Online Appendix (supplementary file)

Table A1: Search-strings used in funding-focused searches in Web of Science and Scopus

Web of Science:

TS=("R01 grant*" OR "baseline grant*" OR "funding mechanism*" OR "Research fund*" OR "Science fund*" OR "funding instrument*" OR" funding scheme*" OR "federal funding" OR "well-funded scien*" OR "well-funded research*" OR "well-funded investigat*" OR "grant portfolio*" OR "investment portfolio" OR "research grant*" OR "research investment*" OR "investment* in research" OR "science grant*") AND TS=("research productivity" OR "scientific productivity" OR "scientific performance" OR "research performance" OR "research impact" OR "technological performance" OR "grant size*" OR "scientific impact*" OR "citation impact" OR "scientific quality" OR "scholarly impact" OR "scientific output*" OR "critical mass" OR "centers of excellence" OR "centres of excellence" OR "grant size*" OR "funding size*" OR "epistemic effect*" OR "research excellence" OR "scientific excellence" OR "distributional equit*" OR "allocation of funding" OR "distribution of funding" OR "research allocation*" OR "funding allocation*" OR "funding distribution*" OR "size of research funding" OR "concentrat*" OR diversity OR diversifying OR diversification* OR dispersion OR dispersal OR "increasing marginal return*" OR "decreasing marginal return*" OR "large-scale" OR "small-scale" OR "small science" OR "big science" OR "funding cap" OR "project size" OR "peer-review system" OR "strategic funding" OR "research agenda" OR "ground-breaking research" OR "scientific breakthrough*" OR concentration*)

Timespan: no limitation
Index: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI.
Document types: Article, Book, Book Chapter, Discussion or Letter.
Language: English
N publications retrieved: 1,158

Scopus:

TITLE-ABS-KEY ("R01 grant*" *OR* "baseline grant*" *OR* "funding mechanism*" *OR* "Research fund*" *OR* "Science fund*" *OR* "funding instrument*" *OR* " funding scheme*" *OR* "federal funding" *OR* "well-funded scien*" *OR* "well-funded research*" *OR* "well-funded investigat*" *OR* "grant portfolio*" *OR* "investment portfolio" *OR* "research grant*" *OR* "research investment*" *OR* "investment* in research" *OR* "science grant*" *) TITLE-ABS-KEY (* "research productivity" *OR* "scientific productivity" *OR* "scientific performance" *OR* "research performance" *OR* "research impact" *OR* "technological performance" *OR* "grant size*" *OR* "scientific impact*" *OR* "citation impact" *OR* "scientific quality" *OR* "scholarly impact" *OR* "scientific output*" *OR* "critical mass" *OR* "centers of excellence" *OR* "centres of excellence" *OR* "grant size*" *OR* "funding size*" *OR* "epistemic effect*" *OR* "research excellence" *OR* "scientific excellence" *OR* "distributional equit*" *OR* "allocation of funding" *OR* "distribution of funding" *OR* "research allocation*" *OR* "funding allocation*" *OR* "funding distribution*" *OR* "size of research funding" *OR* "concentrat*" *OR* diversity *OR* diversifying *OR* diversification* *OR* dispersion *OR* dispersal *OR* "i ncreasing marginal return*" *OR* "decreasing marginal return*" *OR* "large-scale" *OR* "small-scale" *OR* "small science" *OR* "big science" *OR* "funding cap" *OR* "project size" *OR* "peer-review system" *OR* "strategic funding" *OR* "research agenda" *OR* "ground-breaking research" *OR* "scientific breakthrough*" *OR* concentration* *)*

Timespan: no limitation
Document types: no limitation
Language: no limitation
N publications retrieved: 2,231

Table A2: Search-strings used in searches combining a focus on funding and group size in Web of Science and Scopus

Web of Science:
TS =("funding structure*" OR "grant award*" OR "research council" OR "funding agency" OR "science agency" OR "centers of excellence" OR "centres of excellence" OR "R01 grant*" OR "baseline grant*" OR "funding mechanism*" OR "Research fund*" OR "Science fund*" OR "funding instrument*" OR "funding scheme*" OR "federal funding" OR "well-funded scien*" OR "well-funded research*" OR "well-funded investigat*" OR "grant portfolio*" OR "investment portfolio" OR "research grant*" OR "research investment*" OR "investment* in research" OR "science grant*") AND TS = ("lab size*" OR "group size*" OR "big group*" OR "small group*" OR "team siz*" OR "big team*" or "small team*")

