

Müller-Langer, Frank; Fecher, Benedikt; Harhoff, Dietmar; Wagner, Gert G.

Working Paper

The economics of replication

Munich Discussion Paper, No. 2017-3

Provided in Cooperation with:

University of Munich, Department of Economics

Suggested Citation: Müller-Langer, Frank; Fecher, Benedikt; Harhoff, Dietmar; Wagner, Gert G. (2017) : The economics of replication, Munich Discussion Paper, No. 2017-3, Ludwig-Maximilians-Universität München, Volkswirtschaftliche Fakultät, München, <http://nbn-resolving.de/urn:nbn:de:bvb:19-epub-31972-3>

This Version is available at:

<http://hdl.handle.net/10419/162381>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



Frank Mueller-Langer; Benedikt Fecher; Dietmar Harhoff;
Gert G. Wagner:

The Economics of Replication

Munich Discussion Paper No. 2017-3

Department of Economics
University of Munich

Volkswirtschaftliche Fakultät
Ludwig-Maximilians-Universität München

Online at <http://epub.ub.uni-muenchen.de/31972/>

The Economics of Replication

Frank Mueller-Langer^{1,2}, Benedikt Fecher^{3,4}, Dietmar Harhoff^{1,5} and Gert G. Wagner^{3,6,7*}

¹Max Planck Institute for Innovation and Competition, Department of Innovation and Entrepreneurship Research

²European Commission, Joint Research Center

³German Institute for Economic Research (DIW Berlin)

⁴Alexander von Humboldt Institute for Internet and Society, Internet-enabled Innovation

⁵LMU, Munich School of Management

⁶Max Planck Institute for Human Development, Fellow

⁷Berlin University of Technology (TUB), Faculty of Economics and Management

Munich and Berlin, 30 January 2017

Abstract

Replication studies are considered a hallmark of good scientific practice. Yet they are treated among researchers as an ideal to be professed but not practiced. To provide incentives and favorable boundary conditions for replication practice, the main stakeholders need to be aware of what drives replication. Here we investigate how often replication studies are published in empirical economics and what types of journal articles are replicated. We find that from 1974 to 2014 less than 0.1% of publications in the top-50 economics journals were replications. We do not find empirical support that mandatory data disclosure policies or the availability of data or code have a significant effect on the incidence of replication. The mere provision of data repositories may be ineffective, unless accompanied by appropriate incentives. However, we find that higher-impact articles and articles by authors from leading institutions are more likely to be subject of published replication studies whereas the replication probability is lower for articles published in higher-ranked journals.

Keywords: Replication, economics of science, science policy, economic methodology

JEL codes: A1, B4, C12, C13

* We gratefully acknowledge financial support from the German Research Foundation (DFG) under the project European Data Watch Extended (DFG-Grant Number WA 547/6-2). We thank Fabian Gässler, Bronwyn Hall, Karin Hoisl, Joachim Wagner, Stefan Wagner and Peter Winker as well as seminar and conference participants at MPI-IC, LMU Munich, and TUM School of Management for comments. Moritz Mosenhauer, Wolfgang Rösch, and Christoph Winter provided research assistance.

1 Introduction

The scientific community has repeatedly experienced instances of misconduct and erroneous analyses (Lacetera and Zirulia, 2011). The data fraud scandal concerning social psychologist Diedrik Stapel (Levelt et al., 2012), Hwang's fraudulently reported breakthroughs in stem-cell research (Cyranoski, 2006), or Schoen's entirely fabricated results on organic transistors in over 40 publications (Grant, 2002) are only the most prominent examples. In times of increasing publication rates and data-intense research, the traditional peer review alone is unlikely to guarantee the correctness of published findings. Given the increasing demand for science to be open and transparent (e.g., regarding access to scientific outputs), expectations regarding the replication of published results are growing. However, despite its importance, replication is an ideal professed but not practiced among researchers (Duvendack et al., 2015; Hamermesh, 2007).

Here we investigate how often replication studies are published in empirical economics and which types of journal articles are replicated. We find that high-impact articles and articles by authors from leading institutions are more likely to be replicated, but the overall incidence of less than 0.1% of articles being replications is surprisingly low. We do not find empirical support for the hypothesis that the lower cost of replication that is associated with the availability of data or code has a significant effect on the incidence of replication. Our results suggest that the mere provision of data repositories may be ineffective, unless accompanied by appropriate incentives.

The remainder of the paper is organized as follows. Section 2 provides an overview of the data, sample creation and variables under study. In Section 3, we outline the methodological approach. Section 4 discusses our results and provides robustness checks. Section 5 concludes.

2 Data and variables

The period under study is 1974 to 2014. We consider all replicated and nonreplicated articles published in issues of the top 50 economics journals that contain at least one replicated article. Our sample consists of 1,243 articles, 10.5% of which are subject to replication studies. Our definition of replication studies includes (a) narrow replications using the same data and methods as the replicated article, (b) wide replications using the same methods but different data, (c) replications using the same data but different methods, and (d) replications that use new data and new methods (Duvendack et al., 2015).

2.1. Data and sample creation

We followed two distinct strategies to identify replication studies. First we considered Web of Science (WoS) metadata for all articles published in the top 50 economics journals (in total, 126,505 articles) and counted how often indicative terms such as “replication,” “reassessment,” “reexamination,” “revisit,” “retesting,” or “reappraisal” among others appeared in the titles and abstracts of these articles. All articles were ranked in terms of the likelihood of being a replication study.

For the 100 highest-ranked articles of each journal, we studied the articles in detail in order to identify replication studies. In addition, we included all eligible replication studies published on the website of *ReplicationWiki*² in our data set. We then identified the respective journal article (henceforth, replicated article) that was the subject of any replication study. For the analysis, we only considered empirical research articles and removed purely theoretical articles. We defined a purely theoretical article as an article that does not use any data. We

² http://replication.uni-goettingen.de/wiki/index.php/Main_Page (last accessed 30 January 2017)

searched for summary statistics and statistical tables in the PDFs in order to distinguish between empirical and purely theoretical articles. Lastly, we considered all replicated and nonreplicated articles published in issues with at least one replicated article. From the 1,243 published journal articles in our sample 130 are replicated articles (1,113 nonreplicated articles).

Among the top 50 economics journals (according to the WoS impact factor), 23 had published at least one replicated article in the past. Table 1 provides an overview of the journals under study.

[Table 1 HERE]

We retrieved article metadata from WoS, i.e., publication date, number of references, pages and authors, and journal information. We gathered information on the rank position of the institutions that the authors are affiliated with from the Ranking Web of Universities 2014 and obtained author citation metrics from Scopus.

