Please, no more scientific journals! The strategy of the scientific publication system

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Abstract.

In the same way ecosystems tend to increase maturity by decreasing the flow of energy per unit biomass, we should move towards a more mature science by publishing less but high-quality papers and getting away from joining large teams in small roles. That is, we should decrease our scientific productivity for good.

The number of scientific journals listed in the Journal of Citation Reports has increased during the last decade from $6,443$ to $8,860$ (Table 1), and hence, the world's scientific production (i.e., number of papers published by the scientific community per year) has grown from $905,349$ to $1,398,003$ in that period (Fig. 1a). Journals act like fertilizers for the soil, opening up new opportunities for scientists to publish the results of their research. Consolidated scientists can increase their scientific productivity (i.e., number of papers published per scientist and year). On the other hand, novel scientists—who did not publish before because of the fierce competition for space in journals—can enter into the scientific publication system. Disentangling the detrimental consequences of the never-ending increase of the number of journals (i.e., higher scientific productivity) from its advantageous effects (i.e., recruiting novel scientists) is of paramount importance to support or discourage the proliferation of new scientific journals.

Since the number of authors has increased (from $3,052,068$ to $5,318,208$) faster than the number of papers published during the last decade (75% and 50%, respectively), adding more journals into the publication system seems to have reduced scientific productivity. Note, however, that using the ratio $\frac{\#\text{papers}}{\#\text{authors}}$ (i.e,. scientific production over the number of authors) as a proxy of scientific productivity (Fig. 1b) assumes single-authored papers. This negative linear relationship still holds for multiple-author papers if we assume that the average number of authors signing a research paper has not changed over time. Yet, the only way to keep scientific productivity constant over time when the number of authors increases faster than the number of papers is by increasing the number of authors signing a paper. This suggests that, even when the number of papers grows at a lower pace than the number of authors, the higher the frequency of papers signed by many authors is, the higher might be scientific productivity.

The relative frequency of papers signed by five or more authors has increased during the last decade from 40% to 53% (Fig. 1c). Single-author papers, papers signed by two, three and four authors—but not by five or more authors—have decreased over time (shown by negative and statistically significant correlations; see Table 2). This resulting increase in the average number of authors per paper over time must be incorporated in any measure of scientific productivity.

One way to measure scientific productivity per year taking into account the increase of the frequency of papers signed by many authors is the following:

$$\text{scientific productivity} = \frac{\sum_{i=1}^{20}\left(\#\text{papers}_{(i)} * \; i\right)}{\#\text{authors}},$$

where $\#\text{papers}_{(i)}$ is the number of papers signed by i authors and #authors is the total number of authors of all the papers published that year. Note that we did not consider papers signed by more than 20 authors because the percentage of those papers was lower than 0.5%. This measure shows that scientific productivity has increased over time (5% during the last decade; Fig. 1d) as a consequence of the proliferation of new journals.

While it is true that having more journals has allowed novel scientists to enter into the scientific publication system, most of them are just part of multi-authored papers. In the same way ecosystems tend to increase maturity by decreasing the flow of energy per unit biomass (Margalef, *The American Naturalist*, 97 (1963): 357-374), we need to move towards a more mature science where we should publish less but high-quality papers (i.e., trend towards decreasing scientific productivity). It's time to face the conflict between the strategies of science and publishers.

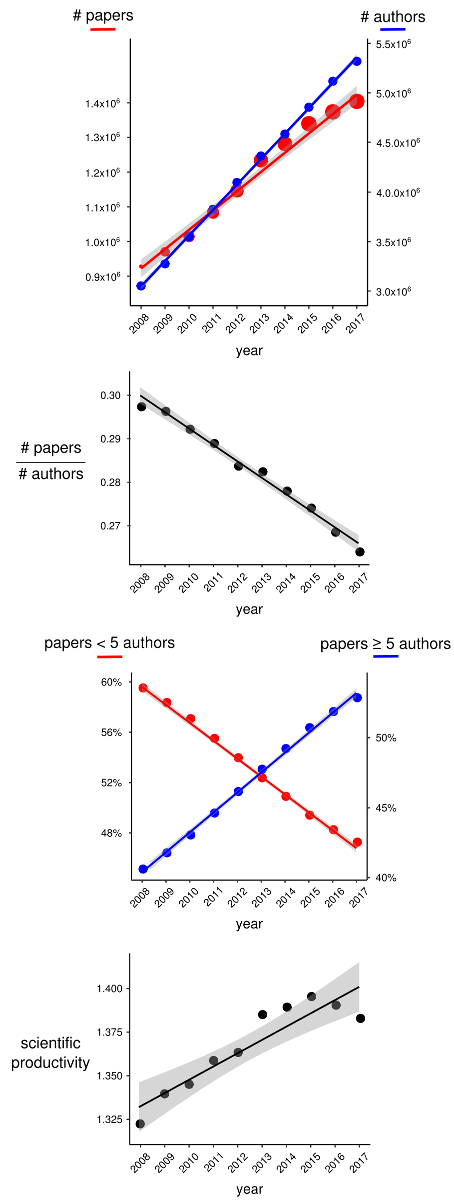

Figure 1. **The strategy of the scientific publication system.** a) Trends in the number of papers (red) and authors (blue) over the last decade. b) Scientific productivity over time measured as the ratio between the number of papers published per year and the number of scientists authored them. c) Change in the frequency of papers signed by four or less scientists (red) and more than four scientists (blue). **d)** Scientific productivity over time measured after taking into account the increase in the number of authors per paper.

