DICE

DISCUSSION PAPER

NO 360

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March 2021

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Universität Düsseldorf

IMPRINT

DICE DISCUSSION PAPER

Published by:
Heinrich-Heine-University Düsseldorf,
Düsseldorf Institute for Competition Economics (DICE),
Universitätsstraße 1, 40225 Düsseldorf, Germany
www.dice.hhu.de

Editor:
Prof. Dr. Hans-Theo Normann
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ISSN 2190-9938 (online) / ISBN 978-3-86304-359-9

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The Impact of the German 'DEAL' on Competition in the Academic Publishing Market

Justus Haucap *† Nima Moshgbar*

Wolfgang Benedikt Schmal*

March 2021

Abstract:

The German DEAL agreements between German universities and research institutions on the one side and Springer Nature and Wiley on the other side facilitate easy open access publishing for researchers located in Germany. We use a dataset of all publications in chemistry from 2016 to 2020 and apply a difference-in-differences approach to estimate the impact on eligible scientists' choice of publication outlet. We find that even in the short period following the conclusion of these DEAL agreements, publication patterns in the field of chemistry have changed, as eligible researchers have increased their publications in Wiley and Springer Nature journals at the cost of other journals. From that two related competition concerns emerge: First, academic libraries may be, at least in the long run, left with fewer funds and incentives to subscribe to non-DEAL journals published by smaller publishers or to fund open access publications in these journals. Secondly, eligible authors may prefer to publish in journals included in the DEAL agreements, thereby giving DEAL journals a competitive advantage over non-DEAL journals in attracting good papers. Given the two-sided market nature of the academic journal market, these effects may both further spur the concentration process in this market.

JEL Classification: D43, I23, L86

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Acknowledgements: The authors are grateful for helpful comments from seminar participants at DICE, U Düsseldorf. Wolfgang Benedikt Schmal gratefully acknowledges financial support from the German Research Foundation (GRK 1974).

1 Introduction

Scientists across many disciplines have become rather unhappy about the academic publishing process. Some academics have long been critical about the merits and the organisation of the peer review process (for economics see, e.g., Laband, 1990; Hamermesh, 1994; Frey, 2003; Azar, 2007; and Ellison, 2002 & 2011; for management e.g. Lewin, 2014) or else about the "publish or perish" philosophy prevalent in many disciplines (for economics, see, e.g., Akerlof, 2020; Heckman and Moktan, 2020; or van Dalen, 2021). There has also been a long-standing criticism of the high and increasing prices of journals in the 'STM' fields, i.e. science, technology and medicine (see, e.g., Edlin and Rubinfeld, 2004; Resnick, 2019).

In response, various academics have tried to initiate -– more or less successfully — boycotts by authors, reviewers, and editors of highly priced STM journals, so as to bring down journal prices (see, e.g., Bergstrom, 2001; or Flood, 2012). The best known example may have been the so-called "cost of knowledge campaign" that was launched in response to a blog-post by the prominent mathematician Timothy Gowers (2012). Many of the boycott campaigns specifically targeted the publisher Elsevier and its high prices for subscriptions as well as its practice of selling journals in large bundles featuring many unwanted titles. Similarly, academic libraries have long complained about the sharp and continuous increase of prices, often leaving them with less budget for books and for journals that are considered less important than the so-called top-journals that are indispensable. Even competition authorities such as the UK Office of Fair Trade (OFT) have investigated the leading commercial publishers' behaviour, without taking any action though (see Vickery, 2003).

In response to the growing criticism by academics and academic libraries, an increasing number of research funding organizations, such as most prominently the National Institutes of Health (NIH) in the US, have started to require both their employees and recipients of research funds not to transfer their copyrights any longer to publishing houses, so as to facilitate parallel publications in research repositories such as arXIv, EconStor, RePEc, SSRN and so on.[1] In addition, many academics have repeatedly suggested to shift publications to open access outlets – a process that has proven to be rather slow and difficult due to the underlying collective action and coordination problems already described by Bergstrom (2001). In addition, academics have suggested to form purchasing alliances so as to increase academic libraries' buyer power (see, e.g., Haucap, Hartwich, and Uhde, 2005).

