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Social stratification in Higher Education: What it means at the micro-level of the individual academic scientist

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Abstract

The academic profession is internally divided as never before. This cross-national comparative analysis of stratification in Higher Education is based on a sample of European academic scientists (*N* = 8,466) from universities in 11 countries. The analysis identifies three types of stratification: academic performance stratification, academic salary stratification, and international research stratification. This emergent stratification of the global scientific community is predominantly research-based, and internationalisation in research is at its centre; prestige-driven, internationally competitive, and central to academic recognition systems, research is the single most stratifying factor in Higher Education at the level of the individual scientist today. These stratification processes pull the various segments of the academic profession in different directions. The study analyses highly productive academics ('research top performers'), highly paid academics ('academic top earners'), and highly internationalised academics ('research internationalists') and explores the implications for individual scientists.

Abstrait

La profession académique est divisée en interne comme jamais auparavant. Cette analyse comparative transnationale de la stratification dans l'enseignement supérieur repose sur un échantillon de scientifiques universitaires européens (N = 8 466) issus d'universités de 11 pays. L'analyse identifie trois types de stratification: la «stratification de la performance académique», la «stratification de la rémunération académique» et la «stratification de la recherche internationale». Cette stratification émergente de la communauté scientifique mondiale est principalement basée sur la recherche et l'internationalisation de la recherche est au centre de celle-ci; axée sur le prestige, compétitive sur le plan international et au cœur des systèmes de reconnaissance académique, la recherche est le facteur le plus déterminant dans l'enseignement supérieur au niveau de chaque chercheur. Ces processus de stratification entraînent les différents segments de la profession universitaire dans différentes directions. L'étude analyse les universitaires hautement productifs («chercheurs les plus performants»), les universitaires bien rémunérés («chercheurs hautement rémunérés») et les universitaires hautement internationalisés («chercheurs internationalistes») et explore les implications pour les scientifiques.

1 | INTRODUCTION

Social stratification has been a recurring theme in Higher Education research for more than half a century. Drawing on new cross-national evidence, the present study explores this phenomenon using large-scale comparative quantitative data from across Europe (11 countries; *N* = 8,466, university sector only) to test the assumption that the increasing tensions attributed to changes in Higher Education governance and funding regimes extend to the micro-level of the individual academic, who is at the centre of these changes and the tensions that ensue (Altbach, 2015; Fumasoli, Goastellec, & Kehm, 2015; Marginson, 2009). In both elite research-focused institutions and their less prestigious teaching-focused counterparts, systemic and institutional changes filter down into the work and life of academic scientists (Carvalho, 2017). The increasing stratification of institutions and individuals mirrors the ongoing evolution of governance and funding regimes and the resultant academic job requirements. Although these issues are routinely analysed at the meso-level of university organisation (Lewis, 2013), their far-reaching implications for the academic profession are best understood from micro-level data.

This study examines three types of social stratification in Higher Education, which are linked by the university sector's core activity—research:

- Academic performance stratification: Individual research performance differentials across Europe between top research performers and their lower-performing colleagues.
- Academic salary stratification: Income differentials versus research performance differentials across Europe between academic top earners and their lower-earning colleagues.
- International research stratification: Research productivity differentials versus international collaboration differentials between research internationalists and research locals.

Clearly, there are other types of stratification within the academic profession (Kwiek, 2015b, 2019b). Among these, power stratification divides scientists by academic position; age stratification divides academics by age cohort; role stratification divides academics by teaching and research roles; research funding stratification divides scientists by funding opportunities; and journal stratification divides academics by publication status. Additionally, there is strong gender stratification that cross-cuts the above types. In short, the scientific community is heavily divided by research achievement, income, academic position, gender, age cohort, distribution of teaching and research time, research funding opportunities, and prominence in prestigious journals. The central factor in this stratification of the global scientific community is research, and in particular, the trend towards internationalisation in research.

Social stratification in science is internal rather than external to the academic profession—that is, it refers directly to scientists and their work and life. On that basis, the present study addresses the following questions: Is it useful to investigate changes in the European academic profession in terms of the three types of social stratification associated with research productivity? Assuming that the profession is heavily divided, how does this help to clarify the divisions and implications at the individual level?

At the micro-level of the individual scientist, research and the increasing competition for research funding is the single most stratifying factor in Higher Education today. Among scientists, prestige, success and recognition are inseparable from significant and consequential research reported in high-quality publications. Although it is not central to the activities of most Higher Education systems and institutions in Europe or elsewhere, research is the key factor linking the three types of stratification analysed here. Viewed here as a powerful academic game, research is not inclusive, democratic or egalitarian, and it is unrelated to universities' community engagement agenda and teaching mission. Instead, research is prestige driven and ruthlessly internationally competitive and central to systems of academic recognition and reward.

At the individual level, social stratification in Higher Education reveals that the scientific community is not a company of equals: rather, 'individuals, groups, laboratories, institutes, universities, journals, fields and specialties, theories, and methods are incessantly ranked and sharply graded in prestige' (Zuckerman, 1988, p. 526). Academic recognition translates into resources for further research, and the distribution of academic rewards—including research funding—is sharply graded. While the intense research-related stratification of the academic profession is not readily observable from without, it is enormously powerful. This elitist, exclusive, and hierarchical role of research in differentiating and rank-ordering the academic profession (Marginson, 2014) has intensified in the era of New Public Management.

The paper is structured as follows. Reflecting the tripartite focus, the theoretical background is divided into three sections discussing the three types of stratification. A description of the data is followed by the findings, also in three parts, referring to the three types of stratification. The paper ends with a discussion of the findings and their implications at the level of the individual scientist, followed by conclusions.

2 | THEORETICAL BACKGROUND

This section briefly examines each of the three stratification types: academic performance stratification, academic salary stratification and international research stratification.

2.1 | Academic performance stratification: Research productivity and inequality in knowledge production

The world of science has always been unequal (Ruiz-Castillo & Costas, 2014; Stephan, 2012); the intrinsic character of science is what de Solla Price (1963) termed 'essential, built-in undemocracy' (p. 59). Rather than a Gaussian (normal) distribution, individual performance in science tends to follow a Paretian (power law) distribution (O'Boyle &

Aguinis, 2012). In general, social phenomena such as income, wealth and price show 'strong skewness with long tail on the right, implying inequality' (Abramo, D'Angelo, & Soldatenkova, 2017, p. 324), and academic knowledge production is no exception (Kwiek, 2018c).

Although highly productive academic scientists are rarely scrutinised as a separate segment of the academic profession, scientific productivity is skewed, and this skewness has been widely studied using two standard measures of individual performance: number of publications and number of citations (Albarrán, Crespo, Ortuño, & Ruiz-Castillo, 2011; Carrasco & Ruiz-Castillo, 2014). In their study of 17.2 million authors and 48.2 million publications in Web of Science, Ruiz-Castillo and Costas (2014) found that 5.9 per cent of authors accounted for about 35 per cent of all publications. Scholarly interest in the skewness of science and high individual research performance has grown exponentially in the last few years. Highly productive academic scientists have mostly been studied intra-nationally and within single disciplines (notably economics and psychology), including studies of star scientists (Abramo, D'Angelo, & Caprasecca, 2009; Yair, Gueta, & Davidovitch, 2017), star performers (Aguinis & O'Boyle, 2014) and superstars (Agrawal, McHale, & Oettl, 2017; Serenko, Cox, Bontis, & Booker, 2011).

The superstar effect refers to markets where 'relatively small numbers of people earn enormous amounts of money and dominate the activities in which they engage' (Rosen, 1981, p. 845). This is associated with the Matthew effect (Cole & Cole, 1973; Merton, 1968), in which a small number of scholars in the science system produce most of the published research; with more citations and prestigious academic positions, they define their discipline's identity (Cortés, Mora-Valencia, & Perote, 2016; Serenko et al., 2011). According to Merton (1968) and Rosen (1981), performance determines reward. In Rosen's 'economics of superstars', small differences in talent translate into disproportionate success. While Rosen emphasises the role of innate talent, Merton emphasises external resources (DiPrete & Eirich, 2006). Resources (and the drive to publish) flow to scientists who are highly esteemed within the scientific community, and that esteem 'flows to those who are highly productive' (Allison & Stewart, 1974, p. 604). It follows that Merton's Matthew effect is inevitably associated with inequalities in terms of resources, research outcomes and monetary or non-monetary rewards (Xie, 2014).

