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The Internationalization of Research in Europe: A Quantitative Study of 11 National Systems From a Micro-Level Perspective

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Abstract

This article focuses on the impact of international research collaboration on individual research productivity in 11 European countries. Research productivity and international publication co-authorship of "internationalists" and "locals" (or academics collaborating and not collaborating internationally) are compared. The article uses a micro-level (individual) approach and relies on the primary data collected in a comparable format through a survey from 17,211 European academics. In all countries and all clusters of academic fields studied, international collaboration in research is strongly correlated with substantially higher research productions. Internationalization increasingly plays a stratifying role, though: More international collaboration tends to mean higher publishing rates and those who do not collaborate internationally may be losing more than ever before in terms of resources and prestige in the process of "accumulative disadvantage." The competition is becoming a permanent feature of the European research landscape, and local prestige combined with local publications may no longer suffice in the race for resources and academic recognition. Cross-disciplinary and cross-national differences apply but our study shows a powerful role of internationalization of research for both individual research productivity and the competitiveness of national research outputs.

Keywords

cooperation and competition, globalization and international higher education, international cooperation in higher education, internationalization of higher education, internationalization of teaching, learning and research

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Introduction

In this study, we use a micro-level (individual) approach that relies on the primary (rather than secondary) data collected from European academics in a consistent, internationally comparable format. The individual academic is the unit of analysis, rather than the national higher education system or the individual academic institution. A new "data-rich" research environment in international comparative academic profession studies created by two large-scale research projects (global CAP and European EUROAC projects on the academic profession, that is, "Changing Academic Profession" and "Academic Profession in Europe: Responses to Societal Challenges," respectively) allows to analyze the internationalization of research of European academics in a comparative quantitative context and to analyze its correlation with research productivity. The primary data analyzed in this article come from 11 European countries, with 17,211 usable cases.

There are two approaches to "measure" the internationalization of research in a national higher education system. One approach is *external* to the system and relies on such secondary data as, for instance, the national statistics on input and output in academic research. In particular, the aggregated national academic research production can be compared internationally, through either the international publication reports or the international citation reports. The other approach is *internal* to a national higher education system and relies on academic behavioral and attitudinal data, voluntarily provided by the academic faculty in a consistent, internationally comparable format. The former approach relies on the aggregate macro-level national data, the latter on the disaggregate micro-level (that of individual academics) data. Both approaches are highly complementary. Until recently, due to the scarcity of the reliable international data, only the former approach was used in Europe for international comparative quantitative purposes. Now, with new datasets, the latter approach is becoming highly useful for both research and public policy objectives.

Method and Data

The data used in this study are drawn from European countries involved in both the CAP and EUROAC projects (Austria, Finland, Germany, Ireland, Italy, the Netherlands, Norway, Poland, Portugal, Switzerland, and the United Kingdom), subsequently cleaned and weighted in a single European dataset by the University of Kassel team.[1] The combined CAP/EUROAC dataset is the most comprehensive source of cross-national attitudinal and behavioral data on academics available today. (There is a wide panorama of research themes explored with this dataset as an empirical background in the last 3 years: Shin, Arimoto, & Cummings, 2014, on "teaching and research"; Locke, Cummings, & Fisher, 2011, on "governance and management"; Huang, Finkelstein, & Rostan, 2014, on "internationalization"; Teichler & Höhle, 2013, on "work situation"; Bentley, Coates, Dobson, Goedegebuure, & Meek, 2013, on "job satisfaction"; and Teichler, Arimoto, & Cummings, 2013, on "the changing academic profession" from a long list of cross-national and single-nation studies available.) The

Table 1. Sample Characteristics, by Country.

	n	Universities (%)	Other HEIs (%)	Full-time	Part-time
Austria	1,492	100.0	0.0	65.8	34.2
Finland	1,374	76.5	23.5	82.4	17.6
Germany	1,215	86.1	13.9	70.7	29.3
Ireland	1,126	73.3	26.7	91.2	8.8
Italy	1,711	100.0	0.0	96.9	3.1
Netherlands	1,209	34.4	65.6	56.0	44.0
Norway	986	93.3	6.7	89.7	10.3
Poland	3,704	48.3	51.7	98.0	2.0
Portugal	1,513	40.0	60.0	90.3	9.7
Switzerland	1,414	45.6	54.4	58.5	41.5
United Kingdom	1,467	40.8	59.2	86.5	13.5

Note. In Austria and Italy, there was no distinction between "Universities" and "Other HEIs" in the sample. HEI = higher education institution.

data quality is high (Teichler et al., 2013; Teichler & Höhle, 2013), as is the relevance of the data for the present article. Our research follows what is perceived as the "gold standard" of social science research design: primary data collection analysis (Goodwin, 2012, p. xxi).