[1] In 2016, SSRN has been acquired by Elsevier, see `https://www.elsevier.com/about/press-releases/corporate/elsevier-acquires-the-social-science-research-network-ssrn,-the-leading-social-science-and-humanities-repository-and-online-community`

In fact, in Germany the so-called 'Alliance Initiative', a task force of all German research institutions,[2] has been assigned with negotiating collective, nationwide open access agreements with the three largest commercial publishers of scholarly journals, namely Elsevier, Springer Nature, and Wiley, on behalf of all German academic institutions, including universities, research institutes, and their libraries. The objective of the so-called "Projekt DEAL" is to secure immediate (a) open access publication of all new research articles by authors from German research institutions, (b) permanent full-text access to the publishers' complete journal portfolio, and (c) fair pricing for these services according to a simple cost model based on the number of articles published.[3]

While negotiations have broken down with Elsevier in 2018, agreements were reached with Wiley and Springer Nature in 2019. More precisely, "Projekt DEAL" signed a three-year contract with Wiley on 15 January 2019 so that researchers at more than 700 German academic institutions are now able to (a) access content from Wiley journals back to 1997 and (b) to publish open access in all of the publisher's hybrid and gold open access journal portfolio. A similar agreement was reached with Springer Nature on 11 August 2019, when DEAL signed a Memorandum of Understanding with Springer Nature, followed by a three-year contract starting 1 January, 2020. The agreement enables open access publishing of articles in approximately 2,500 Springer Nature journals and offers participating institutions extensive access to the publisher's journal portfolio.

Several smaller publishers consequently complained with the German competition authority, the Federal Cartel Office (FCO), as the DEAL consortium did not enter into negotiations with smaller publishers such as C.H. Beck, De Gruyter or Mohr Siebeck in Germany or else Taylor and Francis, the several university presses and others abroad.[4] The competition concerns are two-fold: First, libraries in Germany most likely have to finance the Projekt DEAL in the end and will have fewer resources to subscribe to journals not published by Wiley or Springer Nature, thereby impeding competition in the journal subscription or reader market. Second, authors from qualified institutions in Germany may prefer to publish in Springer Nature and Wiley journals, as they can publish open access in these journals at no private marginal cost, once the agreements are concluded.

[2]Adjunct institutions are the Alexander von Humboldt Foundation, the National Academy of Sciences Leopoldina, the German Research Foundation (DFG), the German Academic Exchange Service (DAAD), the Fraunhofer Society, the Helmholtz Society, the German Rectors' Conference (HRK) representing all universities and colleges, the Leibniz Association, the Max Planck Society and the German research council (Wissenschaftsrat).

[3]`https://www.projekt-deal.de/about-deal/`

[4]See (in German): `https://www.buchreport.de/news/noch-allianz-oder-schon-kartell/`

In this paper, we focus on the second concern and analyse whether the DEAL contracts affect incentives for authors in their choice of submission. For that purpose, we estimate within a difference-in-differences (DiD) approach the treatment effect on the treated (TT) authors' choice of journals for publication. Put differently, we analyse whether scholars that are eligible for open access publications in Wiley and Springer Nature journals under the DEAL agreements show a different publication pattern than scholars that are not eligible. Manuscript turnaround times differ substantially between different fields of science and are rather long in some disciplines such as economics (see, e.g, Ellison, 2002). Hence, the vast majority of articles published in economics journals in 2019 and 2020 will have been submitted before the DEAL agreements were announced. Therefore, our analysis focuses on the field of chemistry which has much faster turnaround times so that we can expect the DEAL agreements to already have at least some impact. Since, however, the contracts have only been in force for a rather short period of time – since 2019 and 2020 with Wiley and Springer Nature, respectively – our results have to be regarded accordingly as early empirical evidence.

