Supplementary Material for:

Female-led teams produce more innovative ideas yet receive less scientific impact

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Note 1. Descriptive analysis

Table S 1.1 Description of the variables

Type	Variables	Description/Definition	Sources
Dependent variable	**Female authorship as the first author**	If the first author is a female scientist, the dummy variable is assigned a value of 1; otherwise, it is assigned a value of 0.	(Van Buskirk et al., 2023)
	Female authorship as the last author	If the last author is a female scientist, the dummy variable is assigned a value of 1; otherwise, it is assigned a value of 0.	(Van Buskirk et al., 2023)
Independent variable	**Hit paper**	The top 1% of highly cited papers within their respective publication year and field.	(Fortunato et al., 2018; Liu et al., 2018; Wang et al., 2019; Yin et al., 2019)
	Novel paper	Scientific novelty is operationalized by scrutinizing the observed distribution of journal pairs within a paper's reference list and comparing it to the random distribution of journal pairs generated by a null model. Novel paper is a dummy variable.	Uzzi et al. (2013)
	Disruptive paper	A paper is considered to be disruptive when its CD index is above zero (The CD index is defined as the proportion of disruptive citations in the total citations received by the paper).	(Funk & Owen-Smith, 2017; Park et al., 2023; Wu et al., 2019)
Paper level controls	**Reference count**	The number of references in a paper	(Fortunato et al., 2018)
	Funding	Indicates whether the researcher was funded by the National Institutes of Health (NIH) or the National Science Foundation (NSF).	(Yang, Gong, et al., 2024)
Team level controls	**Team size**	The number of authors in a paper.	(Wuchty et al., 2007)
	International team	Indicates whether the paper's authorship includes individuals from different countries.	(Lee et al., 2019)
	Multidisciplinary team	Indicates whether the paper's authorship spans multiple fields of study.	(Liu et al., 2024)
Author level controls	**Career age**	The number of years elapsed from their initial publication in the MAG dataset until the publication year of the focal paper.	(Yang, Xu, et al., 2024)
	Author productivity	The total number of publications by the author up to the year the focal paper was published.	(Jones, 2009)
	Author citations	The total number of citations by the author up to the year the focal paper was published.	(Mukherjee et al., 2017)
	Focal field	We categorize the primary field of each scientist using first-level MAG field-of-study labels. If the focal paper aligns with the scientist's most frequently studied fields before its publication date, we assign it a value of 1; otherwise, we assign it a value of 0.	(Zeng et al., 2019)

Table S 1.2 Statistical analysis of the variables.

	COUNT	MEAN	STD	MIN	MEDIAN	MAX

	COUNT	MEAN	STD	MIN	MEDIAN	MAX
Female	6851166	0.44	0.50	0	0	1
5-year citation count	6851166	20.89	49.58	0	11	22658
Disruptive	6851166	0.18	0.38	0	0	1
CD index	6604593	0.00	0.01	-0.74	0.00	0.89
Novelty score	6787839	0.05	2.57	-10.37	0.85	5.54
Novel	6851166	0.56	0.50	0	1	1
Grant funding	6851166	0.13	0.34	0	0	1
Reference count	6851166	35.44	31.63	5	29	8087
Team size	6851166	5.05	8.35	1	4	3017
Multidisciplinary team	6851166	0.36	0.48	0	0	1
International team	6851166	0.19	0.39	0	0	1
Author age	6851166	12.13	7.26	0	11	29
Author productivity	6851166	50.89	73.45	0	28	2140
Author citations	6851166	911.93	2395.77	0	208	118657
Focal Field	6851166	0.35	0.48	0	0	1

Panel b. first author	COUNT	MEAN	STD	MIN	MEDIAN	MAX
Female	3324327	0.46	0.50	0	0	1
5-year citation count	3324327	20.78	48.76	0	10	16218
Disruptive	3324327	0.18	0.39	0	0	1
CD index	3197542	0.00	0.01	-0.74	0.00	0.86
Novelty score	3289681	-0.03	2.59	-10.28	0.72	5.54
Novel	3324327	0.54	0.50	0	1	1
Grant funding	3324327	0.12	0.33	0	0	1
Reference count	3324327	34.42	32.09	5	27	2519
Team size	3324327	4.74	5.03	1	4	2265
Multidisciplinary team	3324327	0.33	0.47	0	0	1
International team	3324327	0.18	0.39	0	0	1
Author age	3324327	9.18	6.57	0	8	29
Author productivity	3324327	29.60	47.73	0	15	2140
Author citations	3324327	411.16	1379.24	0	71	105939
Focal Field	3324327	0.35	0.48	0	0	1

Panel c. last author	COUNT	MEAN	STD	MIN	MEDIAN	MAX
Female	3526839	0.425008	0.494344	0	0	1
5-year citation count	3526839	20.98964	50.34973	0	11	22658
Disruptive	3526839	0.168672	0.374462	0	0	1
CD index	3407051	-0.00215	0.010586	-0.54135	-0.00069	0.890091
Novelty score	3498158	0.130496	2.547659	-10.3715	0.959838	5.509716
Novel	3526839	0.570116	0.495059	0	1	1
Grant funding	3526839	0.138506	0.345431	0	0	1
Reference count	3526839	36.40297	31.15499	5	30	8087
Team size	3526839	5.328876	10.55951	1	4	3017
Multidisciplinary team	3526839	0.389184	0.487565	0	0	1
International team	3526839	0.202379	0.401773	0	0	1
Author age	3526839	14.91549	6.772684	0	15	29
Author productivity	3526839	70.95889	86.62499	0	45	2140
Author citations	3526839	1383.944	2982.886	0	491	118657
Focal Field	3526839	0.341466	0.474202	0	0	1

