Research funding in the context of high institutional stratification. Policy scenarios for Europe based on insights from the United States.

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Abstract

This paper argues that stratified structures in university systems should be addressed more explicitly in debates on research funding. The paper connects findings from several streams of literature on US-American research universities: (a) the relationship of organizational status and scientific quality, (b) positional competitions among elite universities, (c) concentration of research funding, and (d) faculty exchange networks as measures of university prestige. Taken together, these literatures reveal a crystalline hierarchy with intense competition for scientific talent at the top but little opportunity for upward institutional and personal mobility. While elite universities provide advantages in terms of research output and prestige, the findings point to social closure as a potentially problematic outcome for a democratic knowledge society. Therefore, the comparison highlights two policy challenges by means of two scenarios: closing the gap in organizational resources, while at the same time ensuring continuing expansion of the research university system in Europe.

Keywords: research funding concentration; stratification of university systems; university prestige; higher education United States; higher education Europe; faculty placement networks.

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Introduction

Top research universities in the United States are much admired by the rest of the world for their superior research performance and their formidable wealth. Many countries in Europe strive to emulate their success and seek to concentrate governmental funding in their best performing universities in turn. But it has also long been recognized that the organizational field of doctoral universities in the United States is characterized by pronounced stratification and fierce competition for educational prestige. Social closure effectively limits the upward social mobility of universities, faculty scientists, and students.

This paper argues that research funding policies should not be conceived in isolation from knowledge about institutional structures of university systems. Instead, investigating the interaction between research funding and university system stratification is necessary to learn more about long-term structural effects of different funding policies. As a review, this paper combines previously disjoint literatures that shed light on university system stratification in the United States. We consider basic findings concerning the comparability of the situation in Europe to that in the United States and discuss two scenarios for research funding policies in Europe.

The paper is structured as follows. The first section introduces a theoretical account of the relationship between organizational status and scientific quality. Throughout this paper, we use "status" as the general term that applies to organizations as well as individuals. In the case of universities, status is referred to more specifically as organizational "prestige", whereas "reputation" denotes the status of individual scientists. Reputation means recognition for relevant scientific contributions by fellow scientists. Reputation is to be distinguished from occupational status of individuals within organizations such as "full professor" or "head of laboratory". The first section describes how scientific competition is linked to organizational competition via inter-individual differences in scientific productivity.

As part of a handbook on research funding, this chapter is focussed on research universities. Doctoral research universities are defined by the Carnegie classification as institutions that annually have awarded at least 20 research/scholarship doctoral degrees and had at least $5 million in total research expenditures.[i] Research universities are but one of six categories of colleges that scholars distinguish in the United States: baccalaureate colleges (liberal arts colleges), comprehensive colleges (baccalaureate and advanced degrees), research universities (focused on more advanced degrees and knowledge creation), associate degree colleges (community colleges), special-focus institutions (theology, medicine, law, art), and for-profit entities (special focus, baccalaureate, associate, and advanced degrees) (Scott & Biag, 2016, p. 28). In its most recent report, the population of 418 doctoral universities were further subdivided by Carnegie into "very high research" (131 HEIs), "high research" (135), and "doctoral/ professional universities" (152) (IUCPR, 2018).

Sections II–IV characterize stratification within the segment of research universities in the United States from different angles. Section II treats characteristics of positional competitions for university prestige. Section III summarizes findings on the concentration versus dispersion of research expenditures. Section IV reviews findings on the measurement of university prestige based on faculty exchange networks. Section V refers to the European Tertiary Education Register (ETER) to consider the broad comparability between research universities in Europe and the United States. Based on the results of Sections II–IV, we sketch two scenarios for the future of European research universities, with conclusions for research funding policy (Section VI).

This overview of interdisciplinary findings demonstrates that stratification of research universities in the United States is accompanied by social closure and reduced social mobility on several levels, from students to individual scientists to research organizations. We conclude from this body of research that university system stratification and social closure are part of the long-term societal impacts of research funding. The more an organizational prestige hierarchy solidifies, the more the discretionary influence of public policy on eventual funding distributions can be expected to diminish (Bozeman, chapter 2 in this *Handbook*). Therefore, the design details of competitive funding instruments appear less decisive for long-term distributive outcomes than governments' overall strategic direction on the question of vertical differentiation versus system expansion.

Organizational prestige and scientific quality

In general terms, scientific progress is characterized by a fundamental tension between originality or novel contributions on one side and disciplinary traditions or more established knowledge on the other (Heinze & Münch, 2016; Polanyi, 1969). Scientific competition takes place between individual scientists and their research groups in intellectual fields (Whitley, 2000), as well as between competing research programs (Lakatos, 1970). While organizations do not literally engage in intellectual competition, they support individual competitors so that organizational capabilities and resources have an influence on intellectual developments. Viewed from this analytical angle, universities primarily fulfill various administrative and professional functions, such as acting as employers, providing basic funding, managing external research grants, being a platform for collaboration, connecting research and teaching, and training young scientists. Furthermore, as institutions in democratic societies, universities act as fiduciaries for intellectual freedom and scientific renewal (Parsons & Platt, 1974).