The survey questionnaire was sent out to the CAP countries in 2007 and to the EUROAC countries in most cases, including Poland, in 2010 (this time difference is viewed here as of marginal importance to the final results). The total number of returned surveys was 17,211 and included between 1,000 and 1,700 returned surveys in all countries studied except for Poland where it was higher, as shown in Table 1. Overall, the response rate differed from more than 30% (in Norway, Italy, and Germany), to 20% to 30% (in the Netherlands, Finland, and Ireland), to about 15% in the United Kingdom, 11% in Poland, and 10% or less in Austria, Switzerland, and Portugal. Relatively low response rates may be caused by an increasing number of surveys to which the academic profession is routinely exposed (Mesch, 2012). There are no indications that the pool of respondents differs from the pool of non-respondents, though, and consequently the "non-response bias" (Stoop, 2012, p. 122) does not seem to occur. Overall, simple random sampling, systematic sampling, and stratified random sampling methods were used, depending on the country. In Poland, we used the sampling method of an "equal probability of selection method" (Hibberts, Johnson, & Hudson, 2012, p. 55): Every element in a sample (every Polish academic) had an equal chance of being selected for the study (performed by a national research institute OPI, or the Center for Information Processing), with individualized invitations to participate in the survey sent to about 39,000 academics, or all academics whose email addresses were available at a central level. In contrast, in Germany, Switzerland, and Austria, cluster sampling methods were used, with a pre-selection of some institutions. In the process of international data coordination, sample weights

were made by the Kassel statistical team; sample values were weighted to reflect the actual parameters of the academic profession in the countries studied. For the purposes of the current research, basic frequencies were computed on selected items from the weighted dataset; cross-tabulations of selected dependent variables were computed against some independent variables (especially cluster of academic fields, institutional type, age, and career stage).

From a full weighted sample of 17,211 cases across 11 countries, the study analyzed only subsamples of full-time academics (13,633) and academics working in universities (10,777), rather than in any "other higher education institutions." We have excluded part-timers to avoid distortions to the picture: The share of part-time academics in the sample is too differentiated, from 2% to 3% in Poland and Italy to more than 40% in the Netherlands and Switzerland. "Universities" were defined by national research teams. Consequently, data are drawn from about 9,000 ($N = 8,886$) cases. Our study is focused on full-time academics in the United Kingdom from the Russell Group, in Finland from universities rather than polytechnics; similarly, in the Netherlands, we have excluded academics from *hogescholen*; in Germany, academics from *Fachhochschulen*; and in Norway, from *statlige høgskoler*; only in Italy and Austria we focused on all full-time academics as no other institutional types were represented in the sample.

Individual data files were produced in all participating countries but all specifically national categories (faculty rank structures, institutional type structures, etc.) were reduced to internationally comparable categories. An international codebook was created and a number of coding modifications were introduced in national data files, in particular the dichotomization of all faculty into "senior" and "junior" faculty and into faculty employed in "universities" and those employed in "other higher education institutions." The data cleaning process included the use of "survey audits" prepared by national teams. In the process of international data coordination, sample values were weighted so that the national samples in the countries studied were broadly representative of national academic populations for most independent variables, especially gender, academic fields, institutional types, and institutional ranks (national-level sampling techniques are described for the CAP European countries in a report published by the Research Institute for Higher Education at Hiroshima University, RIHE, 2008, and for the EUROAC countries in Teichler & Höhle, 2013). All problems and complexities of large-scale international collaborative empirical studies do apply, though. The proportion of faculty by clusters of academic fields is given in Table 2.[2]

There are several limitations relevant for this study. The first is our inability to compare academics across individual institutions: We can only draw comparisons between large clusters of them. We are therefore unable to study differences in the internationalization of research and in research productivity between academics from institutions of lower academic standing and those from most prestigious ones (all we could do was to distinguish between a broad cluster of "universities" and a broad cluster of "other higher education institutions" in each system studied). The second limitation is our inability to compare the internationalization of research and research productivity across academic generations: Cohort aspects cannot be easily studied through

Table 2. Proportion of Faculty by Clusters of Academic Fields and Sample Size (*n*).

	Life sciences and medical sciences	Physical sciences, mathematics	Engineering	Humanities and social sciences	Professions	Other fields	Total (*n*)
Austria	20.2	9.8	11.9	41.3	8.7	8.2	1,492
Finland	15.7	9.7	21.5	18.6	12.1	22.4	1,374
Germany	29.3	15.2	14.8	15.6	11.1	13.9	1,215
Ireland	23.0	11.5	8.8	23.8	20.5	12.4	1,126
Italy	28.6	23.3	11.1	17.5	13.6	5.9	1,711
Netherlands	12.6	10.9	10.7	22.3	34.7	8.8	1,209
Norway	29.0	14.1	7.4	27.5	8.9	13.1	986
Poland	24.6	8.4	21.5	23.0	12.5	10.0	3,704
Portugal	16.9	7.9	20.4	10.5	20.6	23.7	1,513
Switzerland	30.8	10.2	12.7	16.9	23.9	5.5	1,414
United Kingdom	21.9	11.6	6.3	18.6	11.0	30.7	1,467

