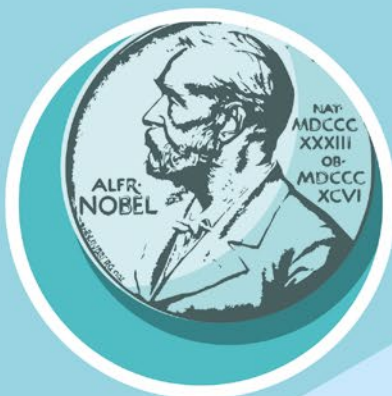


# B2 International Mobility in the Science and Innovation System



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# B2 International Mobility in the Science and Innovation System

A competitive science and innovation location is dependent on competent personnel for its tertiary education institutions, research institutions and businesses. In the global competition for scientists and employees in research and development (R&D employees), Germany has only been moderately successful in the past.

According to a study for the Commission of Experts' 2014 Annual Report, more scientists left Germany between 1996 and 2011 than immigrated to the country. It was particularly difficult to attract top scientists to work in Germany at that time. A similarly negative picture emerged regarding the international mobility of R&D employees. These findings led the Commission of Experts to conclude in 2014 that massive efforts were needed to offer internationally mobile researchers and R&D employees in Germany competitive working and research conditions.

Ten years later, the Commission of Experts is again addressing the international mobility of scientists and R&D employees with this chapter. The aim is to examine whether and how Germany's position in international competition has changed since the analysis in the 2014 Annual Report. This is relevant for two reasons: first, some significant legal reforms have been implemented in Germany since then and programmes to increase the attractiveness of the science and innovation location have been launched or continued, which may have had an impact on mobility in the meantime. Second, it is to be expected that the increased shortage of skilled labour due to demographic ageing will also lead to growing staff shortages in the German science and innovation system. Germany will be increasingly reliant on internationally mobile scientists and R&D employees to counter these bottlenecks.

In line with the analyses in the 2014 Annual Report, developments in the international mobility of scientists and R&D employees are mapped based on examinations of data on scientific publications and patent applications. This data can be used to analyze the mobility of scientific authors and patent-active inventors.<sup>255</sup> The analyses show that the situation has changed significantly since the 2014 Annual Report. Germany has become a net receiving country for publishing scientists.<sup>256</sup> Many highly-published authors return to Germany after spending time abroad. A decreasing net outward flow can be observed among patent-active inventors. Overall, Germany is therefore on a favourable trajectory. However, the German science and innovation system continues to lose human capital across the board. Additional reforms and packages of measures should therefore further increase Germany's attractiveness as a science and innovation location for international scientists and R&D employees. In addition, the administrative processes associated with the inward flows of skilled workers should be accelerated and digitized and the regulatory framework harmonized internationally. The academic labour market should become more permeable for internationally mobile researchers.

## B2-1 Asymmetry of International Migration Flows

A considerable proportion of all scientists and R&D employees change countries at least once in the course of their career (cf. B2-2 and B2-3). Country-specific factors influence which locations these people choose for their work.<sup>257</sup>

### Inward Flows Beneficial for Chosen Locations

International mobility enables researchers and R&D employees to acquire new knowledge and expand their scientific network.<sup>258</sup> Surveys show their subjective conviction that international mobility has a positive impact on career prospects.<sup>259</sup> Empirical studies also show that mobile authors are on average more productive in generating knowledge than their non-mobile colleagues (cf. B 2-2 and B 2-3) and suggest a positive influence of mobility on the quality of performance.<sup>260</sup>

From the perspective of the target country, the mobility of researchers and R&D employees can increase research performance and innovation potential both directly through an increase in human capital and indirectly through newly created networks and collaborations.<sup>261</sup> In addition, international mobility also enables the dissemination of knowledge that has not (yet) been published and is therefore difficult to access by other means.<sup>262</sup> From the perspective of the target country, it is desirable to attract internationally mobile researchers and R&D employees. However, in certain cases these incomers may lead to an undesirable transfer of critical knowledge to their country of origin. This is particularly problematic if it impairs the technological sovereignty of the country from which the knowledge drains.

### Focus on Brain Gain and Brain Drain Too Narrow

The analyses presented below in B 2-2 and B 2-3 present net balances of incoming and outgoing authors of scientific publications and patent-active inventors in a specific period for individual countries. The countries under analysis differ in terms of whether they were net donor or net recipient countries for these groups of people over the entire period. In the scientific literature and in the public debate on skilled labour mobility, net outward flows are often associated with brain drain (loss of human capital) and net inward flows with brain gain (increase in human capital).

Debates about brain drain and brain gain are generally based on the idea of international skilled labour migration as a zero-sum game between countries. Accordingly, brain drain from the viewpoint of a particular location is directly accompanied by a corresponding brain gain from the viewpoint of other

locations. However, this notion ignores two major advantages of international mobility:

First, international mobility can contribute to increasing research quality and innovation potential globally. At the respective locations, the fit between the individual skills and competences available and those required at the location is improved. The opportunities for international division of labour and specialization are better exploited in the global science and innovation system. Consequently, the supposed zero-sum game of international mobility becomes a positive-sum game.

Second, focussing on current migration balances ignores the fact that international mobility can also have positive medium- and long-term effects on countries that are confronted with outward flows.<sup>263</sup> Outgoing scientists and R&D employees can gain valuable experience abroad, expand their network and then return to their home country more productive than before. Such circular migration movements are known as brain circulation. The home country becomes better integrated into international networks through the outgoers and can benefit from the cross-border exchange of knowledge.<sup>264</sup> Finally, the possibility of future emigration itself can motivate young people to invest in education.<sup>265</sup>

### B 2-2 Scientific Publications: International Mobility of Authors

A study conducted on behalf of the Commission of Experts looks at the mobility patterns of authors from a German viewpoint.<sup>266</sup> Authors who published at least two scientific publications in the period from 2005 to 2020 and who indicated an organizational affiliation with a research institution in Germany for at least one of these were taken into account. This results in the two groups of non-mobile authors and mobile authors. Authors are classified as mobile if the country of their organizational affiliation changes between two publications.<sup>267</sup> Within the group of mobile authors, the study distinguishes between incomers and outgoers. Incomers are further subdivided into immigrants (people who come from abroad and remain in Germany) and returnees (people who return to Germany from abroad). Outgoers are further subdivided into emigrants (people who leave Germany and stay abroad) and visitors (people who come to Germany from abroad and leave again).<sup>268</sup>

### Net Immigration Into the German Science System

In total, 31 percent of all authors who reported a German organizational affiliation in the observation period between 2005 and 2020 were internationally mobile during this period.<sup>269</sup> The share of immigrants exceeded that of emigrants, which is reflected in a net immigration of more than 5,400 authors.<sup>270</sup> More differentiated insights can be gained from a country-specific analysis of authors immigrating to and emigrating from Germany. Strong bilateral mobility flows exist primarily between Germany on the one hand and the USA, Switzerland and the UK on the other (cf. figure B2-1). Compared to these three countries, Germany has a significant net emigration. The overall net immigration is primarily driven by Germany’s role as a destination country for authors from Italy, Spain, China, Russia and India.

Figure B2-2 uses OECD data to illustrate the development of the annual mobility balances<sup>271</sup> of incom-

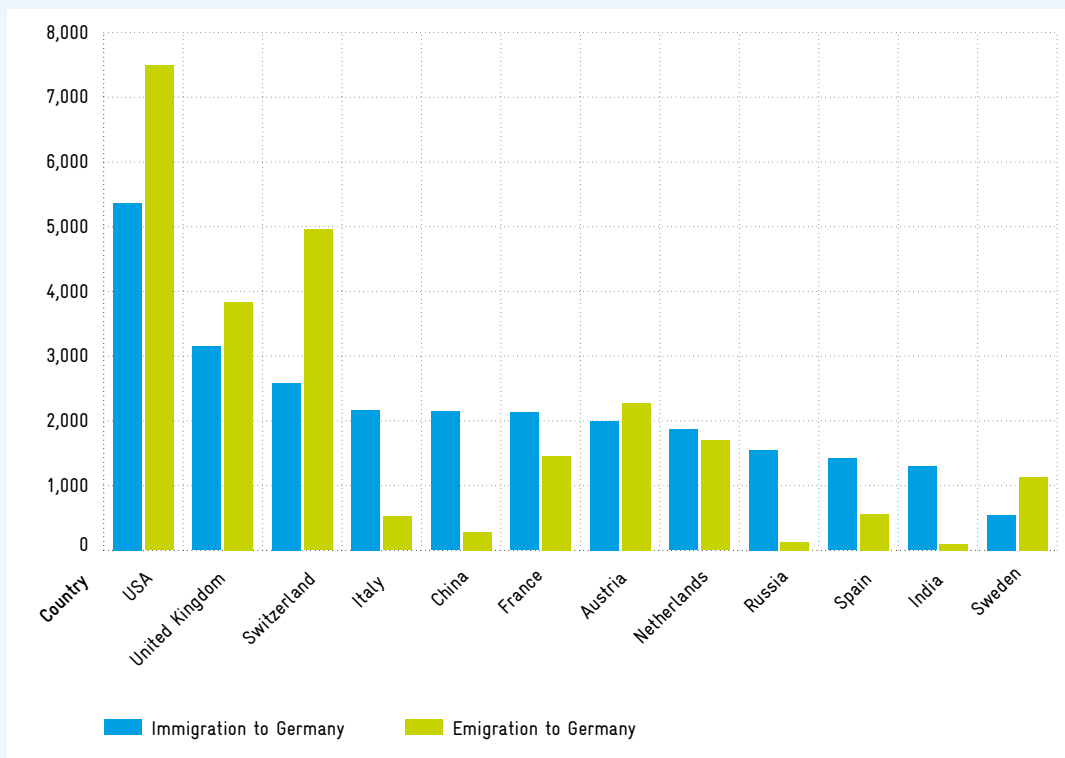
ing and outgoing authors for selected countries.<sup>272</sup> The negative mobility balance in Germany at the beginning of the observation period turned positive in 2014 and has continued to show a positive trend since then. Compared to other major European countries, Germany’s net mobility balances show a fairly stable positive trend over the period under review. The UK experienced strong net outward flows of authors after 2016, which is likely due to the effects of Brexit. In a global comparison, the USA has by far the highest net inward flows of authors.<sup>273</sup> China and Canada have recently seen higher net inward flows than Germany. Authors are increasingly leaving the newly industrializing countries of Brazil and India.