High research productivity has been of interest for a long time (see for example Cole & Cole, 1973; Crane, 1965; de Solla Price, 1963; Merton, 1968). Individual and institutional factors that are known to influence high research productivity include size of department, disciplinary norms, reward and prestige systems, and individual psychological constructs such as the intrinsic rewards of puzzle solving (see Hermanowicz, 2012; Leišyte & Dee, 2012; Stephan & Levin, 1992). Faculty-level orientation to research is generally thought to predict higher research productivity, as does time spent on research, faculty collaboration, faculty academic training, years since PhD, as well as being male, a cooperative climate, and support at the institutional level (Fox, 2015; Lee & Bozeman, 2005; Smeby & Try, 2005). The extreme differences in individual research productivity can be explained by a number of theories, notably the sacred spark, cumulative advantage, and the utility maximising theory (Kwiek, 2016).

Cole and Cole's (1973) sacred spark theory holds that 'there are substantial, predetermined differences among scientists in their ability and motivation to do creative scientific research' (Allison & Stewart, 1974, p. 596). Highly productive scholars are 'motivated by an inner drive to do science and by a sheer love of the work' (Cole & Cole, 1973, p. 62). According to Merton's (1968) cumulative advantage theory, productive scientists are likely to be even more productive in the future while low performers will be even less productive. At its simplest, this theory states that 'scientists who are rewarded are productive, and scientists who are not rewarded become less productive' (Cole & Cole, 1973, p. 114). Finally, the utility maximising theory posits that researchers choose to reduce their research efforts over time because they believe that other tasks may prove more advantageous. As Kyvik noted, 'eminent researchers may have few incentives to write a new article or book, as that will not really improve the high professional reputation that they already have' (1990, p. 40). These three main theories of research productivity are complementary rather than competing. The contrast between highly productive academics and others is briefly discussed at the start of the Findings section.

2.2 | Academic salary stratification: Research productivity and income

As in every other economic sector, the number of highly paid academic positions in Higher Education is limited. With the possible exception of full professors in major European systems, most academics globally cannot sustain a middle-class lifestyle on the basis of their academic salary alone (Altbach, 2015, p. 7). Traditionally, academic scientists are seen to trade-off pecuniary and non-pecuniary elements of their work or to place greater emphasis on the non-pecuniary advantages of academic work than on its pecuniary disadvantages (Ward & Sloane, 2000). Like other occupations, academic positions offer both extrinsic rewards (salary and other material benefits) and intrinsic rewards (from the work itself) (Blau, 1994, p. 80), and academic scientists make individual career choices by assessing these two types of reward.

One major issue for European universities is the lure of corporate and industry work in certain areas and the lack of it in others, which generates cross-disciplinary tensions in relation to salary levels. Specifically, there is a tension between more curiosity-driven research in lower-paid academic work and more applied research in higher-paid industry positions. Recent evidence suggests that freedom to pursue one's own research 'compensates for much lower monetary rewards in academe' (Balsmeier & Pellens, 2016, p. 25).

In more open salary systems, notably the United States (US), institutions are better able to attract top-quality researchers from regions with less open salary systems, notably Continental Europe (Kwiek, 2018b). Across large parts of Europe, academic scientists are still civil servants whose earnings are based largely on a single well-defined fixed-salary system (Altbach, Reisberg, Yudkevich, Androushchak, & Pacheco, 2012). While unstructured merit-based systems reward performance, more structured systems operate on a fixed salary schedule. This has inevitable implications for academics in European-type systems, where salaries are unrelated to performance differences (Hansen, 1992, p. 1478).

The continuum between these two types of system blends elements of both. Most European systems are based on some form of merit pay, moving slowly away from the extreme of a pure structured salary system (see relevant chapters in Enders & de Weert, 2004 and Altbach et al., 2012). However, efforts to reward individual merit hinges on the definition of merit (Hansen, 1992, p. 1481); for example, 'internally determined merit' (assessment of contribution to one's own institution) differs sharply from 'externally determined merit' (as assessed by other institutions or based on publication record). In increasingly stratified European systems, externally determined merit based on research achievements tends to matter more in high-level institutions while internally determined merit matters more in the lower echelon that focuses more on teaching and service.

At the individual level, scientists' engagement in research may be either investment motivated (based on future financial reward), consumption motivated (solving research puzzles) or both (Thursby, Thursby, & Gupta-Mukherjee, 2007). While the investment motive implies a decline in research productivity over the course of a career, this is not the case for those who are consumption motivated. In general, a taste for science (see Roach & Sauermann, 2010) causes scientists to choose academia over industry. Academics with different abilities and tastes in terms of non-pecuniary returns also differ in their career choice of basic or applied research (in academia or industry; Agarwal & Ohyama, 2013).

To test the posited link between high research productivity, high prestige and high salary, the present study looks beyond the traditional account of scientists rewarded for their research performance almost exclusively by their peers. The question posed here is whether high research performance, beyond traditional academic recognition, is reflected in higher salaries. Both universities and individual academics are viewed here as competing in prestige markets. In particular, there is a strong link between individual and institutional prestige as the prestige maximisation theory suggests: 'In maximizing their individual prestige, faculty members simultaneously maximize the prestige of their departments and institutions' (Melguizo & Strober, 2007, p. 635). On this view, prestige maximisation is strongly correlated with faculty salaries. Academics who help their institution to become more prestigious are seen to be rewarded with higher salaries; more articles and books published in prestigious outlets and more prestigious research grants mean higher institutional prestige, resulting (if not directly) in higher individual salaries.

Based on the logic of this salary model, highly productive academics should be disproportionately over-represented among highly paid academics. Because more time spent on teaching means less time spent on research (and vice versa; Fox, 1992), academics who spend more time on research should be in receipt of higher average salaries. In turn, spending more time on teaching should have a negative or at best neutral effect on salary (Fairweather, 1993).

2.3 | International research stratification: Research productivity and international research collaboration

International research collaboration (IRC) is highly discipline-sensitive, and previous research suggests that the collaborative imperative predominates in academic science (Lewis, 2013). This is especially the case in 'hard' disciplines, where internationally co-authored publications ensure academic recognition and, increasingly, access to national and international competitive research funding (Jeong, Choi, & Kim, 2014). In university hierarchies of prestige across Europe, internationalists (defined as academic scientists involved in IRC) increasingly compete with locals (defined as those not involved in IRC). Within this theoretical framework, internationalists are seen to compete for international academic recognition while locals tend to focus on research and publication for national consumption (Kwiek, 2019a). However, the extent of international research orientation depends on the researchers themselves (Wagner & Leydesdorff, 2005) and is disproportionately shaped by individual predilection.

Impediments to IRC relate to macro-level factors (geopolitics, history, language, cultural traditions, country size, country wealth and geographical distance); institution-level factors (reputation and resources); and individual-level factors (Georghiou, 1998). IRC has both benefits and costs (Katz & Martin, 1997); the latter include transaction costs (Georghiou, 1998) and coordination costs (Cummings & Kiesler, 2007), which are higher for international than national research collaboration. In collaborative research, there is always a trade-off between additional publications and research funds and these higher transaction and coordination costs (Landry & Amara, 1998).