Even though the observation period has been short, we find a statistically significant increase in the likelihood to publish in eligible Springer Nature or Wiley journals, amounting to 2% for authors from eligible institutions in the treatment period. This suggests that open access publications in eligible journals under DEAL contracts are attractive for researchers. While definite conclusions on the persistence of such an observation have to remain for future research at this stage, such a development may have severe implications for competition in the STM journal market, as large commercial publishers may have advantages in the competition for authors. This may induce further market concentration in an already concentrated market (Larivière, Haustein, & Mongeon, 2015). Hence, large-scale DEAL-like contracts can further strengthen the leading publishing groups' positions. In turn, national science alliances may prefer to negotiate contracts with large publishing firms that have the largest journal portfolio, thereby further fostering concentration and, in the long term, possibly further price increases.

This paper now proceeds as follows. In section 2, we briefly describe some key characteristics and developments in the academic publishing market. Section 3 provides details on the German DEAL agreements. The empirical analysis is provided in section 4. Implications for market competition are discussed in section 5, before section 6 concludes.

2 The Academic Publishing Market

As any other media outlet, academic journals are platforms that bring together authors and readers, i.e., academic journals operate in two-sided markets. Readers are interested in scientific research and results while authors are interested in publishing their ideas and findings. In principle, readers are interested in the most important results in their fields which are published in so-called top journals. From the readers' perspective, academic journals are typically rather complements than substitutes, as knowledge about a particular study published in a particular journal cannot easily substituted by knowledge about a different study published in a different journal. Hence, from the readers' perspective, it is beneficial to have access to as many journals as possible. Libraries, however, only have limited budgets so they typically cannot subscribe to all journals but have to make choices between journals. From the libraries' perspective, journals are substitutes. Put differently, journals compete for library budgets. As some journals, however, are almost indispensable, as they publish the most important research results, the academic journal market works differently than most other markets. As McCabe (2002) has shown, an increase in top journal prices can lead libraries to cancel subscriptions of other journals – a clear sign of complementarity rather than substitution effects.

In principle though, readers are not interested in journals as such, but in particular papers. Technological progress, in particular digitization, allows for a particular form of unbundling. Readers could purchase single articles and also obtain them very fast through electronic intra-library article sharing or from research repositories. These possibilities imply that journal subscription would become less and less beneficial from the readers' perspective, as long as single papers can be easily accessed.

In addition, Ellison (2011) convincingly argues that the role of academic journals has fundamentally changed. Traditionally, journals used to fulfil two functions: research dissemination and signalling research quality due to quality assurance processes such as peer review. With the rise of digitization, the information dissemination function has become less and less important. Many research results and ideas are well-known long before publication due to preprint servers and research repositories. Nowadays social media platforms also contribute to the circulation of research. Hence, as the dissemination function of journals is dramatically reduced, a journal's main function is to serve as a quality signal for authors, but also for less informed readers. This development, in turn, means that journal subscriptions would be less valuable for libraries, as the journals' information dissemination function has become less important, and library subscriptions are not required for the quality signalling function. In order to deal with the development of journal subscriptions becoming more dispensable, publishers have started to offer bundles and packages that include the most important top journals that libraries cannot really substitute.

From an author's perspective two related aspects are important in the choice of publication outlets: journal reputation and visibility which facilitates citations, which are sometimes described as the ultimate currency among scholars. Journal reputation is typically an imperfect function of citation frequency and some other factors (see, e.g., Bräuninger and Haucap, 2003). Citations, in turn, are a function of journal reputation (so there is a clear endogeneity issue), but also of other factors. In particular, several studies have found that open access positively affects citations in various ways even though the findings are not unambiguous (see, e.g., Antelman, 2004; Eysenbach, 2006; Atchison and Bull, 2015; McCabe and Snyder, 2014, 2015, 2020; Mueller-Langer and Watt, 2010). For the author publications outlets are substitutes to some degree. That means journals compete to attract high-quality papers or authors. One competitive advantage in that process may be, ceteris paribus, the option to publish open access, as this can enhance visibility and increase citations and, thereby, an author's H-index or some other measure of citations.