Looking at net mobility balances alone does not reveal the share of returnees and visitors in international mobility, which is of significant importance for the empirical relevance of brain circulation. From Germany’s viewpoint, all outgoers are also potential returnees in the medium term, while incomers may only be in the country temporarily.

**Fig. B2-1 Bilateral immigration and emigration of authors (relating to Germany) 2005–2020**



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Legend: In the period between 2005 and 2020, 7,491 authors moved from Germany to the USA and 5,364 came to Germany from the USA. Source: Own representation based on Coda-Zabetta et al. (2024). © EFI – Commission of Experts for Research and Innovation 2024.

The ratio of returnees to all outgoers (return ratio) and the ratio of immigrants to all incomers (stay ratio) are therefore insightful. During the observation period, there were 44 returnees for every 100 authors who left Germany during this period. This corresponds to a return ratio of 0.44.<sup>274</sup> In addition, the observed stay ratio of 0.45 shows that of 100 authors who came to Germany during the observation period, 45 have not yet left Germany again.

### Female Scientists Less Mobile

Overall, the share of women among all authors in Germany between 2005 and 2020 is around 36 percent.<sup>275</sup> At 73 percent, the share of non-mobile women is 7 percentage points higher than that of men (66 percent).<sup>276</sup> It is also apparent that female scientists are particularly mobile in the early stages of their careers and that they often only change location once. Female authors who emigrate from Germany are less likely to return than male authors.<sup>277</sup> At the same time, female authors who immigrate to Germany are more likely to stay in Germany than male authors.<sup>278</sup>

### Emigration Linked to Loss of Research Quality

For Germany's research performance and innovation potential, it is not only of great importance how many people move in and out, but also what inflow and outflow of scientific performance is associated with this. Indications of scientific performance can be found in the quality of publications by authors moving in and out of Germany. In the study conducted for the Commission of Experts, the quality of publications is approximated by the average number of citations of the scientific journal in which they were published.<sup>279</sup> This quality indicator records the average influence that publications in the respective scientific journal have on further research.<sup>280</sup> The publications assessed in this way are considered separately for the incoming and outgoing authors.

Figure B 2-3 provides an overview of the average value of the quality indicator for publications by non-mobile authors and the different types of mobile authors. Overall, the average quality of publications by emigrating authors is higher than that of publications by immigrating authors. Publications by non-mobile authors in Germany are of the lowest quality on average. These differences are particularly pronounced in the life sciences.<sup>281</sup> A further distinction by country of origin and country of destina-

tion shows that the publications of researchers who come to Germany from the newly industrializing countries of Brazil and China are of higher quality on average than those of authors who leave Germany for these countries. The opposite is true for most of the industrialized countries examined, such as the USA, France and the UK.<sup>282</sup>

A comparison of the values of the quality indicator between cohorts, i. e. authors who moved to or from Germany in different years, shows different developments depending on the type of mobility.<sup>283</sup> As shown in figure B 2-4, the quality of publications by immigrants and returnees has increased in later cohorts, with the gap between the two types of mobility becoming noticeably smaller at the end of the observation period. At the same time, when comparing the cohorts of emigrants, it can be observed that the quality of their publications initially decreased over time and has hardly changed since 2011.

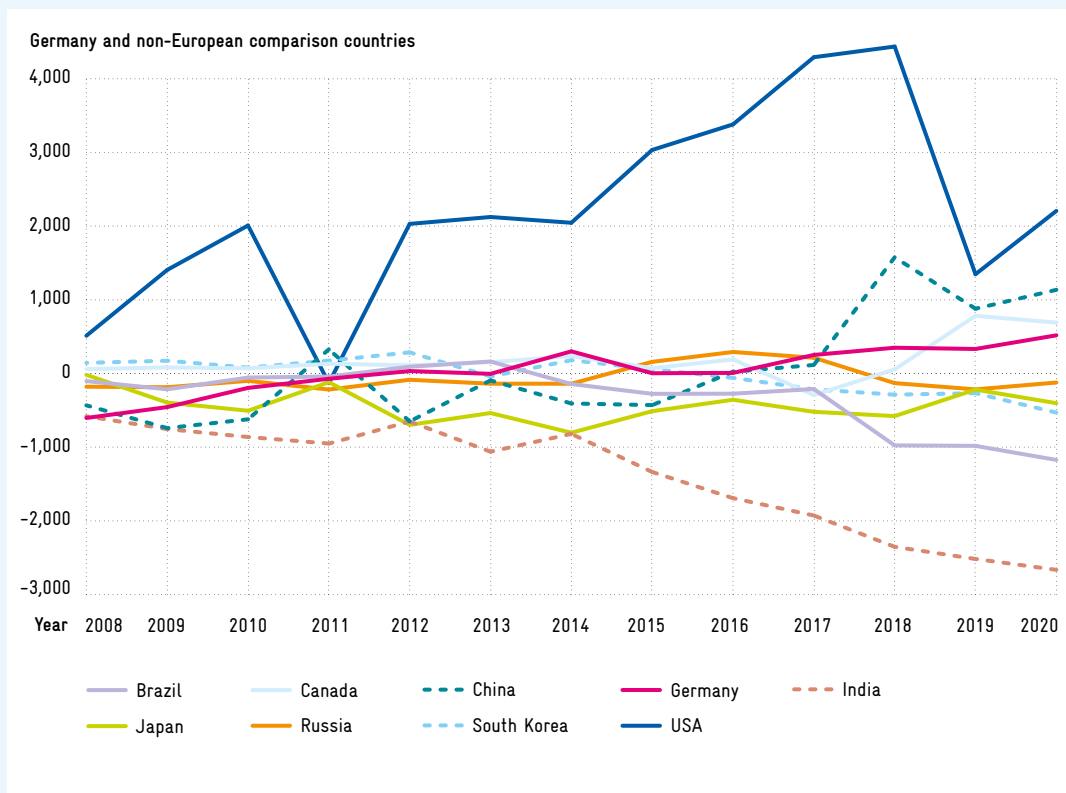
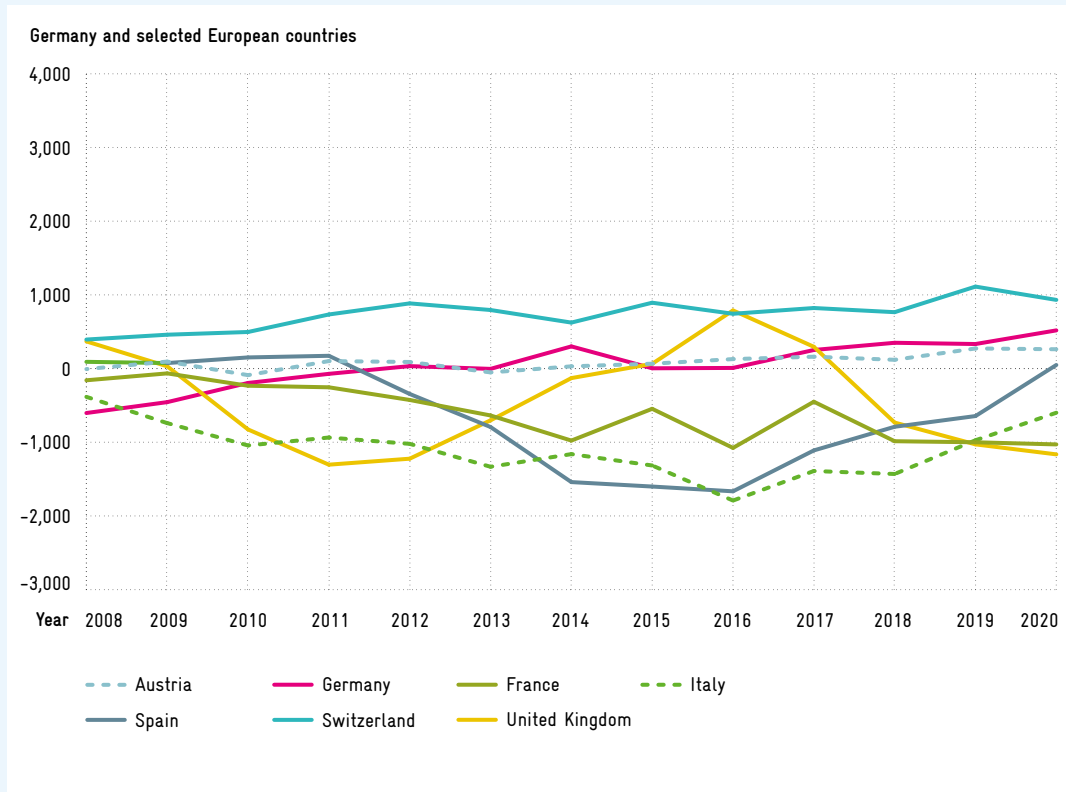
### Mobility Important for International Collaborations and Research Quality

International mobility of scientists is a driving factor in the initiation of scientific collaborations.<sup>284</sup> Co-authorships generate higher quality publications than single authorships.<sup>285</sup> International mobility can therefore indirectly lead to an increase in research performance by creating a basis for international collaboration.