Following Andreoli-Versbach and Mueller-Langer (2014) we identified journals that have data disclosure policies in place and the first volume in which the policy was adopted in order to identify articles that are subject to a data disclosure policy. In our sample, nine of the 23 journals under study have a mandatory data disclosure policy (see Table 1). Notably, *Experimental Economics* is the only top-50 economics journal with an explicit replication policy. Its website indicates: “*Lastly, the journal publishes articles with a primary focus on methodology or replication of controversial findings.*” Two other replication policies (JPE and Labour Economics) were suspended, according to the editors, due to a lack of interest in replication (Hamermesh, 2007). Moreover, 292 of the empirical articles under study are subject to a mandatory data disclosure policy. Notably, the data sets used or program codes are available on the respective journal website for 183 of these articles (62.7%). We identified one article out

of 292 that was subject to a mandatory data disclosure policy, but for which the data or program code was not available because it was proprietary (which leads to an exemption from disclosure). This suggests that for 37% (108) of the 292 empirical articles subject to mandatory data disclosure policies, the data or program code was not available although the data was not proprietary. This result raises concerns regarding the enforcement of mandatory data disclosure policies. Figure 1 illustrates the total number of articles published under a mandatory data disclosure policy and the total number of articles published under a mandatory data disclosure policy where the policy is not strictly enforced. It suggests that both numbers increase over time and that for a large share of journals mandatory data disclosure policies are announced but not always enforced or monitored.

[Figure 1 HERE]

We also analyzed the funding guidelines of 36 research funding bodies worldwide regarding their data management policies. To this end, we randomly selected 27 public funding bodies from the 15 countries with the highest public expenditure for research according to the OECD (2016). We added 9 funding bodies that are not necessarily public, but that support noncommercial research (e.g., Bill and Melinda Gates Foundation), that are international (e.g., the European Commission's Horizon 2020), or that are from countries that are too small to appear in the list of the top funding countries (e.g., the Swiss National Science Foundation). In addition to screening the websites manually for the guidelines, we contacted every funding body in our sample via email in two waves and asked for relevant documents. 20 funding bodies replied to our information request. We were able to gather the guidelines from all 36 funding bodies. We regard the guidelines as textual data and code if they mention data management, if they specify where and how data should be stored, its terms of access (e.g., on request or public),

documentation standards, and if they mention replication studies. From the 36 guidelines under study, 22 (61%) mention data sharing; 19 (53%) specify how or where to publish data;³ 20 (56%) mention data documentation; 16 (44%) require data management plans; and 20 (56%) mention an embargo period for data in which the principal investigator has exclusive rights to access and publish with the data. Notably, none of the funding bodies under study has an explicit replication policy.

2.2. Variables

Table 2 provides an overview of the dependent and independent variables used in our study.⁴ The dependent variable, *ReplicatedArticle*, is a binary variable indicating whether the article under study was subject of a successfully published replication study. This variable measures the joint likelihood of a replication being undertaken and then being published. Merely analyzing the incidence of replication studies being undertaken (measurable by replications described in discussion papers or other pre-publication media) would not capture the most important filter mechanism in academic communication: review and ultimate publication. We obtained this variable by identifying replication studies published in the top-50 economics journals and the respective replicated articles published in these journals.

[Table 2 HERE]

Figure 2 shows that the total number of journal articles has increased at a higher rate than the total number of published replication studies. It is also noteworthy that the share of published replication studies on the total number of journal articles per year never exceeds 0.26% in the

³ For instance, 12 guidelines (33%) indicate that data from funded projects should be stored in a public repository while 2 (6%) mention that data needs to be made available upon request.

⁴ Appendix 1 provides a correlation matrix for the dependent variable and main variables of interest.

period from 1974 to 2014. From our sample we also estimate that the share of empirical articles rose from about 73% in 1975 to about 80% in 2010 (Figure 3).

[Figures 2 and 3 HERE]

Regarding our independent variables, we distinguish between the main variables of interest and control variables indicating article, author, journal, and institutional characteristics (see Table 2).

As for the main variables of interest, *CitesPreReplication* indicates the total number of citations of replicated articles and nonreplicated articles in the same issue one year prior to the publication of a replication study. Arguably, replicated articles may attract more cites prior to the publication of a replication study if there is a longer lag between the publication of the article and the publication of the respective replication study. *LagReplication* measures this lag in years. Table 3 provides extended descriptive statistics on *CitesPreReplication* and *LagReplication* by subgroups while distinguishing between replicated and nonreplicated articles. The descriptive statistics indicate that, prior to replication, replicated articles have attracted more cites than nonreplicated articles for virtually all subgroups.

[Table 3 HERE]

The quality of a journal is given by WoS impact factor 2014, *ImpactFactor*. We include a dummy variable, *Top5Journal*, which indicates whether an article was published in one of the top five economics journals according to Card and DellaVigna (2013), i.e., American Economic Review, Econometrica, Journal of Political Economy, Quarterly Journal of Economics, and Review of Economic Studies. *Top-50 University* indicates that an author is affiliated with a top-50 university according to the Ranking Web of Universities 2014. *MandatoryDisclosure* is a binary variable indicating whether an article is subject to a mandatory data disclosure policy.

DataOrCode is a dummy variable indicating whether the data or program code used in an article are available on the journal website.

As for the control variables, *SelfCreatedData* is a dummy variable indicating whether the data used in an article are self-created (in contrast to archived data which is re-analyzed), e.g., via laboratory or field experiments, surveys, or interviews. We read all explanatory notes in order to determine whether the data used in an article was confidential or proprietary to generate the dummy variable *ConfidentialData*. *ProceedingsArticle* is a binary variable indicating whether articles were published in conference proceedings. *References* and *Pages* are defined as the total number of references and pages. *Authors* indicates the number of authors. To control for author quality, we created the variable *BestH*, which indicates the h-index of authors of single-authored articles or the highest h-index of all co-authors in the case of multi-authored articles, respectively. *Funded* is a dummy variable indicating whether an article received third-party funding (18.5% of the articles under study). *FunderDataSupport* reflects the number of data policies and data management tools that external research funders provide to the authors they support. This variable can be thought of as the extent to which external funders have policies that facilitate data availability. Table 4 provides an overview of the data guidelines of the funding agencies under study.

[Table 4 HERE]

FunderDataSupport takes on one of five values, from 0 (no policy facilitating data availability) to 5 (full set of policies). It is computed as the sum of five binary variables that take on the value of 0 or 1.

3 Methodology

To examine the determinants of the likelihood of a journal article being the subject of a published replication study we run probit (and OLS) regressions as given by:

$$\begin{aligned} \text{prob}(Replicated\ Article) = & \beta_1 \cdot ProceedingsArticle + \beta_2 \cdot LogReferences + \beta_3 \cdot LogPages \\ & + \beta_4 \cdot Authors + \beta_5 \cdot LogBestH + \beta_6 \cdot SelfCreatedData + \beta_7 \cdot ConfidentialData \\ & + \beta_8 \cdot Funded + \beta_9 \cdot FunderDataSupport + \beta_{10} \cdot LogCitesPreReplication \\ & + \beta_{11} \cdot LogLagReplication + \beta_{12} \cdot Top5Journal + \beta_{13} \cdot LogImpactFactor \\ & + \beta_{14} \cdot Top50University + \beta_{15} \cdot MandatoryDisclosure + \beta_{16} \cdot DataOrCodeAvailability. \end{aligned}$$

We also include dummy variables for 23 journals and for nine 5-year intervals. Note that author citation metrics are not available for 18 out of 1,243 observations. In the regressions we use log transformations. As some researchers have an h-index of zero, we define $LogBestH = \log(LogBestH + 1)$. We follow the same procedure for $LogReferences$. We compute robust standard errors clustered at the journal level. All specifications reported in this paper are straightforward modifications of this baseline specification.