In principle though, authors aim at publishing in journals with the highest reputation and citation rates that also attract most readers, while readers also particularly focus on the top journals. This lends enormous market power to top journals (see, e.g., Heckman and Moktan, 2020), which is rather difficult to break due to an underlying coordination problem between authors and readers. As Bergstrom (2001) has explained long ago, the academic publication market inherently faces a coordination problem which is typical for two-sided markets. Theoretically, the scientific community could move to other less expensive journals, such as non-profit open access journals. Practically, this is unlikely to happen, however, due to the underlying collective action problem. While all scholars and scientists may jointly be better off if the best research would be published open access in low-priced journals, no individual scholar has strong incentives to be the first to move. Especially young researchers have very strong incentives to publish in well-established journals with a long-standing reputation to gain visibility and reputation. In fact, empirical research by Heyman, Moors, and Storms (2016) suggests that in case of the Elsevier boycott "only 37% of the 'won't publish' signatories are clearly boycotting Elsevier by publishing elsewhere." As the authors explain, the situation "actually resembles a social dilemma in which people might reason: If I still publish in impactful Elsevier journals and most other researchers/signatories stop publishing in these journals, it will be good for my résumé/career, while Elsevier will have to change its ways."

Open Access is often suggested as an alternative. Suber (2012) defines mainly two columns: Green and Gold Open Access (OA). While the latter encompasses free access to an article published in a peer-reviewed journal, green OA only allows an upload of an article in non-reviewed repositories for papers. The final article published in a journal is still protected behind a subscription wall. Green OA sometimes includes a delay or waiting period before it is published in a repository, but is likely to be less expensive than Gold OA. The establishment of OA has raised its own questions. McCabe and Snyder (2005) discuss the risk of lower quality in OA publications. The main argument put forward is that publishers can increase profits by additional publication of papers as OA publishers earn per paper. To counteract this problem, McCabe and Snyder (2005) suggest separation of the publication fees into a submission and an acceptance part. Another commitment to quality would be the establishment or preservation of a long-run reputation that would be harmed with too many low-quality publications.

In an evaluation of the status quo in 2008, Björk et al. (2010) found that 20.4% of scientific articles have been published open access using a random sample of 1837 articles. Another study finds an average share of approximately 24% for the years 2005-2010 using a sample of some 100,000 publications in 14 disciplines, i.e. some 1,300 articles per discipline per year. 21.4% are published under green OA, 2.4% under gold OA with an annual growth rate of 1% (Gargouri et al., 2012). A more recent study finds a share of 27.9% using a sample drawn from the Crossref-database and a share of 36.1% using the World of Science database (Piwowar et al., 2018). Solomon (2013) provides a deeper investigation of the types of publishers that make OA articles available. The largest share of one half of the journals and 43% of the published articles is held by universities and societies, that have their own open access programmes. In 2010, for-profit publishers count for one third of the journals and 42% of the articles. The university-based journals are often free of any charge and can most likely be found in countries with less settled research institutions and infrastructure than the US or Western Europe. Furthermore, it is noted that a growing number of research projects financed by foundations and government agencies in North America and Europe require OA publication of the project results (Solomon, 2013).