Changing incentive and reward systems in the increasingly output-oriented context of European science (Kyvik & Aksnes, 2015) make it ever more important for individual academic scientists to cooperate internationally. With wider awareness of international research-based university rankings, scholarly publishing is more than an individual matter. Publishing is closely linked to institutional prestige and therefore to funding. However, in the highly competitive arena of global science, IRC is motivated primarily by academic reward structures and the benefits to individual scientists, who collaborate because it is beneficial to them. As Wagner and Leydesdorff have argued, these are 'highly visible and productive researchers, able to choose, work with those who are more likely to enhance their productivity and credibility' (2005, p. 1616). Again, the interrelations between scientists and their institutions can be explained by the prestige maximisation account of how highly cited internationally co-authored publications (and international research funding) increase individual prestige and salary, with non-profit Higher Education institutions acting largely as prestige maximisers (Melguizo & Strober, 2007, p. 635). At an individual level, research collaboration is seen to be determined by researchers' pragmatism; 'when there is something to gain, then a particular collaboration will occur; otherwise, it will not' and by their self-organisation—that is, individual rather than institutional determination of 'with whom to cooperate and under which forms' (Melin, 2000, p. 39). In these bottom-up collaborations, what matters is the individual interests of researchers seeking resources and reputation above all else (Wagner & Leydesdorff, 2005, p. 1616).

3 | A BRIEF NOTE ON DATA

The data used here were sourced from the European Academic Profession: Responses to Societal Challenges (EUROAC) study, which is one strand of the global Changing Academic Profession (CAP) project (see Carvalho, 2017 for a recent overview of the CAP/EUROAC family of studies). Based on 11 European countries participating in both the CAP and EUROAC projects, national datasets were cleaned, weighted and merged to create a single European dataset. We worked on the final dataset (dated 17 June 2011), which was created by René Kooij and Florian Löwenstein from the International Centre of Higher Education and Research (INCHER-Kassel). The original survey questionnaire was distributed to CAP countries in 2007 and to most EUROAC countries in 2010. In total, 17,211 surveys were returned—between 1,000 and 1,700 from all other than Poland, where the number was higher. The overall response rate ranged from more than 30 per cent (in Norway, Italy and Germany), to 20–30 per cent (in the Netherlands, Finland and Ireland), to about 15 per cent in the UK, 11 per cent in Poland and 10 per cent or less in Austria, Switzerland and Portugal.

Depending on the country, simple random sampling, systematic sampling, and stratified random sampling methods were used. In most countries, stratified random sampling was used to ensure that the resulting sample was distributed in the same way as the population (Bryman, 2012, pp. 192, 193; Hibberts, Burke Johnson, & Hudson, 2012, pp. 61, 62). Stratified sampling frames were created, using stratifying criteria that included gender and academic position. Sample stratification mirrored the population on the stratifying criteria and mirrored a simple random sample in every other way. Random sampling was used to obtain elements from each stratum. No groups of scientists were systematically excluded from the sampling frame (so sampling bias did not occur: no members of the sampling frame had no or limited chances for inclusion in the sample, Bryman, 2012, p. 187). However, it is impossible to determine the extent to which extent the pool of respondents differed from the pool of non-respondents—in other words, whether non-response bias occurred. This form of bias can occur when certain groups of respondents fail to respond or are less likely than others to participate or to answer certain survey questions (Hibberts et al., 2012, p. 72), or when survey participation is correlated with survey variables (Groves, 2006).

The sub-sample included only European academic scientists involved in both teaching and research and employed full-time in the university sector (*N* = 8,466) in each of the 11 countries. The analysis looked at the characteristics of three internationally under-researched groups: highly productive academics (research top performers, representing the upper 10 per cent in terms of productivity); highly paid academics (academic top earners, representing the upper 20 per cent in terms of gross academic income)—in both cases selected separately in each country and in each of the major clusters of academic fields—and highly internationalised academics (or academics involved in IRC).

4 | FINDINGS

4.1 | Academic performance stratification

Academic scientists are heavily stratified by research output. Academic performance stratification reflects systematic inequalities in individual academic knowledge production. Our results show that the distribution of research productivity is strongly skewed, with a long tail to the right indicating inequality (Figure 1). Universally across Europe, the tiny 10 per cent minority of scientists referred to here as top performers accounts for roughly half of all peer-reviewed academic publications during the three-year reference period. On average, top performers produce 53.4 per cent of peer-reviewed articles and book chapters, 45.6 per cent of publications in English, and 50.2 per cent of internationally co-authored publications, with small national variations (Kwiek, 2019b). Across the major academic clusters (Figure 2), the mean research productivity of top performers is on average 8.56 times

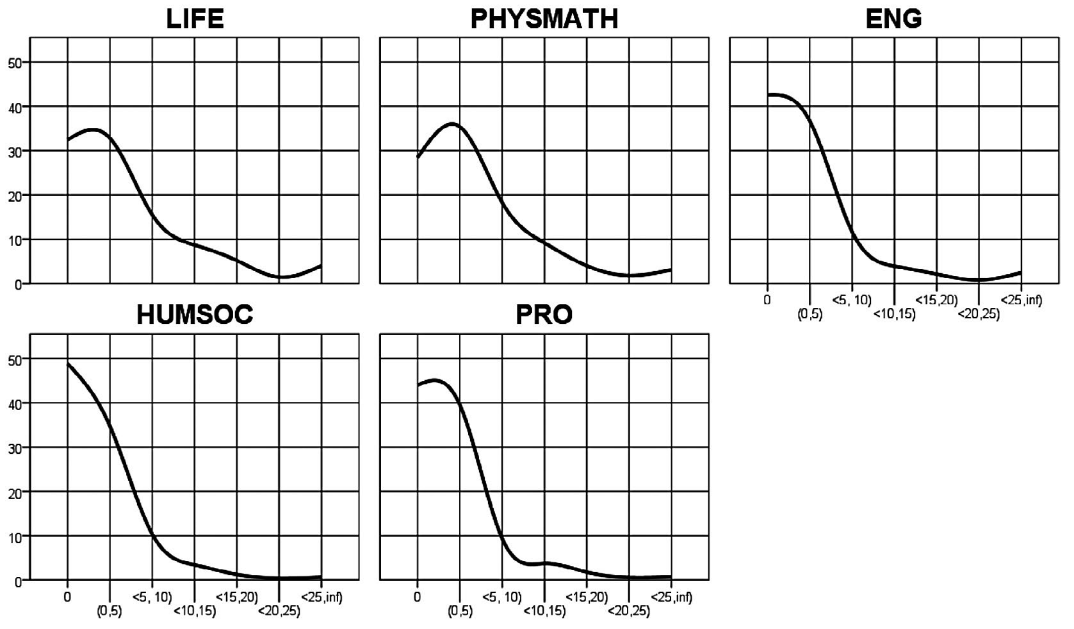

FIGURE 1 Distribution of peer-reviewed article equivalents (PRAE) published during the three-year reference period by academic cluster and publication number (%). Vertical axis: percentage of authors; horizontal axis: number of papers published (all 11 European countries combined)

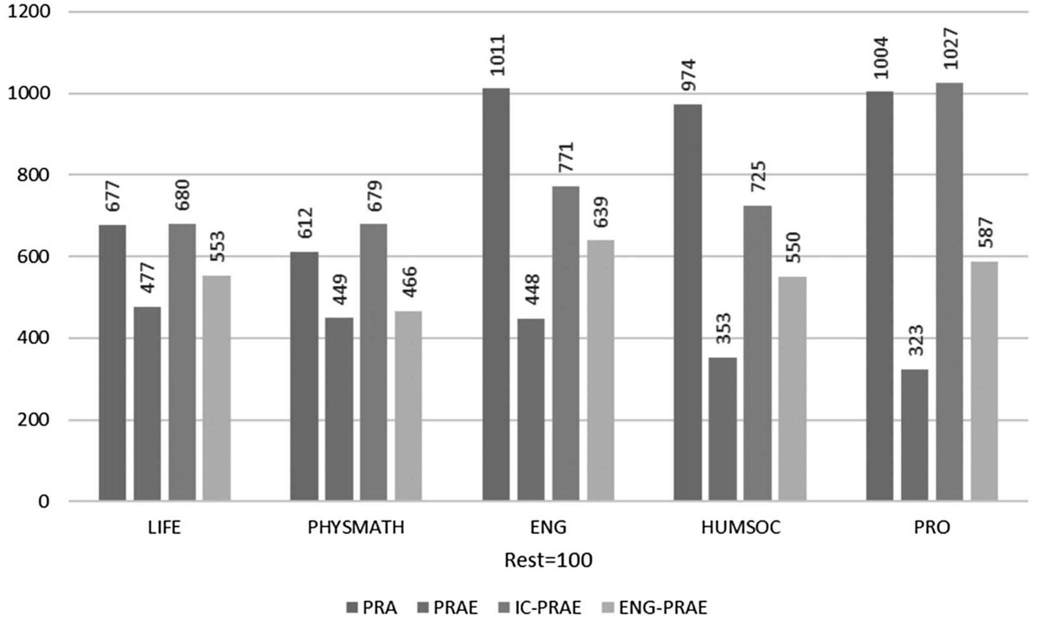

FIGURE 2 Research productivity by academic cluster: top performers versus other scientists. Productivity of top performers is measured as a percentage of other scientists' productivity (=100%), based on average number of peer-reviewed articles (PRA), peer-reviewed article equivalents (PRAE), internationally co-authored peer-reviewed article equivalents (IC-PRAE) and English language peer-reviewed article equivalents (ENG-PRAE) published in the three-year reference period. The results are statistically significant for all clusters (all 11 European countries combined)