Organizational competition can be linked to intellectual competition on the basis of inter-individual differences in scientific productivity. Bibliometric studies have consistently shown that the inter-individual distribution of scientific performance is extremely skewed. A small subset of the population of scientists produces the bulk of publications and accumulates an even larger proportion of all citations, a pattern that persists across disciplines (Ioannidis, Boyack, & Klavans, 2014; Nielsen & Andersen, 2021; Ruiz-Castillo & Costas, 2014; Seglen, 1992). In a stratified organizational field, universities compete primarily for scientific talent and reputation. In the fourth section, we show that university prestige can be measured in terms of faculty hiring as status-deferent behaviour. In reality, inter-university competition is more multidimensional, as it is also about attracting student talent. But the relevant dimensions are not independent. Other dimensions of organizational competition, such as competition for research money, follow suit.

How does organizational competition influence scientific competition? On a general level, two different accounts are available in the literature. Authors more concerned with scientific competition have argued that a concentration of talent can be beneficial because it supports and enhances scientists´ individual and collective productivity (Allison & Long, 1990). In this view, an important function of elite universities is to create an environment that supports highly creative research (Heinze, Shapira, Rogers, & Senker, 2009; Hollingsworth, 2004). Furthermore, rich elite institutions are able to attract from across the world individuals with scientific talent who cannot find comparable working conditions elsewhere (Stephan & Levin, 2007). A related idea in research funding policy is that excellent research requires "critical

mass". While this concept defies a precise numerical definition, it suggests that scientific capabilities and/or resources must be concentrated beyond a certain threshold to enable a self-reinforcing productive process (Aksnes, Benner, Borlaug, & Hansen, 2012; OECD, 2014). A recent review concerning funding concentration at the individual and group levels is provided by Aagaard, Kladakis, and Nielsen (2020).

Authors more interested in organizational competition have argued that stratification provides informational advantages, as it structures the competitive arena in such a way that a complex and dynamic situation (intellectual competition) is transformed into a stable and obvious situation (organizational hierarchies), enabling stable expectations on the part of different market agents. A diverse literature on organizational status in markets treats status as a "quality signal" in the face of information uncertainty (Piazza & Castelluci, 2014; Podolny, 1993; Sauder, Lynn, & Podolny, 2012). This notion of signaling is also applicable in the context of research organizations. Here, widespread uncertainty about "true" quality is primarily a result of scientific specialization.

Signaling has practical importance for research funding, because the "true" scientific quality of an individual contribution, a project proposal, or a researcher's performance can be judged independently and proficiently only by experts or peers from the same field (Whitley, 2000). All others have to rely on expert evaluation and cannot claim an independent judgment of their own. Making matters worse, experts often do not agree in their assessment, and less so for more creative and more risky contributions. As a consequence, organizational processes such as hiring or resource allocations often lead to situations where non-experts are required to take decisions on the relative merit of scientific competitors (Heinze & Jappe, 2020).

The literature on organizational status in markets maintains that stable stratification can structure the competitive arena in a way that mutual observation of status-deferent behavior could reasonably precede or even replace expert judgments of quality. To the extent that there is a commonly recognized gradient of prestige, high-status universities have an advantage in recruiting those individuals with the strongest scientific performance. The more an organizational prestige hierarchy mirrors a true differentiation of departments according to scientific performance, or correlates with the latter, the more organizational status becomes meaningful as a signal of quality (Sauder et al., 2012).

A further implication of the status-in-markets perspective is that markets tend to split up into status segments, effectively reducing the number of direct competitors. In the case of universities, status segments seem particularly relevant for the selection of collaborators. Jones, Wuchty, and Uzzi (2008) found that teamwork in science increasingly spans inter-organizational boundaries and that elite US universities play a dominant role in national co-authorships. The top-tier universities held places in 60 percent of multi-university collaborations in Science & Engineering and 56 percent in Social Sciences in the period 2001–2005 (Web of Science).

Between-university collaborations are frequent not only in publications but also in funding proposals. Therefore, a similar extent of segmentation and functional dominance of elite schools can be expected in national "quasi-markets" for research funding, despite the fact that competitions are construed in different ways for different funding instruments (Arora-Jonsson, Brunsson, & Edlund, chapter 7 in this *Handbook*). Market segmentation means that an organizational prestige hierarchy becomes well-defined and solid in the perception of market agents and that segments permanently offer different opportunity structures for individual

scientists (Section IV). In this way, a prestige hierarchy can become a self-reinforcing mechanism of funding concentration.

While the status-in-markets perspective underscores functional advantages in that status hierarchies reduce situational complexity, other studies also point to disadvantages of organizational stratification for scientific competition. A central problem is that the observation of scientific performance does not remain unaffected by status positions, for either individuals or organizations. Since scientific performance (or productivity) is often measured on the basis of publications and citations, bibliometrics can illustrate this point.

Bibliometric methods have inherent limitations when it comes to the distinction between quality and status. These limitations are directly related to the act of reference selection in scientific writing (for an overview, see Aksnes, Langfeldt, & Wouters, 2019). In most cases, authors select references for specific aspects of scientific content or quality, while in other cases, they also select references out of deference to the reputation of particular colleague-competitors within their respective intellectual field. The act of citing colleagues with a strong reputation can enhance the credibility and legitimacy of particular propositions and can also refer to shared scientific beliefs, so that status deference in scientific work should not per se be deemed problematic. Yet, the extent to which the selection of references is based on independent assessments of quality or rather reflects the mutual observation of status-deferent behavior in research communities cannot be decided on the basis of citation data alone.