Timespan: no limitation
Index: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI.
Document types: Article, Book, Book Chapter, Discussion or Letter.
Language: English
N publications retrieved: 52

Scopus:
TITLE-ABS-KEY ("funding structure*" *OR* "grant award*" OR "research council" OR "funding agency" OR "science agency" OR "centers of excellence" OR "centres of excellence" OR "R01 grant*" OR "baseline grant*" OR "funding mechanism*" OR "Research fund*" OR "Science fund*" OR "funding instrument*" OR "funding scheme*" OR "federal funding" OR "well-funded scien*" OR "well-funded research*" OR "well-funded investigat*" OR "grant portfolio*" OR "investment portfolio" OR "research grant*" OR "research investment*" OR "investment* in research" OR "science grant*") TITLE-ABS-KEY ("lab size*" OR "group size*" OR "big group*" OR "small group*" OR "team siz*" OR "big team*" OR "small team*")

Timespan: no limitation
Document types: no limitation
Language: no limitation
N publications retrieved: 126

Table A3: Empirical studies on the relation between funding size and scientific performance

Reference	Study type	Study population/Sample	Country	Time period	Focus	Results
Arora et al. (1998)	Observation	797 research units applying to a research program in biotechnology and bioinstrumentation funded by the National Research Council in Italy	Italy	1989-1993	Link between size of units/size of research funds and research output	Adjusting for multiple potential confounders, the study finds that unit size does not affect research output. The study, however, finds that "a more unequal distribution of research funds would increase research output in the short-run".
Asonuma and Urata (2015)	Observation	Competitive and Basic research funds for Japanese researchers in 1992 and 2007	Japan	NS	Link between amount of funding and research output	Finds diminishing returns in terms of research output per researcher with increasing amounts of funding
Berg (2010a) Berg (2010b)	Observation	2,938 investigators/labs receiving grants from the National Institute of General Medical Sciences in 2006	USA	2007-2010	Link between grant size and research output/average journal impact factor	Finds that research output and the average journal-impact factor per lab decrease with funding above ~$750,000. Research output and the average journal-impact factor per lab increased modestly with funding above ~$250,000–300,000).
Bloch et al. (2016)	Observation	57 Centers of excellence (CoE) funded by the Danish National Research Foundation	Den-mark	1993-2011	Link between grant-size and research output and citation impact	Finds that larger CoEs have higher average citation impact and more top-cited papers. However panel data indicate that the citation performance on both metrics decrease over the course of the granting period for the largest CoE, while increasing for the smallest 50%. The authors estimate that the optimal annual grant size is €1.45 million. Similarly, they estimate that the average citation impact of CoEs peaks at 6.7 grant years.
Breschi and Malerba (2011)	Observation	734 European Commission FP6 projects funded by the Information Society and Media Directorate	Europe	NS	Link between project size, grant size and research output	In negative binomial regression models, a slight positive association is found between the proportion of university-based project partners and research output (B=.0121, SE=.003, p<.01) and between average grant size per partner and scientific output (B=1.067, SE=.238, p<.01). Further, the study shows diminishing returns of the number of project participants on research output (B=.073, SE=.020, p<.01) with an estimated inflection point at 52 participants. The log of total funding per project also indicates diminishing returns of increasing grant sizes (B=0.595, SE=.118, p<.01).
Danthi et al. (2016)	Observation	623 De novo R01 grants funded by the National Heart, Lung, and Blood Institute in 2009 distributed on 458 payline grants and 165 ARRA grants.	USA	2009-2014	Link between grant size and field normalized citation impact (comparing the citation impact of payline grants (median funding: ($1.87 mill.) vs. ARRA grants (median funding: $ 1.03 mill.)	Adjusting for potential confounders, the study finds that ARRA and payline grants have similar normalized citation impact per $1 mill spent.
Doyle et al. (2015)	Observation	1,755 de novo investigator-initiated R01 grants funded for at least two years by the National Institute of Mental Health between 2000 and 2009.	USA	2000-2009	Link between grant size and citation impact	Finds an association between total award-dollars per grant and normalized citation impact, but with diminishing marginal returns. Using forest regressions, the study finds decreasing grant size to be one of the three most important predictors of returns to investment on citation impact per $million spent.
Fedderke and Goldschmidt (2015)	Observation	76 research chairs awarded by the National Research Foundation (NRF) of South Africa. 67 A-rated researchers without NRF chairs. 157 B-rated researchers without NRF chairs.	South Africa	2009-2012	Link between grant-success and research output	Finds that funding success is associated with moderate gains in publication and citation rates compared to researchers at equivalent standing without chairs. A comparison of high-performing researchers with and without chairs (based on propensity-score matching) indicates that the costs of each additional publication for funding recipients is 22 times as high as for equivalent researchers without funding. Further, the additional cost per citation is 32 times as high.
Fortin and Currie (2013)	Observation	374 individual researchers in three Biology, Chemistry and Ecology disciplines funded by the Natural Sciences and Engineering Research Council of Canada in 2002.	Canada	2002-2007	Link between grant size and research output and impact	Funding size "accounts for between R-square=0.03 to R-square=0.28 of the among-researcher variation in impact" (i.e. citation impact). Average scientific impact generally decreased with funding size. Receiving additional funds other federal granting councils did not result in higher scientific impact.
Gallo et al. (2014)	Observation	227 projects funded by the American Institute of Biological Sciences.	USA	2004-2011	Link between grant size and total-relative citation	The study created nine levels of funding in $400.000 increments, comparing the average TRC per winning application for each level. The study found no