higher than that of other research-active scientists (that is, the remaining 90 per cent). For instance, top performers in life sciences are on average 6.77 times more productive; in engineering and the professions, that figure rises to more than 10 times more productive. The striking productivity difference between top performers in the humanities and social sciences and the professions as measured by peer-reviewed articles (PRA) and peer-reviewed article equivalents (PRAE) can be explained by the significant role of authored and edited books in the PRAE measure. Six major clusters of academic disciplines were studied: life sciences and medical sciences, physical sciences and mathematics, engineering, humanities and social sciences, professions (which included teacher training and education science; business and administration, economics; and law in the questionnaire) and other fields.

Research productivity differentials between top performers and other scientists as measured by PRA and internationally co-authored peer-reviewed article equivalents (IC-PRAE) published during the three-year reference period by academic cluster is shown in Tables 1 and 2, respectively. For instance, in the life sciences, mean research productivity for PRA is 22.5 for top performers and 3.3 for the rest; for IC-PRAE (including articles and authored and edited books), the figure is 8.1 for top performers and 0.9 for the rest.

International comparative studies of Higher Education have not generally explored this unique class of top-performing academics (Kwiek, 2016). To identify these scientists and the factors that increase their chances of entry to this echelon, we investigated working time distribution (Table 3) and academic role orientation (Table 4), both of which are traditionally linked to research productivity. Our analysis identified several common features of top performers across the 11 countries studied. They tend to be male, middle-aged (mean age 47), and are predominantly full professors. Top performers' research tends to be international in scope or orientation; they collaborate more often both nationally and internationally and publish abroad more often than other scientists. They work longer total hours and longer research hours, and they are substantially more research oriented, with a tendency to focus on basic and theoretical rather than applied research. They sit on national and international committees and boards and are more likely than their lower-performing colleagues to participate in peer review.

Working time distribution differs substantially between top performers and other scientists in each country studied. The differential in mean weekly annualised working time (calculated as 60 per cent teaching time and 40 per cent non-teaching time per year) is 5.7 hr, ranging from 3.7 hr in Italy to 7.4 hr in Germany and 8.0 hr in Norway. For example, German top performers work an additional 42.6 days per year when compared to other research-oriented German scientists. In Norway, top performers work an additional 46.0 days. In addition, and contrary to the expected teaching–research productivity trade-off (Dillon & Marsh, 1981; Fox, 1992; Katz, 1973), top research performers in most of these countries spend more time than their lower-performing colleagues on teaching, service and administration. For each pair with a mean difference significantly different from zero, the larger category is identified as Top (for top performers) or Rest (for the rest). Using the Bonferroni correction, tests are adjusted for all pairwise comparisons within a row for each innermost sub-table (Table 3).

In the most instructive example, life sciences returned 2,352 cases and the highest number of statistically significant differences between the two subpopulations across several academic activities. On average, top performers in life sciences seem to align with traditional sociology of science accounts of the productive academic scientist. On average, they work many more hours per week; specifically, they exhibit the traditional working time distribution attributed to high publishers, where allocation of research time competes directly with teaching time (Fox, 1992; Kyvik, 1990; Ramsden, 1994) or the only relevant difference is between research time and non-research time (Stephan, 2012). Their average weekly teaching time is much shorter, and their research time is much longer; in addition, they spend more hours on administration. Presumably, this is because more research involves more research grants, requiring more administrative work. Alternatively, these academic scientists are more often heads of research groups or are medium-level administrators (i.e., directors or deans).

Across all the systems studied, top performers are also more research oriented than others. Bluntly put, identifying teaching as one's primary interest all but excludes one from the class of research top performers; in Ireland, for example, the maximum level of entry is 1.1 per cent. Again, being interested in both but leaning toward teaching all but excludes one from the class of top research performers, with figures ranging from 3 to 8 per cent in

TABLE 1 Research productivity: peer-reviewed articles (PRA) published in the three-year reference period for research top performers (10%) versus the rest (90%) (all 11 European countries combined) by academic cluster

	Top performers (upper 10%)						Rest (90%)					
	Mean PRA	95% confidence interval, lower band	95% confidence interval, upper band	Median	Standard deviation	*N*	Mean PRA	95% confidence interval, lower band	95% confidence interval, upper band	Median	Standard deviation	*N*
LIFE	22.5	21.2	23.8	20.0	11.9	316	3.3	3.1	3.5	2.0	4.1	2,036
PHYSMATH	21.8	19.6	24.1	20.0	13.8	149	3.6	3.3	3.8	2.0	4.0	1,037
ENGITECH	17.2	14.4	20.1	13.6	14.7	107	1.7	1.5	1.9	0.3	2.6	716
HUMSOC	11.8	10.8	12.9	10.0	8.9	262	1.2	1.1	1.3	0.0	1.9	1,708
PRO	12.3	11.0	13.6	10.0	7.7	133	1.2	1.1	1.4	0.0	1.9	800

TABLE 2 Research productivity: internationally co-authored peer-reviewed articles (IC-PRA) published in the three-year reference period, research top performers (10%) versus the rest (90%) (all 11 European countries combined) by academic cluster

	Top performers (upper 10%)						Rest (90%)					
	Mean IC-PRA	95% confidence interval, lower band	95% confi-dence interval, upper band	Median	Standard deviation	*N*	Mean IC-PRA	95% confidence interval, lower band	95% confidence interval, upper band	Median	Standard deviation	*N*
LIFE	8.1	7.2	9.0	5.7	8.3	316	0.9	0.8	1.0	0.0	2.0	2,036
PHYSMATH	11.2	9.0	13.4	8.0	13.7	149	1.3	1.2	1.5	0.0	2.4	1,037
ENGITECH	5.4	4.1	6.7	2.6	6.8	107	0.3	0.3	0.4	0.0	1.1	716
HUMSOC	2.5	2.0	3.1	0.4	4.6	262	0.2	0.1	0.2	0.0	0.6	1,708
PRO	3.3	2.4	4.1	1.3	4.9	133	0.2	0.1	0.2	0.0	0.6	800

TABLE 3 Results of *t* tests for equality of means: top performers (Top) versus the rest (Rest) (all 11 European countries and all academic clusters combined)

	AT	FI	DE	IE	IT	NL	NO	PL	PT	CH	UK
Teaching				Rest	Rest		Top	Rest		Top	
Research			Top	Top	Top			Top	Top		Top
Service					Top		Top				
Administration	Top	Top	Top		Top	Top	Top	Top		Top	
Other	Top		Top	Top			Top				
Total	Top	Top	Top	Top	Top	Top	Top	Top	Top	Top	Top

Note: Question B1: 'Considering all your professional work, how many hours do you spend in a typical week on each of the following activities?' ('Classes in session' and 'classes not in session'; scientists employed full-time in universities and involved in both teaching and research).