While the relation of content quality and author status in citations cannot be disentangled for individual publications, bibliometric studies show that reputation produces network effects in citation data ("preferential attachment"). On the individual level, these effects have been referred to as "cumulative advantage" (Barabási et al., 2002; DiPrete & Eirich, 2006). Cumulative effects have also been observed at the level of universities. Several studies have reported super-linear scaling of citations with university size (as measured in publications or in research expenditures), which means that citation numbers increase disproportionately with organizational size (Lepori, Geuna, & Mira, 2019; van Raan, 2013).

So far, it has not been determined whether these organizational effects can be explained by the aggregated reputation of affiliated scientists or whether there are independent organizational effects that would indicate productivity advantages connected to university size or university prestige. In any event, the measurement of scientific quality and status appear to be closely associated in citation data on multiple levels. Consequently, while citation data can reduce uncertainty concerning the quality of scientific work, they cannot determine quality independently of status positions within the science system.

A related problem is that status hierarchies can filter ideas and might reduce intellectual renewal. Certainly, the logic of a status-deferent social exchange and resulting status hierarchies stand in fundamental tension with the epistemic norms of a rational exchange of arguments. Network science offers an analytical perspective to connect the two. It maintains that hubs in a network have higher diffusion power compared with that of nodes that are less well connected. It follows that ideas from the periphery need to be more persuasive—that is, have stronger arguments, higher originality and relevance, and stronger rhetorical qualities—to successfully spread in a network, compared with ideas originating from a tightly interconnected "rich core" structure (Morgan, Economou, Way, & Clauset, 2018).

High-status actors, such as disciplinary elites, will at times effectively delay or suppress the adoption and growth of new ideas in their particular domain of competence (Heinze & Münch,

2016; Whitley, Gläser, & Laudel, 2018). If research funding aims to support invention and intellectual renewal, it appears recommendable not to follow the signals of reputation and prestige alone, mechanically enforcing the hierarchical re-organization and centralization of universities, but to carefully observe unfolding tensions between established disciplinary hierarchies and efforts to establish more innovative and interdisciplinary research areas, and more generally to support intellectual diversity (Heinze & Münch, 2016; Münch, 2014).

Positional competition for university prestige

While some insights from the market-oriented literature on organizational status also apply to universities, universities are not just any market when it comes to the phenomenon of social status. This section refers to the situation in the United States, where the competition for prestige between top universities appears to be so entrenched that it has been characterized by economists as an instance of "positional competition", the characteristics of which are analytically defined in contrast to more classical market situations (Frank & Cook, 2010/1995; Podolny, 1993; Winston, 1999). This applies to universities on two different levels. On the one hand, universities, through graduation, confer the certificates needed for entry to professional careers and thus for access to high occupational and income status at later stages. On the other hand, universities as organizations compete for talent on all steps of the academic career ladder, from high school seniors to Nobel Prize winners.

Frank and Cook (2010/1995) argue that digitalized economies are increasingly characterized by "winner-take-all markets" and that this phenomenon is important for the explanation of increasing income inequality in the United States and other modern economies. Those careers that lead to the highest incomes in US-American society, including finance, corporate-oriented law firms, or corporate management, can be conceived of as a "series of elimination tournaments". This expression both highlights the intensity of the competition and, through the notion of a "tournament", implies that the competition is primarily about the winner gaining higher status than the losers. The final winners, that is, those who persevere and reach the top of the hierarchy, eventually receive disproportionate rewards to a degree comparable only to the elevation of stars in sports or music or similar "winner-take-all markets" (Frank & Cook, 2010/1995).

Graduation from elite universities has long been a prerequisite for access to careers in high-status firms (Frank & Cook, 2010/1995), but also within academia (Section IV). As a result, high school seniors with the highest test scores compete for a limited set of study places and increasingly concentrate at the most prestigious universities (Winston, 1999). This competition among prospective students is about access to occupational status at a later stage, when university prestige is evaluated as a status attribute of individuals. Elite universities therefore function as gatekeepers for those careers that lead to the highest ranks in society.

The competition between universities for the best students differs from a more typical market situation in that top universities do not expand their enrolments in response to rising demand. Crow and Dabars (2015) criticized US-American elite universities for keeping the number of study places artificially restricted in order to maintain or even increase the distinctive value of the positional good which they offer. According to these authors, selectivity of study access is unwarrantedly interpreted as a signal of educational quality. Rather, they argued that a large and demographically diverse pool of talent in the United States remains untapped as a result of this policy. In any case, strong selectivity leads to a situation where relative advantages in performance become more important than absolute performance, which is a defining

characteristic of positional competitions. Small differences in performance can thus lead to enormous differences in outcome (Frank & Cook, 1995).