cross-sectional datasets. Cohort effects mean that academics employed under different conditions and in different times are being inter-generationally compared at a given moment in time, and it is difficult to disentangle age effects from cohort effects. We can analyze academics by age brackets (e.g., academics in their 30s, 40s, 50s, and 60s), but they still belong to different academic generations. The generational effect is clear from our study of the junior–senior split in Polish academia presented elsewhere. The third limitation comes from a tacit assumption that the major concepts used across all 11 systems in the survey instrument have a somehow similar sense: The concepts include "scholarship," "academic knowledge," "professional obligations," "primary research," "performance-based allocation of resources," "entrepreneurial activities," "evaluating research," and many others. A clear limitation of the study is that there may be different senses of these terms used in academic perceptions in different countries. Finally, there are two major missing systems in this article: France and Spain. Also, other Central European systems for which no data are available in a comparable format have not been analyzed (see Kwiek, 2001). But this is a problem of many cross-European studies based on primary data, and we have decided to rely solely on a coherent European dataset rather than to refer selectively to secondary data.

Internationalization, Research Productivity, and Publication Co-Authorship Across Academic Fields: "Internationalists" and "Locals"

The relationships between international cooperation and research productivity have been widely discussed in research literature, with a general assumption that collaborative activities in research, including international collaborative activities, increase

research productivity (Abramo, D'Angelo, & Solazzi, 2011b; Godin & Gingras, 2000; He, Geng, & Campbell-Hunt, 2009; Lee & Bozeman, 2005; Shin & Cummings, 2010; Teodorescu, 2000). International research collaboration is most often found to be a critical factor in predicting high research productivity, whereas domestic collaboration is most often found not to be significant. But as Lee and Bozeman (2005) pointed out, "despite the ubiquitous nature of collaboration in science, the benefits of collaboration are more often assumed than investigated. . . . Do those who collaborate more tend to have more publications?" (p. 673). Yes indeed, they tend to, and very much so, as we shall clearly show below in the case of international collaboration.

We shall analyze two specific aspects of internationalization in research: first, the correlation between international academic cooperation in research and academic productivity (following Teodorescu's [2000] definition of research productivity as a "self-reported number of journal articles and chapters in academic books that the respondent had published in the three years prior to the survey," p. 206) and, second, the correlation between international academic cooperation in research and the co-authorship of publications with international colleagues (at the aggregated European level, across five major clusters of academic fields, globally; see Rostan, Ceravolo, & Metcalfe, 2014).

Academic disciplines (together with academic institutions) determine both the patterns of academic attitudes and the patterns of academic behaviors: in our case, international orientation in research as an attitude and international publishing patterns as a behavior. The notions of Burton Clark's "small worlds, different worlds" and Tony Becher and Paul R. Trowler's "academic tribes and territories" are as important to cross-disciplinary patterns of international cooperation as Karin Knorr Cetina's "epistemic cultures" and Mary Henkel's "academic identities." These studies show, through different concepts and based on different empirical material, that cooperation patterns (and international cooperation patterns) are discipline-sensitive.

In some disciplines, the imagery of "lonely scholars" rules, whereas in others, collaboration is key for both academic success and academic recognition (Lewis, Ross, & Holden, 2012; Wanner, Lewis, & Gregorio, 1981). The national and international collaboration intensity is not uniform across different academic fields (Abramo, D'Angelo, & di Costa, 2009; Rostan 2012). As Lewis (2013) recently showed on a sample of academics interviewed in Australia, New Zealand, and the United Kingdom, research in 2008 in these countries was done "alone" by about two thirds of academics in the humanities and only by 1 in 14 academics in science (65.6% vs. 7.4%); it was done "with others" by only 1 in 7 in the humanities and by three fourths in sciences (13.5% vs. 75.3%; for the rest of academics, the option was "mixed," p. 103). We shall study here the cross-disciplinary differences in detail.

The International Academic Cooperation in Research and Academic Productivity

The first question is how strongly international collaboration in research is correlated with higher than average research productivity and whether the relationships found

hold across all academic disciplines. Responses to the question "How many of the following scholarly contributions have you completed in the past three years?" with the number of "articles published in an academic book or journal" were analyzed. The analysis was conducted with reference to two separate groups of academics, termed *internationalists* and *locals* in this article, referring to Alvin Gouldner's traditional distinction between *cosmopolitans* and *locals* in science: Locals see academics from their country as their frame of reference in research, and cosmopolitans' frame of reference is the international academic community (Gouldner, 1957; see also *internationalists and insular peers* in the United States in Cummings & Finkelstein, 2012, and *internationalists* and *insulars* in Finkelstein & Sethi, 2014; for Poland, see Kwiek, 2014). The differences in national research productivity according to different items (beyond articles) and the average productivity indexes for all European countries studied are shown in Table A1 in the appendix.