Note 2. Novelty and disruption

Novelty involves the introduction of new ideas or the recombination of existing fragments of knowledge (March, 1991; Nelson, 1985; Schumpeter, 1939). Scientific and technological advancements do not arise spontaneously but are derived from the existing corpus of knowledge (Arthur, 2009). Scientific breakthroughs are often likened to a journey through a vast expanse of combinatorial possibilities, leading to fresh insights and technological progress. Research studies have emphasized the crucial role of combinations in connecting innovation with scientific and technological impact (Hofstra et al., 2020; Trapido, 2015). Most efforts to model the creative process perceive it as an accumulative and interactive recombination of existing fragments of knowledge, merged in novel ways (Azoulay et al., 2011). Novel research endeavors, while potentially entailing higher risks, often strive to address challenging issues and projects sought after by policymakers (Stephan et al., 2017; Wang et al., 2018). Novel studies push the boundaries of existing knowledge and venture into unexplored domains of scientific inquiry (Xu et al., 2022). In this study, we follow the methodology of Uzzi et al. (2013), using the yearly journal distribution in the reference list of papers to calculate scientific novelty. As our dataset includes papers with at least 10 references, this method effectively measures atypical combinations of knowledge.

To assess the novelty of papers, we examine the presence of atypical combinations of knowledge. Scientific novelty is operationalized by scrutinizing the observed distribution of journal pairs within a paper's reference list and comparing it to the random distribution of journal pairs generated by a null model. As shown in Fig. S1, we run Monte Carlo simulations by randomly switching the reference links between random paper pairs while controlling for time. Novelty as the atypical combinations of knowledge is quantified through these Monte Carlo simulations. The simulations involve creating reshuffled networks with random edge reassignment while preserving the temporal and distributional attributes of the original citation network. Each journal pairing is transformed into z-scores, representing standardized values. The computation of atypical combinations for each journal pair ($pair_{mn}$) is encapsulated by the following formula:

$$Z\ score_{m,n} = \frac{obs(pair_{mn}) - exp(pair_{mn})}{\sigma(pair_{ij})}$$

where $obs(pair_{mn})$ signifies the observed frequency of the journal pair in the actual dataset, $exp(pair_{mn})$ represents the mean, and $\sigma(pair_{mn})$ denotes the standard deviation of journal pairs obtained from 10 randomized simulations of the reshuffled network. To encapsulate the information within the distribution, denoted as a set $\{Z\ score_{m,n} \mid m, n \in J\}$, wherein J encompasses all journals within the reference list, we leverage the 10th percentile value of the novelty set as a succinct summary statistic. We denote papers as novel if their 10th

percentile value of the novelty set is lower than 0; otherwise, they are not considered novel papers.

$$Novel\ paper = \begin{cases} 1, if\ 10pct\{Z\ score_{m,n} \mid m,n \in J\} < 0 \\ 0, if\ 10pct\{Z\ score_{m,n} \mid m,n \in J\} \geq 0 \end{cases}$$
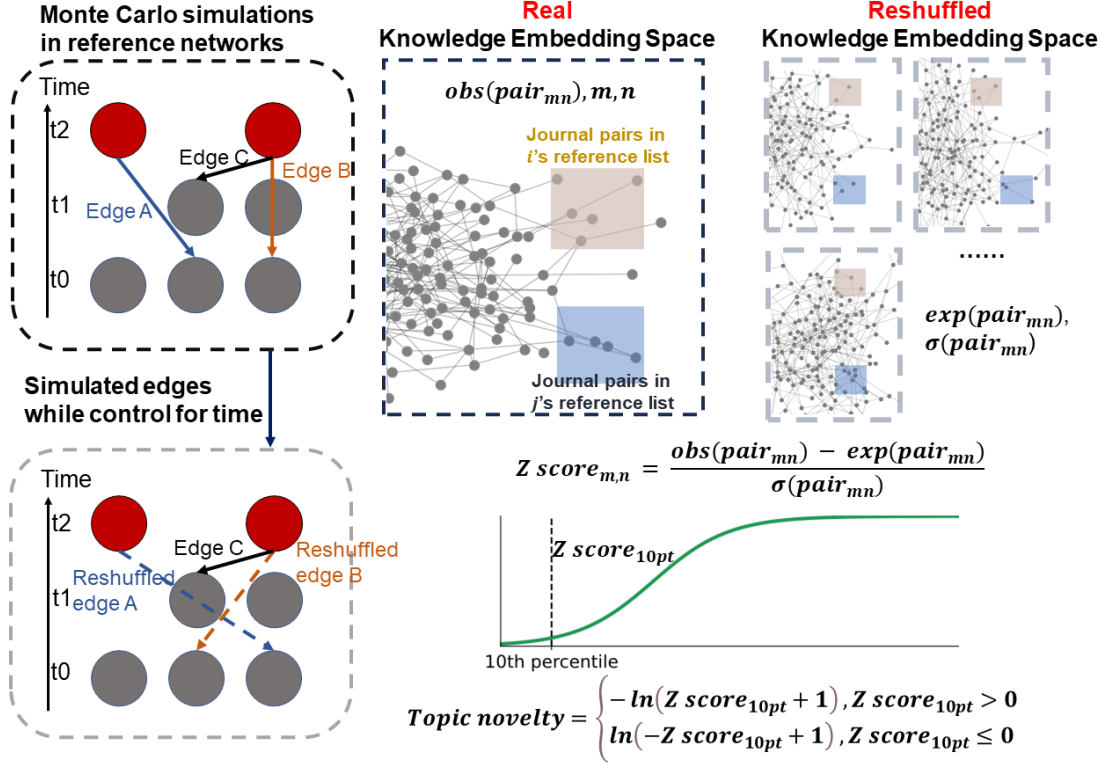

Fig. S2.1 Quantifying novelty in scientific papers

The CD index is defined as:

$$CD\ index = p_D - p_C = \frac{n_i - n_j}{n_i + n_j + n_k} \tag{1}$$

where n_i represents the number of future papers citing the focal paper (FP) that do not reference its cited sources, n_j denotes the number of future papers citing FP and its references, and n_k represents the number of papers citing FP's references without citing FP itself. A lower CD index indicates alignment with established knowledge, while a higher CD index signifies papers with the potential to induce paradigm shifts.