Up to the recent years, the movement towards open access has been slow. The problem of schools and departments being unwilling or unable to provide structured green OA to eligible papers has remained prevalent. Unlike in other industries such as music, transportation, or travel booking, the academic publishing market has not faced a severe transition caused by the internet. A reason might be missing intermediaries and substitutes. (Björk, 2017). The Max Planck Digital Library (MPDL), an administrative subunit of the German Max Planck Society published a white paper that argues in favour of a large-scale transition of academic publishing towards open access (Schimmer, Geschuhn, & Vogler, 2015). Dividing the estimated total subscription fees by the number of articles published, the authors find costs per articles between 3,800€ and 5,000€ for the mainly subscription-based model. This money could be used to pay the 'article processing charges' (APC) that have to be paid for an OA publication. As the authors calculate an average APC of 2,000€, they do not only see full coverage for a transition but also the chance for sufficient savings (Schimmer, Geschuhn, & Vogler, 2015). Open access publishing appears to be also attractive for authors, McCabe and Snyder (2014) estimate a positive effect of 8% on citations for an open access article analysing a panel data set in several subfields of biology. In a survey among economists from the DACH-region, Stich, Spann, and Schmidt (2020) find an average willingness to pay of 1,324$ to 1,547$ to make a hypothetical publication in a top 5 journal with full OA. Further detailed analyses of the economic effects of copyrights, open access publishing, and its costs and benefits, risks and opportunities are provided by Mueller-Langer and Scheufen (2013), Scheufen (2015), and Eger and Scheufen (2018).

3 The German DEAL

The German DEAL is a project aimed at addressing many of the issues discussed in the previous section. This "Alliance of Science Organisations" is a network of nearly all research institutions in Germany. The members are universities, colleges, research libraries, the German Research Foundation (DFG), the Max Planck Society, the Fraunhofer Society, the Leibniz Association, the Helmholtz Association, and all their subunits. Together with further entities, the group of members consists of more than 700 institutions from all fields of research in academia. This makes the German DEAL globally unprecedented in scope and size. The goal of this alliance is to negotiate 'publish and read' agreements with all major publishers against the backdrop of rising fees of big publishing companies. These should include immediate and full open access (gold OA) and full access to the publishers' full journal portfolios.[5] Negotiations started with the three major publishers Elsevier, Springer Nature, and Wiley. The DEAL taskforce did not conclude with Elsevier. The main dispute was the aim of the publisher to split the 'publish and read' agreement into two separate contracts along with offering only green OA (Hunter, 2018). The alliance could sign

[5] `https://www.projekt-deal.de/about-deal/`

two DEAL agreements with Wiley and Springer Nature.

Responsible for the signing and the administration of the DEAL is the Max Planck Digital Library (MPDL), a subsidiary of the Max Planck Society. The society combines 86 institutes that conduct basic research and produce a research output of some 15,000 scientific publications annually.[6] In general, both DEAL contracts encompass the same two major aspects: a ‘publish’ and a ‘read’ part. The former means that every article published at an eligible journal is immediately after publication available under Gold OA. The latter provides all German research institutions full access to the online journal databases of the publishers (Hunter, 2020). The research institutions do not pay subscription fees for any included journal anymore. There is rather a fixed Article Processing Charge (APC) that is paid per article by the MPDL to the publishers, that also contains some price for the access to the publisher’s journal portfolio. In turn, the MPDL charges the institutions for the publication costs of their researchers. In the beginning, this is meant to be covered by the former subscription fees. In later years, the payments of the institutions shall also reflect an institution’s individual research output.[7] Researchers do not have to pay the APC fee in general as their institutions cover this. Nevertheless, the institutions could require some cost sharing in the future in case the institution’s budget is not sufficient to cover the costs for all publications of its researchers within a billing period.[8]

Part of the DEAL are three types of journals: Hybrid journals are those that are sold globally on a subscription base. The hybrid part stems from the fact that articles from authors with a German affiliation are published open access as outlined earlier. Full OA journals are journals that are already published as full open access publications. The last type is ‘read only’ journals. Authors *cannot* publish Gold OA in these journals but the whole content is fully available at all German research institutions. Table 1 displays the timeline of the negotiations and the dates, when the different journal types fall under the DEAL conditions.