International collaborations are increasing in importance in the German science system.<sup>286</sup> Since 2005, the percentage of publications resulting from international collaboration has steadily increased. This development is particularly positive in view of the quality of the publications. As figure B 2-5 shows, publications with international co-authorship are on average of a significantly higher quality than publications with single authorship or those with exclusively national co-authorship.

In terms of the number of co-authorships, the USA and the UK have consistently been the most important partner countries for authors working in Germany since 2005. France and Switzerland are also important partner countries but have been overtaken by China. The importance of China for collaboration with authors affiliated with German organizations has increased immensely in recent years (cf. figure B 2-6), which can be viewed criti-

Fig. B2-2 Annual mobility balances of incoming and outgoing authors 2008–2020

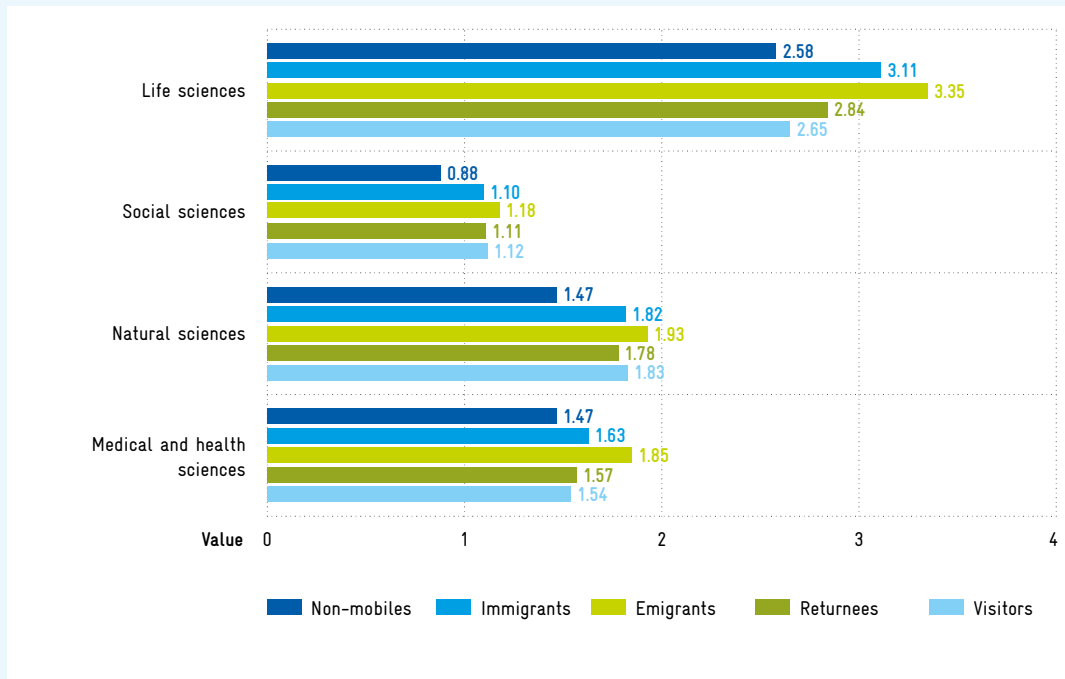


Legend: In 2019, the mobility balance of incomers and outgoers in Germany was +330. This means that more authors came to Germany that year than left the country.  
Source: <https://www.oecd.org/sti/scoreboard.htm> (last accessed on 5 November 2023) and OECD (2017). Own representation.  
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**Fig. B2-3 Average value of the quality indicator for publications by authors of different mobility types (relating to Germany), differentiated by scientific discipline 2005–2020**



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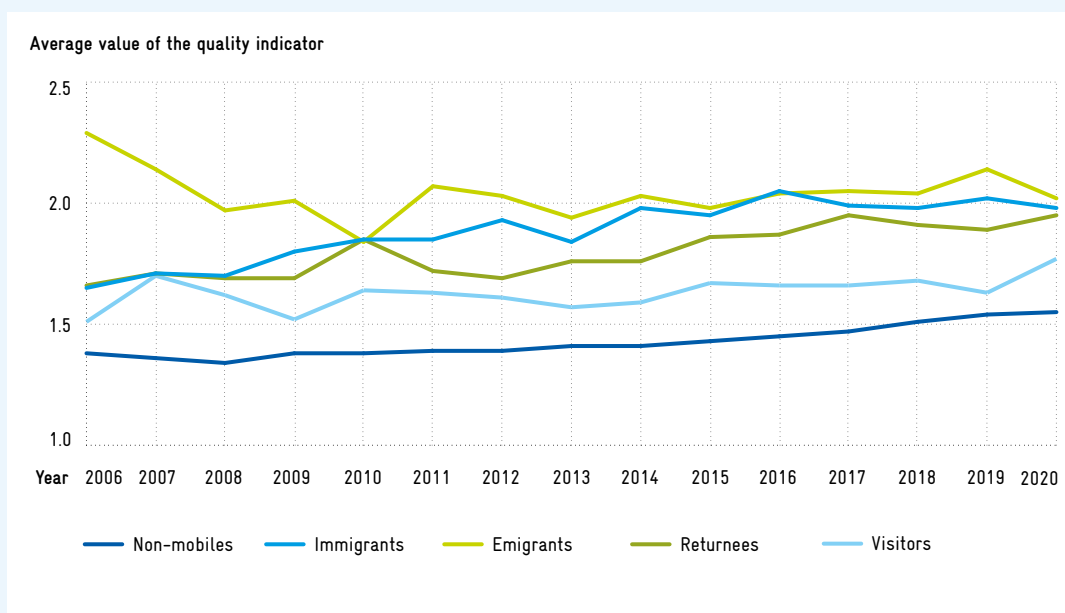


Legend: In the life sciences, publications by emigrants have the highest value of the quality indicator with an average of 3.35. Publications by immigrants have the second-highest value of the quality indicator with an average of 3.11, followed by returnees with 2.84 and visitors with 2.65. Publications by non-mobile authors have the lowest value of the quality indicator with an average of 2.58. Source: Own representation based on Coda-Zabetta et al. (2024). © EFI – Commission of Experts for Research and Innovation 2024.

**Fig. B2-4 Average value of the quality indicator for publications by authors of different mobility types (relating to Germany) 2006–2020**



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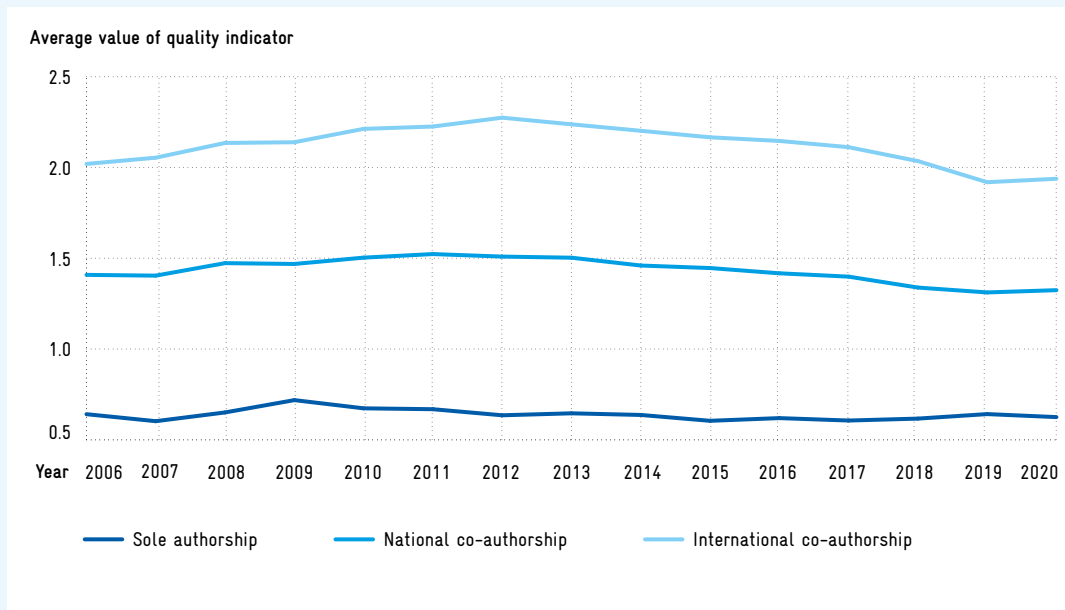
Legend: In 2019, the value of the quality indicator for publications by emigrants with German organizational affiliation was 2.13 on average. The value of the quality indicator thus exceeded that of publications by immigrants (2.02) and returnees (1.89). Publications by non-mobile authors had the lowest average value of the quality indicator in 2019 (1.63). Source: Own representation based on Coda-Zabetta et al. (2024). © EFI – Commission of Experts for Research and Innovation 2024.