Leibel and Bornmann (2023) provide a comprehensive appraisal of the disruption index, deliberating on its conceptual underpinnings, capabilities, extensions, and constraints. Although it has some flaws and limitations, the CD index has been widely used in bibliometrics, the science of science, and many other fields of study. Notably, at least three papers published in the esteemed journal Nature in the last 3 years utilized the CD index as the main variable (Lin et al., 2023; Park et al., 2023; Wu et al., 2019).

a

References k Citations

$$CD\ index = p_D - p_C = \frac{n_i - n_j}{n_i + n_j + n_k}$$

i cites only the focal paper.

j cites both the focal paper and its cited references

k cites the focal paper's references but not the the focal paper itself

b

Maximally disruptive paper   Maximally consolidating paper

$5year\ CD\ index = 1$ $5year\ CD\ index = -1$

c

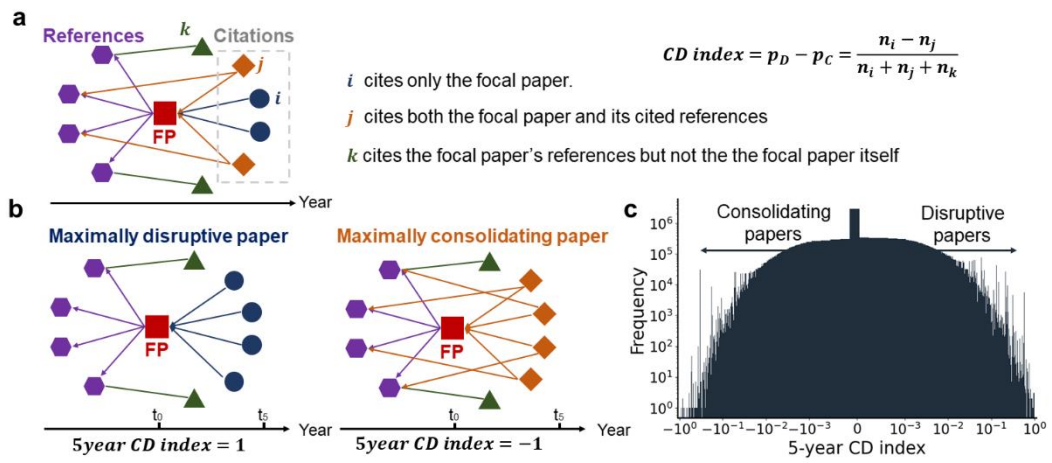Consolidating papers   Disruptive papers

Frequency

5-year CD index

Fig. S2.2 Quantifying the 5-year CD index

Note 3. Main regression tables

Table S 3.1 Effect of the female leadership on the probability of hit papers.

Models	(1)	(2)	(3)	(4)	(5)	(6)
	P (Hit papers)					
	First author			Last author		
Female	-0.1465*** (0.0064)	-0.1021*** (0.0072)	-0.0697*** (0.0081)	-0.1814*** (0.0069)	-0.0742*** (0.0077)	-0.0336*** (0.0091)
Grant funding		0.2708*** (0.0090)	0.1419*** (0.0114)		0.2178*** (0.0093)	0.0832*** (0.0130)
ln(#Reference)		1.284*** (0.0069)	1.261*** (0.0076)		1.282*** (0.0078)	1.279*** (0.0091)
ln(Team size)		0.4070*** (0.0063)	0.4278*** (0.0071)		0.4216*** (0.0076)	0.3949*** (0.0090)
Multidisciplinary team		-0.1568*** (0.0083)	-0.1370*** (0.0092)		-0.1410*** (0.0086)	-0.1164*** (0.0099)
International team		0.1408*** (0.0087)	0.1139*** (0.0096)		0.1438*** (0.0089)	0.1224*** (0.0100)
ln(Author age)			-0.3980*** (0.0110)			-0.5845*** (0.0145)
ln(Author productivity)			-0.0300*** (0.0083)			-0.1098*** (0.0101)
ln(Author citations)			0.2250*** (0.0051)			0.2825*** (0.0068)
Focal field			0.0612*** (0.0082)			0.0100 (0.0091)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Field FE	Yes	Yes	Yes	Yes	Yes	Yes
Journal FE		Yes	Yes		Yes	Yes
Affiliation FE			Yes			Yes
Obs.	3,304,856	2,682,999	2,098,780	3,505,475	2,819,138	2,095,369
Pseudo R2	0.0095	0.2579	0.2768	0.0112	0.2590	0.2777

Note: robust standard errors are reported in parentheses. $^{*} p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$.

Table S 3.2 Effect of the female leadership on the probability of novel papers.

Models	(1)	(2)	(3)	(4)	(5)	(6)
	P (Novel papers)					
	First author			Last author		
Female	0.1078*** (0.0023)	0.0302*** (0.0026)	0.0327*** (0.0030)	0.0909*** (0.0022)	0.0400*** (0.0025)	0.0458*** (0.0030)
Grant funding		0.1867*** (0.0042)	0.1332*** (0.0052)		0.1672*** (0.0039)	0.0966*** (0.0052)
ln(#Reference)		0.8636*** (0.0022)	0.8804*** (0.0026)		0.8440*** (0.0023)	0.8597*** (0.0027)
ln(Team size)		0.0681*** (0.0023)	0.0900*** (0.0027)		0.1106*** (0.0027)	0.1490*** (0.0033)
Multidisciplinary team		0.4269*** (0.0031)	0.4148*** (0.0034)		0.4491*** (0.0028)	0.4302*** (0.0033)
International team		-0.0364*** (0.0035)	-0.0399*** (0.0038)		-0.0290*** (0.0032)	-0.0431*** (0.0036)
ln(Author age)			0.0411*** (0.0036)			0.0182*** (0.0043)
ln(Author productivity)			0.0513*** (0.0030)			0.1245*** (0.0032)
ln(Author citations)			-0.0573*** (0.0017)			-0.0873*** (0.0020)
Focal field			-0.2490*** (0.0030)			-0.2628*** (0.0030)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Field FE	Yes	Yes	Yes	Yes	Yes	Yes
Journal FE		Yes	Yes		Yes	Yes
Affiliation FE			Yes			Yes
Obs.	3,304,856	3,282,703	2,650,210	3,505,475	3,484,394	2,677,601
Pseudo R2	0.02799	0.14939	0.15343	0.02075	0.14145	0.14896

Note: robust standard errors are reported in parentheses. $^{*} p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$.