We define "internationalists" as academics indicating their involvement in international research collaboration and "locals" as academics indicating their lack of involvement in it. The independent samples *t* test was used: It is a parametric statistical test used for testing a null hypothesis of equality of the means in two independent subpopulations (if a hypothesis concerns more than two subpopulations, one-way ANOVA is used).

Across all clusters of academic fields, the difference in productivity rates between European "internationalists" and European "locals" is statistically significant at a high level ($p < .001$, see Table 4). Those European academics who were collaborating with international colleagues in research had published on average substantially more articles in academic books or journals than their colleagues in the same academic field who were recently *not* collaborating internationally.

As shown in Table 3, the percentage of academics collaborating internationally in research across Europe is high, and it is the activity reported on average by two thirds of academics. There are huge cross-disciplinary and cross-national differences, though. The share of "internationalists" varies significantly across major clusters of academic fields. Consistently with previous studies, academics in the cluster of physical sciences and mathematics are by far the most internationalized in research (three fourths of them are collaborating internationally) and academics in the cluster of professions are the least internationalized (only about half of them are collaborating internationally). Surprisingly in the light of previous studies, the level of internationalization as viewed through the proxy of international collaboration in research is similar for the humanities and social sciences on one hand and engineering on the other (about 63%-65% of academics are collaborating internationally). The "European field mean" column shows the mean percentage for all European academics studied in a given cluster of academic fields (regardless of the country), whereas the "Field mean" column shows the mean of the countries' means (i.e., takes into account differences in national populations per cluster of fields).

Huge cross-national differences apply, as seen in the same Table 3. There are clearly four categories of countries: internationalization "leaders," "followers," "moderates," and "laggards." The most highly internationalized systems in Europe,

Table 3. Percentage of Academics Collaborating Internationally in Research, by Academic Fields and Countries, Only Research-Involved Academics (in %).

	European field mean	DE	AT	FI	IE	IT	NL	NO	PT	CH	UK	PL	Field mean
Life sciences and medical sciences	64.8	58.7	84.4	77.4	80.7	58.6	79.3	66.7	55.6	71.7	83.3	54.8	70.1
Physical sciences, mathematics	74.7	72.0	88.3	84.7	80.0	71.4	91.7	68.5	54.2	83.3	71.4	72.4	76.2
Engineering	60.0	26.9	76.1	75.0	74.0	58.2	86.4	66.1	68.3	75.4	61.6	26.8	63.2
Humanities and social sciences	62.5	51.8	82.2	73.4	83.6	56.9	80.4	59.3	64.9	—	61.0	47.5	66.1
Professions	52.6	34.6	56.1	63.6	84.6	42.0	67.5	42.7	54.6	77.8	25.0	38.3	53.3
Country mean	63.0	48.8	77.4	74.8	80.6	57.4	81.1	60.7	59.6	77.1	60.5	48.0	66.0

Note. "—" indicates missing data. The country codes are as follows: DE (Germany), AT (Austria), FI (Finland), IE (Ireland), IT (Italy), NL (Netherlands), NO (Norway), PT (Portugal), CH (Switzerland), UK (United Kingdom), and PL (Poland).

or internationalization leaders, are the relatively small systems of Ireland and the Netherlands (on average more than four in every five academics are collaborating internationally), followed by Austria, Switzerland, and Finland, internationalization followers (about three fourths of academics). The two least internationalized systems, or internationalization laggards, are relatively big systems of Poland and Germany, with slightly less than a half (about 48%) of all academics collaborating internationally. The remaining countries are internationalization moderates. Surprisingly, the patterns of internationalization of Polish and German systems are almost identical in all five clusters of academic fields: the highest for physical sciences and mathematics (more than 70%) and life sciences and medical sciences (in the 50%-60% range), the lowest for professions (in the 30%-40% range) and engineering (slightly below 30%). Both systems are among the biggest in Europe, with powerful hierarchical differences and strictly defined career ladders, and are still rooted in Humboldtian, nation-oriented ideals of the university (see the role of modern universities in providing national consciousness and national social glue, Kwiek, 2006, 2009b, 2013).