4 Results

We run our regressions with five different specifications as reported in Table 5. In specification [1], we consider control variables (article, author and institutional characteristics), journal and year fixed effects. Table 5 does not report marginal effects of the control variables (Appendix 2 provides the full version of Table 5). For all specifications, we provide the Wald test statistics for these variables. We include the log of total cites before publication of a replication study and the log lag between the publication of replicated articles and of the respective replication studies in specification [2] to examine the effect of article impact on the replication probability. In specification [3], we include the Top-5 economics journal dummy variable and the log of the journal impact factor to account for the effect of journal quality on the probability of replication.

In specification [4], we add the affiliation with a top-50 university. We include binary variables for data policies and data or code availability in specification [5] to examine the impact of mandatory data disclosure policies on the probability of replication.

[Table 5 HERE]

The results reported in Table 5 provide empirical evidence that the impact of journal articles—measured in citations—positively affects the probability of them being the subject of published replication studies. The marginal effects at the mean of *LogCitesReplication* range from 0.053 to 0.057 and are statistically significant at the 0.1% level across specifications. In addition, the log lag between the publication of the replicated articles and of the respective replication studies negatively affects the probability of replication. This effect is statistically significant at the 0.1% level across specifications. Interestingly, the effect of *LogLagReplication* is larger in magnitude than that of *LogCitesPreReplication*. This indicates that articles initially published further in the past are less likely to be the subject of a published replication study, irrespective of their citation performance. Our analysis further suggests that articles published in better journals are less likely to be the subject of published replication studies. The marginal effects of both *Top5Journal* and *LogImpactFactor* are negative and statistically significant at the 0.1% level across specifications. We find empirical evidence that journal articles by authors from better institutions have a higher incidence of being replicated. The marginal effects of *Top50University* are positive and statistically significant at the 5% level in specification [4] and [5]. In contrast, we find no significant effect of *MandatoryDisclosure* and *DataOrCode* on replication. For robustness, we also perform linear probability regressions. Table 6 reports OLS regression coefficients. We essentially yield the same results.

[Table 6 HERE]

5 Conclusion

We argue that researchers behave highly rationally, as they tend to replicate high-impact research from renowned researchers and institutions, presumably because in this case replications are more likely to be publishable. Our results are in line with previous assumptions that relate replication to impact. Hamermesh (2007, 2017) proposes that the probability that an individual will attempt a replication increases with the visibility of the published results. Furman et al. (2012) suggest that results from frequently cited articles generate more interest and scrutiny and—possibly, due to a higher probability of replication—have a higher probability of observed retraction. Dewald et al. (1986) suggest that replication studies in empirical economics are more likely to be published when they detect error or fraud. Sukhtankar (2017) finds that the strongest predictor of whether or not a paper is replicated is the paper’s Google Scholar citation count. In this regard, private incentives are well aligned with societal interests, since high-impact publications are also the studies that are most likely to influence decision-makers in private and public organizations. Moreover, replicators focus on publications that have been published in less demanding journals because the chances of detecting an error might be higher, possibly due to less strict peer review.

However, the question remains whether sufficient replications are conducted to guarantee the correctness of published findings. The overall incidence of less than 0.1% of articles being replications is surprisingly low. In our view, replications—and further meta-analyses (Anderson and Kichkha, 2017)—are necessary extensions to the peer review and should be promoted via journal policies (Hoeffler, 2017), integration in teaching (Fecher et al., 2016) and a higher likelihood of publication. Our results suggest that the decision to conduct a replication study is—at least partly—driven by the replicator’s reputation considerations. Thus the low number of

replication studies being conducted would potentially increase if replication studies received more formal recognition, e.g. through publication in (high-impact) journals.

References

- Anderson, R. & Kichkha, A. Replication versus meta-analysis in economics: Where do we stand 30 years after Dewald, Thursby and Anderson? Paper presented at the American Economic Association Annual Meeting (2017).
- Andreoli-Versbach, P. & Mueller-Langer, F. Open access to data: An ideal professed but not practised. *Research Policy* 43, 1621–1633 (2014).
- Card, D. & DellaVigna, S. Nine facts about top journals in economics. *Journal of Economic Literature* 51, 144–161 (2013).
- Cyranoski, D. Rise and fall. *news@nature* (2006). doi:10.1038/news060109-8.
- Dewald, W., Thursby, J. & Anderson, R. Replication in empirical economics: The Journal of Money, Credit and Banking Project. *American Economic Review* 76, 587–603 (1986).
- Duvendack, M., Palmer-Jones, R. W. & Reed, W. R. Replications in economics: A progress report. *Econ Journal Watch* 12, 164–191 (2015).
- Fecher, B., Fraessdorf, M. & Wagner, G. G. Perceptions and practices of replication by social and behavioral scientists: Making replications a mandatory element of curricula would be useful. IZA Discussion Paper Series No. 9896 (2016).
- Furman, J., Jensen, K. & Murray, F. Governing knowledge in the scientific community: Exploring the role of retractions in biomedicine. *Research Policy* 41, 276–290 (2012).
- Grant, P. Scientific credit and credibility. *Nature Materials* 1, 139–141 (2002).
- Hamermesh, D. Viewpoint: Replication in economics. *Canadian Journal of Economics* 40, 715–733 (2007).
- Hamermesh, D. What is replication? The possibly exemplary example of labor economics. Paper presented at the American Economic Association Annual Meeting (2017).
- Hoeffler, J. H. Replication and economics journal policies. Paper presented at the American Economic Association Annual Meeting in Chicago (2017).
- Lacetera, N. & Zirulia, L. The economics of scientific misconduct. *Journal of Law, Economics, and Organization* 27, 568–603 (2011).
- Levelt, W. J. M., Drenth, P. & Noort, E. Flawed science: The fraudulent research practices of social psychologist Diederik Stapel. (Commissioned by the Tilburg University, University of Amsterdam and the University of Groningen, 2012).
- Organisation for Economic Co-Operation and Development (OECD): Gross domestic expenditure on R-D by sector of performance and field of science: (http://stats.oecd.org/Index.aspx?DataSetCode=GERD_SCIENCE, 2016).
- Sukhtankar, S. Replications in development. Paper presented at the American Economic Association Annual Meeting in Chicago (2017).