TABLE 4 Results of *z* tests for equality of fractions (all countries): preferences for teaching/research

	AT	FI	DE	IE	IT	NL	NO	PL	PT	CH	UK
Primarily in teaching		Rest	Rest	Rest	[a]	[a]	[a]	Rest	Rest		[a]
In both, but leaning towards teaching		Rest		Rest	Rest	Rest	Rest	Rest	Rest	Rest	Rest
In both, but leaning towards research		Top	Top	Top		Top		Top	Top	Top	
Primarily in research				Top	Top			Top	Top		Top

Note: (Question B2: 'Regarding your own preferences, do your interests lie primarily in teaching or in research?') Research top performers (Top) versus the rest (Rest) (all 11 European countries, all academic clusters combined).
[a]This category is not used in comparisons because its column proportion is equal to zero or one.

Finland, Ireland, Italy, the Netherlands, Norway and the UK. In short, research role orientation is a powerful indicator of top-performer status in European countries while teaching orientation virtually excludes one from this class. As before, for each pair with a fraction difference significantly different from zero, the symbol for the larger category appears in the column (Table 4). These findings confirm that academic knowledge production in Europe hinges on top performers, who are highly homogeneous in terms of working pattern and role orientation. They are similar cross-nationally and differ substantially from other scientists intra-nationally.

4.2 | Academic salary stratification

Scientists are also heavily stratified by the positive relationship between research productivity and academic income. Our research on academic top earners calls into question several common assumptions made in traditional studies, which are usually based on single-nation data rather than cross-national comparison. We adopted a cross-national perspective to investigate predictors for entry to the class of top earners, defined as those in the 80th percentile of gross academic income—that is, the top 20 per cent of scientists in each of the five major academic clusters in each country who were at least 40 years old, had at least 10 years of academic experience and were involved in both teaching and research. Interestingly, our results do not support previous findings from single-nation studies, where research time was found to be positively correlated with high academic income, teaching time was negatively correlated with high academic income, and there was a strong correlation between research orientation, gender and high income (Dillon & Marsh, 1981; Gomez-Mejia & Balkin, 1992; Katz, 1973). Instead, our findings suggest that the link between higher time investment in research and higher academic income—consistently demonstrated for Anglo-Saxon countries over the last four decades—may be less pronounced across Continental Europe. While top earners in three European countries were found to work longer total hours, they also worked longer service and/or administrative hours in seven countries.

In terms of individual academic careers, top earners as defined here tend to spend more time on all academic activities except teaching and research (Table 5). The only exception is the UK, where highly paid scientists traditionally spend more time on research while their lower paid colleagues spend more time on teaching; specifically, highly paid scientists spend more time on administration and service. The annualised total weekly working time differential between top earners and others ranges from 5.5 hr in Finland to 7.5 hr in Germany and 8.25 hr in Switzerland. For example, when compared to other German scientists, top earners in Germany work an additional 43.1 days each year. Of particular interest is the high productivity differential between top earners and other scientists, especially in relation to peer-reviewed article equivalents (see Figure 3 for differential by country), even though teaching time and research time are not statistically significant differentiating factors. In seven countries (Poland, Germany, Finland, Italy, Norway, Portugal and the UK), top earners are 80–140 per cent more productive than other research-oriented scientists aged over 40 who work in the university sector. In the case of internationally co-authored article equivalents (see Figure 4 for differential by country), the figures rise to 180.49 per cent higher in Poland, 178.05 per cent higher in the UK, and 145.56 per cent higher in Germany. In short, top earners in most of these European countries are substantially more productive and publish more internationally co-authored research than other scientists from the same (older) age cohort. Surprisingly, while they work longer administrative and service hours—rather than longer research hours and shorter teaching hours, as traditionally assumed in the productivity literature—they are substantially more academically productive (Table 6).

One of our research questions asked whether high academic income is positively correlated with high research performance even though income does not seem to be positively correlated with higher research time investment (other than in the UK). We concluded that top earners are disproportionately represented among highly productive scientists; in Germany, for instance, an average 43.1 per cent of highly productive scientists are also highly paid. Across Europe, an average 31.8 per cent of national highly productive scientists are among the national top earners, ranging from 80 per cent in the United Kingdom to about 40 per cent in Finland, Germany and Portugal, and 30 per cent in Norway. (Poland, with a flat and uncompetitive salary system, is the only European exception.) This is the first time the prototypical figure of the academic top earner has been identified and discussed cross-nationally in the Higher Education literature.

TABLE 5 Working hours differentials: results of *t* tests for equality of means for top earners (Top) versus the rest (Rest) in 10 European countries

	PL	DE	AT	FI	IT	NL	NO	PT	CH	UK
Teaching hours										Rest
Research hours										Top
Service hours	Top					Top	Top		Top	
Administration hours	Top	Top		Top			Top			
Other hours		Top					Top			
Total hours		Top		Top					Top	

Note: Question B1: ‘Considering all your professional work, how many hours do you spend in a typical week on each of the following activities?’ (‘Classes in session’ and ‘classes not in session’; scientists employed full-time in universities and involved in both teaching and research; annualized mean weekly hours).

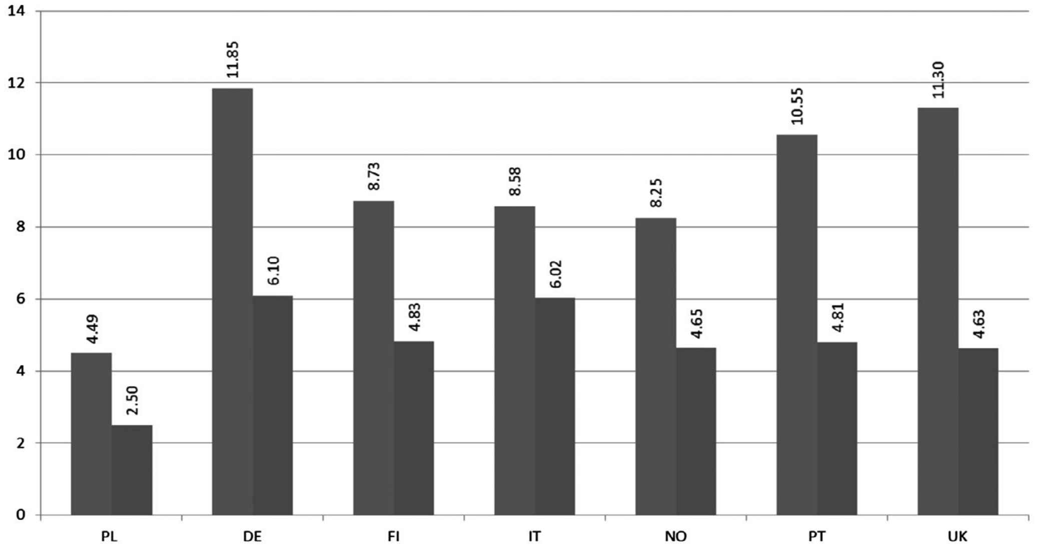

FIGURE 3 Academic productivity and high academic income: top earners versus the rest. Average number of peer-reviewed article equivalents (PRAE) published in a three-year reference period (top earners in blue, others in red; scientists employed full-time in universities and involved in both teaching and research; only countries with statistically significant results are included)

