2. Institutional factors shaping the performance of research organizations

Groundbreaking research achievements are rare and unevenly distributed across research organizations and countries. In addition, national research systems are institutionally stratified, i.e., divided into a core area of elite institutions and a peripheral area of all other research institutions. Sociologists Joseph Ben-David and Rogers Hollingsworth have investigated the relationship between global groundbreaking research and institutional stratification using the example of biomedicine. Prof. Thomas Heinze's reserach group is continuing this work with grant-funded research projects and PhD dissertations, including the DFG-funded Research Training Group "Transformations of Science and Technology since 1800: Topics, Processes, Institutions." An important part of this work involves establishing high-quality repositories and making them available to the research community. This includes a dataset of all Nobel Prize winners and their career stages, a repository of all available Nobel Prize nominators and nominees, and a repository on the development of subject structures at state universities in Germany. The empirical analyses carried out refer to middle-range sociological theories.

2.1 The United States as a global center of science

The study of the global and organizational distribution of scientific excellence is the subject of a long-term research project in Prof. Heinze's working group. To this end, the careers of all Nobel Prize winners in chemistry, medicine or physiology, and physics from 1901 to 2020 were reconstructed and documented according to a uniform data collection scheme(!!! INVALID CITATION !!! (Heinze, Jappe, et al. 2019; Heinze et al. 2020; Heinze, Fuchs 2022)). The Nobel Prize is the world's most prestigious scientific award and is therefore suitable for measuring global cutting-edge research. Several publications have emerged from this project, including a PhD dissertation(von der Heyden 2024).

A first set of publications by Prof. Heinze's research group examines the question of whether North America – especially the US – is still the global center of science(!!! INVALID CITATION !!! (Heinze, Jappe, et al. 2019; Heinze et al. 2020; Heinze, Fuchs 2022)). To this end, data on the three career points (or phases) of all Nobel Prize winners were collected: when and where the highest degree (typically a PhD) was obtained (*highest degree*, HD); when and where the scientific work that later won the Nobel Prize was carried out (*prize-winning research*, PWR); when and where the Nobel Prize winners were working when they received the prize (*Nobel Prize*, NP). In addition, three regions were distinguished: North America, Europe, and Asia-Pacific, and the specific research institutions where these three career milestones took place (HD, PWR, NP) were identified.

As Figure 1 shows, North America's catch-up process began in the 1920s and continued steadily until the 1960s. After a transitional phase, North America took over global leadership that had previously been held by Europe, and Germany in particular, by the 1970s at the latest. During the hegemonic phase between the 1970s and 1990s, North American universities trained almost 60 percent of all future prize winners and, together with non-university research institutions, were home to 75 percent of all projects that later led to Nobel Prizes. There was a visible decline in North America's share in the 1990s and 2000s, a result that should be interpreted with caution, however, because there is now a gap of around 25 years between research breakthroughs and the awarding of prizes, meaning that the career data for

the 1990s and 2000s will be included in the data set once future prizes have been awarded(Heinze, Jappe, et al. 2019).

