perhaps also by expanding universities of applied sciences. Broad-based and top-level education – Germany only really began to try to bring these two conflicting priorities into alignment in the course of the Excellence Initiative.

There is a diverse non-university research infrastructure

Research, on the other hand, offers a somewhat different picture. Alongside traditional universities, there is a diverse non-university research infrastructure. With its declared mission of advancing cutting-edge research, the Max Planck Society is an essential component of this structural diversity. Within our organization, outstanding scientists find working conditions that only leading international universities can otherwise offer.

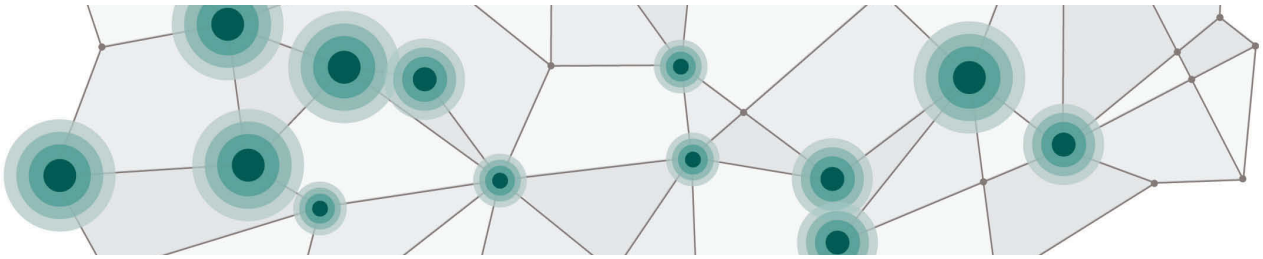
But how does German research fare internationally? To answer this question, I will first analyze Germany as a research hub and compare it with the US, the UK and the Netherlands. The four countries vary in size. To be able to compare the specific performance factors that set a country apart from the global average, I will standardize the parameters. The basis is always the country's share in the global population. Using this as a premise, the question is: by which factor is a country's performance greater than would be expected given its share of the global population? I'm going to call this factor the "performance indicator".

Since good research requires a sound financial foundation, I will begin with a few economic figures. The US accounts for about 4.5 percent of the global population and 22 percent of the world's gross national product. With a performance indicator of 5, the US is economically five times as successful as its share of the global population would indicate. At the same time, the country supplies some 30 percent of the globally available resources in research and development. In terms of America's share of the global population, that's six times the global average.

The German figures are similar: With a performance indicator of 4.5, we are four and a half times as successful as our share of the population would indicate. And like the US, we invest about six times more in research and development.

The UK and the Netherlands follow suit. So what we notice is that, measured in relation to their population figures, these four countries are about equally successful in economic terms and invest disproportionately large amounts of money in research and development. As such, they are deliberately investing in scientific and, ultimately, economic competition.

The crucial question is then: What do the countries achieve with the money they invest? How successful are they, from a scientific vantage point, compared with the others? A detailed answer to this general question would, of course, require an extensive analysis for which there is not enough space here. I will therefore answer the question regarding the German science system's performance by focusing on publication figures – in the knowledge that such an analysis cannot properly accommodate all disciplines. Nevertheless, an analysis of this sort



does provide sufficient insight to reflect the importance of German cutting-edge research by international comparison.

How good are the four cited countries at converting their investments into scientific output?

Let us begin by analyzing the total number of publications. The US produces about 22 percent of all scientific publications globally. If we relate this to the number of inhabitants, then the US is about five times more successful than its share of the global population would indicate. The UK is slightly more successful, Germany is somewhat less successful and the Netherlands, measured in terms of its size, is surprisingly successful. One might conclude that the quantity is determined by the amount of available funds.

Let us now take a look at the share of publications that are in the top 10 percent of the most frequently cited publications in their field. The US has a performance indicator of 7, as does the UK, while Germany manages an indicator of 6. And the Netherlands leads the pack with an indicator of 10.

If we look at the share of publications that are among the top one percent of the most frequently cited publications, the US manages a performance indicator of 8.4, and the UK is just slightly behind. Germany has an indicator of 5.7. The Netherlands – once again with an indicator of 10 – shows that much can be achieved even with less money.

This "pyramid" of publication excellence becomes all the steeper the more successfully a country concentrates on the quality of its scientific output, and the more well known and influential the country's leading scientists are.