Table S 3.3 Effect of the female leadership on the probability of disruptive papers.

Models	(1)	(2)	(3)	(4)	(5)	(6)
	P (Disruptive papers)					
	First author			Last author		
Female	0.1391*** (0.0029)	0.0632*** (0.0032)	0.0649*** (0.0038)	0.1221*** (0.0029)	0.0360*** (0.0032)	0.0279*** (0.0039)
Grant funding		-0.0812*** (0.0058)	-0.1320*** (0.0071)		-0.1029*** (0.0056)	-0.1507*** (0.0075)
ln(#Reference)		-0.8523*** (0.0029)	-0.8660*** (0.0033)		-0.8726*** (0.0030)	-0.8883*** (0.0036)
ln(Team size)		-0.1857*** (0.0030)	-0.1799*** (0.0035)		-0.1665*** (0.0037)	-0.1584*** (0.0045)
Multidisciplinary team		0.1129*** (0.0039)	0.1149*** (0.0044)		0.1466*** (0.0037)	0.1527*** (0.0043)
International team		-0.0850*** (0.0047)	-0.0879*** (0.0051)		-0.0874*** (0.0044)	-0.0690*** (0.0049)
ln(Author age)			0.0881*** (0.0045)			0.0435*** (0.0054)
ln(Author productivity)			0.0701*** (0.0038)			0.0876*** (0.0042)
ln(Author citations)			-0.0438*** (0.0021)			-0.0704*** (0.0026)
Focal field			-0.1264*** (0.0039)			-0.1313*** (0.0040)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Field FE	Yes	Yes	Yes	Yes	Yes	Yes
Journal FE		Yes	Yes		Yes	Yes
Affiliation FE			Yes			Yes
Obs.	3,181,201	3,167,066	2,567,637	3,389,438	3,374,407	2,599,804
Pseudo R2	0.0350	0.1458	0.1558	0.0321	0.1405	0.1494

Note: robust standard errors are reported in parentheses. $^{*} p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$.

Note 4. Female/male leadership combinations

Table S 4.1 Effect of the mixed leadership on the probability of hit papers (Team size>1).

Models	(1)	(2)	(3)
Both male	Baseline	Baseline	Baseline
First male+ last female	-0.1376*** (0.0180)	-0.0889*** (0.0207)	-0.0729** (0.0235)
First female+ last male	-0.1272*** (0.0203)	-0.00117	-0.0878*** (0.0265)
Both female	-0.3567*** (0.0191)	-0.1510*** (0.0224)	-0.1437*** (0.0257)
Grant funding		0.1899*** (0.0190)	0.0273 (0.0257)
ln(#Reference)		1.236*** (0.0169)	1.223*** (0.0190)
ln(Team size)		0.5459*** (0.0175)	0.5045*** (0.0200)
Multidisciplinary team		-0.1488*** (0.0185)	-0.1158*** (0.0208)
International team		0.1181*** (0.0185)	0.1110*** (0.0210)
ln(Author age)			-0.4001*** (0.0254)
ln(Author productivity)			-0.0020 (0.0187)
ln(Author citations)			0.2106*** (0.0115)
Focal field			0.0811*** (0.0187)
Year FE	Yes	Yes	Yes
Field FE	Yes	Yes	Yes
Journal FE		Yes	Yes
Affiliation FE			Yes
Obs.	567,494	389,748	298,924
Pseudo R2	0.013	0.25974	0.28555

Note: robust standard errors are reported in parentheses. $^{*} p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$.

Table S 4.2 Effect of the mixed leadership on the probability of novel papers (Team size>1).

Models	(1)	(2)	(3)
Both male	Baseline	Baseline	Baseline
First male+ last female	0.1331*** (0.0072)	0.0551*** (0.0082)	0.0632*** (0.0095)
First female+ last male	0.1314*** (0.0082)	0.0832*** (0.0093)	0.0806*** (0.0106)
Both female	0.2076*** (0.0073)	0.0990*** (0.0086)	0.0932*** (0.0101)
Grant funding		0.2109*** (0.0091)	0.1651*** (0.0120)
ln(#Reference)		0.8811*** (0.0060)	0.9082*** (0.0069)
ln(Team size)		0.0909*** (0.0078)	0.1323*** (0.0091)
Multidisciplinary team		0.4959*** (0.0073)	0.4847*** (0.0083)
International team		-0.00013	-0.0245** (0.0086)
ln(Author age)			0.0426*** (0.0091)
ln(Author productivity)			0.0524*** (0.0073)
ln(Author citations)			-0.0602*** (0.0042)
Focal field			-0.2311*** (0.0073)
Year FE	Yes	Yes	Yes
Field FE		Yes	Yes
Journal FE		Yes	Yes
Affiliation FE			Yes
Obs.	567,505	555,775	463,350
Pseudo R2	0.01291	0.13045	0.14442

Note: robust standard errors are reported in parentheses. $^{*} p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$.

Table S 4.3 Effect of the mixed leadership on the probability of disruptive papers (Team size>1).