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**Fig. B2-5 Average value of the quality indicator for publications by authors by type of cooperation (relating to Germany) 2006–2020**



Legend: In 2019, the value of the quality indicator for publications by an international team of authors was 1.94 on average. For publications by a team of authors, all of whom stated affiliation with a German organization, this value was 1.32 on average. For publications authored by a single author, this value averaged 0.63 in 2019. Source: Own representation based on Coda-Zabetta et al. (2024). © EFI – Commission of Experts for Research and Innovation 2024.

cally in view of the aforementioned possibility of unintended knowledge outflows and potential impairment of Germany’s technological sovereignty.

Authors who leave Germany often continue to collaborate with colleagues in Germany. For example, around 50 percent of those outgoers continue to work with colleagues working in Germany even two years after changing their organizational affiliation. This percentage is particularly high for those who move to leading research institutions<sup>287</sup> in the target countries.<sup>288</sup>

The analysis makes it clear why simply looking at the mobility balance of a location is not enough to capture the effects of international mobility. International mobility leads to larger research networks, which in turn can have a positive effect on the quality of research output.<sup>289</sup>

### More Mobile Scientists in Top Positions

Professorships funded by the Alexander von Humboldt Foundation and fellowships under the Emmy

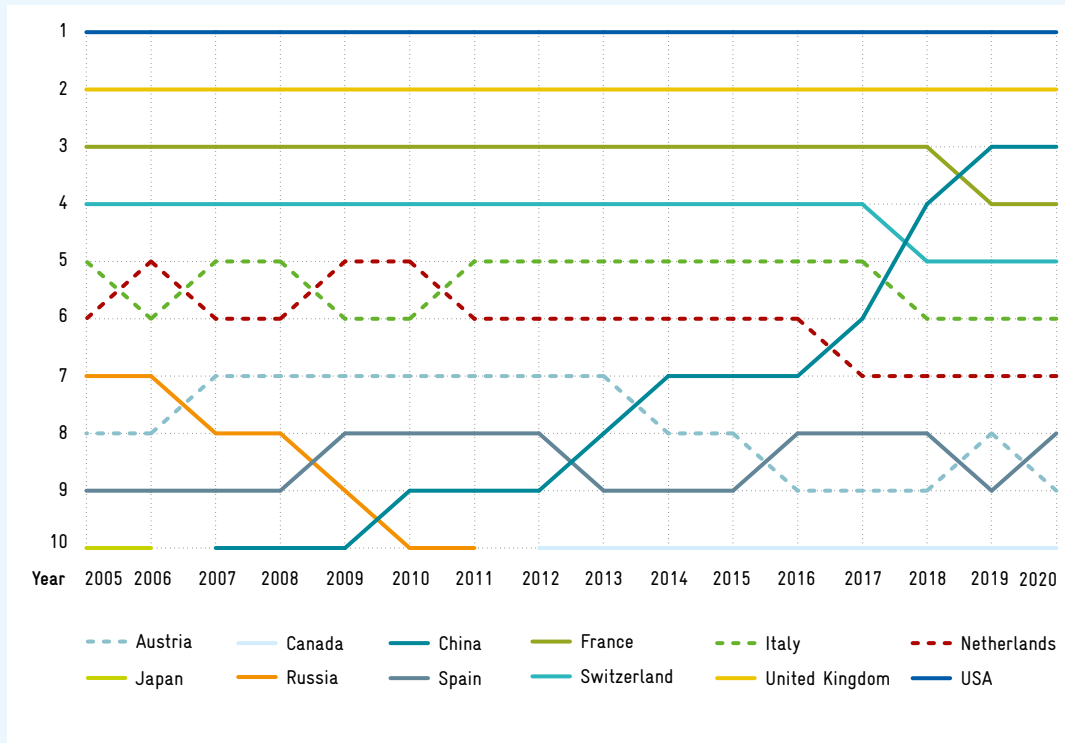
Noether Programme of the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) are among the most internationally renowned positions in the German science system. A professorship at a particularly research-intensive German university also offers top international scientists an attractive research environment. An above-average number of authors in such positions are either immigrants or returnees.<sup>290</sup>

Science locations benefit directly from attracting particularly high-performing scientists. Analyses conducted for the Commission of Experts also indicate that these scientists have a positive impact on their new environment. For instance, increases in the average quality of a faculty’s scientific publications can be observed following the appointment of a new Alexander von Humboldt Professor.<sup>291</sup> Increased standards as well as co-authorships and the transfer of knowledge at the new location are possible explanations. The reputation of top scientists and the resulting increased appeal of the location can also attract other high-performing scientists.<sup>292</sup>

Fig. B2-6 Germany's top 10 partner countries for scientific co-authorships 2005–2020



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Legend: Over the entire period, authors who stated a German organizational affiliation were most frequently co-authors with their US colleagues. France ranked third among the partner countries in 2017 but was overtaken by China in the following year. In 2020, more authors with a Chinese organizational affiliation published joint publications with authors from German research institutions than authors with a French organizational affiliation. Source: Own representation based on Coda-Zabetta et al. (2024). © EFI – Commission of Experts for Research and Innovation 2024.

### B2-3 Patent Applications: International Mobility of Inventors

Like the data on the mobility of authors of scientific publications analyzed above, the international mobility of R&D employees can be approximated using the information on inventors in patent documents. When R&D employees are mobile between organizations or countries, they take their knowledge with them to their new place of work. This benefits companies or countries that attract new R&D employees. Companies or countries that lose R&D employees may experience short-term setbacks in their innovation potential, but in the long term they too can benefit from an exchange of knowledge and expertise.<sup>293</sup>

This section analyzes the international mobility of patent-active inventors in the German science and innovation system based on a study<sup>294</sup> conducted on behalf of the Commission of Experts. The PATSTAT

database of the European Patent Office provides the basis for the analyses,<sup>295</sup> whereby the focus is on the registration of transnational patents<sup>296</sup> in the period from 2000 to 2020.<sup>297</sup> Similar to the above analysis of publication data, mobile and non-mobile inventors are compared here too and a distinction is made between different types of mobility (immigrants, returnees, emigrants, visitors).

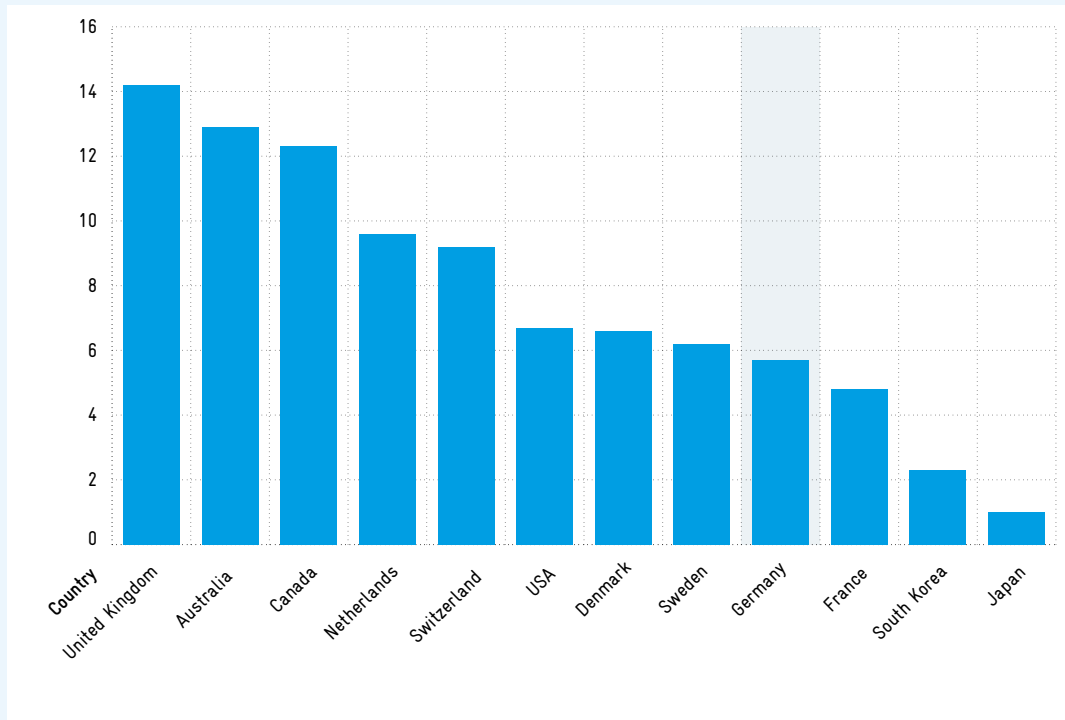
#### Net Emigration of Inventors

In the period between 2000 and 2020, 5.7 percent of all patent-active inventors in Germany were internationally mobile (cf. figure B 2-7). This means that Germany has a rather low mobility rate compared to other countries. For example, the UK (14.2 percent), Canada (12.3 percent) and the USA (6.7 percent) have higher mobility rates. Among the countries compared, only France (4.8 percent), South Korea (2.3 percent) and Japan (1.0 percent) have even lower mobility rates than Germany.<sup>298</sup>

Fig. B2-7 Percentage of mobile inventors, differentiated by country 2000–2020



[Download Data](#)



Legend: 5.7 percent of all inventors in Germany between 2000 and 2020 were internationally mobile.  
Source: Own representation based on Karaulova et al. (2024).  
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Over the entire period from 2000 to 2020, Germany recorded a net emigration of inventors: 5.6 percent fewer inventors came to Germany than left it. Japan, France and the UK also experienced net emigration. In contrast, Switzerland, the Netherlands and South Korea recorded a net immigration. Switzerland, for example, attracted 22.7 percent more inventors than it lost.<sup>299</sup>

Looking at the mobility balances<sup>300</sup> of the same countries separately for each year, it can be seen that Switzerland and South Korea have consistently positive balances (cf. figure B 2-8). Countries with largely balanced inward and outward flows of inventors are Australia, Denmark and Sweden. Together with Japan, the UK and the USA, Germany is one of the countries that consistently record more outward than inward flows of inventors. However, the net outward flows of inventors from Germany have decreased since 2014, and a small net inward flow was recorded for the first time in 2020. This development differs significantly from that in the UK and the USA, both of which are experiencing increasing net outward flows.