					impact (TRC)	statistically significant difference in TRC across the funding levels (F[8,217] = 1.50; p = 0.16). The total annual TRC correlated moderately with the number of funded applications (R-square= 0.64, p = 0.017), but not with the total annual programmatic budget (R-square =0.17, p= 0.32).
Gaughan and Bozeman (2002)	Observation	436 PhD level scientists and engineers in biotechnology and microelectronics-related with funding grants. Of these 177 are recipients of NSF center grants.	USA	NS	How center funding influences individual researchers' research output	Adjusting for potential confounders, the study finds no association between Center funding and research output. However, having another type of government or foundation grant is associated with increasing research output (B=.028, SE=.11, p<.05). In general, grant volume slightly (i.e. number of grants) improves performance (B=.03, SE=.01, p<.05).
Gök et al. (2016)	Observation	All researchers from BE, DK, NL, NO, CH and SE with publications in WoS in the period 2009-2011 (242,406 articles)	Europe	2009-2011	Link between funding intensity/funding variety and citation impact per paper	In per-country logistic regressions adjusting for country of co-authors, broad subject categories, number of authors and publication year the study finds a negative association between funding intensity (i.e. the number of funding sources acknowledged in a paper/number of authors) and per-paper citation rates. A positive association is shown between funding variety (i.e. "number of funders/the number of unique funders per each paper) and citation impact.
Ida and Fukuzawa (2013)	Observation	374 Japanese research teams of which some were funded as Centres of Excellence.	Japan	1997-2008	Comparing the impact of CoE funding on research output and impact	Comparing the citation and publication rates of CoE participants before and after funding (difference in difference) with the performance a control group, the study finds a positive association between CoE funding and research output in four out of eight scientific fields. Further, it shows a positive association between CoE funding and citation impact in three out of eight fields. In the remaining fields no statistically significant association between CoE funding and research output and impact is demonstrated, with one exception: the study shows a negative association between CoE funding and citation impact in Mathematics and Physics.
Jung et al. (2017)	Observation	Researchers receiving grants from South Korea's National Research Foundation between 2003 and 2009. Analysis was based on 3228 published paper.	South Korea	NS	Link between amount of funding and journal impact factor and journal ranking	In regressions adjusting for multiple confounders, the study finds that funding size correlates slightly negatively with journal impact factor per paper and journal ranking per paper.
Katz and Matter (2017)	Observation	Recipients of NIH R grants in the period 2005-2010. N is not specified for the given period of analysis, but the data are taken from a larger sample of nearly 90,000 NIH funded projects between 1985 and 2015.	USA	2005-2010	Link between distribution of funding and scientific performance	Finds that the most highly funded R-grant recipients have a considerably larger number of publications, than less funded recipients, accumulate a larger number of citations and have more publications in the most prestigious journals. The study does not look into possible inflection points for diminishing marginal returns.
Langfeldt et al. (2015)	Observation	12 Scandinavian Centres of Excellence. Performance is measured 5 years prior to and after the establishment of the CoEs.	Scandi-navia	NA	Link between CoE grants and research output, normalized journal impact and normalized citation impact	Based on descriptive analysis, it is concluded that "CoE grants seem to have limited impact for some already high performing and distinguished groups (…) [T]he status and opportunities offered by the CoE grant add less to the situation of some of the highest performing groups, than for less recognized groups".
Lauer et al. (2015)	Observation	6873 de novo cardiovascular R01 grants funded by the National Heart, Lung, and Blood Institute between 1980 and 2011	USA	1980-2011	Link between grant size and citation impact (in terms of top-10% most cited papers)	Finds an association between annual total budget per project and citation impact in terms of field-normalized top-10% most cited papers, but with varying marginal returns depending on funding size. Finds an association between total grant budget and top-10% most cited paper rates but with diminishing returns on investment.
Lauer et al. (2017)	Observation	71,936 researchers funded by the NIH between 1996 and 2014.	USA	1996-2014	Link between grant size and citation impact (measured by three metrics)	Finds diminishing returns in terms of citation impact with increasing grant sizes.
Mongeon et al. (2016)	Observation	12,720 unique funding recipients in Quebec between 1998-2012	Canada	2000-2013	Link between grant size and research output and impact	Finds that increasing research funding yields decreasing marginal returns with respect to research output and citation impact (including top-10 percent most cited) in both health research, science and engineering research and social science research. The study concludes that researchers receiving a moderate amount of funding provide the best returns in terms of research output and citation impact per dollar.
Nag et al. (2013)	Cross-sectional survey	720 Bio-scientists performing agriculturally related molecular or cellular	USA	2003-2006	Link between financial support/lab size and research	Adjusting for multiple potential confounders, the study finds that that the mean bioscience laboratory "is too large to make efficient use of its resources". A 10%