"Internationalists" (lines "Yes" in Table 4) across all academic fields had published on average about twice as many articles as "locals" (lines "No" in Table 4), with a large differentiation between academic fields. (Similarly, the "volume" of international collaboration, which we are unable to measure here based on the survey instrument used, is reported on the basis of a bibliometric analysis to be "positively correlated to productivity," Abramo et al., 2011b, p. 642.) In some academic fields, "internationalists" produced on average about 140% (engineering) and about 120% (physical sciences, mathematics) more articles, whereas in others (humanities and social sciences, and professions), they produced about 70% more articles in the reference period. "Internationalists" in life sciences and medical sciences, the academic field with the highest productivity rate, produced on average 8.80 articles (and it was 79% more than "locals" who produced on average 4.91 articles). The 95% confidence interval for mean (e.g., 8.26 articles as a lower bound and 9.34 articles as an upper bound in the

Table 4. Articles Published by European Academics in an Academic Book or Journal by International Collaboration in Research ("Internationals"—Yes, and "Locals"—No) and Academic Fields.

Academic field	International collaboration	*n*	%	Mean no. of articles (3 years)	*SE*	95% confidence interval for mean		*t* test for equality of means	*df*	*p* value
						LB	UB			
Life sciences and medical sciences	Yes	1,542	64.8	8.80	0.28	8.26	9.34	11.27	2,293.69	<.001
	No	837	35.2	4.91	0.21	4.50	5.32			
Physical sciences, mathematics	Yes	887	74.7	8.13	0.34	7.46	8.80	10.17	1,069.66	<.001
	No	301	25.3	3.74	0.26	3.22	4.25			
Engineering	Yes	502	60.0	6.97	0.54	5.92	8.03	6.76	696.67	<.001
	No	335	40.0	2.91	0.27	2.38	3.44			
Humanities and social sciences	Yes	1,249	62.5	6.61	0.27	6.09	7.13	8.24	1,936.99	<.001
	No	749	37.5	3.89	0.20	3.50	4.27			
Professions	Yes	503	52.5	6.85	0.35	6.15	7.54	6.04	901.80	<.001
	No	455	47.5	4.12	0.28	3.35	4.60			

Note. LB = lower bound; UB = upper bound.

Table 5. Percentage of Articles Published by Academics Collaborating Internationally in Research in an Academic Book or Journal (No International Collaboration in Research = 100%), by Academic Fields.

	European field mean	DE	AT	FI	IE	IT	NL	NO	PT	CH	UK	PL	Field mean[a]
Life sciences and medical sciences	178	253	334	270	232	144	n.s.	272	n.s.	274	n.s.	149	241
Physical sciences, mathematics	217	357	n.s.	370	n.s.	168	n.s.	369	n.s.	n.s.	278	317	310
Engineering	240	326	1,098	268	n.s.	140	n.s.	297	323	—	n.s.	432	412
Humanities and social sciences	170	114	n.s.	249	382	186	n.s.	196	320	357	184	157	238
Professions	166	n.s.	n.s.	234	294	188	n.s.	n.s.	n.s.		n.s.	n.s.	239
Country mean	194	263	716	278	303	166	n.s.	284	322	316	231	264	314

Note. n.s. = results not statistically significant, $p > .05$; "—" refers to missing data.
[a]Countries only. The country codes are as follows: DE (Germany), AT (Austria), FI (Finland), IE (Ireland), IT (Italy), NL (Netherlands), NO (Norway), PT (Portugal), CH (Switzerland), UK (United Kingdom), and PL (Poland).

case of life sciences and medical sciences) indicates that the [8.26, 9.34] interval covers the number of articles with 95% of certainty; similarly, "internationalists" in the humanities and social sciences, the academic field with the lowest productivity rate, produced on average 6.61 articles (and it was 70% more than "locals" who produced on average 3.89 articles). The academic field with the highest productivity rate differential between "internationalists" and "locals" in Europe is clearly engineering: with the average productivity rates of 6.97 articles for the former group and 2.91 articles for the latter group.

As Table 5 clearly demonstrates, in all countries and in all clusters of academic fields studied, international collaboration in research is correlated with a substantially higher number of publications. Only for the Netherlands, the most highly internationalized system in Europe, the results are not statistically significant. If we assume that the mean number of publications of locals is 100%, then the mean field for internationals varies from about 240 to more than 400, and the country mean for internationals varies from 166 in Italy to 716 in Austria (based on two clusters only). The average of country means is more than 300. International collaboration pays off most in terms of knowledge production in engineering (on average, academics collaborating internationally produce four times more publications), and the least for humanities and social sciences and professions (about two and a half times more). Results were statistically significant for only seven countries in the cluster of engineering, six countries in physical sciences and mathematics, and merely three in professions.

The International Academic Cooperation in Research and the Co-Authorship of Publications With International Colleagues

There seems to be a fundamental difference between internationalization as research *collaboration* and internationalization as *international co-authorship* of research publications. The former is more informal, the latter is more formal (Rostan et al., 2014).