### Female Inventors Less Mobile

Around 10 percent of all inventors in Germany are women. Of all mobile inventors, however, only 6.7 percent are women. Interestingly, only 2.9 percent of all returnees are women.<sup>301</sup> Women are therefore not only underrepresented overall, but also especially among mobile inventors. After a slight increase in the percentage of mobile female inventors in the early 2000s, this has been stagnating since 2010. There has therefore been no alignment with the mobility behaviour of male inventors.

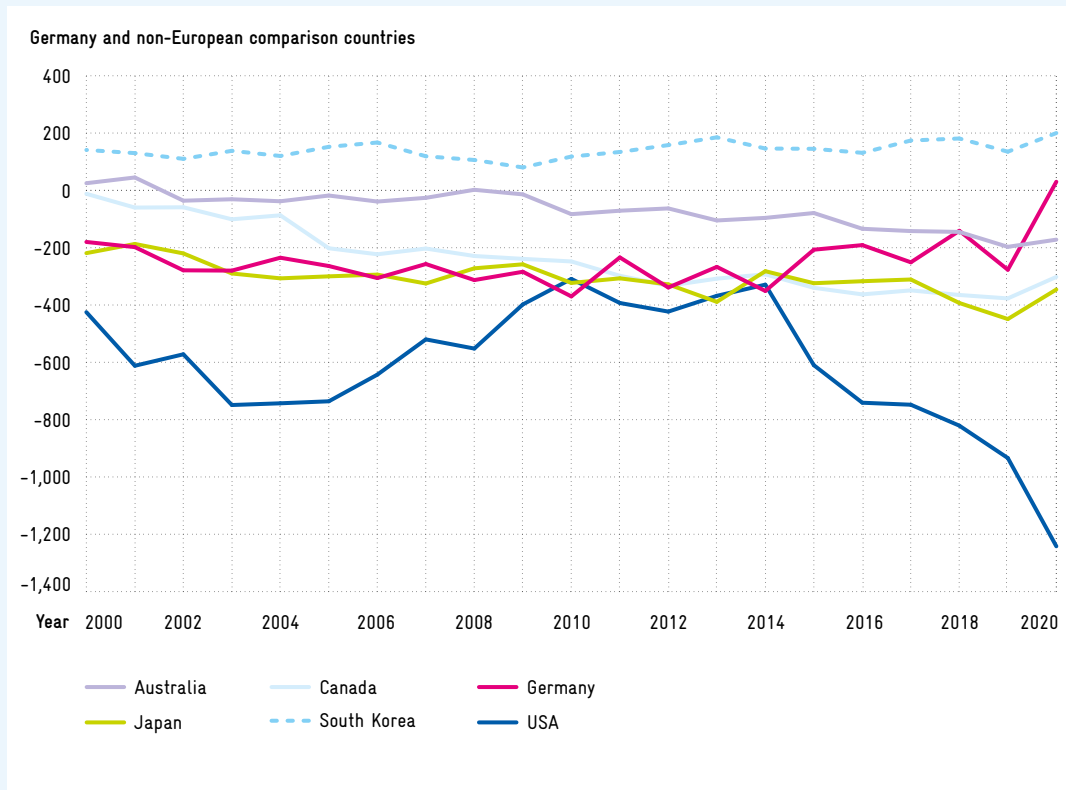
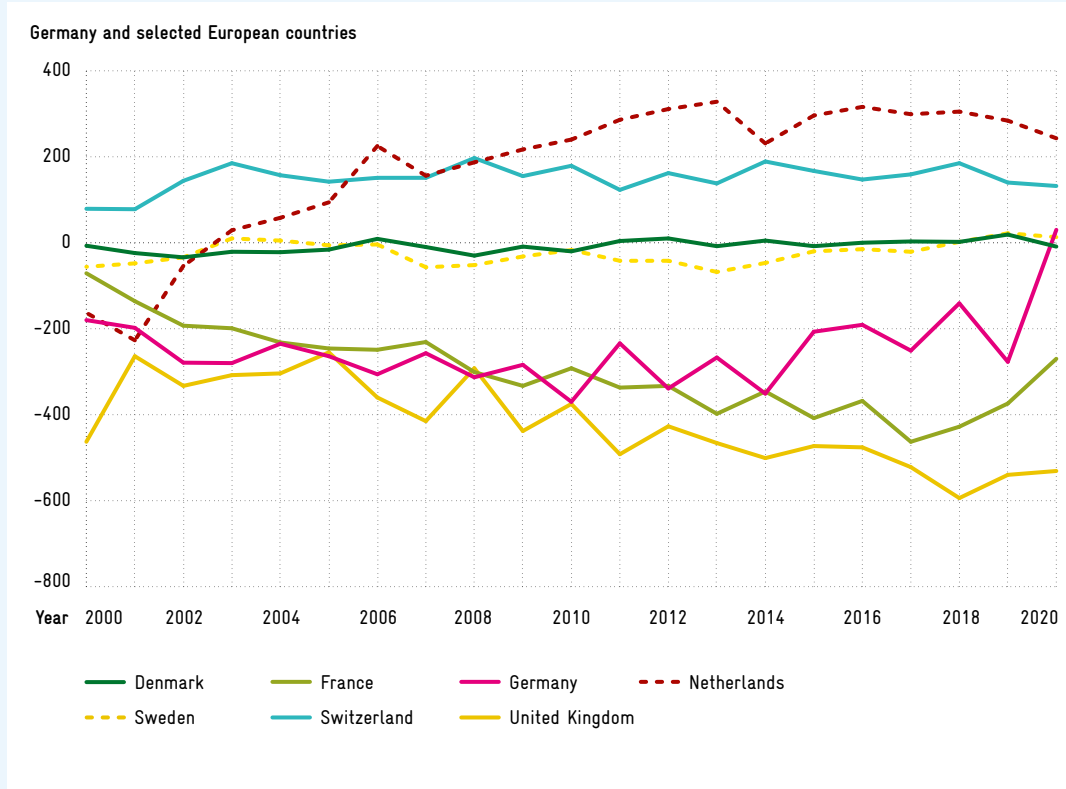
### Inventors Mostly Mobile Within Companies

Figure B 2-9 shows the inward and outward flows of inventors to and from Germany for selected countries in the observation period 2000 to 2020.<sup>302</sup> Strong bilateral migration flows of inventors exist primarily between Germany on the one hand and the USA, Austria, the UK, France and the Netherlands on the other. While there are net outward flows from Germany to the USA and the Netherlands, net inward flows can be seen from Austria, the UK and

Fig. B2-8 Annual mobility balances of incoming and outgoing inventors 2000–2020



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Legend: In 2017, the mobility balance (the difference between incoming and outgoing inventors) in Germany was -251. This means that more inventors left Germany that year than came to Germany.  
Source: Own representation based on Karaulova et al. (2024).  
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France. Compared to the European and North American regions, the Asian region is less significant for inventor mobility to and from Germany.

The companies in which the inventors work play a decisive role in the mobility of inventors. Over 90 percent of mobile inventors in selected countries<sup>303</sup> have changed countries within the same multinational corporation. In Germany, this figure is even higher at 95 percent. As most mobile inventors continue to work for the same multinational corporation in another country, their knowledge is retained within the business.

### Many Inventors Returning to Germany

To make statements about brain circulation, outgoers are further divided into emigrants and visitors and incomers into immigrants and returnees.<sup>304</sup> Important indicators here are again the stay ratio and the return ratio. Figure B 2-10 illustrates these

ratios for selected countries in the period between 2000 and 2020.<sup>305</sup>

Across all countries analyzed, the return ratio is between 0.20 and 0.40 and the stay ratio is between 0.60 and 0.82. Returnees are of foremost importance for the exchange of knowledge and the all-important brain circulation. At 0.40, Germany has the highest return ratio in an international comparison, together with South Korea.<sup>306</sup> The picture is somewhat different for the stay ratio. Here, Germany ranks in the international midfield at 0.71.