		level research (total sample 1441)			output	boost in laboratory budget results in a 7.5% increase in article output.
Shibayama (2011)	Observation	Projects supported by the Japanese Grants-in-Aid since 1965, i.e. approx. 600,000 grants and 210,000 funded university researchers.	Japan	2001-2005	Efficiency of funding distribution in terms of research output	Finds inequality in research funding (calculated by the Gini-coefficient) to be larger than the inequality in research output (calculated by the Gini-coefficient) at the institutional level (.845 vs .919) and at the level of the individual researcher (.592 vs. .685).
Spanos and Vonortas (2012)	Cross-sectional survey	Randomly selected sample of 54,492 participating organizations funded through the European Framework Programme 5 and 6. Final sample employed in the analysis: 583/586 organizations	Europe	2006	Link between funding size/N project partners and research output/technological output (patents)	Adjusting for multiple project-level controls, the study does not find a statistically significant relationship between funding size and research output (B= .23, p>.1.) or technologic output (B= .24, p>.1) and number of project partners and research output (B=.88 , p>.1) or technologic output (B= .39, p>.1)
Yan et al. (2018)	Observation	5 core-journals from 7 STEMM disciplines	International	2010-2016	Link between funding size and citation impact	Funding size is found to increase citation impact considerably. Number of funding sources is a weak predictor of citation impact.

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Methods and results: Team size and research performance

To identify research exploring associations between research performance and the size of groups, teams, units or labs, we carried out semi-automated searches in WoS and Scopus. Our search strategy for this part of the literature survey may not be exhaustive and should only be seen as indicative of main conclusions in the literature. Based on the search strings presented in Table A3, we retrieved 420 potentially relevant papers

from Web of Science and Scopus (Figure A1). Of these, 44 were excluded due to overlap between the databases. An additional 352 papers were excluded after reviewing titles, abstracts and (in instances of doubt) full-texts. The final sample of eligible papers identified in WoS and Scopus consisted of 15 papers, of which 14 were accessible for us through Aarhus University's library databases. As demonstrated by the dashed text box in Figure A1, we identified 12 additional papers through snowball methods. Only 10 of these were accessible through Aarhus University's library database. Our final sample consists of 24 papers (A reference list is included at the bottom of the appendix).