Presumably, only a fraction of international collaboration activities lead to internationally co-authored publications. Academics can collaborate internationally and still be *not* involved in cross-border knowledge transfer, that is, joint academic publishing. International publication co-authorship occurs at a more individual level than international collaboration, and at the individual level, some pre-conditions have been identified in research literature. As Smeby and Gornitzka (2008) argued in their study of the changing internationalization of Norwegian academics across two decades, the integration of researchers into transnational academic communities is dependent on two separate factors: a motivation on the part of the researcher and his/her attractiveness as a researcher to international colleagues. Both factors are closely linked: "The researcher needs to have the motivation to make the effort to engaging internationally. Attractiveness refers to the extent to which international colleagues perceive a researcher as a relevant and interesting partner" (Smeby & Gornitzka, 2008, p. 43). Another relevant factor is the availability of resources (Smeby & Gornitzka, 2008; see also Kwiek, 2009a; Kwiek & Kurkiewicz, 2012).

The second aspect of internationalization studied here is the difference in the *proportion* of internationally co-authored publications between the subsample of "internationalists" and the subsample of "locals" in Europe. In our analysis, the difference is statistically significant at a high level ($p < .001$) across all clusters of academic fields. While research productivity was analyzed above in correlation with international collaboration across different academic fields, here the intensity of international publication co-authorship is analyzed in correlation with international collaboration across academic fields.

At an aggregated European level, the differences between "internationalists" and "locals" are consistent across all clusters of academic fields, and they can be summed up in a single statement: "no international collaboration, no international co-authorship." The average proportion of internationally co-authored publications for "internationalists" differs across academic fields (see Table 6): Consistent with previous research results, which link international research collaboration with higher research productivity across disciplines (for instance, Shin & Cummings, 2010), it is the highest for physical sciences and mathematics (41%) and the lowest for humanities and social sciences (only 14%) and professions (19%). There is a powerful relationship between being involved in international cooperation in research and international co-authorship of articles in books and journals. The difference in the share of the latter type of publications between "internationalists" and "locals" is huge: The average rate of international co-authorship for "internationalists" is between 4 and 5 times higher (in engineering and in life sciences and medical sciences) and 7.5 times higher (in professions).

Academics *not* collaborating internationally report no more than merely 7% of their publications being internationally co-authored in the three "hard" fields and no more than merely 3% in the two "soft" fields only. The highest difference in the share between academics collaborating and not collaborating internationally is in the second least internationalized academic field (professions) and the lowest difference is in the

Table 6. Percentage of Articles by European Academics Published in an Academic Book or Journal Co-Authored With Colleagues Located in Other (Foreign) Countries, by International Collaboration in Research and Academic Field.

Academic field	International collaboration	*n*	%	Mean percentage of articles	*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	1,373	66.3	34.67	0.89	32.92	36.42	24.24	2,029.05	<.001
	No	699	33.7	6.69	0.73	5.25	8.13			
Physical sciences, mathematics	Yes	818	75.5	41.00	1.23	38.60	43.40	20.48	833.11	<.001
	No	266	24.5	6.16	1.18	3.85	8.47			
Engineering	Yes	479	62.9	25.02	1.34	22.40	27.64	10.29	743.83	<.001
	No	283	37.1	6.57	1.19	4.23	8.91			
Humanities and social sciences	Yes	1,109	65.1	14.20	0.70	12.83	15.57	13.86	1,698.49	<.001
	No	594	34.9	2.39	0.49	1.43	3.35			
Professions	Yes	461	55.2	19.14	1.25	16.70	21.58	12.00	654.00	<.001
	No	374	44.8	2.54	0.60	1.36	3.72			

Note. LB = lower bound; UB = upper bound.

second most internationalized academic field (life sciences and medical sciences). In the most internationalized academic field (physical sciences and mathematics), the share of internationally co-authored publications for "internationalists" is 41% whereas the share for "locals" is only 6.16%.

The pattern is consistently similar for both academics collaborating internationally and those not collaborating internationally across all academic fields studied. Those not collaborating internationally produce only a marginal percentage of their publications as co-authored with colleagues from other countries. Their share in the academic profession in Europe is substantial, though: About 4 out of 10 academics in professions and engineering; about 3 out of 10 in humanities and social sciences, and life sciences and medical sciences; and about a quarter of all academics in physical sciences and mathematics do not collaborate internationally. There are strong patterns across Europe, with some variations, though, as can be seen from the detailed national data in Table A2 in the appendix.

Finally, at least two serious reservations need to be made. The first reservation is about the direction of causality in the research productivity–international cooperation relation and the existence of a number of indirect factors enhancing international cooperation. The identification of high research productivity correlates (e.g., international collaboration) does not mean the identification of causal relations (Ramsden, 1994). International cooperation in research may be generally undertaken by more productive academics as such academics are sought by most productive academics across all systems (Smeby & Try, 2005). Also more productive academics tend to have

better access to funding for international cooperation (Geuna, 1998; Lee & Bozeman, 2005; Smeby & Trondal, 2005). The cooperation with productive academics generally increases individual research productivity but the cooperation with non-productive academics generally decreases it (Katz & Martin, 1997; Lee & Bozeman, 2005). In some cases, the costs of international cooperation (travel, subsistence, the time spent on project preparation, administration, and reporting) may exceed individual and/or institutional benefits (Katz & Martin, 1997). International cooperation involves numerous individual and institutional "transaction costs" (Abramo et al., 2011b). On top of that, individual benefits may be incommensurable with institutional costs. The second reservation is about an important difference between publication numbers and their scientific significance.