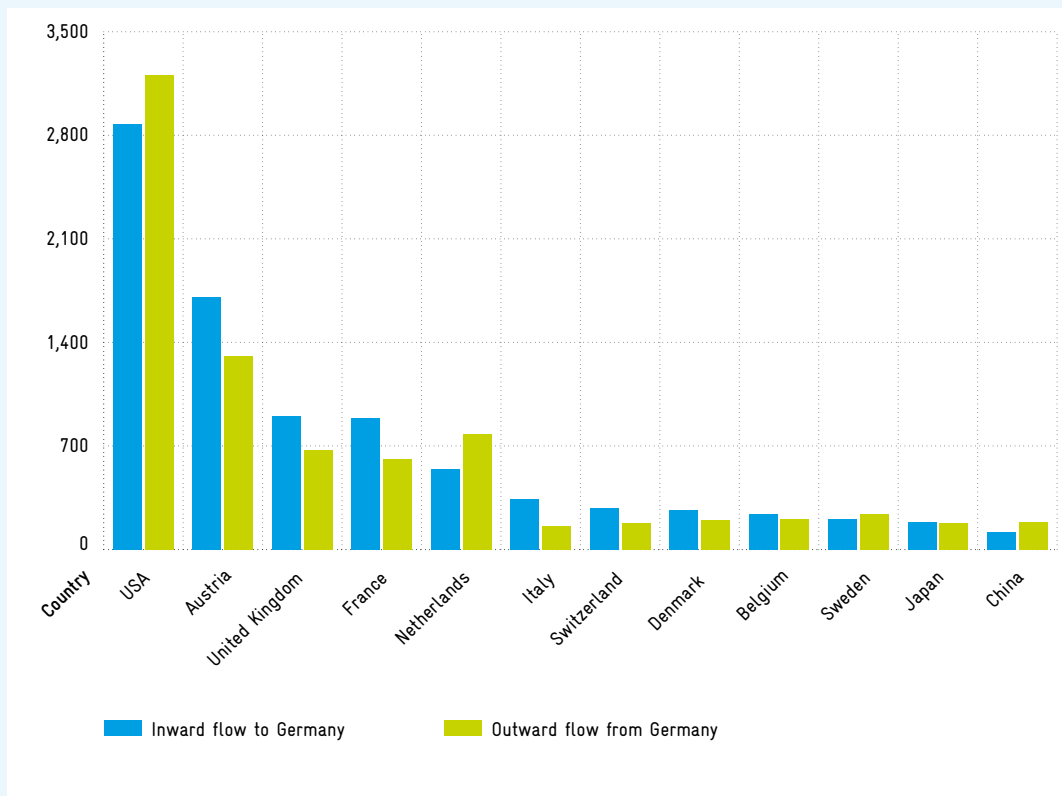
### Mobile Inventors Are Higher Performing

For Germany's innovation potential, it is not only of significant importance how many R&D employees move in and out, but also what inflow and outflow of innovation-relevant performance is associated with this. In the study conducted on behalf of the Commission of Experts, innovation-relevant capa-

**Fig. B2-9 Bilateral inward and outward flows of inventors (relating to Germany) 2000–2020**



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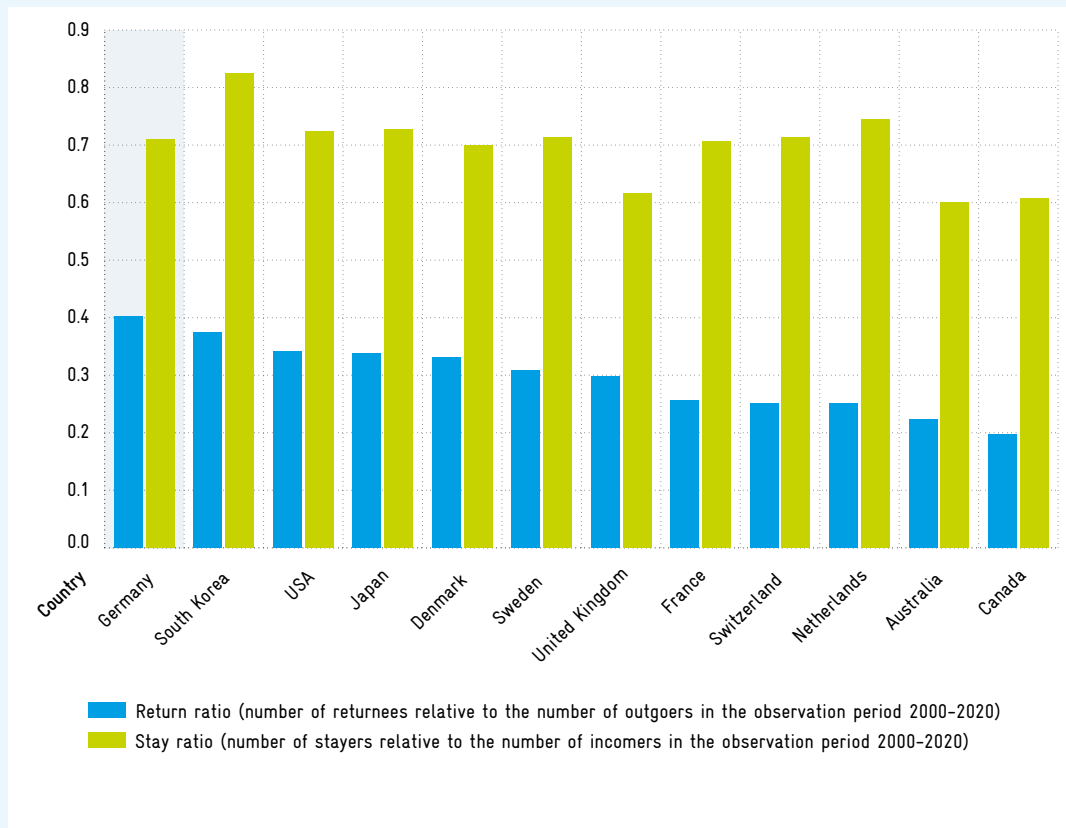


Legend: In the period between 2000 and 2020, 3,206 inventors moved from Germany to the USA and 2,876 came from the USA to Germany.  
Source: Own representation based on Karaulova et al. (2024).  
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**Fig. B2-10** Return ratio of outgoing inventors and stay ratio of incoming inventors, differentiated by country 2000–2020



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Legend: For every 100 inventors who left Germany in the period between 2000 and 2020 there are 40 returnees. For every 100 inventors who came to Germany, 71 remain in Germany by the end of the survey period.  
Source: Own representation based on Karaulova et al. (2024).  
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bility is approximated by the number and quality of an inventor’s patents. The number of citations received within four years of application is used as an indicator of the quality of a patent.

Figure B2-11 shows the average number and average quality of patents by country and by mobility type.<sup>307</sup> Across all countries, mobile inventors register more patents than non-mobile inventors.<sup>308</sup> Returnees and visitors have a higher number of patents than immigrants and emigrants. In an international comparison, both mobile and non-mobile inventors in Germany have an above-average number of patents. Those returning to Germany have a particularly high number of patents in an international comparison.