In accordance with the literature on funding size presented in section 5.1, the scholarship on team size is characterized by inconsistencies in how 'team size' and 'research performance' are conceptualized and measured. However, a few general conclusions can be synthesized from the results. Apart from the following studies mentioned in brackets (Engels et al. 2013; Kenna and Berche 2012; Louis et al. 2007; van Raan 2007; Wallmark and Sellerberg 1966; Wallmark et al. 1973; Qurashi 1984), the literature on team size and research performance can be subsumed under the following three types of main conclusions: 1) A number of studies find no association between unit-, group- and lab-size and research output (Bonaccorsi and Daraio 2005; Cohen 1980; Cohen 1981; Horta and Lacy 2011; Kretschmer 1985; Seglen and Aksnes 2000). 2) Some studies find diminishing returns to scale at the group size-level (Brandt and Schubert 2013; Cook et al. 2015; Conti and Liu 2014; Qin and Buccola 2017). 3) Finally, other studies find an inverse relationship between number of researchers per lab and productivity; or in other words small-/medium-sized-labs do better than large ones (Carayol and Matt 2004; Carayol and Matt 2006; Hsiehchen, Espinoza and Hsieh 2015; Kenna and Berche 2011; Perovic et al. 2016; Qurashi 1991; van der Wal et al. 2009).

Web of Science:

TS= ("group*" OR "lab*" OR "team*" OR "unit*") AND TS= (size* OR scale*) AND TS=(science OR research) AND TS= ("research impact" OR "citation impact" OR "scholarly impact" OR "scientific impact" OR "research productivity" OR "scientific productivity" OR "scholarly productivity" OR "research performance" OR "scientific performance" OR "scholarly performance" OR "citation performance" OR "publication output" OR "scholarly output" OR "research output" "scientific output" OR "number of publications" OR "number of citations" OR "citation rate*" OR "publication rate*" OR "number of articles" OR "number of papers")) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article)

Timespan: no limitation
Index: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI
Document types: Articles
Language: English
N publications retrieved: 332

Scopus:

TITLE-ABS-KEY ("group*" OR "lab*" OR "team*" OR "unit*") AND TITLE-ABS-KEY (size* OR scale*) AND TITLE-ABS-KEY (science OR research) AND TITLE-ABS-KEY ("research impact" OR "citation impact" OR "scholarly impact" OR "scientific impact" OR "research productivity" OR "scientific productivity" OR "scholarly productivity" OR "research performance" OR "scientific performance" OR "scholarly performance" OR "citation performance" OR "publication output" OR "scholarly output" OR "research output" "scientific output" OR "number of publications" OR "number of citations" OR "citation rate*" OR "publication rate*" OR "number of articles" OR "number of papers")

Timespan: no limitation
Document types: no limitation
Language: no limitation
N publications retrieved: 88

Table A4. Search-strings used in general group-focused searches in Web of Science and Scopus