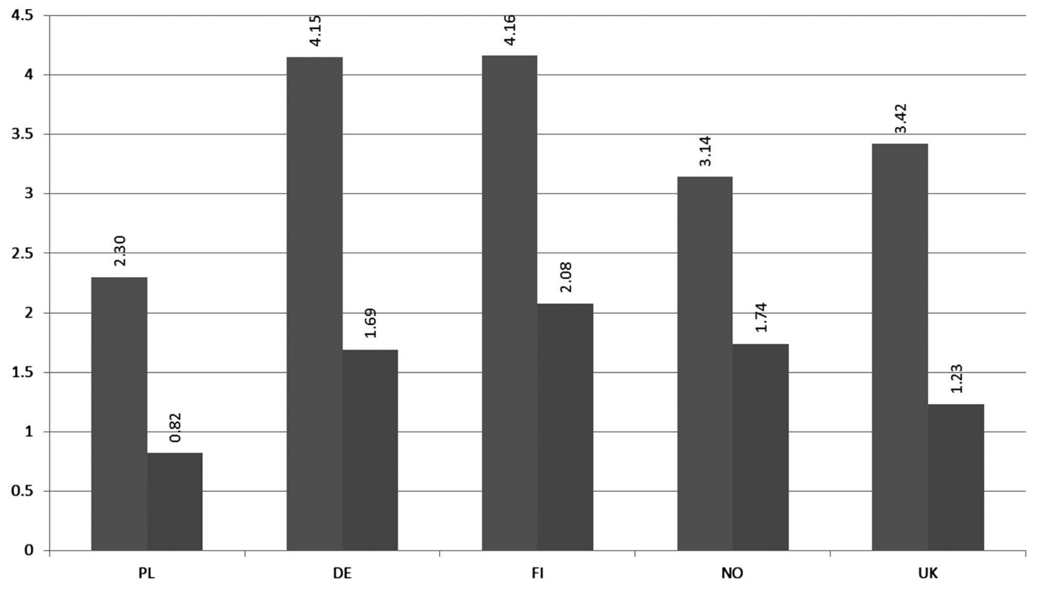

FIGURE 4 Academic productivity and high academic income: top earners versus the rest. Average number of internationally co-authored article equivalents (IC-PRAE) published in a three-year reference period (top earners in blue, others in red; scientists employed full-time in universities and involved in both teaching and research; only countries with statistically significant results are included)

4.3 | International research stratification

Finally, individual scientists are also heavily stratified by international research collaboration, which tends to be correlated with higher research productivity. This form of stratification was examined here in terms of internationalists and locals as two prototypical figures that emerged from our study (i.e., those who collaborate

TABLE 6 Research productivity and high academic income: summary

	PL	DE	AT	FI	IT	NL	NO	PT	CH	UK
Peer-reviewed article equivalent (PRAE)	Top	Top		Top	Top		Top	Top		Top
Internationally co-authored article equivalent (IC-PRAE)	Top	Top		Top			Top			Top
Foreign language article equivalent (ENG-PRAE)	Top	Top		Top	Top		Top	Top		

Note: Results of *t* tests for equality of means for top earners (Top) versus the rest (Rest) in 10 European countries. Group with significantly larger mean shown by country; scientists employed full-time in universities and involved in both teaching and research).

internationally in research and those who do not, a simple definition). Across Europe, we found that, in terms of research, some systems, institutions, academic clusters, and scientists were more internationalised than others. This was especially true of two relatively small systems, Ireland and the Netherlands, where more than four in every five scientists are collaborating internationally. In Austria, Switzerland and Finland, about three-quarters of scientists collaborate internationally. The least internationalised systems are the relatively larger Poland and Germany, where there are powerful internal research markets (about 48 per cent); the remaining European countries in our sample are moderately internationalised.

The findings confirm that IRC contributes to the increasing stratification of the academic profession, as it is positively correlated with higher publishing rates (and higher citation rates, which are not studied here). European scientists who do not collaborate internationally suffer increasing losses in terms of research resources and academic prestige. As research-based competition becomes a constant, local prestige and local publication in a regional language may no longer suffice to prosper in academia. Increasingly, internationalists compete directly with locals for national and institutional prestige and for access to project-based research funding, and mechanisms that enable the rich to get richer while the poor get poorer continue to transform the academic profession. It seems clear that academic performance stratification is linked to stratification of research resources, and that both are linked to the stratification of international research and publishing. To begin, the international stratification of research was explored across countries, discipline clusters and generations. Additionally, we investigated the correlation between IRC and individual research productivity and systematically compared research productivity and international publication co-authorship among internationalists and locals in each of the 11 countries (Kwiek, 2018a).

The relationship between international cooperation and research productivity has been widely discussed in the relevant literature, and there is a general assumption that international collaborative activities tend to be strongly positively correlated with research productivity (Abramo, D'Angelo, & Solazzi, 2011; Shin & Cummings, 2010). International research collaboration is commonly considered a critical predictor of high research productivity. However, intensity of national and international collaboration is not uniform across academic fields (Abramo et al., 2009; Lewis, 2013, p. 103). We found that research productivity is strongly positively correlated with international research collaboration; in all academic clusters and in all 11 countries, average productivity was consistently higher among internationalists.

At the aggregated European level reported here, differences between internationalists and locals are consistent across all academic clusters and can be summarised in a single statement: ‘No international collaboration, no international co-authorship’. The average proportion of internationally co-authored publications for internationalists differs across academic clusters; in line with previous evidence (e.g., Shin & Cummings, 2010), this is highest for physical sciences and mathematics (41 per cent) and lowest for humanities and social sciences (14.2 per cent) and professions (19.14 per cent). There is a powerful relationship between involvement in IRC and international co-authorship of articles in books and journals (Table 7). The difference in terms of journal publication is sizeable;

TABLE 7 Percentage of articles by European scientists (11 countries combined) published in an academic book or journal co-authored in international collaboration (IC-PRA) with colleagues located in other countries and academic cluster (%)

Cluster of academic disciplines	International collaboration	*N*	%	Mean percentage of internationally-coauthored peer-reviewed articles (3 years)	*SE*	95% confidence interval for mean LB	95% confidence interval for mean UB	*t* test for equality of means	*df*	*p*-value
Life sciences and medical sciences	Yes	1,542	64.8	34.67	0.89	32.92	36.42	20.662	2,070	<0.001
	No	837	35.2	6.69	0.73	5.25	8.13			
Physical sciences. mathematics	Yes	887	74.7	41.00	1.23	38.60	43.41	15.450	1,081	<0.001
	No	301	25.3	6.16	1.18	3.84	8.48			
Engineering	Yes	502	60.0	25.02	1.34	22.39	27.65	9.373	760	<0.001
	No	335	40.0	6.57	1.19	4.22	8.92			
Humanities and social sciences	Yes	1,249	62.5	14.20	0.70	12.83	15.57	11.602	1,701	<0.001
	No	749	37.5	2.39	0.49	1.43	3.35			
Professions	Yes	503	52.5	19.14	1.25	16.69	21.59	11.173	832	<0.001
	No	455	47.5	2.54	0.60	1.36	3.71			

for internationalists, the average rate of international co-authorship is 4–5 times higher in engineering, life sciences and medical sciences and 7.5 times higher in the professions.

Among academic scientists who do not collaborate internationally, a mere 7 per cent of their publications in the three 'hard' fields and no more than 3 per cent in the two 'soft' fields are internationally co-authored. In the most internationalised cluster of academic disciplines (physical sciences and mathematics), the share of internationally co-authored publications for internationalists is 41.00 per cent while the share among locals is only 6.16 per cent.

The pattern is consistent for both internationalists and locals across all academic clusters studied. Those who do not collaborate internationally produce only a marginal percentage of their publications as co-authored with colleagues from other countries. However, they represent a substantial proportion of the academic profession in Europe (Table 7, second column; cross-national differences are substantial but not studied here; see Kwiek, 2018a). Those who do not collaborate in international research account for about half of academic scientists in the professions; about four out of ten in engineering, humanities and social sciences; about one third in life sciences and medical sciences; and about a quarter of those in the physical sciences and mathematics.

We asked whether those who collaborate internationally in research (internationalists) tend to publish more; the answer was that they do (Table 8: lines Yes and No); across all academic clusters, internationalists publish at least twice as many peer-reviewed articles as locals. However, clusters exhibit considerable differentiation in this regard; in some clusters, internationalists produced over 200 per cent more articles during the reference period (222.35 per cent in engineering). In the life and medical sciences, physical sciences, mathematics and professions, the figure ranged between 120 and 130 per cent. In the humanities and social sciences, internationalists produced 106.17 per cent more articles.