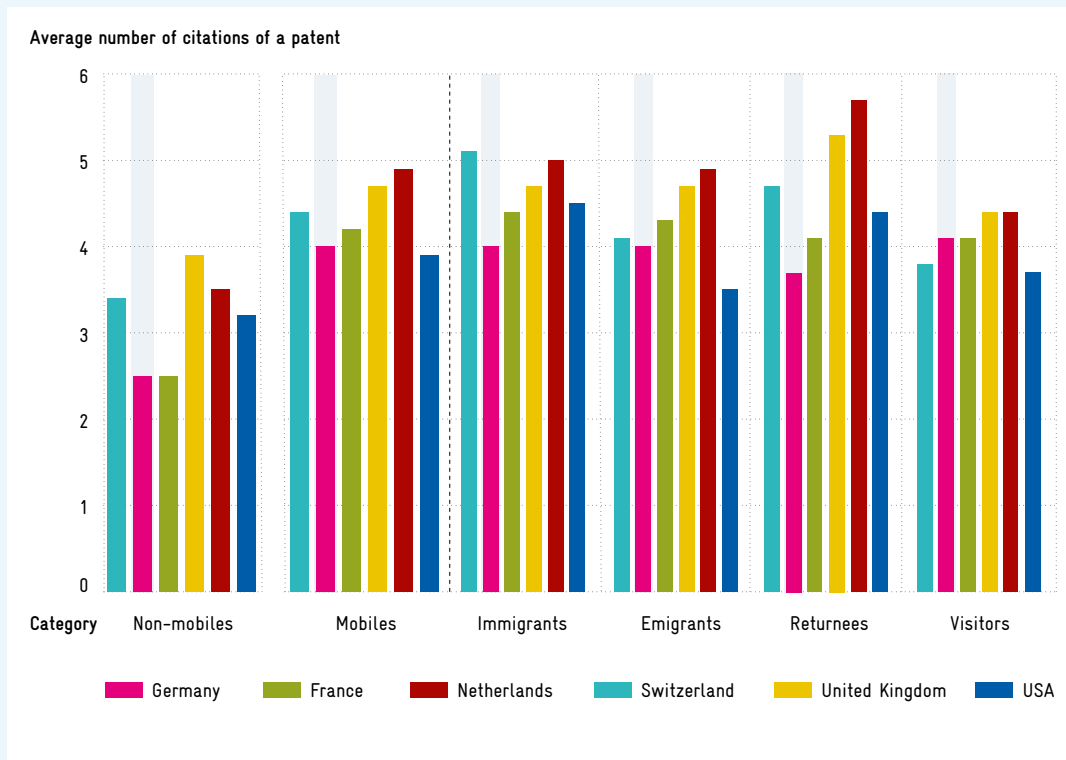
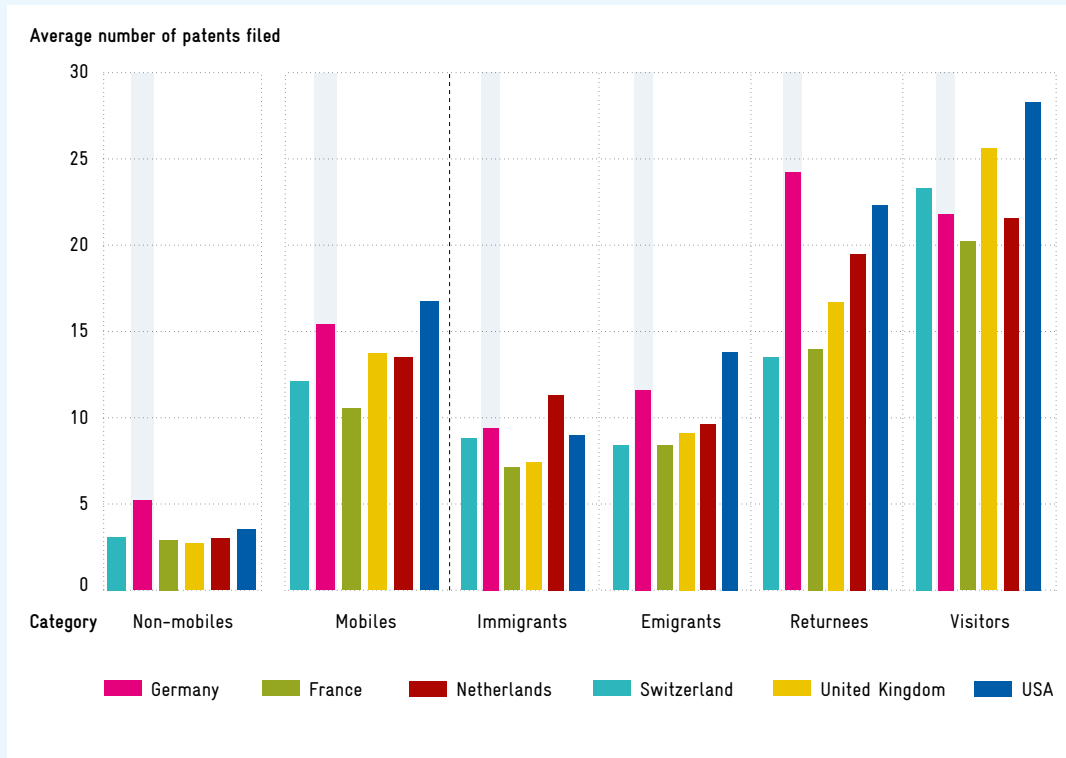
The average quality of patents differs less between countries and mobility types. Patents by non-mobile inventors are cited less frequently than patents

by mobile inventors across all countries. Within the group of mobile inventors, no significant differences in the quality of patents can be observed. An international comparison reveals that patents from Germany are cited less frequently than average across almost all types of mobility. This difference between the number and quality of patents is particularly evident among returnees to Germany. They have the most patents in an international comparison, albeit of the lowest quality.

### B2-4 Developments Since the 2014 Annual Report

The Commission of Experts previously addressed international mobility in the German science and innovation system in its 2014 Annual Report. It concluded that Germany was not a particularly attractive location for top scientists and inventors.

**Fig. B2-11** Number and quality of patents by inventors of different mobility types, differentiated by country 2000–2020



Legend: Inventors immigrating to Germany are named in an average of 9.4 patent applications. The patents of inventors immigrating to Germany are cited an average of four times.  
Source: Own calculation and representation based on Karaulova et al. (2024).  
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The main reasons for scientists to relocate internationally are related to the excellence of the science system in the respective countries of origin and destination. These motivations were already explained in detail in the 2014 Annual Report.<sup>309</sup> Scientists are attracted to where they find the best research conditions.<sup>310</sup> These include, above all, good career prospects, the reputation of the research institutions, the research infrastructure as well as freedom of expression and freedom in the selection and implementation of research projects. Empirical studies show that R&D employees primarily relocate to countries where they find exceptionally good research and innovation conditions – approximated by high R&D expenditure in relation to gross domestic product.<sup>311</sup>

The Commission of Experts' recommendations for action from 2014 were therefore aimed at a substantial and consistent expansion of the strengths of the German science and innovation system in order to facilitate internationally competitive research conditions, especially for the top segment. Over the past ten years, various measures have indeed been introduced to make Germany more attractive as a

centre of science and innovation for top international talent.

### Improved General Conditions for International Mobility

Regarding the inward flows of foreign scientists, academics and R&D employees, a number of adjustments have been made to the regulatory framework since 2014 with the objective of reducing administrative barriers (cf. box B2-12).

Special funding programmes such as the Alexander von Humboldt Professorships have been introduced, expanded and continuously funded for the recruitment of scientists from abroad, including returnees. Excellence-oriented measures to increase the general attractiveness of the science location, such as the Emmy Noether Programme, the support activities as part of the Excellence Initiative and the Excellence Strategy of the Federal Government and the Länder and the Tenure Track Programme, all promote the recruitment of internationally mobile scientists (cf. box B2-13). Study results indicate that these programmes have succeeded

#### Box B2-12 Regulatory Changes for International Mobility for Research and Development Purposes

In 2014, the Commission of Experts identified various legal issues and challenges that impaired the process of recruiting and integrating researchers and R&D employees. The main issues included ambiguous and complex regulatory conditions, a lack of efficient information provision and strict income requirements.<sup>312</sup> In the meantime, regulatory changes have been made to facilitate residence for research purposes. In particular, the introduction of Sections 18d, 18e and 18f of the Residence Act (Aufenthaltsgesetz) and the ICT (Intra-Corporate Transfer) card have brought significant improvements in the regulation of residence and work permits.

Sections 18d-f of the Residence Act relate to residence permits for research purposes. Under Section 18d, a residence permit for research purposes is issued without the approval of the Federal Employment Agency (Bundesagentur für Arbeit) being required if there is an effective

hosting agreement with a recognized research institution and the costs are borne by the research institution. Section 18e enables foreign researchers who already have a residence permit for the purpose of research in an EU Member State to conduct research in Germany for up to 180 days without having to apply for an additional residence permit. Section 18f regulates the residence permit for researchers who wish to stay in Germany for longer than 180 days and offers a way to obtain the necessary permits.

The ICT card, regulated in Sections 19, 19a and 19b of the Residence Act, is another important instrument. It is a residence permit for the purpose of an intra-company transfer of third-country nationals within an international enterprise or group. The ICT card considerably facilitates and simplifies the secondment of highly qualified individuals who are resident outside the EU. This is particularly relevant for the mobility of R&D employees because it provides clear conditions and criteria for secondment and at the same time enables short-term stays of up to 90 days without the need for an additional residence permit.



in increasing the attractiveness of the science system.<sup>313</sup>

### Increased Migration Balance, Major Demographic Challenges

A comparison between the findings of this report and the results of the 2014 Annual Report reveals clear developments towards greater international mobility of authors of scientific publications.<sup>314</sup> The number of authors moving to and from Germany increased from around 40,000 in the period from 2005 to 2020 to around 70,000 in the period from 1996 to 2011.<sup>315</sup>

Germany has developed from a net donor to a net receiving country. While the 2014 Annual Report still indicated a net emigration of around 4,000 authors between 1996 and 2011,<sup>316</sup> the period from 2005 to 2020 shows a net immigration of over 5,000 authors.<sup>317</sup> The mobility rate of inventors has hardly changed over the past two decades and remained fairly stable at 6 percent between 2000 and

2020. The net outward flows of inventors have decreased over time. A net inward flow was recorded for the first time in 2020.<sup>318</sup>

However, it is unclear whether these positive developments will be sufficient to meet the challenges posed by demographic ageing and the general shortage of skilled labour in the German science and innovation system.<sup>319</sup>

### B2-5 Remaining Barriers

Germany has experienced a net immigration of authors over the past 15 years. It has also been possible to attract many top researchers back to Germany. Overall, however, those immigrating to Germany are on average performing less well than those leaving Germany. This indicates that there is still potential to improve the excellence and attractiveness of Germany as a centre of science and research across the board.

#### Box B2-13 Select Support Programmes in the Science System

The Commission of Experts already pointed out in 2014 that measures under the Excellence Initiative, launched in 2005, can prove particularly attractive to researchers from abroad.<sup>320</sup> The Excellence Initiative provided considerable funding over two phases and several funding lines (graduate schools, clusters of excellence and institutional strategies) to promote projects at select universities, improve research cooperation and increase research productivity.<sup>321</sup> The Excellence Initiative was replaced by the Excellence Strategy in 2016.<sup>322</sup>

The Alexander von Humboldt Professorship, which was introduced in 2008, aims to attract world-leading scientists working abroad for long-term employment in the German science system. An Alexander von Humboldt Professorship is funded with up to €5 million over a period of five years and a potential two-year extension.<sup>323</sup>

The Emmy Noether Programme<sup>324</sup> was established in 1999 to enable particularly qualified young scientists to conduct a phase of independent research after completing their doctorate. The programme enables the recipients to lead their own junior research group for a period of usually six years and thereby qualify for a professorship. The Emmy Noether Programme promotes international mobility by requiring applicants to have international research experience and supporting the establishment of international networks.