Models	(1)	(2)	(3)
Both male	Baseline	Baseline	Baseline
First male+ last female	0.1352*** (0.0102)	0.0733*** (0.0113)	0.0710*** (0.0132)
First female+ last male	0.1096*** (0.0115)	0.0359** (0.0127)	0.0287. (0.0147)
Both female	0.2695*** (0.0099)	0.0887*** (0.0115)	0.0925*** (0.0137)
Grant funding		-0.0448*** (0.0131)	-0.0918*** (0.0170)
ln(#Reference)		-0.8220*** (0.0078)	-0.8722*** (0.0091)
ln(Team size)		-0.1564*** (0.0111)	-0.1655*** (0.0129)
Multidisciplinary team		0.1323*** (0.0098)	0.1480*** (0.0112)
International team		-0.0769*** (0.0109)	-0.0894*** (0.0123)
ln(Author age)			0.0699*** (0.0120)
ln(Author productivity)			0.0552*** (0.0098)
ln(Author citations)			-0.0244*** (0.0056)
Focal field			-0.1275*** (0.0102)
Year FE	Yes	Yes	Yes
Field FE	Yes	Yes	Yes
Journal FE		Yes	Yes
Affiliation FE			Yes
Obs.	567,503	545,640	448,030
Pseudo R2	0.02712	0.13341	0.15287

Note: robust standard errors are reported in parentheses. $^{*} p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$.

Note 5. Robustness check (American authors only)

Table S 5.1 Effect of the female leadership on the probability of hit papers.

Models	(1)	(2)	(3)	(4)	(5)	(6)
	P (Hit papers)					
	First author			Last author		
Female	-0.1299***	-0.0985***	-0.0698***	-0.1772***	-0.1138***	-0.0651***
	(0.0101)	(0.0115)	(0.0119)	(0.0118)	(0.0134)	(0.0140)
Grant funding		0.1174***	0.1226***		0.0325*	0.0335*
		(0.0130)	(0.0136)		(0.0150)	(0.0157)
ln(#Reference)		1.130***	1.127***		1.156***	1.151***
		(0.0108)	(0.0108)		(0.0132)	(0.0134)
ln(Team size)		0.5231***	0.5261***		0.5443***	0.5102***
		(0.0099)	(0.0100)		(0.0129)	(0.0134)
Multidisciplinary team		-0.1548***	-0.1385***		-0.1362***	-0.1181***
		(0.0136)	(0.0139)		(0.0152)	(0.0155)
International team		0.0733***	0.0552***		0.0791***	0.0749***
		(0.0157)	(0.0160)		(0.0164)	(0.0168)
ln(Author age)			-0.3802***			-0.6206***
			(0.0163)			(0.0228)
ln(Author productivity)			-0.00033			-0.1207***
						(0.0155)
ln(Author citations)			0.2106***			0.2970***
			(0.0073)			(0.0105)
Focal field			0.0816***			0.0372**
			(0.0122)			(0.0141)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Field FE	Yes	Yes	Yes	Yes	Yes	Yes
Journal FE		Yes	Yes		Yes	Yes
Affiliation FE			Yes			Yes
Obs.	849,424	681,995	668,656	796,548	631,411	618,295
Pseudo R2	0.00652	0.23854	0.25298	0.00871	0.24894	0.2643

Note: robust standard errors are reported in parentheses. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table S 5.2 Effect of the female leadership on the probability of novel papers.

Models	(1)	(2)	(3)	(4)	(5)	(6)
	P (Novel papers)					
	First author			Last author		
Female	0.1113***	0.0369***	0.0370***	0.1015***	0.0382***	0.0442***
	(0.0045)	(0.0052)	(0.0053)	(0.0047)	(0.0054)	(0.0056)
Grant funding		0.1743***	0.1715***		0.1308***	0.1371***
		(0.0061)	(0.0063)		(0.0062)	(0.0065)
ln(#Reference)		0.9122***	0.9276***		0.8893***	0.9098***
		(0.0045)	(0.0045)		(0.0049)	(0.0050)
ln(Team size)		0.0672***	0.0734***		0.1288***	0.1356***
		(0.0045)	(0.0046)		(0.0056)	(0.0058)
Multidisciplinary team		0.4847***	0.4674***		0.5027***	0.4865***
		(0.0064)	(0.0065)		(0.0063)	(0.0064)
International team		-0.0609***	-0.0563***		-0.0781***	-0.0843***
		(0.0080)	(0.0081)		(0.0073)	(0.0075)
ln(Author age)			0.0644***			0.0429***
			(0.0066)			(0.0085)
ln(Author productivity)			0.0548***			0.1552***
			(0.0053)			(0.0061)
ln(Author citations)			-0.0548***			-0.1088***
			(0.0030)			(0.0039)
Focal field			-0.2439***			-0.2695***
			(0.0054)			(0.0056)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Field FE	Yes	Yes	Yes	Yes	Yes	Yes
Journal FE		Yes	Yes		Yes	Yes
Affiliation FE			Yes			Yes
Obs.	849,424	838,686	837,136	796,548	786,450	785,015
Pseudo R2	0.01653	0.15057	0.15735	0.01353	0.14793	0.15571

Note: robust standard errors are reported in parentheses. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table S 5.3 Effect of the female leadership on the probability of disruptive papers.

Models	(1)	(2)	(3)	(4)	(5)	(6)
	P (Disruptive papers)					
	First author			Last author		
Female	0.1529*** (0.0045)	0.1000*** (0.0049)	0.0890*** (0.0050)	0.1064*** (0.0046)	0.0656*** (0.0050)	0.0593*** (0.0052)
Grant funding		0.0121* (0.0057)	0.0175** (0.0059)		-7.9E-05	-9.1E-05
ln(#Reference)		-0.0160*** (0.0039)	-0.0113** (0.0040)		-0.0665*** (0.0044)	-0.0612*** (0.0044)
ln(Team size)		0.1351*** (0.0042)	0.1401*** (0.0043)		0.0587*** (0.0053)	0.0643*** (0.0054)
Multidisciplinary team		0.0637*** (0.0060)	0.0592*** (0.0060)		0.1129*** (0.0059)	0.1088*** (0.0059)
International team		-0.1042*** (0.0074)	-0.1019*** (0.0075)		-0.0580*** (0.0068)	-0.0591*** (0.0069)
ln(Author age)			0.1713*** (0.0062)			0.1889*** (0.0080)
ln(Author productivity)			-0.0376*** (0.0049)			0.0284*** (0.0057)
ln(Author citations)			-0.0369*** (0.0028)			-0.0582*** (0.0037)
Focal field			-0.0358*** (0.0051)			-0.0407*** (0.0052)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Field FE	Yes	Yes	Yes	Yes	Yes	Yes
Journal FE		Yes	Yes		Yes	Yes
Affiliation FE			Yes			Yes
Obs.	849,424	842,181	840,884	796,548	789,459	788,274
Pseudo R2	0.02518	0.07498	0.07909	0.02358	0.07271	0.07647

Note: robust standard errors are reported in parentheses. $^* p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$.