Figure A1. Flowchart of article inclusion and exclusion in the literature survey

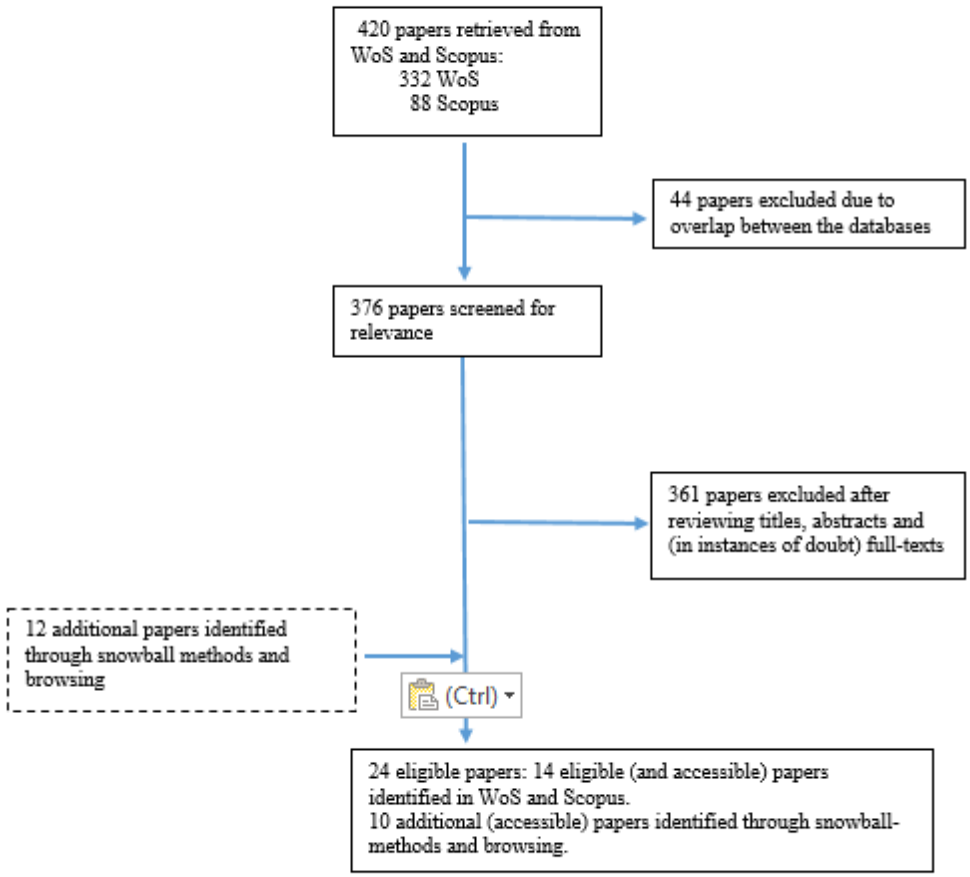

Table A5: Empirical studies on the relationship between team size and research performance

Reference	Study type	Country	Study population/Sample	Time period	Focus	Results
Bonaccorsi and Daraio (2005)	Observation	Italy	187 institutes in multiple disciplines funded by the National Research Council in Italy.	1997	Link between size of institutes and research output.	Using simple Pearson correlation, the study finds no association between institute size and research output per researcher. In chemistry, engineering and environmental science, size correlates negatively with research output per researcher.
Brandt and Schubert (2013)	Cross-sectional survey	Germany	Survey responses from a total of 473 chairs and corresponding extra-university units combined with institution-specific data.	2007-2009	Link between group size and research output and citation impact.	Adjusting for multiple confounders, including time for research, research group characteristics, PI characteristics, and discipline, the study finds decreasing returns to scale at the group-size level for both publications and citations.
Carayol and Matt (2004)	Observation	France	Archival data from more than 80 labs belonging to Louis Pasteur University (ULP) of Strasbourg.	1993-2000	Link between lab size and lab research output.	Adjusting for potential confounders, including number of PhDs, Postdocs and technical staff per permanent researcher, share of full time researchers, age of permanent researchers and discipline, the study finds an inverse relationship between the number of permanent researchers per lab and publication productivity (β= -0.036, SE=0.018, P>0.05). Conclusion: small sized labs do better than large ones.
Carayol and Matt (2006)	Observation	France	Archival data from 79 labs belonging to Louis Pasteur University (ULP) of Strasbourg.	1993-2000	Link between lab size and the publication rates of individual researchers.	Adjusting for potential confounders, including researcher age, professional status, discipline, share of permanent and full-time researchers, and lab funding, the study finds that the number of permanent researchers is negatively associated with publication intensity per researcher. Conclusion: individual researchers publish more when they are in in smaller labs.
Cohen (1980)	Observation	United States	60 laboratories at Rockefeller University.	1977-1978	Link between group size and research output	The study finds the number of papers per capita to be roughly independent of the size of the collaborating group.
Cohen (1981)	Observation	United States	21 units at the National Cancer Institute, Bethesda, Maryland US and 46 units at the National Institute for Medical Research in London.	1976-1977/ 1977-1978	Link between group size and research output.	The study finds no correlation between group size and research output.
Cook et al. (2015)	Observation/Cross-	United Kingdom	Research groups in biomedical research departments in the UK.	2008-2012/ 2009-2013	Link between group size and research output, citation impact	The study finds a "diminishing returns" relationship between group