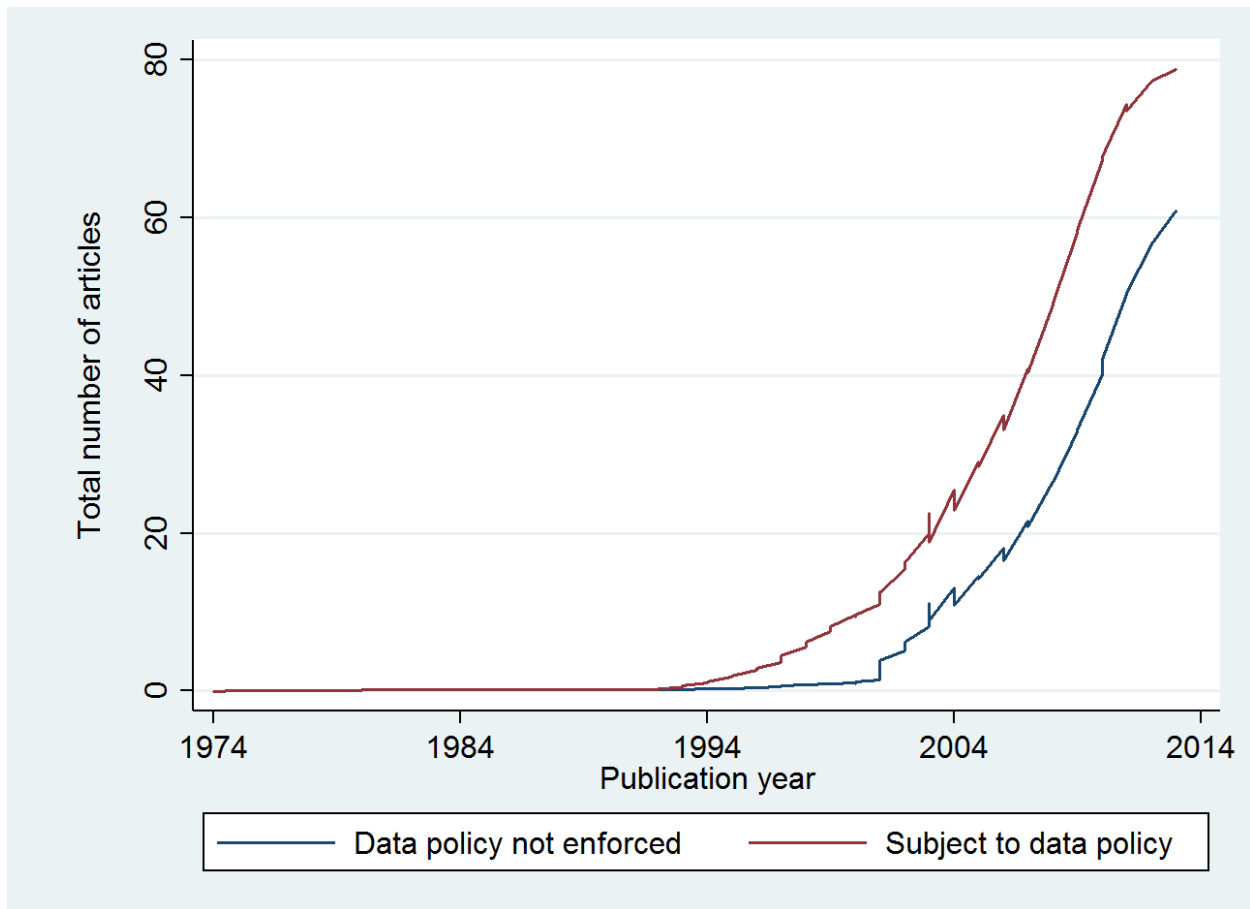


Figure 1 | Prevalence and enforcement of mandatory data disclosure over time (Lowess line)

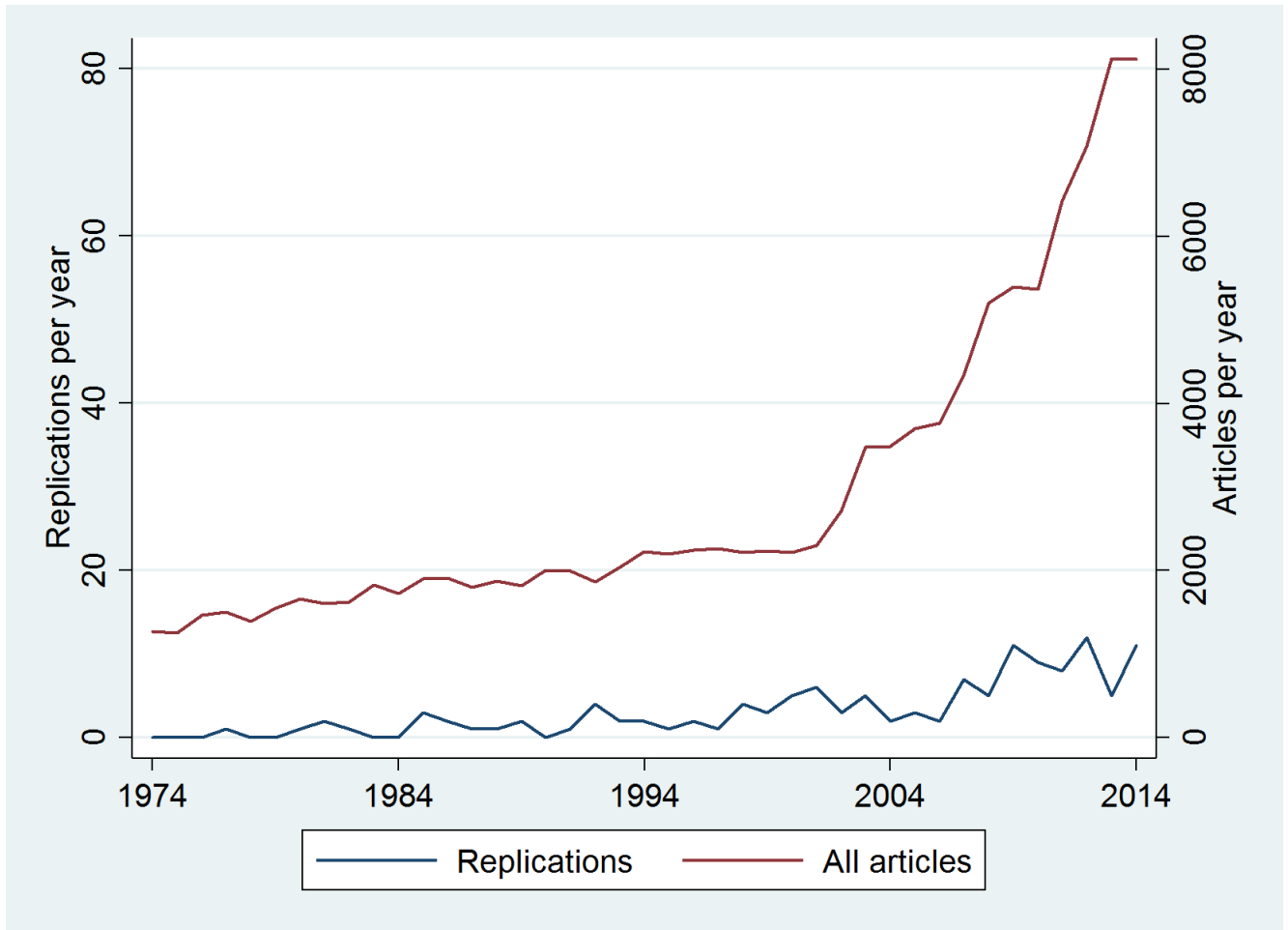


Figure 2 | Total number of published replication studies and of all journal articles by publication year