The perception of a scarcity of top positions among universities is also enforced by public rankings. University rankings can produce reactive effects in the sense that differences in performance between study programs that were once small and difficult to measure later become real and solidified as an effect of the repeated communication of initial differences in departmental prestige (Espeland & Sauder, 2007). Clauset, Arbesman, and Larremore (2015: SM) also investigated to what extent prestige rankings based on faculty placement data are associated with rank uncertainties and found large uncertainties for intermediate ranks but relatively low uncertainty for very high– or very low–prestige universities.

From the perspective of research funding, it is important to recognize that assumptions of classical economic theory regarding an efficient allocation of resources through markets do not necessarily apply to situations of positional competition among elite US universities. On the contrary, competitors are here compelled to make every investment that could lead to a positional advantage. Since the number of top positions is limited from the outset, these competing investments can be mutually offsetting and may eventually fail to achieve any positional gains. This type of competitive game has therefore been called a "positional arms race" (Frank & Cook, 2010/1995; Winston, 2000). Positional arms races can encourage investments that are wasteful from the perspective of society at large (Winston, 2004).

Likewise, research funding policy should consider that the positional arms race in inter-university competition is inherently linked to a global race in science and technology. The competitive structure of the US-American higher education system can perhaps best be interpreted to the effect that research universities become aligned to an arms race that ultimately is not about national but about global leadership (Heinze, Pithan, & Jappe, 2019; Leydesdorff & Wagner, 2009). From the perspective of a global race in science and technology, questions regarding the efficient allocation of societal resources appear almost subordinate. At the least, it could be argued that the economic gains through technology leadership in the past have more than compensated any potential efficiency losses for the United States, as the histories of big tech firms in Silicon Valley or the biotech industry illustrate (Jasanoff, 2006; Saxenian, 1994).

Concentration of research funding and social closure at the level of universities

The concentration of research resources is an important indicator for the measurement of stratification within a university system, and one that directly relates to research funding. This section reviews empirical findings on the concentration of research expenditures in US universities. Proponents of university system stratification hold that the concentration of resources should follow the concentration of performance. In the hands of the most capable individuals, research money is expected to generate the most benefits. The analytical question of whether this constitutes an efficient allocation of resources through market mechanisms or whether the situation could be more adequately analyzed as a positional arms race cannot be decided on the basis of these descriptive findings.

After a period of strong expansion of research universities from the 1960s until the 1980s, a political consensus against further dispersion emerged in the early 1990s, according to Geiger and Feller (1995). Proponents argued that as a result of the expansion of research capacities, federal research funding would be spread out too thinly to continue to support excellence. In a similar vein, Hicks and Katz (2011, p. 142) state that "cumulative advantage in scientific

performance establishes a conflict between efficiency and equity considerations in public funding of research", and argued that decision makers will probably not dare to concentrate funding as much as would be justified by differences in merit. They make the criticism that a concentration of funding equivalent to the concentration in performance is difficult to assert politically because of a widespread attitude of "inequality aversion" (Hicks & Katz, 2011, p. 149).

The development of research funding concentration in US-American HEI is less well studied empirically than one might assume in light of this important political debate. Davies and Zarifa (2012) investigated the development of university income and expenditure concentration in the period 1971–2006, comparing the United States and Canada. This study documented a very unequal distribution of resources among universities and four-year colleges. Research-related income is the most highly concentrated of all income streams: in 2006, "federal grants per student (FTE)" had the highest concentration (private sector Gini: 0.86; public sector Gini: 0.71), followed by "provincial/state grants per student" (private sector Gini: 0.78; public sector Gini: 0.75). By comparison, "course/tuition fees" showed less concentration across HEIs (private sector Gini: 0.30; public sector Gini: 0.29), while the "revenues and investment returns" ranged in between (private sector Gini: 0.51; public sector Gini: 0.58).

As regards the long-term development over 35 years, the study documented an increasing separation between the "masses" of HEIs and a small number of extremely wealthy institutions. Upper outliers in terms of total income and expenditures per student already existed in the 1970s, but increasingly they "have pulled away from the pack". On the basis of boxplot distributions, Davies and Zarifa (2012, p. 150) characterized US HEI as "a hierarchical system dominated by a small number of super-resourced, elite institutions that are highly distinct from the masses". The Gini-index of federal research funding inequality was similar in 2006 to that in 1971, after having temporarily decreased in the decades between (mid-1970s to mid-1990s).

Brint and Carr (2017) investigated concentration of input and output indicators and mobility among US research universities over the period 1980–2010, building on Geiger and Feller (1995). Their sample includes 188 top research universities in terms of R&D expenditures, and is thus a more selective sample than that studied by Davies and Zarifa (2012). As measures of research output, Brint and Carr used Web of Science publications (whole counts) and cumulative citations. The study produced two main findings. First, the period of 1980–2010 was marked by steady and impressive growth in input and output indicators on both the system and campus levels. The strongest growth was in R&D expenditures (a 964% increase in 2010 prizes), followed by publications (190%) and citations (146%). At the same time, inequality remained virtually unchanged. While the first quartile of institutions lost slightly in its proportion of R&D spending, from more than 60 to closer to 50 percent, its proportion of publications remained constant at about 55 percent with citations at 60 percent. Gini coefficients for the entire sample (1980 versus 2010) declined slightly for R&D spending (0.52 versus 0.48) and citations (0.59 versus 0.56) and remained constant for publications (0.48).