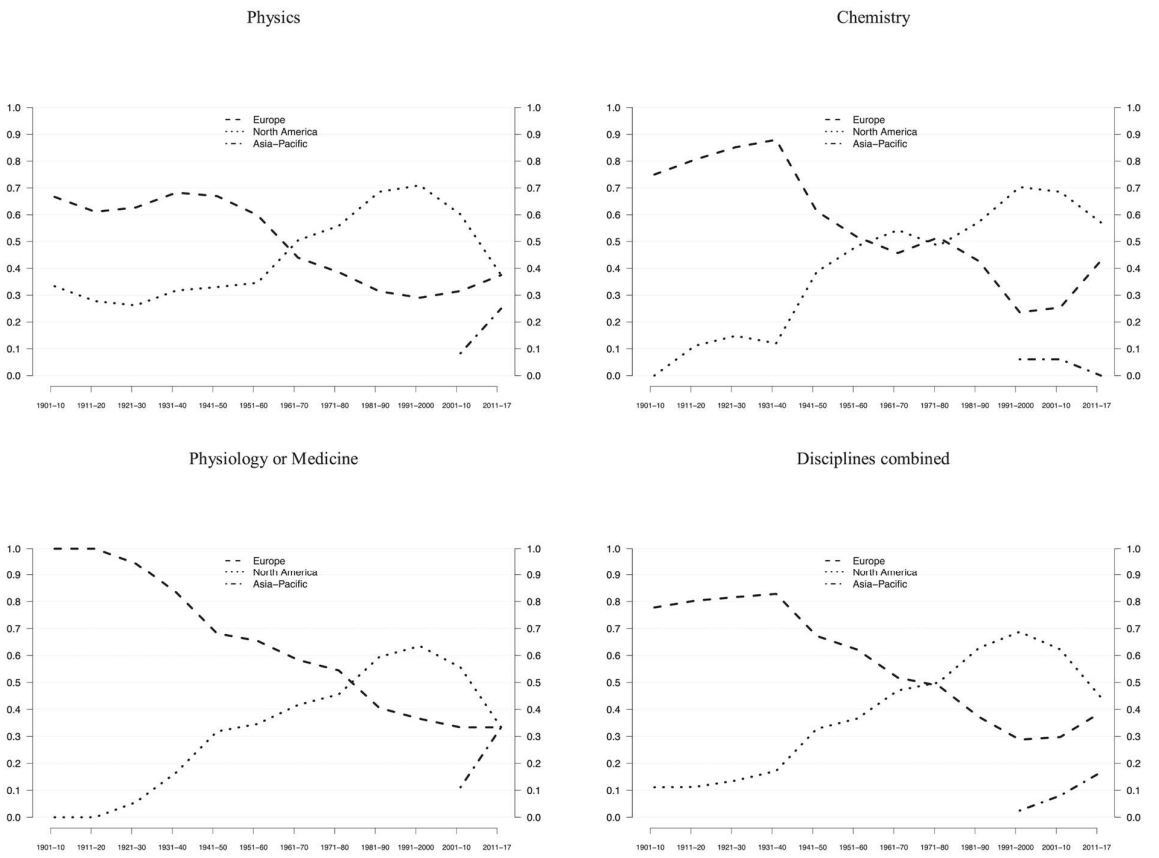

Figure1: Relative frequency of Nobel Prize winners (all career phases: HD, PWR, NP).

Source:Heinze, Jappe, et al. (2019).

Three other indicators also point to global leadership. First, North America has attracted many future Nobel Prize winners since the mid-20th century. Since the 1970s, approximately one future Nobel laureate per year has emigrated to North America from Europe and the Asia-Pacific. Second, we can show that North America has most mentor-student relationships between future Nobel laureates. In such working relationships, younger scientists learn the skills to conduct groundbreaking research from experienced scientists. In the 1970s and 1990s, two-thirds of all mentor-student relationships were found in universities and research institutes in North America, whereas in the first half of the 20th century they were mainly found in Europe. Third, the proportion of research institutions that produced a Nobel laureate for the first time in one of the career phases was significantly higher in North America in the 20th century than in Europe. This means that there is less competition for the "best minds" in Europe(Heinze, Jappe, et al. 2019).

In another publication, Prof. Heinze's research group examines the importance of the institutional environment for the frequency of Nobel Prizes (in the three career phases mentioned) in Germany, France, the United Kingdom, and the United States(Heinze et al. 2020). The paper examines Rogers Hollingsworth's proposition (!!! INVALID CITATION !!! (2004, 2006; 2011)) that new topics and fields can develop better in research organizations if the latter are embedded in an institutional context that offers a high degree of flexibility in terms of establishing subject areas, funding, and staff recruitment. Conversely, new topics and fields are less likely to flourish if the institutional context imposes many restrictions on them. According to Hollingsworth, both France and Germany had highly restrictive institutional contexts in the 20th century, while the United Kingdom and the United States had flexible ones.