[6] https://www.mpg.de/short-portrait
[7] https://www.projekt-deal.de/faq-for-participating-institutions/
[8] https://www.projekt-deal.de/faq-for-authors/

Date	Publisher	Event
18.08.2016	Elsevier	Start of negotiations
28.04.2017	Wiley	Start of negotiations
17.05.2017	Springer Nature	Start of negotiations
05.07.2018	Elsevier	DEAL consortium suspends further negotiations
15.01.2019	Wiley	Signing of the DEAL agreement for 2019-2021
22.01.2019	Wiley	Submissions to Full OA journals fall under DEAL conditions
01.07.2019	Wiley	Submissions to Hybrid journals fall under DEAL conditions
22.08.2019	Springer Nature	Memorandum of Understanding signed
08.01.2020	Springer Nature	Signing of the DEAL agreement for 2020-2022
01.01.2020 (retroactive)	Springer Nature	Submissions to Hybrid journals fall under DEAL conditions
01.08.2020	Springer Nature	Submissions to Full OA journals fall under DEAL conditions

Table 1: Timeline of the DEAL negotiations

3.1 The DEAL contracts with Wiley and Springer Nature

The contract between Wiley and the Max Planck Digital Library on behalf of the German research alliance was signed on January 15, 2019. The agreement started operating on January 22 for existing full open access journals, and on July 1, 2019 for hybrid journals. The agreement is set to expire at December 31, 2021. It is automatically extended by one year if no party objects to it. Eligible for publications under the agreement are corresponding authors affiliated to an institution that is part of the German research alliance. The 'read' part grants full access to all Wiley journals from 1997 onwards. The fee for publishing a paper in a hybrid journal is set to 2,750€. For the OA journals, an individual publication fee is needed. Wiley grants a 20% discount on the scheduled price (Sander et al., 2019, full contract). Part of the contract are 1,747 journals.[9] By that, nearly the complete current portfolio of the Wiley group is part of the DEAL. Table 2 distinguishes the number of included by journal type, i.e. hybrid, full OA or 'read only'.

The contract between Springer Nature and the MPDL has been signed on January 8, 2020. The 'publish part' entered into force with retroactive effect from January 1, 2020 for hybrid journals and for full OA journals from August 1, 2020.

[9] https://keeper.mpdl.mpg.de/f/1578cfa1ea894d50970f/?dl=1, last updated: 12.10.2020

The contract expires at December 31, 2022 with an option to extend the contract by 12 months. The read part was immediately active. Equivalently to the Wiley contract, the publication fee per research paper is 2,750€. Springer Nature also provides a 20% rebate for publication in its full OA journals(Kieselbach, 2020, full contract). The eligible journals encompass also publications from Springer subsidiaries such as BioMed Central, Pleiades Publishing and Palgrave Macmillan. In total, the contract encompasses 2,857 journals. The RHS of table 2 shows the shares of the three journal types. Similar to Wiley, the lion's share consists of hybrid journals.[10] The whole portfolio of the publisher contains 3,175 journals. By that, approximately 92% of the whole portfolio is part of the DEAL agreement.[11]

	Wiley		*Springer Nature*	
Journal type	No. of Journals	Percentage	No. of Journals	Percentage
Hybrid	1,437	82.26%	2,086	73.01%
Full Open Access	226	12.94%	452	15.82%
Read Only	76	4.35%	319	11.17%
Miscellaneous	8	0.46%		
Total	1,747	100%	2,857	100%

The numbers encompass all academic disciplines

Table 2: Journals of Wiley and Springer Nature being part of the DEAL by journal type

3.2 'Deal' contracts in other countries

The German DEAL contracts with Springer Nature and Wiley are not the first and not the only 'publish and read' agreements between research consortia and publishers. Wiley has closed large scale agreements with Hungarian, Austrian, Dutch, Finnish, Hungarian, Norwegian, Swedish and UK universities. This does not encompass necessarily all research institutions of a country but large consortia.[12] Springer Nature has similar contracts with universities within the mentioned countries and additionally closed DEAL agreements in Italy, Poland, Qatar and Switzerland.[13] El-

[10] https://keeper.mpdl.mpg.de/f/a6dc1e1ed4fc4becb194/?dl=1, last updated: 08.10.2020

[11] https://resource-cms.springernature.com/springer-cms/rest/v1/content/18466124/data/v2, last update 08.10.2020