The Federal Government and Länder programme (Bund-Länder-Programm)<sup>325</sup> introduced in 2016 aims at establishing tenure track professorships more structurally in order to create more transparent and predictable career paths in science. The programme enables participants to be appointed directly to a lifetime professorship after a successful probationary phase. The programme is designed to create attractive conditions for talented scientists.

### Administrative Processes Inefficient and Complicated

Current surveys among foreign skilled workers who are willing to come to Germany show that lengthy, complex and sometimes non-transparent administrative processes are among the biggest current barriers to the inward flow of skilled workers.<sup>326</sup> In expert interviews, reference was made to the lengthy procedures for issuing visas at German diplomatic missions abroad. Overburdened foreigners authorities and different interpretations of laws, regulations and processes depending on the location were also cited as hindrances.<sup>327</sup> At least larger employers such as corporations and universities can often minimize these, albeit with considerable effort, by approaching the authorities directly.<sup>328</sup>

### Switching Between Social Security Systems Complex

Insufficiently harmonized recognition procedures between national social security systems make it difficult for foreign scientists and R&D employees

to come to Germany and thus represent a barrier to mobility.<sup>329</sup> Complex and opaque crediting procedures for pension and pension entitlement periods as well as inconsistent regulations on taking existing pension entitlements with you when you later leave the civil service and move to a third country constitute an obstacle for potential incoming scientists in particular.<sup>330</sup>

### Incomers Hindered by Language Barriers

A recent study on the challenges of coming into the German science system also emphasizes that the German language is one of the biggest hurdles that international scientists face in appointment procedures, in administration, in academic self-administration and in teaching.<sup>331</sup>

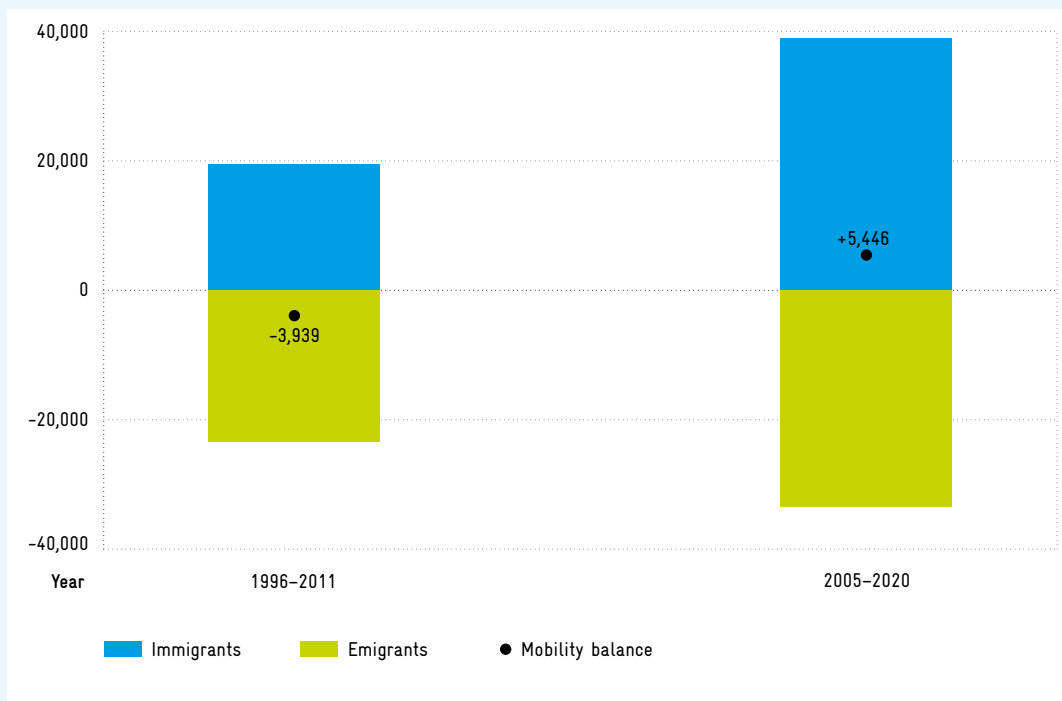
### Importance of Communicating Location Advantages

Neither internationally competitive working and research conditions nor an excellent research environment will improve Germany's position in the

**Fig. B2-14** Number of emigrating and immigrating authors and the migration balance in comparison between 1996–2011 and 2005–2020



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Legend: In the period between 2005 and 2020, 38,973 authors came into the German science system and remained here. In the same period, 33,527 authors left the German science system and did not return. This results in a positive migration balance of 5,446.  
Source: Own representation based on Coda-Zabetta et al. (2024).  
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international competition for scientists and R&D employees if they are not aware of the advantages of Germany as a location. In addition to employers, the key actors coordinating the recruitment, attraction and integration into the German science and innovation system<sup>332</sup> are the foreign representative offices of institutions such as the DFG and the German Academic Exchange Service (Deutscher Akademischer Austauschdienst, DAAD).<sup>333</sup> The regular threat of budget cuts at many of these institutions restricts their room for manoeuvre.

## B2-6 Recommendations for Action

The analyses presented in this chapter indicate that Germany is competing intensively with a number of other countries for leading scientists and R&D employees and is definitely successful in this respect. Overall, Germany is on a favourable trajectory. However, there is still considerable potential to increase the attractiveness of the location. The Federal Government has a key role to play here, as it shapes the political framework conditions for the international mobility of scientists and R&D employees.

### Simplify Regulations for International Mobility and Accelerate Administrative Processes

Complicated and lengthy administrative processes and, in some cases, differently interpreted legislation impede the international mobility of scientists and R&D employees. This impairs the recruitment of top international talent from outside the EU. Complex regulations for residence permits and long waiting times at diplomatic missions abroad as well as lengthy administrative processes at immigration authorities are particular obstacles. The Commission of Experts recommends the following measures:

- A digital system based on the Online Access Act (Onlinezugangsgesetz, OZG), which in future may also be supported by AI, should be set up to link all parties involved in the process (diplomatic missions abroad, foreigners authorities, registration offices, research institutions or businesses and persons wishing to come to Germany). Provision should be made for individual sub-processes, such as the recognition of foreign educational and professional qualifications, to be digitized, accelerated and integrated into an overall process.

- To ensure that visa applications are processed promptly, diplomatic missions abroad should be strengthened in terms of organization and, if necessary, staffing.
- Comprehensive and up-to-date information on topics such as visa processes, work and residence permits, health and pension insurance and social security should be made available digitally in English and other relevant languages.

Particularly when it comes to the international mobility of scientists, the civil servant status, which per se is attractive in international comparison, can lead to administrative problems, for example due to uncertainty about the extent to which previous periods of employment result in pension entitlements. The Commission of Experts recommends:

- The Federal Government should work with the Länder to introduce standardized and digitized procedures in order to speed up these decisions and provide international applicants with certainty about their pension entitlements at an early stage.

### Promote Harmonization of Regulations at EU Level

The lack of harmonization of regulatory frameworks at EU level is a major obstacle to the international mobility of scientists and R&D employees. The Commission of Experts expressly welcomes the National Action Plan for the European Research Area recently adopted by the Federal Government, which also plans to reduce bureaucratic hurdles.<sup>334</sup> However, the Action Plan does not go far enough for a general simplification of international mobility and remains too vague on key points.

- The Federal Government should work at EU level to harmonize the regulations on the transferability of combined qualifying periods for pension insurance. In addition, the claiming of pension information and pension entitlements in cases of entitlement in several EU countries should be centralized rather than requiring separate claims for each country.
- The Federal Government should work with the Länder to create uniform regulations for supplementary pension insurance in the event

of voluntary termination of civil servant status (e.g. old-age payment (Altersgeld) regulations). These should also cover all cases where civil servants take up a new job in a non-EU country.

### Expanding Excellence Promotion in the Science System

The existing support measures help to attract international researchers and keep them in Germany. Excellent tertiary education and research institutions, faculties and research teams are a key factor in attracting top researchers from abroad. They can also encourage scientists who have moved away from Germany to return.

- Initiatives and programmes of the Alexander von Humboldt Foundation and the DFG to recruit and win back high-performing scientists from abroad should be further expanded.
- The Federal Government-Länder programme for the creation of tenure track professorships should be expanded with a clear focus on making the newly created positions consistently compatible with the international labour mar-

ket in order to support international research careers and attract international scientists. To this end, positions should be advertised as salaried positions with attractive pay.

- The tenure track principle should also be utilized to a greater extent for mid-level academic positions in order to increase the international appeal of Germany as a centre of science below the level of professorship.<sup>335</sup>

### Safeguarding Financial Conditions

The institutions of the German science system need the financial conditions to contribute to internationalization and to promote the international mobility of scientists.

- The Federal Government should work to ensure that the internationalization of tertiary education is given high priority in Federal Government-Länder agreements on tertiary education funding.
- The increases in the DAAD's basic funding stipulated in the coalition agreement should be adhered to and secured in the long term.