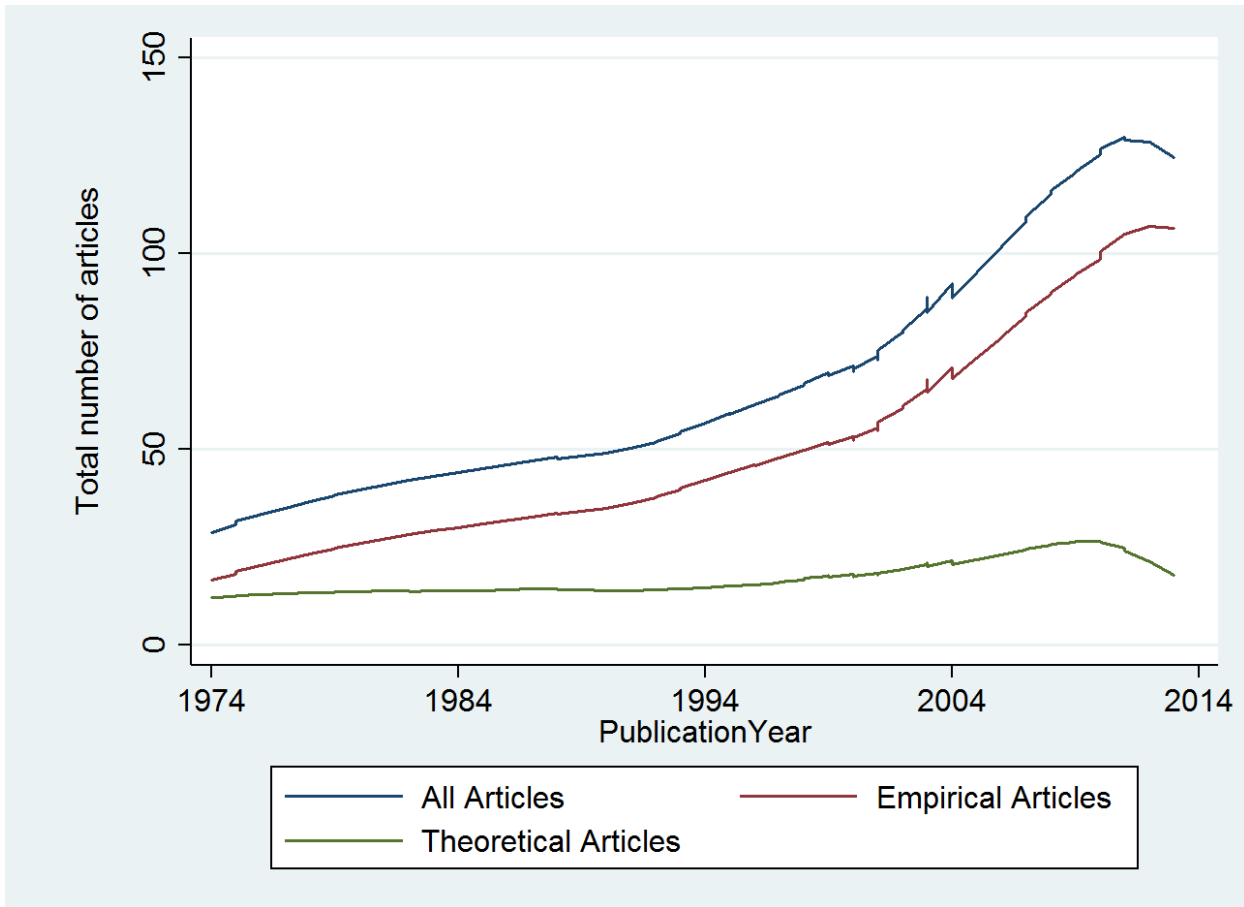


Figure 3 | Total number of empirical articles in our sample by year (Lowess line)

Table 1 | Overview of the journals and data policies under study

| Journal | Impact Factor Rank | Mandatory Data Disclosure Policy | # Replicated Articles |
|---|-----------------------------------|---|----------------------------------|
| JOURNAL OF ECONOMIC LITERATURE | 1 | | |
| JOURNAL OF FINANCE | 2 | | 10 |
| QUARTERLY JOURNAL OF ECONOMICS | 3 | | 10 |
| JOURNAL OF ECONOMIC PERSPECTIVES | 4 | | |
| TRANSPORTATION RESEARCH PART B-METHODOLOGICAL | 5 | | |
| JOURNAL OF FINANCIAL ECONOMICS | 6 | | 9 |
| JOURNAL OF POLITICAL ECONOMY | 7 | YES | 13 |
| REVIEW OF FINANCIAL STUDIES | 8 | | 1 |
| ECONOMETRICA | 9 | YES | 3 |
| JOURNAL OF THE EUROPEAN ECONOMIC ASSOCIATION | 10 | YES | 1 |
| REVIEW OF ENVIRONMENTAL ECONOMICS AND POLICY | 11 | | |
| PHARMACOECONOMICS | 12 | | |
| AMERICAN ECONOMIC REVIEW | 13 | YES | 35 |
| ECONOMIC GEOGRAPHY | 14 | | |
| REVIEW OF ECONOMIC STUDIES | 15 | YES | |
| JOURNAL OF ECONOMIC GROWTH | 16 | | |
| BROOKINGS PAPERS ON ECONOMIC ACTIVITY | 17 | YES | 1 |
| AMERICAN ECONOMIC JOURNAL-APPLIED ECONOMICS | 18 | YES | |
| JOURNAL OF FINANCIAL STABILITY | 19 | | |
| VALUE IN HEALTH | 20 | | |
| AMERICAN ECONOMIC JOURNAL-MACROECONOMICS | 21 | YES | |
| ECONOMIC POLICY | 22 | | 1 |
| JOURNAL OF ACCOUNTING & ECONOMICS | 23 | | 9 |
| JOURNAL OF ECONOMIC GEOGRAPHY | 24 | | |
| TECHNOLOGICAL AND ECONOMIC DEVELOPMENT OF ECONOMY | 25 | | |
| REVIEW OF ECONOMICS AND STATISTICS | 26 | YES | 4 |
| ECONOMIC JOURNAL | 27 | YES | 1 |
| ENERGY ECONOMICS | 28 | | |
| AMERICAN ECONOMIC JOURNAL-ECONOMIC POLICY | 29 | YES | |
| EXPERIMENTAL ECONOMICS | 30 | | 1 |
| TRANSPORTATION RESEARCH PART A-POLICY AND PRACTICE | 31 | | 1 |
| JOURNAL OF ENVIRONMENTAL ECONOMICS AND MANAGEMENT | 32 | | 2 |
| ECOLOGICAL ECONOMICS | 33 | | 4 |
| ANNUAL REVIEW OF ECONOMICS | 34 | | |
| ECONOMICS & HUMAN BIOLOGY | 35 | | |
| JOURNAL OF INTERNATIONAL ECONOMICS | 36 | | 1 |
| JOURNAL OF DEVELOPMENT ECONOMICS | 37 | YES | 1 |
| ECONOMIC SYSTEMS RESEARCH | 38 | | |
| FOOD POLICY | 39 | | |
| JOURNAL OF BUSINESS & ECONOMIC STATISTICS | 40 | YES | 3 |
| JOURNAL OF AGRARIAN CHANGE | 41 | | |
| JOURNAL OF POLICY ANALYSIS AND MANAGEMENT | 42 | | |
| JOURNAL OF HEALTH ECONOMICS | 43 | | 12 |
| JOURNAL OF TRANSPORT GEOGRAPHY | 44 | | |
| TRANSPORTATION RESEARCH PART E-LOGISTICS AND TRANSPORTATION REVIEW | 45 | | 1 |
| HEALTH ECONOMICS | 46 | | 6 |
| WORLD BANK RESEARCH OBSERVER | 47 | | |
| JOURNAL OF MONETARY ECONOMICS | 48 | | |
| JOURNAL OF REGIONAL SCIENCE | 49 | | |
| JOURNAL OF LABOR ECONOMICS | 50 | YES | |
| | | | TOTAL: 130 |

Notes: 23 journals under study that published at least one replicated article in bold.