Numbers do not determine scientific value but it is assumed in the studies on the social stratification in science that a higher number of publications leads to more significant research than a lower number of them:

> Since quality and quantity of research output are fairly highly correlated, the high producers *tend* to publish the more consequential research. The gist of the matter is that engaging in a lot of research is in one sense a "necessary" condition for the production of high-quality work. (Cole & Cole, 1973, p. 111; see Abramo, D'Angelo, & Solazzi, 2011a, p. 630; Rostan et al., 2014, p. 141)

In a similar vein, Derek J. de Solla Price, one of the founding fathers of bibliometrics, argued in the 1960s in his study on *Little Science, Big Science* that there is "a significant correlation between qualitative solidness and quantitative solidness" (de Solla Price, 1963, p. 77). In this sense, we explore research productivity through a rather crude measure of publication numbers (rather than through an impact factor and citation analysis); but in this way, we are able to seek correlations with international research collaboration, and especially, to show how *not* collaborating internationally impedes individual research productivity and total national academic output.

Conclusion

Our study shows that research productivity of European academics is strongly correlated with international research collaboration: The average research productivity rate of European academics involved in international collaboration (whom we term *internationalists*) is consistently higher than the rate of European academics *not* involved in international collaboration (whom we term *locals*) in all academic fields and in all countries studied.

The international publication co-authorship is also powerfully correlated with international research collaboration: The average rate of international co-authorship for "internationalists" is between about 4 and 5 times higher (in the clusters of engineering and life sciences and medical sciences) and 7.5 times higher (in the cluster of professions) than this rate for "locals." Academics *not* collaborating internationally report no more than merely 7% of their publications being internationally

co-authored in the "hard" fields and no more than merely 3% in the "soft" fields studied. Thus, in a specific case of publishing in co-authorship with international colleagues, the policy lesson is simple: "no international collaboration, no international co-authorship."

These results lead to strong policy implications: Large-scale international publication co-authorships are on average only possible if produced by "internationals" on the basis of their international collaboration. Only a negligible fraction of publications from nationally isolated science (produced by "locals") can be internationally co-authored, and internationally co-authored publications are strictly related to collaborative activities with international colleagues. And, if cross-border activities are to involve more than "a small attractive elite" (Smeby & Gornitzka, 2008, p. 39), incentives combined with resources are a necessary pre-condition. Consequently, what Lee and Bozeman (2005, p. 693) termed "the collaboration-as-synergy assumption" held by policy-makers (strongly believing that scientific collaboration has positive effects on research productivity) affects not only "particular research awards" but also "entire programs of research policy." Consequently, any national system focused on increasing the international visibility of its knowledge production needs to install the internationalization of research in the center of its national research policy.

The distinction between "internationals" and "locals" permeates European research. Some systems, institutions, and academics are consistently more internationalized in research than others. For "internationals," the international academic community is a reference group, whereas "locals" publish predominantly for the national academic community. Internationalization increasingly plays as stratifying role, though: More international collaboration tends to mean higher publishing rates, and those who do not collaborate internationally may be losing more than ever before in terms of resources and prestige in the process of "accumulative disadvantage" (Cole & Cole, 1973, p. 146). The competition is becoming a permanent feature of European research landscape, and local prestige combined with local publications may no longer suffice in the race for resources and academic recognition.

Huge cross-disciplinary and cross-national differences apply but, in general terms, our study shows a powerful role of internationalization of research for both individual research productivity and the competitiveness of national research outputs.

Appendix

Table A1. Average Research Productivity, All Items (Question D4 "How Many of the Following Scholarly Contributions Have You Completed in the Past Three Years?" (Academics Involved in Research Only, Employed Full-Time in the University Sector).