Data.

Table 1. **Summary descriptors of the scientific publication system in the last decade.** Number of journals included in the Science Citation Index Expanded, number of scientific articles, number of distinct authors signing those articles, articles signed by less than five authors, and articles signed by five or more authors.

year	**#journals**	**#articles**	**#authors**	**$<$ 5 authors**	**$\geq$ 5 authors**
2008	6443	905349	3052068	59.45%	40.55%
2009	7175	967999	3274946	58.29%	41.71%
2010	7848	1033298	3545223	57.01%	42.99%
2011	8095	1102155	3824334	55.45%	44.55%
2012	8253	1158923	4095396	53.91%	46.09%
2013	8335	1228952	4362849	52.31%	47.69%
2014	8490	1270887	4584087	50.83%	49.17%
2015	8660	1326996	4854865	49.34%	50.66%
2016	8734	1370378	5117270	48.18%	51.82%
2017	8860	1398003	5318208	47.19%	52.81%

Table 2. **Number of multi-authored papers published in the last decade.** Number of scientific articles signed by no more than $i = 1, 2, ...20$ authors and published in journals included in the Science Citation Index Expanded.

# articles by:	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
1 author	73808	74699	75568	74636	72706	71087	68511	66815	65178	62498
$\leq$ **2 authors**	224878	231238	237675	240647	240413	240937	237165	236058	232985	228850
$\leq$ **3 authors**	391368	407505	422235	434066	439167	447095	444570	447216	447805	443948
$\leq$ **4 authors**	538245	564238	589092	611093	624712	642833	646027	654702	660279	659724
$\leq$ **5 authors**	652270	687901	722446	755205	776687	805935	815932	834279	845160	848867
$\leq$ **6 authors**	736860	780314	822926	864534	895138	934300	951937	978605	995837	1003703
$\leq$ **7 authors**	792343	841197	889773	939086	976128	1023502	1047355	1081325	1103269	1116058
$\leq$ **8 authors**	829702	882154	935310	990260	1032466	1086613	1115059	1154773	1181896	1198092
$\leq$ **9 authors**	853888	909020	965507	1024224	1070302	1128542	1161147	1204739	1236128	1254763
$\leq$ **10 authors**	870687	927821	986747	1048033	1097294	1158671	1193574	1240850	1274854	1296180
$\leq$ **11 authors**	881065	939696	1000216	1063458	1114245	1177799	1214514	1263871	1299822	1322448
$\leq$ **12 authors**	888280	947840	1009344	1074136	1126327	1191349	1229326	1280264	1317667	1341144
$\leq$ **13 authors**	892744	952939	1015247	1080910	1134327	1200507	1239372	1291214	1329877	1354124
$\leq$ **14 authors**	895749	956465	1019339	1085814	1139990	1206906	1246378	1299073	1338727	1363672
$\leq$ **15 authors**	897905	959041	1022337	1089235	1144095	1211520	1251474	1304948	1345063	1370543
$\leq$ **16 authors**	899352	960852	1024407	1091749	1146946	1214830	1255187	1309123	1349826	1375728
$\leq$ **17 authors**	900437	962104	1025935	1093523	1149041	1217286	1257977	1312168	1353387	1379444
$\leq$ **18 authors**	901213	963094	1027123	1094968	1150550	1219191	1260005	1314618	1356007	1382345
$\leq$ **19 authors**	901806	963762	1028034	1096027	1151782	1220603	1261640	1316455	1358224	1384633
$\leq$ **20 authors**	902332	964418	1028847	1096902	1152800	1221776	1262971	1317998	1360019	1386621
any # authors	905349	967999	1033298	1102155	1158923	1228952	1270887	1326996	1370378	1398003

Methods.

Data were obtained from inCites (https://incites.thomsonreuters.com/#/analytics; "Journals" and "People"), an integrated web-based platform based on the data from the Web of Science by Clarivate Analytics (provided by the University of Zurich). We focused on the journals included in the Science Citation Index Expanded which covers 177 subject areas out of the 252 subject categories comprised by the Web of Science schema (i.e., "Filters: Research Area"; we selected the areas from http://mjl.clarivate.com/scope/scope_scie/). We count as papers only regular scientific articles that report original research, not books, reviews, editorials, letters to the editor and the like (i.e., "Filters: Document type"; we selected "Article"). We restrict our search to the journals listed in the Journal Citation Reports (i.e., "Thresholds: JIF Quatile"; we selected Q1, Q2, Q3, Q4). The number of papers published by $i = 1, 2, ...n$ authors was obtained using an additional threshold (i.e., "Thresholds: Authors per Document"; we selected Min=1 and Max=1 for single-authored papers, ...).