While numbers differ from country to country, the general patterns are similar across the 11 European countries in question (Kwiek, 2015a, 2019a). For instance, the Polish case shows that internationalists are much more productive in terms of internationally co-authored publications (Table 9) at 2,320 per cent of locals' productivity for peer-reviewed articles and 1,600 per cent for peer-reviewed article equivalents. For English language peer-reviewed articles, the figure is 290.9 per cent, and for article equivalents, it is 276.5 per cent. In this sense, Polish internationalists are a world apart from Polish locals in terms of international co-authorship and almost three times as productive in terms of publications in English. They are also about 70 per cent more productive in terms of conference papers and about 50 per cent more productive in terms of peer-reviewed articles, article equivalents, and books, and they tend to produce twice as many reports for funded projects.

However, one qualification must be noted. Identification of correlates of high research productivity (e.g., international research collaboration) does not imply any necessary causal relation (Ramsden, 1994, p. 223). International cooperation in research may generally be associated with the more productive, who are in turn sought out by the most productive academics across all systems (Smeby & Try, 2005). More productive academic scientists also tend to have better access to funding for international cooperation (Lee & Bozeman, 2005, p. 677, Smeby & Trondal, 2005, p. 463). While cooperation with productive colleagues generally increases individual research productivity, the converse is also true (Katz & Martin, 1997, p. 5, Lee & Bozeman, 2005, p. 676).

5 | DISCUSSION

Top-performing European academics are a homogeneous group whose strong research performance is driven by structurally similar factors. They exhibit similar working patterns and share similar academic attitudes. While similar from a European cross-national perspective, they differ substantially from their lower-performing colleagues at intra-national level. As a universal academic species, they share roughly the same burden of academic production; the 10/50 rule holds strongly across Europe (that is, the upper 10 per cent of academics produce 50 per cent of all peer-reviewed publications). This paper is focused on cross-national and intra-national patterns rather than any exact numbers.

TABLE 8 Peer-reviewed articles (PRA) published by European scientists (11 countries combined) in an academic book or journal based on international research collaboration (Internationalists: Yes; Locals: No) and academic cluster; scientists employed full-time in universities and involved in both teaching and research

Cluster of academic disciplines	International collaboration	*N*	%	Mean number of peer-reviewed articles (3 years)	*SE*	95% confidence interval for mean: LB	95% confidence interval for mean: UB	*t* test for equality of Means	*df*	*p*-value
Life sciences and medical sciences	Yes	1,542	64.8	7.48	0.26	6.97	7.98	10,927	2,285	<0.001
	No	837	35.2	3.34	0.18	2.98	3.71			
Physical sciences. mathematics	Yes	887	74.7	6.92	0.32	6.28	7.55	6,654	1,159	<0.001
	No	301	25.3	3.06	0.25	2.56	3.55			
Engineering	Yes	502	60.0	5.19	0.43	4.35	6.03	6,391	799	<0.001
	No	335	40.0	1.61	0.20	1.23	2.00			
Humanities and social sciences	Yes	1,249	62.5	3.34	0.17	2.99	3.68	6,983	1,905	<0.001
	No	749	37.5	1.62	0.12	1.39	1.85			
Professions	Yes	503	52.5	3.81	0.27	3.28	4.33	6,367	901	<0.001
	No	455	47.5	1.67	0.18	1.31	2.03			

TABLE 9 Example of a national system: Poland

	Internationalists (INT)				Locals (LOC)				All				LOC versus INT
	Mean	*SD*	Min	Max	Mean	*SD*	Min	Max	Mean	*SD*	Min	Max	LOC = 100%
Books authored/co-authored	0.6**	1.2	0	18	0.4	1.2	0	30	0.5	1.2	0	30	150.0
Books edited/co-edited	0.4***	0.9	0	9	0.3	0.8	0	7	0.3	0.8	0	9	133.3
Research reports/monographs written for a funded project	0.8***	1.8	0	25	0.4	1.3	0	30	0.6	1.6	0	30	200.0
Papers at a conference	5.0***	6	0	30	3.0	5	0	30	4	6	0	30	166.7
Articles (newsp. or magazine)	1.1	3	0	30	1.0	3.1	0	30	1.1	3	0	30	100.0
Peer reviewed articles (PRA)	4.79***	6.63	0	33	3.04	5.17	0	30	3.94	6.03	0	33	157.6
Peer reviewed article equivalents (PRAE)	8.3***	11	0	106.2	5.6	9.1	0	165	7	10.2	0	165	148.2
Int. co-authored peer-rev. articles (IC-PRA)	1.16***	3.15	0	33	0.05	0.47	0	13.3	0.62	2.35	0	33	2,320.0
Int. co-authored peer-rev. article equivalents (IC-PRAE)	1.6***	4.3	0	42.8	0.1	0.7	0	20	0.9	3.2	0	42.8	1,600.0
English language peer-reviewed articles (ENG-PRA)	3.2***	5.3	0	33	1.1	2.8	0	30	2.2	4.4	0	33	290.9
English language peer-rev. article equivalents (ENG-PRAE)	4.7***	7.6	0	58.4	1.7	3.9	0	43.2	3.3	6.3	0	58.4	276.5

Note: Average individual research productivity by publication type (internationalists/locals/all scientists) for the three-year reference period and difference between internationalists and locals (LOC = 100%) by publication type.
**$p < 0.01$; ***$p < 0.001$.

The analysis confirms that European academic knowledge production hinges on Europe's top performers. Kyvik (1989, p. 209) reached a similar conclusion about the skewness of Norwegian productivity, reporting that the most prolific 20 per cent of faculty produced 50 per cent of the total research output. Abramo et al. (2009, p. 143) found similar productivity patterns in Italy, where 12 per cent of authors accounted for 35 per cent of the total research output when averaged across disciplinary areas.

Interestingly, the distribution of average research productivity is highly skewed—not only for all European academic scientists in the sample, as might be expected, but also for the top-performing segment. The upper 10 per cent of academic scientists is as internally stratified as the lower-performing 90 per cent, with a very small number of very high publishers; the right tail of the productivity distribution tends to behave in exactly the same way as the productivity distribution as a whole. This result is consistent with recent findings by Yair et al. (2017, p. 5), who showed that, in a sample of Israel Prize laureates, the tail of excellence may behave like the overall productivity distribution. Abramo et al. identified the same pattern in the Italian national research system: 'research productivity distribution for all fields is highly skewed to the right, both at overall level and within the upper tail' (2017, p. 334), and this is the case right across Europe.

The academic behaviours and attitudes of top research performers are worlds apart from those of middle performers and low-performers—in other words, in terms of research productivity, there is no single academic profession (as has always been the case in the last half a century) but only professions in the plural. Enders and Musselin (2008, p. 127) mention academic professions in the plural when referring to the growing internal differentiation of the academic profession; professions are mentioned in Marginson (2009, p. 110) with regard to the impact of globalisation on the stratification of 'those with global freedoms and those bound to the soil within nations or localities'; and they appear in Teichler (2014, p. 84) when assessing the validity of the traditional Humboldtian teaching–research nexus in Germany, which he finds to be confined to a group of German university professors. The growing stratification of academic scientists is ubiquitous across Europe, and persistent inequality in academic knowledge production is one of its major dimensions.

From a cross-disciplinary perspective and in line with previous studies (Hoekman, Frenken, & Tijssen, 2010; Lewis, 2013), European academics in the physical sciences and mathematics cluster are the most internationalised. About three fourths are internationalists while in contrast, those in the professions cluster (e.g., law, education) are the least internationalised. Surprisingly, in light of previous findings, the level of research internationalisation (viewed through the proxy of IRC) is similar for the humanities and social sciences cluster on the one hand and the engineering, life sciences and medical sciences clusters on the other (60–65 per cent in both categories). There are national variations, but these generally follow the European pattern.

6 | IMPLICATIONS AT THE MICRO-LEVEL OF INDIVIDUAL SCIENTISTS

Inequalities in academic knowledge production have differing implications for scientists pursuing research-oriented careers (often funded through competitive research grants) and those interested predominantly in teaching, and for scientists in research-intensive as opposed to teaching-focused institutions. However, highly skewed research performance has especially important implications for young scientists (see Horta & Santos, 2016; Yudkevich, Altbach, & Rumbley, 2015). In particular, it is essential for those considering a research-oriented academic career to know what to do—and what not to do—and why.