Note 6. Robustness check (gender entropy)

Table S 6.1 Effect of the female leadership on the probability of hit papers.

Models	(1)	(2)	(3)	(4)	(5)	(6)
	P (Hit papers)					
	First author			Last author		
Female	-0.1499***	-0.1069***	-0.0746***	-0.1802***	-0.0739***	-0.0351***
	(0.0069)	(0.0077)	(0.0087)	(0.0074)	(0.0083)	(0.0099)
Gender entropy	-0.0040	-0.0128	-0.0078	0.0081	0.0119	0.0062
	(0.0118)	(0.0130)	(0.0143)	(0.0124)	(0.0137)	(0.0157)
Grant funding		0.2707***	0.1368***		0.2226***	0.0928***
		(0.0097)	(0.0123)		(0.0100)	(0.0141)
ln(#Reference)		1.282***	1.261***		1.285***	1.278***
		(0.0075)	(0.0082)		(0.0084)	(0.0098)
ln(Team size)		0.4101***	0.4304***		0.4253***	0.3995***
		(0.0068)	(0.0076)		(0.0082)	(0.0097)
Multidisciplinary team		-0.1623***	-0.1422***		-0.1406***	-0.1142***
		(0.0090)	(0.0100)		(0.0093)	(0.0107)
International team		0.1375***	0.1145***		0.1379***	0.1171***
		(0.0094)	(0.0104)		(0.0096)	(0.0108)
ln(Author age)			-0.3947***			-0.5860***
			(0.0119)			(0.0157)
ln(Author productivity)			-0.0289**			-0.1070***
			(0.0090)			(0.0109)
ln(Author citations)			0.2229***			0.2799***
			(0.0055)			(0.0074)
Focal field			0.0605***			0.0112
			(0.0089)			(0.0099)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Field FE	Yes	Yes	Yes	Yes	Yes	Yes
Journal FE		Yes	Yes		Yes	Yes
Affiliation FE			Yes			Yes
Obs.	2,839,773	2,271,860	1,769,737	3,012,204	2,389,278	1,768,853
Pseudo R2	0.00951	0.25716	0.27629	0.01108	0.2584	0.27726

Note: robust standard errors are reported in parentheses. $^{*} p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$.

Table S 6.2 Effect of the female leadership on the probability of novel papers.

Models	(1)	(2)	(3)	(4)	(5)	(6)
	P (Novel papers)					
	First author			Last author		
Female	0.1057***	0.0278***	0.0306***	0.0897***	0.0374***	0.0445***
	(0.0024)	(0.0028)	(0.0032)	(0.0024)	(0.0027)	(0.0032)
Gender entropy	0.0052	0.0039	0.0042	0.0014	0.0008	0.0008
	(0.0042)	(0.0046)	(0.0052)	(0.0041)	(0.0045)	(0.0052)
Grant funding		0.1894***	0.1370***		0.1680***	0.0960***
		(0.0045)	(0.0056)		(0.0042)	(0.0057)
ln(#Reference)		0.8630***	0.8795***		0.8470***	0.8631***
		(0.0024)	(0.0028)		(0.0025)	(0.0030)
ln(Team size)		0.0690***	0.0908***		0.1090***	0.1484***
		(0.0025)	(0.0029)		(0.0029)	(0.0035)
Multidisciplinary team		0.4274***	0.4152***		0.4500***	0.4312***
		(0.0033)	(0.0037)		(0.0031)	(0.0035)
International team		-0.0370***	-0.0407***		-0.0276***	-0.0419***
		(0.0038)	(0.0041)		(0.0035)	(0.0038)
ln(Author age)			0.0428***			0.0161***
			(0.0039)			(0.0047)
ln(Author productivity)			0.0523***			0.1259***
			(0.0032)			(0.0035)
ln(Author citations)			-0.0585***			-0.0874***
			(0.0018)			(0.0022)
Focal field			-0.2482***			-0.2645***
			(0.0032)			(0.0032)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Field FE	Yes	Yes	Yes	Yes	Yes	Yes
Journal FE		Yes	Yes		Yes	Yes
Affiliation FE			Yes			Yes

Obs.	2,839,773	2,817,715	2,274,817	3,012,204	2,992,091	2,298,506
Pseudo R2	0.02793	0.14918	0.1537	0.0208	0.14184	0.14977

Note: robust standard errors are reported in parentheses. $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table S 6.3 Effect of the female leadership on the probability of disruptive papers.