Ultimately, the top indicates the number of scientists who have published the largest number of the top one percent of publications in their discipline. This is a particularly significant number, given that science is still performed by individuals with smart minds, and a country that can attract these smart minds has a genuine locational advantage.

This small global elite currently numbers 3,215 scientists, and more than half of them (1,701) do their research in the US – a substantial share of whom, incidentally, are originally from outside the States. Relative to the size of its population, the US is therefore home to 11.5 times more cutting-edge scientists than it should have based on its share in the global population. The UK has a performance indicator for cutting-edge scientists of 10, and the smaller Netherlands also manages a 10. And what about Germany? Our country is well and truly beaten on this score, with a performance indicator of 4.5. Despite its size, Germany has a total of just 164 scientists of this caliber, compared with 303 in the UK and 76 in the Netherlands.

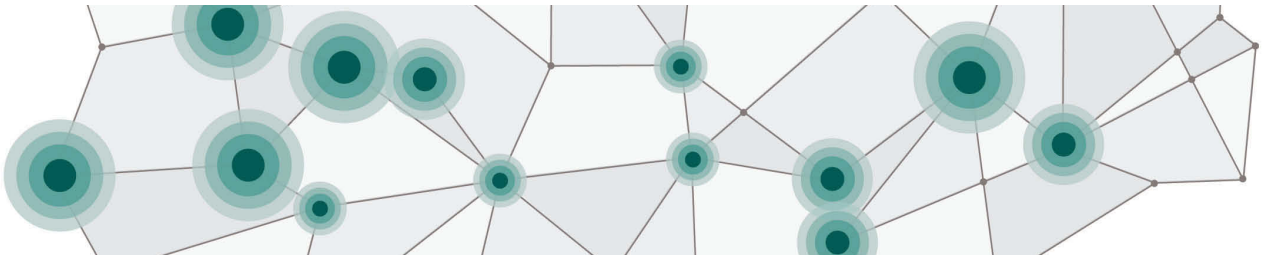
Thus, based on very similar raw data, Germany shows signs of weakness at the top. The Excellence Initiative was and is therefore the right choice and very much needed. It must tackle the point where our biggest deficit lies: in our lack of excellence compared with our toughest international competitors. That is why the Excellence Initiative must prove itself to be what its name suggests: an initiative to improve the excellence of German research.

But the advancement of cutting-edge research in Germany also has some successes to show for itself.

By international comparison, Germany shows signs of weakness at the top

One of the things that demonstrates this is the development of the individual levels of the excellence pyramid over time. Germany succeeded in raising its performance indicator in the area of one percent of the most frequently cited publications by 16 percent in the past ten years, while our biggest competitors lost momentum: the UK's indicator fell by 5 percent, and the United States' even by 24 percent. In absolute figures, however, both countries remain far ahead of Germany.

The Excellence Initiative's programs should therefore be continued. This will strengthen the universities and make them more effective. It will permanently stabilize what they're successful at rather than ending it at an early stage. On this point, the German Research Foundation and the Science Council have already made specific proposals regarding the Initiative.



But beyond that, it is important not to lose sight of the structural evolution of the universities. As the comparison with our Dutch neighbors shows, Germany not only has a problem endowing universities with basic funding, it also has an efficiency problem.

Currently, there is also a lot of talk about additional personnel for universities. Indeed, additional personnel can appear to be beneficial. However, if we want to couple additional personnel with keeping an eye on the strengthening of cutting-edge university research, we need to take into account that genuine excellence is rare. At the moment, the Max Planck Society manages to appoint about 15 elite scientists per year, and even this modest number keeps us all pretty much in suspense.

So we must take care not to award too many permanent posts in great haste while ultimately doing nothing more than consolidating mediocrity. That would be hard on our universities in the long term. To be visible internationally, our universities need some outstanding minds. Top scientists are highly mobile and go where the conditions and the reputation are right. Conditions are more than just financial resources, they also include a large pool of outstanding students – the basis for any scientific success.

If we want to continue taking the Excellence Initiative seriously, we will need to provide these conditions in Germany, and also selectively create new positions at the top — the very place where we are currently lacking them. This takes time – and it may also require new concepts. Establishing excellence at the top of our pyramid demands that we not let our best scientists relocate to other countries and that, at the same time, we attract outstanding minds to Germany from other countries.