These findings suggest that to become a top research performer, a scientist must invest greater than average amounts of time in research and, surprisingly, in all other academic activities, including teaching, service, and administration. At the individual level, there seems to be an ongoing conflict between research time and non-research time, and between research orientation and teaching orientation. Entry to the class of top performers demands long research hours, long working hours, and a strong research orientation. Deciding what to do is predominantly an individual matter, but it is also partly institutional; for the academic, a perfect working environment is one in which institutional requirements (such as a focus on research) align with individual expectations (such as extensive publishing in high-impact journals).

In terms of academic salary stratification across Europe, consistent with prestige maximisation theory, salaries relate increasingly to research output and the availability of competitive research funding. As the quasi-markets of competitive research funding are both national and international, the implications extend to the individual academic. If administrative and service hours (as well as total working hours) are strongly correlated with higher earnings, and if top earners are over-represented among high research performers, then European scientists with a taste for research must accept that much of their time will be spent on non-research activities. For individuals considering an academic career, the core distinction is between research and non-research activities; while research time has traditionally been highly valued, non-research time was considered less valuable.

By implication, institutions offering more research time as a proportion of total working time will be more attractive to research-oriented scientists, especially given more or less similar academic salary levels (adjusted for living costs), across major Western European countries. Systems that offer various forms of merit-based pay may be more attractive to research-oriented scientists, and specifically to top performers, than systems that continue to offer fixed-level, public service-type salaries. While prestige remains central to the academic enterprise, the influence of salary stratification cannot be disregarded.

Finally, international research stratification means that, for individual scientists, fierce competition for prestige and research resources hinges increasingly on internationalisation. Across Europe (and in sharp contrast to the United States), internationalists compete directly with locals, who increasingly stand to lose out (see Wagner & Leydesdorff, 2005). As the rules governing academic prestige, incentives and awards become increasingly homogeneous across the continent, individual evaluations based on prestigious international publications become ever more important for individual academic careers (Kwiek & Antonowicz, 2015). The fundamental divide in science between haves and have-nots, which is another way of understanding the social stratification of Higher Education, hinges increasingly on individual involvement in international research.

For the individual, and especially for young academics, it is important to understand that European academic institutions competing nationally and internationally for public funding, high international rankings and top scientists tend to use the same research-based metrics because their aggregated institutional success hinges on the disaggregated individual research successes of the scientists they employ. Wider awareness of the role of international research in university rankings means that scholarly publishing is more than an individual matter. Publishing (especially international publishing in top journals) and competitive research funding—which is directly linked to highly selective publishing channels—increasingly determine institutional and/or departmental funding. Employing high-publishing scientists generates research funding; conversely, employing low-publishing scientists attracts little funding. By being aware of this trend, the former group can exploit it for their own benefit.

Importantly, the modalities of international collaboration depend almost entirely on scientists themselves (Wagner, 2018). They decide whether and with whom to collaborate, and the decision to internationalise depends on individual choices based on reputation, resources, research interests and the attractiveness of the potential partner. There is always a trade-off between the time and energy spent on international collaboration and the research and publishing outcomes (Landry & Amara, 1998). *External* international research collaboration has powerful *internal* implications, as those who successfully pursue international collaboration become more competitive both institutionally and nationally. At the same time, attractiveness as an international collaboration partner is based on prior international research visibility and output. Scientists with no current internationally visible research are also invisible for the purposes of future international collaboration (see Horta & Santos, 2016).

7 | CONCLUSIONS

After decades of comparing nations and institutions, systems of evaluation and assessment now extend aggressively to the level of the individual scientist. For research funding agencies and evaluation panels, as well as university recruitment committees, the ready availability of individual-level data makes the workings of Higher Education and science systems more visible and more quantifiable in every respect. The ongoing evolution of academic job requirements mirrors the increasing stratification of institutions and individual scientists. 'Winner takes all' logics predominate, and judgments of excellence extend beyond institutions to individual scientists, intensifying their experience of the tensions between teaching and research, economic and social values, and the global scientific (fundamental) and local/regional (applied) goals of research. Big-picture issues of institutional differentiation and mission and the changing character, volume and structure of national research funding now translate into direct anxieties for individual scientists.

In this rapidly changing academic environment, scientists need a clear professional identity. They need to know how to function to gain access to the top layers of the academic profession (if this is what they want). In terms of their own academic career, they need to know what is important, what is not important, and in particular why this is the case. They also need to have a clear image of the successful academic scientist and of successful academic science, both in general terms and within their own national and disciplinary contexts. Career stages must be clearly planned in terms of research achievement, with an understanding of what matters and what does not matter for promotion in the university sector, and especially its upper layers.

As Higher Education systems become increasingly stratified, current and prospective scientists must make more considered decisions about where they plan to work in the future—decisions that have important long-term consequences in terms of access to research funding and career prospects. More international publications in top academic journals increase access to competitive research funding, and a university's status in the national and international hierarchies of prestige increasingly determines one's academic life chances and how working time is distributed, especially with regard to available research time.

The contribution of non-publishing and low-publishing scientists to scientific progress is beyond the scope of this paper, and the dependence of eminent scientists on less eminent colleagues (as posited by the Ortega hypothesis) is an interesting direction for future research (see Cole & Cole, 1973). The belief that all scientists contribute as peers to the collective enterprise of extending knowledge serves to integrate the various strata of scientists and 'provides a degree of stability in a system which is highly competitive and grudging in its major rewards to all but a very few' (Zuckerman, 1970, p. 243).

More generally, today's Higher Education system is stable and is perceived as fair and meritocratic because research achievements remain central. The three types of stratification explored here are all research related. Scientists accept as legitimate the research-focused criteria by which they are judged, and the legitimacy of the system is not in question; the egalitarian ideology that binds scientists together protects the stratified scientific community against polarisation. In Europe, unlike the US, the ideology of commercialism and commercially-oriented reward systems do not threaten to undermine traditional systems of recognition and reward, and intraprofessional conflicts between two distinct modes of scientific work do not create 'a fractured profession' (Johnson, 2017, pp. 135–137) pulling in two different directions. The increasing competition for resources is informed by the legitimate and widely accepted principle that past success in combination with novel research ideas improves access to research resources.

Although the implications of social stratification at institutional and national levels are beyond the scope of this paper, the three levels are bound by a single factor. Academic performance stratification means that hiring policies must be carefully planned, with clear national strategies in relation to vertical stratification of the system. As national Higher Education and science systems may be more or less internally competitive and more or less vertically differentiated, top performers may work alongside low performers scattered across national systems (in less internally competitive and less vertically differentiated systems), or they may be concentrated in elite universities (in more internally competitive and more vertically differentiated systems). The Italian system is an example of the former type, and the UK system is representative of the latter, with other European systems located somewhere between the two. In light of the sharp inequalities in knowledge production, national Higher Education policies must be clear about how to proceed in the future. Is knowledge production to be concentrated in a small number of well publicly-funded elite institutions, or is it to be maintained across the whole spectrum of institutions, from the local and regionally relevant to the elite and globally visible? While some European systems like Germany (Hüther & Krücken, 2018) have traditionally been more egalitarian, others like the UK have tended to be more stratified (Leišyte & Dee, 2012). Recent excellence-based funding initiatives across Europe reflect increasing pressure for further concentration of research in selected institutions. In practice, this may translate into further concentration of top performers, and the policy dilemma is whether to support high-performing scientists or highly ranked institutions. Beyond theoretical questions of equality versus excellence, these are practical issues (of which the academic profession needs to be aware) concerning how to distribute research funding fairly and effectively.

The present study demonstrates that research, and especially international research collaboration, plays a powerful internally stratifying role within the academic profession. Increasingly, the vertical stratification of institutions (reflected in national and international ranking systems) and of scientists (reflected in changing career opportunities) is reshaping national Higher Education systems across Europe. In this highly competitive environment, today's academic profession is internally divided as never before—by research output, salary, academic position, gender, age cohort, working time distribution and access to research funding, as well as by the limited available space in top journals. Understanding the social mechanisms that underlie these internal divisions is critical for the academic scientist's future prospects.

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