	(1)	(2)	(3)	(4)	(5)	(6)
Models	**P (Disruptive papers)**					
	First author			**Last author**		
Female	0.1630***	0.1010***	0.0843***	0.1309***	0.0747***	0.0537***
	(0.0024)	(0.0026)	(0.0030)	(0.0024)	(0.0026)	(0.0031)
Gender entropy	0.0034	0.0013	0.0041	9.5e-5	0.0017	0.0021
	(0.0042)	(0.0044)	(0.0049)	(0.0041)	(0.0043)	(0.0049)
Grant funding		-4.3E-05	-6.7E-05		-0.0513***	-0.0516***
					(0.0039)	(0.0053)
ln(#Reference)		0.0164***	-1.4E-05		-0.0267***	-0.0500***
		(0.0022)			(0.0023)	(0.0027)
ln(Team size)		0.1381***	0.1234***		0.0743***	0.0607***
		(0.0024)	(0.0028)		(0.0028)	(0.0033)
Multidisciplinary team		0.0707***	0.0782***		0.1086***	0.1147***
		(0.0031)	(0.0035)		(0.0029)	(0.0034)
International team		-0.0965***	-0.0921***		-0.0852***	-0.0673***
		(0.0035)	(0.0039)		(0.0033)	(0.0036)
ln(Author age)			0.1806***			0.1703***
			(0.0037)			(0.0045)
ln(Author productivity)			-0.0553***			0.0144***
			(0.0031)			(0.0033)
ln(Author citations)			-0.0308***			-0.0561***
			(0.0017)			(0.0021)
Focal field			-0.0374***			-0.0464***
			(0.0031)			(0.0031)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Field FE	Yes	Yes	Yes	Yes	Yes	Yes
Journal FE		Yes	Yes		Yes	Yes
Affiliation FE			Yes			Yes
Obs.	2,839,773	2,830,653	2,280,274	3,012,204	3,003,659	2,302,757
Pseudo R2	0.01798	0.07103	0.07808	0.0163	0.07081	0.07854

Note: robust standard errors are reported in parentheses. $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Note 7. Robustness check (top 10% highly cited papers)

Table S 7.1 Effect of the female leadership on the top 10% highly cited papers

Models	(1)	(2)	(3)	(4)	(5)	(6)
	P (Top 10% highly cited papers)					
	First author			Last author		
Female	-0.0247***	-0.0409***	-0.0252***	-0.0762***	-0.0363***	-0.0058.
	(0.0025)	(0.0030)	(0.0035)	(0.0025)	(0.0030)	(0.0035)
Grant funding		0.2949***	0.2037***		0.2360***	0.1563***
		(0.0044)	(0.0055)		(0.0042)	(0.0058)
ln(#Reference)		1.088***	1.067***		1.051***	1.036***
		(0.0028)	(0.0032)		(0.0029)	(0.0034)
ln(Team size)		0.3949***	0.4195***		0.3551***	0.3548***
		(0.0028)	(0.0032)		(0.0032)	(0.0038)
Multidisciplinary team		-0.1015***	-0.0941***		-0.0832***	-0.0730***
		(0.0036)	(0.0040)		(0.0034)	(0.0039)
International team		0.1067***	0.0763***		0.1100***	0.0779***
		(0.0039)	(0.0043)		(0.0037)	(0.0041)
ln(Author age)			-0.2644***			-0.3896***
			(0.0043)			(0.0053)
ln(Author productivity)			-0.0583***			-0.0724***
			(0.0035)			(0.0039)
ln(Author citations)			0.1446***			0.1737***
			(0.0020)			(0.0025)
Focal field			0.1012***			0.0538***
			(0.0035)			(0.0036)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Field FE	Yes	Yes	Yes	Yes	Yes	Yes
Journal FE		Yes	Yes		Yes	Yes
Affiliation FE			Yes			Yes
Obs.	3,304,856	3,192,210	2,581,707	3,505,475	3,384,866	2,606,275
Pseudo R2	0.01667	0.23022	0.23876	0.01755	0.22366	0.231

Note: robust standard errors are reported in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Note 8. Robustness check (raw citation count)

Table S 8.1 OLS regression: effect of the female leadership on 5-year citation counts.

Models	(1)	(2)	(3)	(4)	(5)	(6)
	Ln (5-yer citations+1)					
	First author			Last author		
Female	-0.0085*** (0.0013)	-0.0223*** (0.0010)	-0.0128*** (0.0011)	-0.0438*** (0.0012)	-0.0179*** (0.0009)	-0.0015 (0.0011)
Grant funding		0.1701*** (0.0016)	0.1283*** (0.0020)		0.1361*** (0.0014)	0.1003*** (0.0020)
ln(#Reference)		0.5652*** (0.0009)	0.5490*** (0.0010)		0.5308*** (0.0009)	0.5158*** (0.0011)
ln(Team size)		0.2510*** (0.0010)	0.2589*** (0.0011)		0.2170*** (0.0011)	0.2135*** (0.0013)
Multidisciplinary team		-0.0505*** (0.0012)	-0.0482*** (0.0013)		-0.0391*** (0.0011)	-0.0363*** (0.0012)
International team		0.0488*** (0.0013)	0.0292*** (0.0014)		0.0488*** (0.0012)	0.0296*** (0.0013)
ln(Author age)			-0.1313*** (0.0013)			-0.1677*** (0.0016)
ln(Author productivity)			-0.0325*** (0.0011)			-0.0394*** (0.0012)
ln(Author citations)			0.0714*** (0.0006)			0.0862*** (0.0008)
Focal field			0.0545*** (0.0011)			0.0343*** (0.0011)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Field FE	Yes	Yes	Yes	Yes	Yes	Yes
Journal FE		Yes	Yes		Yes	Yes
Affiliation FE			Yes			Yes
Obs.	3,304,856	3,304,856	2,668,372	3,505,475	3,505,475	2,693,457
R2	0.05225	0.47246	0.47667	0.04328	0.46099	0.4581

Note: robust standard errors are reported in parentheses. $^{*}\,p < 0.05$, $^{**}\,p < 0.01$, $^{***}\,p < 0.001$.

Note 9. Robustness check (alternative novelty scores)

We run OLS regression with alternative novelty scores to check the robustness of our findings:

$$Novelty\ score = \begin{cases} -ln(Z\ score_{10pt} + 1), if\ Z\ score_{10pt} > 0 \\ ln(-Z\ score_{10pt} + 1), if\ Z\ score_{10pt} \leq 0 \end{cases}$$

Table S 9.1 OLS regression: effect of the female leadership on the novelty scores.