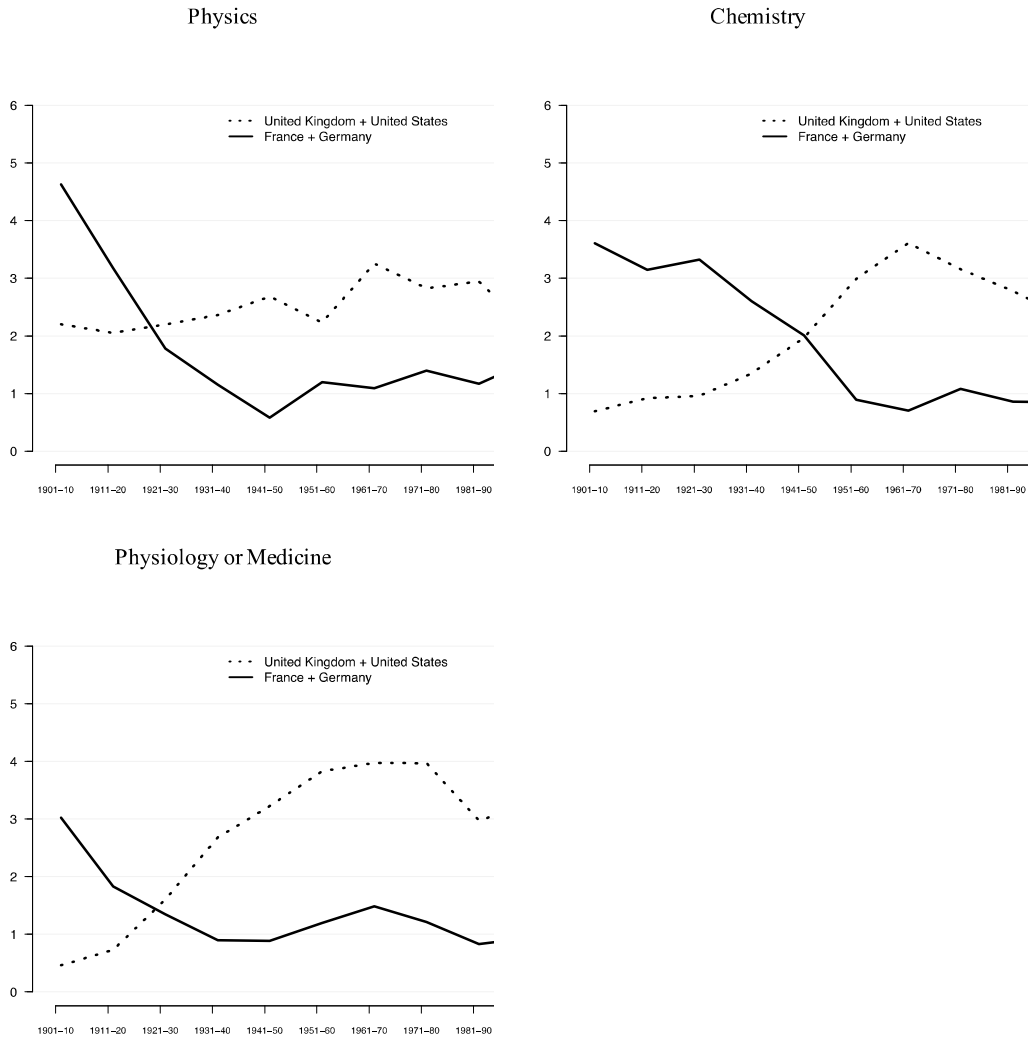

Figure2: Number of Nobel Prize winners per 1 million inhabitants.

The representation includes all career phases (HD, PWR, NP). Source:Heinze et al. (2020).

The key finding ofHeinze et al. (2020) is that the group of two countries with flexible contexts (UK, US) has a significantly higher number of Nobel Prize winners, both in relation to population size (Fig. 2) and in relation to per capita income (Fig. 3). Over the entire period, these countries have two to three times more Nobel Prize winners than the group with restrictive contexts (FR, DE). The biggest differences are found in medicine, followed by chemistry and physics. The argument developed by Hollingsworth using the example of biomedicine can thus also be applied to the other two disciplines.