In the current Excellence Initiative (ExIn), the best minds at the Max Planck Society are already working very successfully with the best minds at the universities: almost half of our Directors are now involved in an ExIn graduate school as Principal Investigators; almost two thirds are involved in excellence clusters. Yet still, these predominantly local networks do not fully leverage the potential of excellent German research. How can we work together to achieve even more?

To find an answer to that question, it pays to take a look at the institutional and geographical distribution of the most frequently cited scientists in Germany. Where do these scientists, who are at the peak of the excellence pyramid in their discipline, work? Half are at German universities (81), and one third are at the Max Planck Society (52). The remainder are split among various other organizations.

In terms of geographical distribution, the greater Munich area leads with 27 most frequently cited scientists, followed by the greater Berlin area and Heidelberg, each with 16. However, none of these regions alone can match scientific hotspots like the Boston area.

Specialist excellence in Germany is spread across different regions and not concentrated in a single place. Were we to superimpose the geographical distribution of the most frequently cited scientists of all disciplines one on top of the other, we would be right back at the beginning and would be able to pick out locations of particularly great performance density. This is where the hubs between the scientific disciplines lie. This realization results not only from this very specific publication analysis: the German Research Foundation's Funding Atlas paints a very similar picture of this cross-regional distribution and the regional interdisciplinary concentration.

We can't let the best scientists relocate to other countries

How can we bring together this geographically dispersed excellence that already exists in Germany in a productive way? How can we cleverly bundle the individual visibility of the best German scientists so that the resulting structure attracts not only the world's best scientists but also the world's best doctoral students to Germany? How do we establish the right conditions for outstanding appointments at German universities?

When leading scientists from the Max Planck Society get together with leading scientists from the universities in future-oriented fields, the result is cross-regional education and research networks – let's call them schools – that can compete with the top institutions in the world. The hubs of these networks

would be embedded in the places where excellent science is practiced in Germany and would integrate them. This would mean a further strengthening of university towns; the best professors, as the key players in cutting-edge university research, would have even greater international visibility in these schools.

Such cross-regional, topic-centered Max Planck Schools could offer outstanding graduate education by global standards. Interdisciplinary hot topics of the future wouldn't necessarily need to be tied to university disciplines. I firmly believe that schools like these would attract the best graduate and Ph.D. students from Germany and abroad – and they would keep them in our country, too.

This can happen through tenure track pathways within the schools I have described, through which we create attractive positions for the best young scientists in Germany beyond the doctoral student level. Doing so would achieve something fundamental: new staff posts for junior scientists, combined with high standards of excellence.

The key to strengthening excellence at the top is, I believe, ultimately the creation of a sustainable environment for successful new appointments from abroad through the cross-regional network of a Max Planck School; and not only for the Max Planck Society but also for the universities working with us. The Alexander von Humboldt Chair is already attractive now – how attractive would it be if it were in the same town as a school at the international cutting edge?

International competition – be it in business or in science – is first and foremost a competition for minds. We need to remain compatible here with attractive offers and an excellent environment. If we take modern cognitive research as just one example, we see that it spans everything from brain research, linguistic research and psychology to robotics and computer science. These are areas that are going to determine our country's economic future. Only those who succeed in bringing the best professors and the best students into their country and giving them chances of advancement there will be able to share in the resulting economic success. ◀

Photo: Axel Griesch

THE AUTHOR

Martin Stratmann, born in 1954, studied chemistry at Ruhr-Universität Bochum (RUB). He completed his Ph.D. at the Max-Planck-Institut für Eisenforschung (iron research) in 1982. Following a postdoctoral position in the US, he became a Group Leader at the Max-Planck-Institut für Eisenforschung. He earned his German postdoctoral lecturing qualification at the University of Düsseldorf and subsequently taught at the University of Erlangen-Nuremberg from 1994 to 1999. In 2000, he accepted the appointment as Scientific Member and Director at the Max-Planck-Institut für Eisenforschung. He has received many awards, including the U. R. Evans Award of the British Institute of Corrosion in 2005. Martin Stratmann has been President of the Max Planck Society since June 2014.

This article is an abridged version of the speech Martin Stratmann gave at the General Meeting of the Max Planck Society in Berlin in June 2015.