Table 2 | Descriptive statistics

| | mean | sd | min | max | N |
|---|-------|-------|-------|-------|-------|
| Dependent variable | | | | | |
| Replicated article | 0.105 | | 0 | 1 | 1,243 |
| Main variables of interest | | | | | |
| Total cites before publication of replication study | 20.89 | 64.18 | 0 | 1,508 | 1,243 |
| Lag between publication of replicated article and of respective replication | 4.851 | 3.601 | 0 | 23 | 1,243 |
| Journal impact factor | 3.516 | 1.153 | 2.137 | 6.033 | 1,243 |
| Top-5 economics journal | 0.512 | | 0 | 1 | 1,243 |
| Top-50 university | 0.606 | | 0 | 1 | 1,243 |
| Mandatory data disclosure policy | 0.235 | | 0 | 1 | 1,243 |
| Data or program code available | 0.169 | | 0 | 1 | 1,243 |
| Control variables | | | | | |
| Self-created data | 0.124 | | 0 | 1 | 1,243 |
| Confidential or proprietary data | 0.012 | | 0 | 1 | 1,243 |
| Article published in conference proceedings | 0.118 | | 0 | 1 | 1,243 |
| Number of references | 29.28 | 17.83 | 0 | 130 | 1,243 |
| Number of pages | 19.51 | 10.94 | 1 | 65 | 1,243 |
| Number of authors | 2.057 | 1.097 | 1 | 16 | 1,243 |
| h-index of best author | 17.42 | 12.90 | 0 | 106 | 1,225 |
| Third party funding | 0.185 | | 0 | 1 | 1,243 |
| Funder's support for data availability | 0.598 | 1.366 | 0 | 5 | 1,243 |
| Year variables | | | | | |
| Publication year 1970-1974 | 0.006 | | 0 | 1 | 1,243 |
| 1975-1979 | 0.039 | | 0 | 1 | 1,243 |
| 1980-1984 | 0.043 | | 0 | 1 | 1,243 |
| 1985-1989 | 0.106 | | 0 | 1 | 1,243 |
| 1990-1994 | 0.091 | | 0 | 1 | 1,243 |
| 1995-1999 | 0.109 | | 0 | 1 | 1,243 |
| 2000-2004 | 0.207 | | 0 | 1 | 1,243 |
| 2005-2009 | 0.223 | | 0 | 1 | 1,243 |
| 2010-2014 | 0.175 | | 0 | 1 | 1,243 |

Table 3 | Extended descriptive statistics

| | Replicated articles | | Nonreplicated articles | |
|-----------------------------------|------------------------------------|-------------------------------|------------------------------------|-------------------------------|
| | <i>CitesPreReplication</i> mean | <i>LagReplication</i> mean | <i>CitesPreReplication</i> Mean | <i>LagReplication</i> mean |
| Main variables of interest | | | | |
| <i>Top5Journal=1</i> | 100.57 | 6.71 | 24.51 | 6.10 |
| <i>Top5Journal=0</i> | 25.23 | 3.64 | 7.40 | 3.45 |
| <i>Top50University=1</i> | 73.07 | 5.04 | 19.67 | 5.07 |
| <i>Top50University=0</i> | 26.69 | 5.17 | 11.32 | 4.47 |
| <i>MandatoryDisclosure=1</i> | 34.84 | 4.16 | 11.94 | 4.14 |
| <i>MandatoryDisclosure=0</i> | 64.99 | 5.23 | 17.66 | 5.05 |
| <i>DataOrCode=1</i> | 29.00 | 4.26 | 20.15 | 3.87 |
| <i>DataOrCode=0</i> | 65.99 | 5.22 | 15.45 | 5.02 |
| Control variables | | | | |
| <i>SelfCreatedData=1</i> | 13.00 | 3.93 | 13.65 | 4.42 |
| <i>SelfCreatedData=0</i> | 66.79 | 5.23 | 16.63 | 4.88 |
| <i>ProceedingsArticle=1</i> | 27.40 | 2.60 | 6.92 | 4.33 |
| <i>ProceedingsArticle=0</i> | 61.91 | 5.18 | 17.62 | 4.90 |
| <i>Funded=1</i> | 118.23 | 5.67 | 23.66 | 5.06 |
| <i>Funded=0</i> | 43.29 | 4.90 | 14.63 | 4.77 |
| Year variables | | | | |
| <i>Pyear1970=1</i> | 78.00 | 8.00 | 12.43 | 8.00 |
| <i>Pyear1975=1</i> | 3.25 | 3.50 | 3.02 | 3.98 |
| <i>Pyear1980=1</i> | 10.29 | 6.57 | 11.25 | 5.04 |
| <i>Pyear1985=1</i> | 71.62 | 5.85 | 10.73 | 4.48 |
| <i>Pyear1990=1</i> | 49.40 | 7.13 | 22.25 | 8.32 |
| <i>Pyear1995=1</i> | 106.57 | 5.71 | 21.11 | 5.75 |
| <i>Pyear2000=1</i> | 99.48 | 5.28 | 30.04 | 5.57 |
| <i>Pyear2005=1</i> | 24.54 | 3.96 | 14.39 | 3.90 |
| <i>Pyear2010=1</i> | 19.25 | 2.08 | 5.08 | 3.17 |