Second, the study investigated the inter-decile mobility of institutions on the same indicators. Only a small number of institutions rose or fell by more than one decile over the 30-year period. In R&D expenditures, slightly more than 20 percent of the sample moved up or down more than one decile, in publications 14 percent and in citations 12 percent. Only 7–8 percent of institutions experienced long-term upward mobility. Some did enter or exit the set of top universities, but Brint & Carr argue that most of these movements happened at the bottom of the list. The authors conclude that "long-range upward mobility was not a prominent feature of

the system of scientific production in US-American research universities during the study period" (Brint & Carr, 2017, p. 450).

Taken together, available studies document strong inequality among US-American HEIs generally and research universities in particular in terms of research funding and performance. Brint & Carr argue that the process of resource dispersion that was found by Geiger & Feller for the 1980s did not continue through the following two decades despite strong growth in R&D expenditures. They describe a stable concentration of resources accompanied by increasing R&D expenditures per unit of research output (publications and citations). Although these results do not contradict the proposition that a strong concentration of resources is beneficial for performance at the top of a university system, they also document social closure on the level of universities as organizations. Over a period of decades, the authors found that there were very few newcomers to the high-performing core of the system.

Concentration of faculty placements and social closure at the level of scientists

This section reviews results from faculty placement studies, which provide more detailed insights into the social structure of US-American HEIs. Recruitment networks can serve as the basis for determining prestige hierarchies among university departments. Prestige is thus conceived not as an attribute attached to an individual department, but derives empirically from the respective departments' positions in a social exchange network (Burris, 2004, p. 240). The measurement of organizational status based on hiring therefore constitutes an instance of an "objective" or structural definition of status, in contrast to an understanding of status as "subjective" evaluation, which might for instance be operationalized through expert opinions (D'Aveni, 1996; Piazza & Castelluci, 2014).

Faculty placement studies investigate networks of "PhD exchange" among university departments (Burris, 2004), based on "who hires whose graduates as faculty" (Clauset et al., 2015, p. 1). They have been conducted for a range of mostly social science disciplines in the US, including sociology (Shichor, 1970); economics (Pieper & Willis, 1999); sociology, history and political science (Burris, 2004); political science (Fowler, Grofman, & Masuoka, 2007); mathematics (Myers, Mucha, & Porter, 2011); law (Katz, Gubler, Zelner, & Bommarito, 2011); communication (Barnett, Danowski, Feeley, & Stalker, 2010; Mai, Liu, & González-Bailón, 2015); and anthropology (Kawa, Michelangeli, Clark, Ginsberg, & McCarty, 2019). Clauset et al. (2015) use the most advanced methods, covering computer science, business, and history.

All available studies show that US faculty (tenure track, tenure) production is skewed so that the most prestigious departments fill a disproportionate share of faculty positions. Clauset et al. (2015) find that 25 percent of research universities produced 71 to 86 percent of all tenure-track faculty in the disciplines of computer science, business, and history during 2011–2013. Fifty percent of all faculty graduated from only 18, 16, and 8 departments in computer science, business, and history, respectively. Pieper and Willis (1999) found that 66 percent of economics faculty had graduated from the top 20 placing programs in 1992. Burris (2004) found 77 percent of history, 74 percent of political science, and 69 percent of sociology faculty were recruited from the respective top 20 placing programs in 1995. In communication, the top 20 placing programs filled 58 percent of faculty positions in 2007 (Barnett et al., 2010). Thus, top placing departments in each discipline compete for a limited set of faculty positions as a central resource of future academic research.

Since recruitment networks consist of behavioural data that are based on collective assessments by disciplinary peers, their conceptual and empirical validity appears superior to reputational survey data as used in popular news rankings. Several studies report moderate to strong correlations with rankings by US News & World Report (Clauset et al., 2015; Fowler et al., 2007) and NRC rankings (Barnett et al., 2010; Burris, 2004; Clauset et al., 2015). An important limitation of the available research is its focus on the social sciences. With the exception of a study of computer science and one of mathematics, to date we do not know if these above-mentioned findings can be extended to the natural sciences, engineering, and medicine, where academic job markets are generally larger (Rosvall & Bergstrom, 2011: figure 3), comprising more institutions with larger average department sizes.

Steep faculty placement hierarchies imply that, in most cases, faculty will hold positions at departments with less prestige than their respective PhD faculties. Clauset et al. determined that downward movement occurred in 86 (business) to 91 percent (history) of placements. Thus, prestige hierarchies also imply that upward social mobility of scientists is rare compared with downward mobility, even if seen over a sample of faculty of all stages of seniority (Clauset et al., 2015: S4). Women from top institutions were found to move somewhat further down the hierarchy than men in the disciplines of computer science and business, but not in history (Clauset et al., 2015: S5).

In addition, faculty placement studies show "rich-club ordering" in inter-departmental recruitment networks, defined as "the tendency of nodes with a high degree to be more interconnected than expected" (Cinelli, 2019, p. 1). "The notion of a rich-club describes nodes which are essentially the hub of a network, as they play a dominating role in structural and functional properties" (Ma, Mondragon, & Latora, 2015, p. 1). Rich-club organization has implications in terms of status in that a high-status group constitutes a segment separated from the rest. But the functional dominance goes further than mere status differentiation. Nodes that belong to the(se) hub(s) have higher diffusion power across the network, so that network structures influence intellectual competition, a case of functional domination.