[12] https://authorservices.wiley.com/author-resources/Journal-Authors/open-access/affiliation-policies-payments/index.html,checked 15.12.20

[13] https://www.springer.com/gp/open-access/springer-open-choice/springer-compact, checked 15.12.20

sevier closed DEALs in Hungary, [14] Italy,[15] Poland,[16] Sweden,[17] and Switzerland[18]. There exist further bundling contracts in many countries and some publish and read contracts with several single universities and research institutions. But neither those small contracts nor the consortial agreements have the size of the German DEAL in terms of the number of participating institutions. There already exist early descriptive evaluations of pilot agreements between universities in the UK (Marques & Stone, 2020) and Sweden (Olsson et al., 2020) in the literature.

4 Empirical Analysis

We estimate the treatment effect on the treated (TT) of the German DEAL in a difference-in-differences (DiD) approach. Due to the DEAL contracts with the publishing firms Wiley and Springer Nature, German research institutions benefit from favourable conditions with respect to fees and access to both obtaining and issuing academic publications. Especially the new possibility to publish own research *open access* in peer-reviewed journals otherwise subject to access barriers, appears as a notable new incentive to researchers. Due to these incentives, researchers from German research institutions might increasingly aim at publishing in journals subject to the German DEAL, if at all. The underlying research question therefore is, whether the academic publishing behaviour of German research institutions reacts to potential incentives set by the German DEAL at all. In order to approach an empirical answer to this question, we estimate whether the German DEAL induces a response in likelihood for authors affiliated to German research institutions to publish their articles in eligible journals subject to the DEAL agreement in the treatment period.

We use a full sample of all publications in the field of chemistry from 2016 to 2020 available on Scopus, a database that collects academic publications and citations. Run by the publisher Elsevier, it contains currently some 75 Million entries, 24,600 journals and 200,000 books.[19] We choose the field of chemistry as a good subject of analysis for several reasons. According to Björk and Solomon (2013), it is a discipline with a comparatively low time lag between submission and publication of a paper, which is a crucial aspect against the backdrop of the very small time period after the treatment to the present day. Also, chemistry is a rather small field of research

[14] https://www.elsevier.com/open-access/agreements/hungary
[15] https://www.elsevier.com/open-access/agreements/crui
[16] https://www.elsevier.com/open-access/agreements/poland
[17] https://www.elsevier.com/open-access/agreements/sweden-bibsam
[18] https://www.swissuniversities.ch/en/themen/digitalisierung/open-access/publisher-negotiations
[19] https://www.elsevier.com/solutions/scopus?dgcid=RN_AGCM_Sourced_300005030

among fields of natural science, in which the support for the DEAL negotiations in Germany was particularly strong.[20]

4.1 Data

We use a dataset that encompasses scientific publications in the field of chemistry from 2016 until 2020.[21] With about 1.4 million observations from 1.005 journals the dataset contains the full range of publications in the field of chemistry in the given period of time. These data are matched with lagged ranking scores from Scimago containing data on the H-Index on the journal level for the years 2015-2019.[22] Scimago itself built its database and ranking system upon data from Scopus.[23] We identify the journals of the leading publishers Elsevier, Springer Nature, Wiley, and the American Chemical Society via journal lists taken directly from the publishers. We add all other chemistry journals from the Scimago list. The positive difference should come from the fact that the big publishers might also list journals from adjacent fields such as biochemistry. With these 1,005 journals, we are confident to have a full sample that includes all relevant journals of the discipline for the years 2016 up to 2020. From the 1.4 million observations, some 1.2 million are used effectively. The reduction stems from removing publications affiliated to countries that count on aggregate for at most 1% of the observations. Furthermore, the quantitative analysis only uses research articles – in contrast to editorials, letters, reviews etc. – as the DEAL agreements focus on this common type of article. Table 10 in the appendix provides information on the publications per country.