Models	(1)	(2)	(3)	(4)	(5)	(6)
	Novelty scores					
	First author			Last author		
Female	0.1470***	0.0285***	0.0290***	0.1193***	0.0395***	0.0456***
	(0.0028)	(0.0026)	(0.0029)	(0.0027)	(0.0025)	(0.0029)
Grant funding		0.2279***	0.1776***		0.2109***	0.1329***
		(0.0041)	(0.0050)		(0.0037)	(0.0051)
ln(#Reference)		1.118***	1.107***		1.066***	1.058***
		(0.0022)	(0.0025)		(0.0023)	(0.0027)
ln(Team size)		0.1232***	0.1418***		0.1703***	0.2092***
		(0.0024)	(0.0027)		(0.0028)	(0.0033)
Multidisciplinary team		0.4998***	0.4779***		0.5267***	0.4988***
		(0.0031)	(0.0034)		(0.0028)	(0.0032)
International team		-0.0520***	-0.0543***		-0.0382***	-0.0540***
		(0.0035)	(0.0037)		(0.0032)	(0.0034)
ln(Author age)			0.0529***			0.0252***
			(0.0036)			(0.0043)
ln(Author productivity)			0.0551***			0.1386***
			(0.0030)			(0.0032)
ln(Author citations)			-0.0687***			-0.0983***
			(0.0017)			(0.0020)
Focal field			-0.2810***			-0.2975***
			(0.0030)			(0.0030)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Field FE	Yes	Yes	Yes	Yes	Yes	Yes
Journal FE		Yes	Yes		Yes	Yes
Affiliation FE			Yes			Yes
Obs.	3,270,418	3,270,418	2,659,680	3,476,984	3,476,984	2,686,561
Pseudo R2	0.04345	0.24445	0.25617	0.03409	0.23359	0.2481

Note: robust standard errors are reported in parentheses. $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Note 10. Robustness check (raw CD-index)

Table S 10.1 OLS regression: effect of the female leadership on CD-index.

Models	(1)	(2)	(3)	(4)	(5)	(6)
	CD-index					
	First author			Last author		
Female	0.0005***	0.0002***	0.0001***	0.0004***	0.0001***	8.71e-5***
	(1.42e-5)	(1.42e-5)	(1.58e-5)	(1.15e-5)	(1.15e-5)	(1.31e-5)
Grant funding		1.54e-5	1.39e-5		-1.32e-5	-2.77e-5
		(1.81e-5)	(2.45e-5)		(1.37e-5)	(2.16e-5)
ln(#Reference)		-0.0007***	-0.0007***		-0.0003***	-0.0002***
		(1.85e-5)	(2.07e-5)		(1.69e-5)	(1.92e-5)
ln(Team size)		-0.0006***	-0.0006***		-0.0004***	-0.0003***
		(1.38e-5)	(1.49e-5)		(1.3e-5)	(1.45e-5)
Multidisciplinary team		0.0003***	0.0003***		0.0004***	0.0003***
		(1.64e-5)	(1.78e-5)		(1.26e-5)	(1.38e-5)
International team		-0.0001***	-0.0002***		-0.0002***	-0.0002***
		(1.71e-5)	(1.83e-5)		(1.3e-5)	(1.41e-5)
ln(Author age)			0.0003***			0.0002***
			(2.08e-5)			(2.21e-5)
ln(Author productivity)			3.64e-5*			8.16e-5***
			(1.72e-5)			(1.54e-5)
ln(Author citations)			-0.0001***			-0.0001***
			(9.89e-6)			(1.02e-5)
Focal field			-0.0004***			-0.0003***
			(1.61e-5)			(1.32e-5)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Field FE	Yes	Yes	Yes	Yes	Yes	Yes
Journal FE		Yes	Yes		Yes	Yes
Affiliation FE			Yes			Yes
Obs.	3,181,201	3,181,201	2,592,199	3,389,438	3,389,438	2,624,304
R2	0.00493	0.04706	0.0597	0.00527	0.04835	0.05699

Note: robust standard errors are reported in parentheses. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Note 11. Robustness check (adjusting citation windows)

Table S 11.1 Effect of the female authorship on the probability of disruptive papers based on 5-year windows.

Models	(1)	(2)	(3)	(4)	(5)	(6)
	P (CD5>0)					
	First author			Last author		
Female	0.1637***	0.1019***	0.0860***	0.1297***	0.0738***	0.0535***
	(0.0023)	(0.0024)	(0.0028)	(0.0022)	(0.0024)	(0.0028)
Grant funding		-0.0104**	-0.0136**		-0.0526***	-0.0531***
		(0.0039)	(0.0048)		(0.0036)	(0.0049)
ln(#Reference)		0.0163***	-0.0060**		-0.0255***	-0.0480***
		(0.0020)	(0.0023)		(0.0021)	(0.0025)
ln(Team size)		0.1378***	0.1238***		0.0741***	0.0607***
		(0.0022)	(0.0026)		(0.0026)	(0.0031)
Multidisciplinary team		0.0699***	0.0768***		0.1082***	0.1144***
		(0.0029)	(0.0033)		(0.0027)	(0.0031)
International team		-0.0961***	-0.0914***		-0.0858***	-0.0678***
		(0.0033)	(0.0036)		(0.0030)	(0.0034)
ln(Author age)			0.1822***			0.1716***
			(0.0034)			(0.0041)
ln(Author productivity)			-0.0540***			0.0145***
			(0.0028)			(0.0031)
ln(Author citations)			-0.0311***			-0.0566***
			(0.0016)			(0.0020)
Focal field			-0.0387***			-0.0467***
			(0.0028)			(0.0028)

Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Field FE	Yes	Yes	Yes	Yes	Yes	Yes
Journal FE		Yes	Yes		Yes	Yes
Affiliation FE			Yes			Yes
Obs.	3,304,856	3,295,787	2,655,638	3,505,475	3,496,906	2,681,781
Pseudo R2	0.0179	0.0704	0.0771	0.0162	0.0705	0.0779

Note: robust standard errors are reported in parentheses. $^{*} p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$.

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