Viewing scientists as carriers of ideas, faculty hiring becomes a process of transmission of ideas. As each applicant is knowledgeable of an individual set of research topics, intellectual traditions, and associated skills, recruiting can be conceived as an organizational process of selecting and adapting particular (new) ideas and capabilities. This cognitive diffusion was investigated in a modelling study by Morgan et al. (2018), who studied how faculty hiring networks could influence the spread of ideas in computer science. Their model shows that ideas from prestigious universities tend to spread farther than those originating from less prestigious universities, for ideas of similar quality. The effect of prestige is stronger for ideas of lower transmissibility (lower quality) and weaker for ideas of higher transmissibility (higher quality).

In sum, faculty placement studies document, first, competition among US research universities for faculty positions as the most central resource for academic research. This competition is organized within disciplines and is dominated by a handful of elite departments. Across studies, the top 20 departments fill between two thirds and four fifths of research positions of the investigated disciplines. Second, available studies strongly suggest that prestige translates into intellectual domination through a shared preference for education from elite departments and the associated reproduction of selected intellectual traditions. Third, these studies reveal that faculty regularly move down the prestige hierarchy from PhD to academic employment, with very few cases of upward mobility. In other words, social closure of academic career paths in the investigated fields had regularly already occurred at the stage of graduate admission. This early timing of social closure aggravates the danger of a predominance of cultural status norms

and intellectual tastes within fields over careful (status-independent) assessment of scientific talent.

Comparability of university systems in the United States and Europe

At present, the European situation differs from that in the United States in important respects. The European university system is more heterogeneous and less integrated by a coherent and stratified network structure. Capabilities for excellent research are more distributed (Bonaccorsi, Cicero, Haddawy, & Hassan, 2017). The European institutional landscape as a whole is also endowed with substantially less resources. From the vantage point of positional competitions for university prestige and global tech races, these are important disadvantages. Yet from the perspective of education and social mobility in democratic knowledge societies, we argue that the current dispersal of HEI capabilities could be turned into an advantage through ambitious policies of system expansion.

To what extent can Europe be regarded as a single university system? The European Higher Education Area, the Bologna Process, and the European Framework Programs are all important political instruments towards integration of European HEI. Yet, by comparison with the prominence of national university systems, it is still not very common in the HEI literature to study universities in Europe as one region. ETER has made important progress in data provision to describe the European landscape of HEI. For the academic year 2016/2017, ETER contained organizational information on HEIs from more than 30 countries, including the EU, EFTA, non-EU Balkan States, and Turkey.

Based on ETER and IPEDS data, the European HEI system appears roughly comparable to the US-American HEI system in terms of number of institutions and number of students. According to Lepori et al. (2019), who applied the Carnegie Classification to European HEIs, 88 percent of 17 million FTE students were enrolled in the two largest categories of "doctoral universities" and "master's colleges and universities" in Europe in 2013, compared with 79 percent of 14 million FTE students in the United States (Table 1). According to Lepori et al. (2019), the major difference between the systems is in resource provision. Not only is the total amount of revenue in the US HEI system much larger than it is in Europe, it is also more concentrated at the top. In Europe, the distribution of revenues tends to mirror the distribution of academic staff (FTE), whereas in the US, revenues are more concentrated than academic staff (Lepori et al., 2019: Figure 6). In 2013, only three European universities (Cambridge, Oxford, University College London) had budgets of more than 1 billion Euros, compared with 50 universities in the US, including 16 top universities with budgets of more than 2 billion Euros. The authors conclude that the "gap in research excellence" between Europe and the US is essentially a gap in resources.

Table 1 Comparison of European and US-American HEI systems

2013	Europe			United States		
Number (percentage)	HEIs	Enrolments	Staff	HEIs	Enrolments	Staff
Doctoral universities	564 (25)	11,200,000 (66)	671,044 (70)	366 (11)	6,291,367 (46)	469,233 (56)
Masters' colleges and universities	545 (24)	3,759,457 (22)	184,660 (19)	815 (25)	4,550,288 (33)	212,263 (25)
Other HEIs	1,134 (51)	2,098,621 (12)	106,646 (11)	2,106 (64)	2,827,541 (21)	161,234 (19)
Total	2,243 (100)	17,058,078 (100)	962,350 (100)	3,287 (100)	13,669,196 (100)	842,730 (100)

Category definitions:
- Doctoral universities: HEIs with at least 20 ISCED 8 degrees in the year.
- Masters' colleges and universities: HEIs with less than 20 ISCED 8 degrees and at least 50 ISCED 8 degrees.
- Other HEIs: baccalaureate colleges, baccalaureate/associate colleges, focused institutions, and unclassified.

Source: Lepori et al. 2019: S3.