Table 4 | Overview of data guidelines of funding agencies

| Funding Agency | [1] Policy/ guideline mentions data sharing | [2] Policy/ guideline specifies how or where to publish data | [3] Policy/ guideline mentions data documen- tation/ metadata | [4] Policy/ guideline requires data manage- ment plan | [5] Policy/ guideline mentions embargo period |
|--|--|---|--|--|--|
| National Science Foundation (NSF) | 1 | 0 | 0 | 1 | 1 |
| US National Institutes of Health (NIH) | 1 | 1 | 1 | 1 | 1 |
| National Natural Science Foundation of China (NSFC) | 0 | 0 | 0 | 0 | 0 |
| Deutsche Forschungsgemeinschaft (DFG) | 1 | 1 | 1 | 0 | 0 |
| Bundesministerium für Bildung und Forschung (BMBF) | 0 | 0 | 0 | 0 | 0 |
| Japanese society for the promotion of science (JSPS) | 0 | 0 | 0 | 0 | 0 |
| Japan Science and Technology Agency (JST) | 0 | 0 | 0 | 0 | 0 |
| Russian Foundation for Basic Research (RFBR) | 0 | 0 | 0 | 0 | 0 |
| French National Research Agency (ANR) | 1 | 0 | 0 | 0 | 0 |
| National Research Foundation of Korea (NRF) | 0 | 0 | 0 | 0 | 0 |
| Ministry of Knowledge Economy (MKE) | 0 | 0 | 0 | 0 | 0 |
| Science & Technology Facilities Council (STFC) | 1 | 1 | 1 | 1 | 1 |
| Medical Research Council (MRC) | 1 | 1 | 1 | 1 | 1 |
| Engineering and Physical Science Research Council (EPSRC) | 1 | 1 | 1 | 0 | 1 |
| Biotechnology and Biological Science Research Council | 1 | 1 | 1 | 1 | 1 |
| Natural Environment Research Council (NERC) | 1 | 1 | 1 | 1 | 1 |
| Economic and Social Research Council (ESRC) | 1 | 1 | 1 | 1 | 1 |
| Arts and Humanities Research Council (AHRC) | 1 | 1 | 1 | 0 | 1 |
| National Research Council (CNR) | 0 | 0 | 0 | 0 | 0 |
| Ministry of Education, Universities and Research (MIUR) | 0 | 0 | 0 | 0 | 0 |
| Spanish Ministry of Economy and Competitiveness | 0 | 0 | 0 | 0 | 0 |
| Social Sciences and Humanities Research Council of Canada | 1 | 1 | 1 | 1 | 1 |
| Natural Science and Engineering Research Council of Canada | 1 | 1 | 1 | 1 | 1 |
| Netherlands Organisation for Scientific Research (NWO) | 1 | 1 | 1 | 1 | 1 |
| Swedish Research Council (VR) | 1 | 1 | 1 | 0 | 1 |
| Swedish Foundation for Strategic Research (SSF) | 0 | 0 | 0 | 0 | 0 |
| Swedish Agency for Innovation Systems (VINNOVA) | 0 | 0 | 0 | 0 | 0 |
| Australian Research Council (ARC) | 1 | 1 | 1 | 0 | 1 |
| Norwegian Research Council | 1 | 1 | 1 | 1 | 1 |
| Portuguese Found. Sci. & Techn. (FCT) | 1 | 1 | 1 | 1 | 1 |
| Bill and Melinda Gates Foundation | 1 | 1 | 1 | 1 | 1 |
| Wellcome Trust | 1 | 1 | 1 | 1 | 1 |
| NASA | 1 | 0 | 1 | 1 | 1 |
| Leverhulme Trust | 0 | 0 | 0 | 0 | 0 |
| European Commission (Horizon 2020) | 1 | 1 | 1 | 1 | 1 |
| Swiss National Science Foundation | 0 | 0 | 0 | 0 | 0 |

Notes: Columns [1] to [5] report the five dummy variables that are used to create *FunderDataSupport* which can be thought of as the extent to which external funders have policies that facilitate data availability. It takes on one of five values, from 0 (no policy facilitating data availability) to 5 (full set of policies). To obtain this variable, we analyzed the funding guidelines of 36 research funding bodies worldwide regarding their data management policies. We regard the guidelines as textual data and code if they mention data management, if they specify where and how data should be stored, its terms of access (e.g., on request or public), documentation standards, and if they mention replication studies.

Table 5 | Marginal effects at the mean after probit regression

| | [1] | [2] | [3] | [4] | [5] |
|---|---------|----------------------|----------------------|----------------------|----------------------|
| VARIABLES | | | | | |
| Log total cites before publication of replication study | | 0.057*** (0.007) | 0.057*** (0.007) | 0.054*** (0.007) | 0.053*** (0.008) |
| Log lag between publication of replicated article and of respective replication | | -0.110*** (0.016) | -0.110*** (0.016) | -0.104*** (0.017) | -0.102*** (0.017) |
| Top-5 economics journal | | | -0.040*** (0.008) | -0.052*** (0.010) | -0.056*** (0.010) |
| Log impact factor | | | -0.079*** (0.016) | -0.097*** (0.017) | -0.096*** (0.018) |
| Top-50 university | | | | 0.042* (0.021) | 0.042* (0.021) |
| Mandatory data disclosure policy | | | | | -0.012 (0.023) |
| Data or program code available | | | | | 0.020 (0.025) |
| Observations | 1,225 | 1,225 | 1,225 | 1,225 | 1,225 |
| Pseudo R-squared | 0.0763 | 0.118 | 0.118 | 0.125 | 0.125 |
| Log Pseudo Likelihood | -382.8 | -365.7 | -365.7 | -362.8 | -362.7 |
| Journal FE | YES | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES | YES |
| <i>Wald Test Statistics, Control variables (*)</i> | | | | | |
| Chi-squared | 133.6 | 23.68 | 23.68 | 23.31 | 16.95 |
| Degrees of freedom | 9 | 9 | 9 | 9 | 9 |
| <i>p</i> -value | 0.000 | 0.005 | 0.005 | 0.005 | 0.049 |
| <i>Wald Test Statistics, Journal FE</i> | | | | | |
| Chi-squared | 506,595 | 4.521e+06 | 6.570e+06 | 1.760e+07 | 4.442e+06 |
| Degrees of freedom | 16 | 18 | 18 | 19 | 20 |
| <i>p</i> -value | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| <i>Wald Test Statistics, Year FE</i> | | | | | |
| Chi-squared | 202.2 | 724.7 | 724.7 | 998.1 | 648.9 |
| Degrees of freedom | 8 | 8 | 8 | 8 | 8 |
| <i>p</i> -value | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Note: *ReplicatedArticle* is the dependent variable. Robust standard errors clustered at the journal level in parentheses. Control variables, not reported (*): *ProceedingsArticle*, *LogReferences*, *LogPages*, *Authors*, *LogBestH*, *SelfCreatedData*, *ConfidentialData*, *Funded*, *FunderDataSupport*. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

Table 6 | Ordinary least squares (OLS) regression coefficients

| VARIABLES | [1] | [2] | [3] | [4] | [5] |
|---|---------------------|----------------------|----------------------|----------------------|----------------------|
| Article published in conference proceedings | -0.006 (0.026) | 0.012 (0.029) | 0.012 (0.029) | 0.007 (0.029) | -0.002 (0.032) |
| Log number of references | -0.002 (0.027) | -0.017 (0.026) | -0.017 (0.026) | -0.014 (0.027) | -0.013 (0.027) |
| Log number of pages | 0.057 (0.031) | 0.031 (0.029) | 0.031 (0.029) | 0.025 (0.030) | 0.025 (0.031) |
| Number of authors | 0.018 (0.012) | 0.015 (0.012) | 0.015 (0.012) | 0.015 (0.012) | 0.015 (0.012) |
| Log h-index of best author | 0.028 (0.016) | 0.008 (0.017) | 0.008 (0.017) | 0.002 (0.015) | 0.002 (0.016) |
| Self-created data | -0.012 (0.014) | 0.003 (0.015) | 0.003 (0.015) | 0.007 (0.016) | 0.008 (0.017) |
| Data proprietary | -0.012 (0.091) | -0.016 (0.076) | -0.016 (0.076) | -0.014 (0.080) | -0.016 (0.082) |
| Third party funding | -0.012 (0.062) | -0.018 (0.055) | -0.018 (0.055) | -0.015 (0.052) | -0.016 (0.053) |
| Funder's support for data availability | 0.009 (0.016) | 0.008 (0.015) | 0.008 (0.015) | 0.007 (0.014) | 0.008 (0.014) |
| Log total cites before publication of replication study | | 0.063*** (0.007) | 0.063*** (0.007) | 0.061*** (0.006) | 0.061*** (0.006) |
| Log lag between publication of replicated article and of respective replication | | -0.109*** (0.017) | -0.109*** (0.017) | -0.106*** (0.016) | -0.106*** (0.017) |
| Top-5 economics journal | | | -0.040*** (0.010) | -0.056*** (0.012) | -0.061*** (0.014) |
| Log impact factor | | | -0.081*** (0.017) | -0.103*** (0.020) | -0.105*** (0.020) |
| Top-50 university | | | | 0.051 (0.026) | 0.050 (0.026) |
| Mandatory data disclosure policy | | | | | 0.023 (0.024) |
| Data or program code available | | | | | -0.012 (0.022) |
| Constant | -0.218** (0.060) | -0.011 (0.066) | 0.134 (0.076) | 0.162* (0.070) | 0.157* (0.071) |
| Observations | 1,225 | 1,225 | 1,225 | 1,225 | 1,225 |
| R-squared | 0.049 | 0.074 | 0.074 | 0.079 | 0.080 |
| Journal FE | YES | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES | YES |
| <i>Wald Test Statistics, Control variables (*)</i> | | | | | |
| F statistic | 7.913 | 1.765 | 1.765 | 1.279 | 1.152 |
| Degrees of freedom | 9 | 9 | 9 | 9 | 9 |
| p-value | 0.000 | 0.133 | 0.133 | 0.302 | 0.371 |
| <i>Wald Test Statistics, Journal FE</i> | | | | | |
| F statistic | 1,143 | 22,636 | 12,730 | 26,923 | 5,988 |
| Degrees of freedom | 16 | 18 | 18 | 19 | 19 |
| p-value | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| <i>Wald Test Statistics, Year FE</i> | | | | | |
| F statistic | 17.31 | 22.06 | 22.06 | 30.46 | 13.03 |
| Degrees of freedom | 8 | 8 | 8 | 8 | 8 |
| p-value | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Note: *ReplicatedArticle* is the dependent variable. Robust standard errors clustered at the journal level in parentheses. Control variables (*): *ProceedingsArticle*, *LogReferences*, *LogPages*, *Authors*, *LogBestH*, *SelfCreatedData*, *ConfidentialData*, *Funded*, *FunderDataSupport*. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