	sectional survey		Information on 398 PI-based groups out of a population of 2,489.		and journal impact.	size and number of papers (B=.57, SE=.06); Spearman's rank correlation =.20, p<.001). A very weak association between group size and average journal impact factor is shown (B=.10, p=.004); Spearman's rank correlation =.14, p=.004). A very weak association between group size and citations per year (B=.10, p=.04) is shown; Spearman's rank correlation =.15, p=.004).
Conti and Liu (2015)	Observation	United States	119 laboratories at MIT's Department of Biology between 1966 and 2000.	1966-2000	Link between lab-size and research output and break-through papers (i.e. papers in the most prestigious outlets).	In regression models adjusting for multiple confounders, the study finds diminishing returns (in terms of research output) as lab-sizes increase. "For the average-sized laboratory, adding one additional member is correlated with an increase in the number of a laboratory's publications by 0.24". An inflection point for diminishing returns is identified at 25 lab participants. The study finds diminishing returns in terms of break-through publications (i.e. publications in the most prestigious journals) as lab-size increases. "Adding one member to the mean laboratory's size increases the likelihood of breakthroughs by 0.03", compared to an average probability of breakthrough articles of 0.39. An inflection point for diminishing returns is identified at 22 lab participants.
Engels et al. (2013)	Observation	Belgium	52 research groups at the University of Antwerp within the fields of Biology, Chemistry, Computer Science and Mathematics, Pharmaceutical Sciences and Physics.	2008-2011	Factors explaining evaluative assessments of research-group quality and productivity. Apart from discipline, the predictors are group size, h-index of the group leader and efficiency.	Using cumulative logistic regressions, the study finds that in addition to discipline, the variables that explain the quality and productivity assessments are the size of the research group, the average yearly number of publications in top journals per full-time-equivalents and the h-index of the group leader.
Hsiehchen, Espinoza and Hsieh (2015)	Observation	International	+24 million articles published over four decades indexed in the Thomson Reuters Web of Science (WOS).	1973-2009	Analysis of multinational research and its citation impact.	The study shows a cumulative advantage of having additional authors and unique countries involved with respect to per-paper citation impact. However, no clear association between author numbers and citations are found for team sizes beyond 20 members. Further,

						the study shows decreased citations per-capita among top-ranked papers (top 1%).
Horta and Lacy (2011)	Cross-sectional survey	Portugal	+9,000 PhD-holding researchers at public and private universities belonging to 283 research units. Final sample employed in the analysis = N 743.	2005-2007	Link between unit size and research output.	Adjusting for age, gender, funding, rank, field and nationality, the study does not find a notable relationship between unit size and total individual research output (B=.000, p>.1). Yet, researchers in small units publish more in national journals and large units publish more in international journals.
Kenna and Berche (2011)	Observation	United Kingdom	Data from the UK Research Assessment Exercise (RAE) on +1,000 UK research groups from multiple disciplines spanning the Humanities, Social Sciences, Health Sciences and Natural Sciences.	2008	Link between group size and research quality (based on the UK Research Assessment Exercise in 2008).	Based on a mathematical model accounting for variations in cooperative behavior, the study finds that the "overall research performance of a given discipline is improved by supporting medium-sized groups over large-ones, while small groups must strive to achieve critical mass". Medium group-sizes and critical mass points vary by discipline.
Kenna and Berche (2012)	Observation	United Kingdom	2008 Data from the UK Research Assessment Exercise (RAE). Extension of Kenna & Berche (2011).	2008	Estimations of optimal group size for achieving a critical mass (i.e. a group size above which research quality markedly improves).	The study finds two critical-mass points: An upper limit and a lower limit. Upper and lower limits vary by discipline. In conclusion, the best performing teams in terms of RAE assessments have sizes slightly above the upper critical mass.
Kretschmer (1985)	Observation	NS	Approx. 450 scientists in 56 research groups in molecular biology.	5 years	Link between group size and research output.	The study finds no relationship between group size and per-capita research output.
Louis et al. (2007)	Cross-sectional survey	United States	A sample of 1,077 graduate students and postdoctoral fellows from 115 departments in computer science, chemical engineering and the life sciences.	2000	Link between work-group size and publication rates of advanced graduate students and postdoctoral fellows.	The study finds a positive association between work-group size and individual publication rates, adjusting for extreme lab sizes (>15 or >people). The findings suggest that graduate students and postdocs in a typical university setting benefit from being in larger labs.
Perovic et al. (2016)	Observation	United States	Data from 27 experiments conducted in Fermilab, a high-energy physics lab.	1981-1995	Link between team size and team performance in terms of publication and citation rates.	Using Data Envelopment Analysis, the study finds a curvilinear relationship between team size and efficiency. Teams of moderate sizes are more efficient in terms of publication and citation rates. No clear estimations are given on optimal team