The composition of funding streams accentuates these differences. For most European HEIs, basic government allocation still represents the largest share of funds, while other sources are only complementary, with the exceptions of private for-profit HEIs and public UK universities that are mostly funded through student fees. In contrast, in the United States, student fees are the most important source of funding for medium-sized HEIs with up to 500 million Euro annual budget; while for large HEIs (500–999 million and 1.000–1.999 million Euro annually), the funding streams of student fees, third party funding, and private donations are of similar average magnitudes. In the group of the richest 16 universities with revenues above 2 billion euros in 2013, private donations are the dominant funding stream, constituting 49 percent of annual revenues (Lepori et al., 2019, p. 12). The distinction between public and private HEIs is complicated by the fact that governmental research funding is concentrated at the same segment of top universities as private donations (Bozeman, 2013).

In contrast to the United States, Europe does not function as one single academic job market but is structured by national university systems that have become increasingly interconnected through research collaborations and scientific mobility (Cañibano, D'Este, Otamendi, & Woolley, 2020; Musselin, 2004). As a consequence, the methodical approach of faculty placement studies cannot be directly transferred to the European scale. Researchers with a strong reputation are more widely distributed in Europe compared with the United States, where the same set of elite universities excel across a wide range of fields (Bonaccorsi et al., 2017). From the perspective of the hierarchical interdependencies between academic departments in the United States, European HEIs are often perceived as peripheral.

National university systems in Europe differ regarding the extent to which they concentrate excellent researchers at prestigious universities. On one side, there is the United Kingdom with an entrenched prestige hierarchy. The five richest European HEIs in terms of annual budget are all located in England: Cambridge, Oxford, University College London, Manchester, and Imperial College London (ETER, 2019b, p. 18; 20). The UK has a policy of concentrating public research funding at the top, through the Research Excellence Framework (Geuna & Piolatto, 2016), as well as through competitive project funding (Ma et al., 2015). On the other side, the Netherlands exemplifies a more equitable policy, seeking to advance all their 13

research universities to the top segment in Europe. Both countries are very successful through the lens of bibliometric performance metrics (Bonaccorsi et al., 2017).

On the European level, the Framework Programs (FP) act as a mechanism of resource concentration. Lepori, Veglio, Heller-Schuh, Scherngell, and Barber (2015) found that FP participation is concentrated among a small subset of large and visible HEIs and turns out to be more concentrated than academic staff, PhD students, or publication output. A group of 157 HEIs with more than 50 participations each accounted for 72 percent of all HEI participations in 2011. Among these 157 HEIs, 148 were also included in the Leiden Ranking based on their output of publications and citation impact. This group represents 15 percent of PhD-awarding universities in Europe. Other studies have investigated collaboration networks and found that participation remains highly stable over time (Enger, 2018). These findings indicate that FP might develop into a powerful mechanism of system stratification and funding market segmentation. The average annual budget of Horizon Europe (2021–2027)[ii] is approximately four times that of FP 5 (1999–2002) in current prizes (Reillon, 2017).

Conclusions: two research policy scenarios

Thus far, this chapter has reviewed findings on university system stratification in the United States from an interdisciplinary perspective. What lessons can be drawn for research policy in Europe? In this section, we delineate two scenarios for the future of the European university landscape concerning the long-term impact of research funding. These scenarios are distinguished by the extent to which policies of funding concentration are counterbalanced by strategies to expand the landscape of European research universities.

Since the 1990s, many European countries have implemented policies that have either the explicit objective or the unintended consequence of resource concentration (Reale, 2017). A common rationale for such policies is that universities should compete for research funding as an incentive to increase performance. Performance-based funding is the category of instruments with the broadest scope (Zacharewicz, Lepori, Reale, & Jonkers, 2019), such as the Research Excellence Framework in the United Kingdom and the Italian Valutazione della Qualità della Ricerca (Geuna & Piolatto, 2016). The scope of research excellence schemes is more restricted, aiming to concentrate investment at selected centres and thus create a critical mass of internationally visible research (Aksnes et al., 2012; OECD, 2014). Even without instruments that specifically target the organizational level (universities, research centres), project funding can have resounding effects of institutional resource concentration (Ma et al., 2015).

Based on the American experience, one might expect that policies of vertical differentiation and resource concentration could eventually lead to a point at which HEI system stratification would become a self-reinforcing and irreversible dynamic. Current funding policies suggest that this tipping point has not yet been reached on a European scale, as many European countries are still struggling with schemes to increase the organizational capabilities and performance orientation of their research universities. An exception is the United Kingdom, where the Research Excellence Scheme converges with project funding to amplify resource concentration. As a result, a few UK-based elite universities have the largest budgets in Europe and also occupy leading positions in global prestige rankings.

At the same time, Europe as a region is undergoing a historical phase of HEI system expansion. During the 70 years from 1945–2015, the number of universities more than tripled, from fewer than 400 to almost 1,300 institutions (ETER, 2019a, p. 22). This expansion can be broken down

into different waves across sub-regions and time periods (ETER, 2019a). From the macro perspective of European societies, the long-term expansion of HEI is about the changing qualifications required by modern economies. From the micro perspective of individual citizens, the expansion of HEI is about individual chances for social mobility and access to higher-income and higher-status occupations, often achieved only over the course of successive generations. From either view, HEI expansion is essential for future participation in a European knowledge society.