Appendix 1 | Correlation matrix for the dependent variable and main variables of interest

| | <i>Replicated Article</i> | <i>CitesPre Replication</i> | <i>Lag Replication</i> | <i>Top5 Journal</i> | <i>Impact Factor</i> | <i>Top50 University</i> | <i>Mandatory Disclosure</i> | <i>DataOr Code</i> |
|----------------------------|-------------------------------|---------------------------------|----------------------------|-------------------------|--------------------------|-----------------------------|---------------------------------|------------------------|
| <i>ReplicatedArticle</i> | 1.00 | | | | | | | |
| <i>CitesPreReplication</i> | 0.21 | 1.00 | | | | | | |
| <i>LagReplication</i> | 0.02 | 0.36 | 1.00 | | | | | |
| <i>Top5Journal</i> | -0.03 | 0.17 | 0.37 | 1.00 | | | | |
| <i>ImpactFactor</i> | -0.01 | 0.11 | 0.08 | 0.11 | 1.00 | | | |
| <i>Top50University</i> | 0.09 | 0.11 | 0.08 | 0.20 | 0.15 | 1.00 | | |
| <i>MandatoryDisclosure</i> | -0.07 | -0.06 | -0.11 | 0.43 | -0.12 | 0.14 | 1.00 | |
| <i>DataOrCode</i> | -0.02 | 0.00 | -0.12 | 0.35 | -0.10 | 0.10 | 0.68 | 1.00 |

Appendix 2 | Full version of Table 5 (Marginal effects at the mean after probit)

| VARIABLES | [1] | [2] | [3] | [4] | [5] |
|---|-------------------|----------------------|----------------------|----------------------|----------------------|
| Proceedings article | -0.054 (0.028) | -0.043 (0.032) | -0.043 (0.032) | -0.045 (0.033) | -0.038 (0.036) |
| Log number of references | -0.005 (0.029) | -0.015 (0.025) | -0.015 (0.025) | -0.012 (0.026) | -0.011 (0.026) |
| Log number of pages | 0.067* (0.034) | 0.038 (0.028) | 0.038 (0.028) | 0.032 (0.029) | 0.030 (0.030) |
| Number of authors | 0.012 (0.008) | 0.009 (0.008) | 0.009 (0.008) | 0.009 (0.007) | 0.008 (0.007) |
| Log h-index of best author | 0.029* (0.014) | 0.007 (0.015) | 0.007 (0.015) | 0.004 (0.014) | 0.003 (0.014) |
| Self-created data | -0.016 (0.013) | 0.003 (0.013) | 0.003 (0.013) | 0.006 (0.013) | 0.005 (0.014) |
| Data proprietary | -0.003 (0.106) | -0.010 (0.088) | -0.010 (0.088) | -0.011 (0.091) | -0.013 (0.091) |
| Third party funding | -0.012 (0.050) | -0.024 (0.043) | -0.024 (0.043) | -0.023 (0.041) | -0.023 (0.041) |
| Funder's support for data availability | 0.009 (0.013) | 0.010 (0.012) | 0.010 (0.012) | 0.009 (0.011) | 0.009 (0.011) |
| Log total cites before publication of replication study | | 0.057*** (0.007) | 0.057*** (0.007) | 0.054*** (0.007) | 0.053*** (0.008) |
| Log lag between publication of replicated article and of respective replication | | -0.110*** (0.016) | -0.110*** (0.016) | -0.104*** (0.017) | -0.102*** (0.017) |
| Top-5 economics journal | | | -0.040*** (0.008) | -0.052*** (0.010) | -0.056*** (0.010) |
| Log impact factor | | | -0.079*** (0.016) | -0.097*** (0.017) | -0.096*** (0.018) |
| Top-50 university | | | | 0.042* (0.021) | 0.042* (0.021) |
| Mandatory data disclosure policy | | | | | -0.012 (0.023) |
| Data or program code available | | | | | 0.020 (0.025) |
| Observations | 1,225 | 1,225 | 1,225 | 1,225 | 1,225 |
| Pseudo R-squared | 0.0763 | 0.118 | 0.118 | 0.125 | 0.125 |
| Log Pseudo Likelihood | -382.8 | -365.7 | -365.7 | -362.8 | -362.7 |
| Journal FE | YES | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES | YES |
| <i>Wald Test Statistics, Control variables (*)</i> | | | | | |
| Chi-squared | 133.6 | 23.68 | 23.68 | 23.31 | 16.95 |
| Degrees of freedom | 9 | 9 | 9 | 9 | 9 |
| p-value | 0.000 | 0.005 | 0.005 | 0.005 | 0.049 |
| <i>Wald Test Statistics, Journal FE</i> | | | | | |
| Chi-squared | 506,595 | 4.521e+06 | 6.570e+06 | 1.760e+07 | 4.442e+06 |
| Degrees of freedom | 16 | 18 | 18 | 19 | 20 |
| p-value | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| <i>Wald Test Statistics, Year FE</i> | | | | | |
| Chi-squared | 202.2 | 724.7 | 724.7 | 998.1 | 648.9 |
| Degrees of freedom | 8 | 8 | 8 | 8 | 8 |
| p-value | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Note: *ReplicatedArticle* is the dependent variable. Robust standard errors clustered at the journal level in parentheses. Control variables (*): *ProceedingsArticle*, *LogReferences*, *LogPages*, *Authors*, *LogBestH*, *SelfCreatedData*, *ConfidentialData*, *Funded*, *FunderDataSupport*. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.