						sizes.
Qin and Buccola (2017)	Cross-sectional survey	International	Survey administered to 25 investigators funded through a USAID fishpond program.	2007-2009	Link between lab size and a study's degree of knowledge change (i.e. mean surprise) and predictive precision (mean precision).	The study finds that increasing lab sizes bring "decreasing returns to scale in the mean-surprise dimension and insignificant returns in the precision dimension" (p. 946).
Qurashi (1984)	Observation	United Kingdom and United States	46 laboratories at the National Cancer Institute (NCI) (US) and 21 laboratories at the National Institute of Medical Research (NIMRC) (UK).	1976-1977/ 1977-1978	Link between lab sizes and research output.	The study finds three peaks in research output for NCI at group size 7, 16 and 28 and finds two peaks in research output for NIMRC at group size 6 and 17.
Qurashi (1991)	Observation	Bangladesh, Pakistan	Two research groups, one from Bangladesh and one from Pakistan.	1944-1965 1952-1984	Link between group-size and per-capita publication rate.	The study finds that "the per-capita publication rate (…) increases linearly with group size for small groups up to N<5, but that it does not increase as fast for larger group sizes and, in fact, reaches a maximum for N between 6 and 8".
Seglen and Aksnes (2000)	Observation	Norway	Articles by 3,846 biomedical and microbiological researchers in 180 research groups.	1992-1996	Link between group size and research output.	The study finds no notable correlation between group size and research output, i.e. the per author research output is independent of group size.
van der Wal et al. (2009)	Observation	United Kingdom	Publication statistics of the UK's Centre for Ecology and Hydrology (CEH) extracted from the Web of Science.	2003-2005/1999-2001/2000-2002/1999-2005	Link between unit size and per-researcher publication output.	The study finds that per-researcher publication productivity decreases with increasing unit sizes. The productivity per scientist was greatest for groupings with up to 30 scientists after which productivity declined.
van Raan (2007)	Observation	Netherlands	All chemistry research from the Netherlands covered by Web of Science and published between 1991 and 2000. The analysis covers 700 researchers, 18,000 publications, and 175,000 citations of 157 chemistry groups.	1991-2000	Dependence of group size (measured by number of publications) on several main bibliometric indicators with a focus on distinguishing between top-performing and lower-performing groups.	The study finds that the "total number of citations received by research groups increases in a cumulatively advantageous way as a function of size only for groups publishing in fields of low citation density, regardless of performance" (p. 574). For low performance groups, "the fraction of non-cited publications decreases considerably with size" (p. 574).
Wallmark and Sellerberg al. (1966)	Observation	International	Articles in the Science Citation Index dealing with laser or optical maser from 1964 (24 teams).	NS	Link between group size and citation impact.	The study finds that the mean citation impact of the "team increases linearly with team size by about one percent per additional author" (p 137).
Wallmark et al. (1973)	Observation	International	Articles in the Science Citation index dealing with "Gunn effect" published between 1965 and 1970 (18 teams).	NS	Link between group size and citation impact.	The study finds that citation impact "increases exponentially with size of the research team". More specifically the citation impact rises by 2.7 percent per additional team member, with no indication of a maximum size.

Final set of 24 references included in the review of team size and performance

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