Based on these trends, two scenarios can be distinguished. Both assume that national and European policies of funding concentration enforce a vertical differentiation of the HEI landscape. We further assume that a commonly recognized university prestige hierarchy would develop into a self-reinforcing mechanism of resource concentration. Given that, across scientific disciplines, the most capable scientists would come to work at the same top European institutions, this would also imply a stronger European integration of academic labour markets.

First, in the "elitist scenario", the self-reinforcing prestige hierarchy will reach a tipping point where markets for research funding and collaboration split up into different segments. The collaborative linkages between organizations in the top segment will intensify to the extent that the whole network becomes functionally dominated by a "rich club" of tightly connected HEIs. Compared with the current situation, there will be a bigger number of large and internationally visible European HEIs that successfully compete with top universities from the United States and other world regions (Lepori et al., 2019). This group of highly prestigious HEIs will orchestrate the broader organizational network in terms of access to European and national funding sources (Ma et al., 2015). The number of Nobel Prizes and high tech firms in Europe will rise, to an extent that will depend also on the wealth and deregulation of European HEIs.

The downside of this concentrated effort is that most European regions will remain lastingly peripheral to the global science system and to the European knowledge society more generally. Policies of vertical differentiation, such as the Italian Valutazione della Qualità della Ricerca, will have desiccated research capabilities in economically weaker and more peripheral regions by promoting a more centralized organization. Positional competition will also lead to surging costs of research in Europe's centres of excellence. As a corollary of social closure, the number of prestigious universities and the size of their educational offerings will expand, yet not in proportion to a growing demand for high-quality education. Access to these prestigious universities will become super-exclusive. As a consequence, migration of young people from Southern, Eastern, and Central Europe to the established hubs of the knowledge society will continue and accelerate (Pruvot, Estermann, & Lisi, 2018). In sharp contrast to the urban lifestyle, cultural diversity, and progressive values cultivated in those hubs, adverse anti-EU, anti-elite, and anti-science attitudes will take root in the periphery (Dijkstra, Poelman, & Rodríguez-Pose, 2020).

Second, in the "expansive scenario", the knowledge society will be geographically expanded to develop a larger number of nodes with higher connectivity (Rodríguez-Pose & Griffiths, 2021; van Raan, 2022). There will still be policies of vertical differentiation in order to enhance the performance level of the strongest research universities, and there will still be research funding concentration at national top institutions. But these policies will be combined with and counter-balanced by political strategies to systematically expand the top segment of European research universities.

In the "expansive scenario", European research policy will be connected to European cohesion policies with the aim of successfully developing new research universities, either from scratch

or as upgrades (or mergers) of existing institutions. New research universities or universities with new research capabilities will be established one by one in Southern, Eastern, and Central Europe, and the wealthier scientific nations in Northern and Western Europe will strive to compete and amplify European efforts at HEI building. A major advantage of this scenario is that new and interdisciplinary research areas will be established more swiftly and with higher frequency, generating a dynamism of innovation and strong societal impact. In this way, two well-known institutional deficiencies of European universities are addressed: first, the deferred and mostly hesitant uptake of new scientific fields (Ben-David, 1971), and second, the widespread fragmentation of scientific capabilities (Bonaccorsi et al., 2017).

In the "expansive scenario", European policy ensures that there will be successive waves of new entrants to a growing field of leading research universities. Instead of social closure on all levels, European policy will act to expand the opportunities for students and scientists with strong talent, increasing participation from different social and cultural backgrounds and the proportion of women and minorities among faculty. European research policy supports the integration of newcomer organizations into international networks of research collaboration. As the organizational field of the European research university will continue to grow, positional competition will become less dominant overall, compared with its role in the "elitist" scenario.

The downside of the "expansive scenario" is that it is expensive and would have to be followed through for quite some time in order to bear fruit. Clearly, not every new research organization or institutional upgrade will become a success. Much learning and entrepreneurial dynamism will be required, as exemplified by the organizational transformation of Arizona State University (Crow & Dabars, 2015). There is a serious risk that European research funding would become diluted away from its most capable centres of excellence and that dispersion would threaten critical mass and weaken international competitiveness. So overall, the amount of investment necessary to achieve the aims of the "expansive scenario" will be of an even larger scale than that required in the "elitist scenario".

Given the large scale of investment that a strategic expansion of European research universities would require, the funding would have to come (in part) from a rededication of European regional and cohesion funds, thus combining objectives of research and innovation policy, higher education, regional development, and cohesion. Clearly, one of the main political challenges in this regard will be to define policy instruments that would go beyond the current European Framework Programmes (Lepori et al., 2015; Reillon, 2017) or the European Research Council (Beerkens, 2019; Luukkonen, 2014). Such new instruments would have to enable the EU to subsidize a permanent supply of faculty positions at European research universities in collaboration with member states, and to create selection procedures for European cities to qualify as locations for such an institutional boost to their scientific and innovative capabilities (Rodríguez-Pose & Griffiths, 2021; van Raan, 2022).

If pursued with long-term consistency and ambition, the investment in an expansive university policy would likely enhance the performance and stability of the European knowledge society as a whole. More talent would be tapped and less cultural cleavage and political disruption would occur, compared with the "elitist scenario". Europe as a world region could develop a strong economic dynamism alongside with ecological sustainability, and become a more educated and more equitable place to live, in comparison with the outcomes of current development paths followed by the United States.

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