Countries/ items	Scholarly books you authored or co-authored	Scholarly books you edited or co-edited	Articles published in an academic book or journal	Research report monograph written for a funded project	Paper presented at a scholarly conference	Professional article written for a newspaper or magazine	Patent secured on a process or invention	Computer program written for public use	Artistic work performed or exhibited	Video or film produced	Others	A composite country index of research productivity
Austria	0.6	0.7	4.3	2.1	9.5	1.1	0.4	0.1	0.3	0.2	0.2	26.1
Finland	0.4	0.4	5.5	1.4	4.9	1.2	0.1	0.2	0.2	0.1	0.3	18.2
Germany	0.4	0.4	7.8	1.9	6.7	1.6	0.3	0.1	0.2	0.2	0.3	23.4
Ireland	0.3	0.3	7.2	1.8	8.2	1.3	0.1	0.2	0.3	0.2	0.2	22.2
Italy	1.0	0.5	9.1	1.6	7.9	1.9	0.1	0.1	0.1	0.1	0.2	30.9
Netherlands	0.5	0.6	10.7	1.7	7.6	2.2	0.1	0.3	0.2	0.0	0.0	28.3
Norway	0.5	0.2	5.0	0.7	4.5	1.4	0.1	0.2	0.3	0.2	0.7	15.8
Poland	0.2	0.2	3.9	0.2	3.2	0.8	0.0	0.0	0.1	0.0	0.2	9.2
Portugal	0.7	0.5	5.7	1.8	8.0	1.4	0.2	0.2	0.3	0.2	0.5	25.9
Switzerland	0.6	0.4	7.8	1.7	6.1	1.3	0.1	0.2	0.1	0.2	0.1	24.9
United Kingdom	0.3	0.2	5.9	1.1	5.7	0.8	0.1	0.2	0.0	0.0	0.6	16.2

Note. The composite country index of research productivity weighs particular outputs and aggregates the scores. From among several options of constructing an index (e.g., Ramsden, 1994; Teichler, Arimoto, & Cummings, 2013; and Arimoto 2011), we have selected the latter: We have attributed 10 points for each book; 5 points for an edited book; 1 point for each book chapter or article; 3 points for each research report; 0.5 point for a paper presented, computer program written, artistic work, or film produced; and 0.3 point for each newspaper article. "Others" are not included in the total average productivity.

Table A2. Summary: Mean *Percentage* of Articles by Academics Published in an Academic Book or Journal Co-Authored With Colleagues Located in Other (Foreign) Countries, by International Collaboration and Academic Field.

Academic field	International collaboration	European mean	PL	DE	AT	FI	IE	IT	NL	NO	PT	CH	UK	Field mean[a]
Life sciences and medical sciences	Yes	34.67	42.77	30.83	43.12	39.06	24.61	29.05	n.s.	38.61	27.99	35.52	20.94	36.72
	No	6.69	3.43	8.57	7.70	10.99	2.47	2.87	n.s.	7.12	9.91	24.69	5.53	9.00
Physical sciences, mathematics	Yes	41.00	44.42	35.66	50.99	37.11	n.s.	40.72	47.89	40.14	n.s.	63.47	37.97	43.94
	No	6.16	11.38	4.38	12.86	1.02	n.s.	4.61	5.29	1.39	n.s.	31.43	7.07	8.83
Engineering	Yes	25.02	66.07	24.15	35.16	15.51	28.63	17.46	n.s.	28.20	n.s.	—	30.07	30.66
	No	6.57	3.12	5.62	13.33	7.06	4.05	3.49	n.s.	4.42	n.s.	—	0.00	5.14
Humanities and social sciences	Yes	14.20	13.55	n.s.	13.28	14.04	24.38	11.04	n.s.	14.82	13.32	n.s.	8.43	14.11
	No	2.39	1.43	n.s.	1.32	0.00	5.18	2.18	n.s.	3.37	2.66	n.s.	2.22	2.30
Professions	Yes	19.14	21.58	15.32	25.90	n.s.	26.81	5.93	31.51	28.59	n.s.	n.s.	n.s.	22.23
	No	2.54	3.16	2.52	1.32	n.s.	3.01	1.41	4.87	1.96	n.s.	n.s.	n.s.	2.61
Country mean	Yes		37.68	26.49	33.69	26.43	26.11	20.84	39.70	30.07	20.66	49.50	24.35	29.53
	No		4.50	5.27	7.31	6.53	3.68	2.91	5.08	3.65	6.29	28.06	3.70	5.58

Note. Based on separate analyses of 11 countries. n.s. = results not statistically significant, $p > .05$, "—" denotes missing data. The country codes are as follows: DE (Germany), AT (Austria), FI (Finland), IE (Ireland), IT (Italy), NL (Netherlands), NO (Norway), PT (Portugal), CH (Switzerland), UK (United Kingdom), and PL (Poland).
[a]Countries only.

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Notes

1. We have worked on the final dataset dated June 17, 2011, and created by René Kooij and Florian Löwenstein from the International Centre of Higher Education and Research—INCHER-Kassel, Germany.
2. We have studied five major clusters of academic fields: "life sciences and medical sciences" (termed "life sciences" and "medical sciences, health-related sciences, social services" in the survey questionnaire), "physical sciences and mathematics" ("physical sciences, mathematics, computer sciences"), "engineering" ("engineering, manufacturing and construction, architecture"), "humanities and social sciences" ("humanities and arts" and "social and behavioral sciences"), and "professions" ("teacher training and education science," "business and administration, economics," and "law").

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