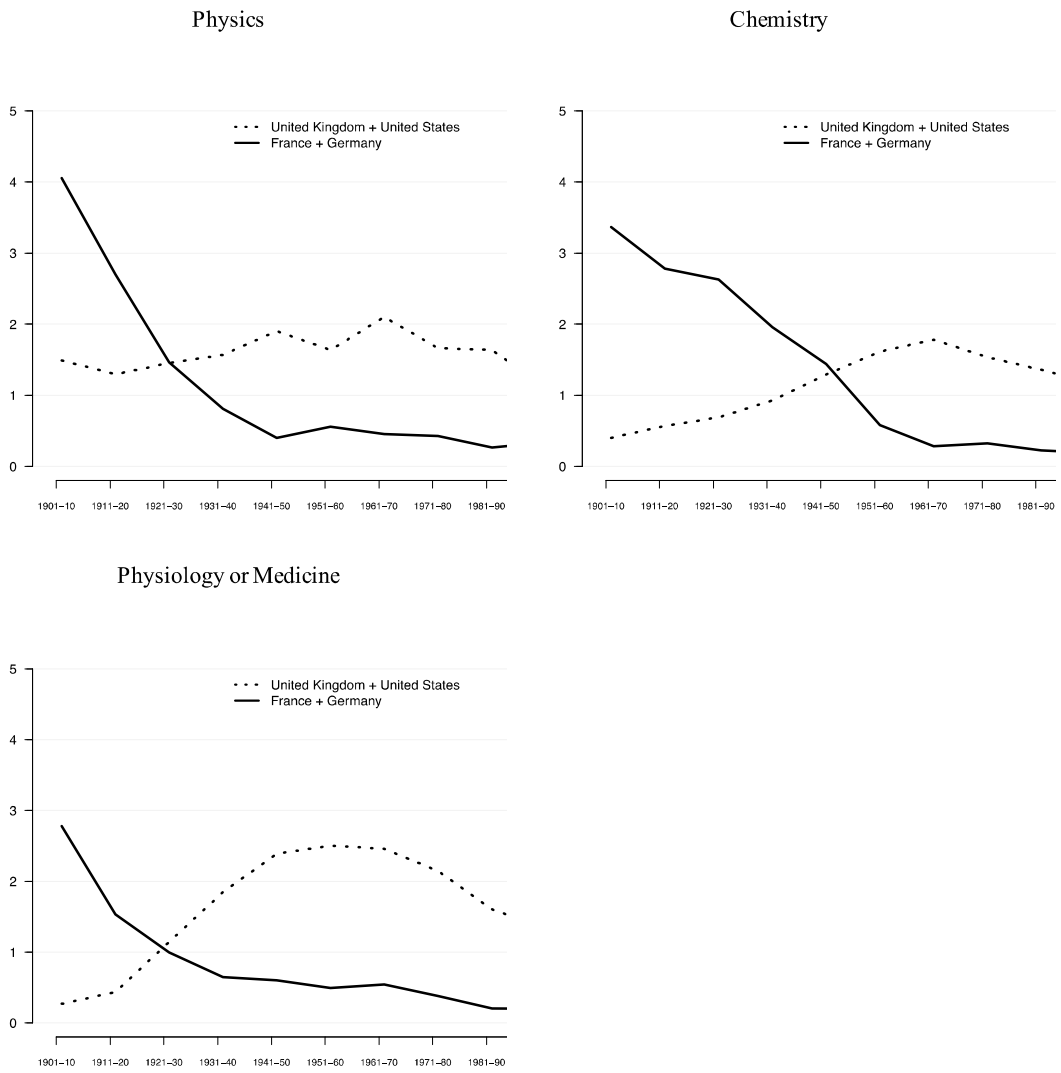

Figure 3: Number of Nobel Prize winners, weighted by annual per capita income, source:Heinze et al. (2020).

The figure includes all career phases (HD, PWR, NP).

Annual per capita income is adjusted for inflation with 2011 as the base year.

In another publication,Heinze & Fuchs (2022) examine the organizational field of those research institutions where a particularly large number of future prize winners completed their training and/or conducted their research. Of particular interest here are those universities and research organizations that have seen a significant increase (or decline) in their capacity for highly innovative research, as well as those organizations that belong to the ultra-elite of science: universities and research institutes that consistently produce an above-average number of future award winners, usually in one career phase, but sometimes across two career phases (Fig. 4).

Finally, Marievon der Heyden (2024) compiled and analyzed a comprehensive survey of all Nobel Prize nominations in the categories of physics and chemistry for the years 1901-1969 in a single dataset. The dataset enables an in-depth analysis of the global nomination network. The results show signs of gender inequality and organizational prestige in the selection of nominees. Nominating power is unevenly distributed, especially between scientifically central and peripheral countries, and shows a clear shift in scientific leadership from Germany to the United States, confirming the findings ofHeinze, Jappe, et al. (2019). However, there is insufficient evidence of an organizational hierarchy in the successful placement of nominations, meaning that placement power is not limited to prestigious universities and research organizations alone. Rather, new organizations entering the field can also successfully place their nominations, demonstrating that prestige hierarchies can change.

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