According to the DEAL, corresponding authors of an article affiliated with eligible research institutions are eligible to benefit from the contract. The Scopus dataset gives information on all co-authors of each research article in the order of which they appear on the respective paper. No explicit information on the corresponding authors are added. We deduce corresponding authors' countries of affiliation from the very order of the authors' appearance on the papers. Accordingly, country dummy variables are constructed on this assumption. The appearing order of the authors in

[20]See for example the disciplines of the researches that withdrew from editorial boards of Elsevier journals after the negotiations with the publishers failed: `https://www.projekt-deal.de/elsevier-news/`.

[21]The data was downloaded from Scopus via the Scopus API using the *pybliometrics* library for Python developed by Rose and Kitchin (2019). The download took place between 30.10.20 and 12.11.2020. This might cause missing data for 2020, but might be mitigated also articles ahead of publication are listed.

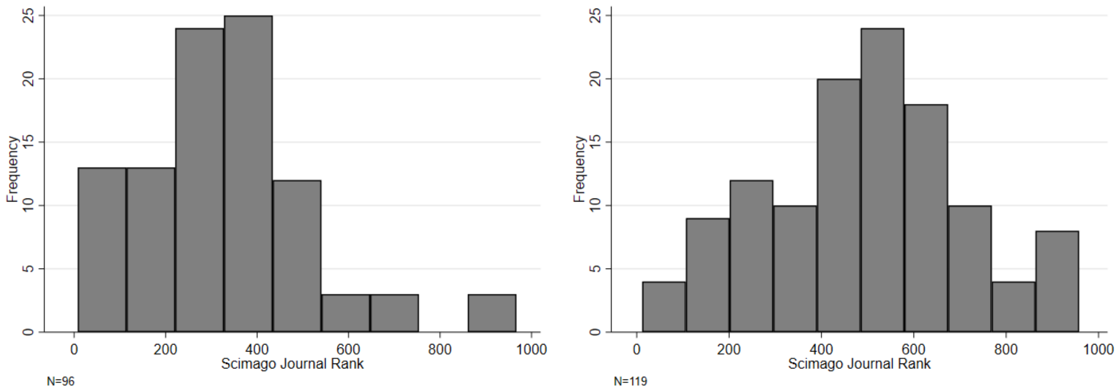
[22]See `https://www.scimagojr.com/journalrank.php?area=1600`.

[23]`Seehttps://www.scimagojr.com/aboutus.php`

chemistry is typically not alphabetically as for example in economics. It may well be possible that we therefore assign some articles to other countries than Germany if several corresponding authors are apparent and their order is such that the German corresponding author is not named first. As the Tables 7, 8, and 9 in the Appendix show, most papers have at most four authors. Among research groups, most of the teams have at least two authors from the same country, often are all of them affiliated to the same. Hence, we consider the threat of miss-assignments as negligibly small.

4.2 Descriptive statistics of DEAL journals

The journals that fall under the DEAL agreements (DEAL journals) are differently distributed with respect to their rank. Figure 1 shows the distribution of journals across ranks for Wiley (1a) and Springer Nature (1b) respectively. This is based on the Scimago journal ranking using the data for all journals listed in the field of chemistry in 2018 – the year before the first DEAL agreement was closed. The rank is based on the Scimago Journal Rank (SJR) criterion[24].



(a) Distribution of Wiley journals across ranks (b) Distribution of Springer journals across ranks

Figure 1: Comparison of journal ranks by publisher

Wiley journals subject to the DEAL contract show a left-skewed distribution implying that Wiley's journal portfolio consists in general disproportionally more top-ranked journals. Springer Nature on the other hand shows a less skewed distributed portfolio with a roughly symmetric peak in the middle of the ranking range. Within

[24]See for an evaluation of this measure e.g. Mañana-Rodríguez (2015)

the Wiley portfolio, 86 journals are related to chemistry as main category. Springer Nature relates 133 journals to this category.[25]

Figure 2 shows the yearly shares of DEAL-journals distinguished by national affiliation of corresponding authors. Both, treatment and control group show some increase in the treatment period (as of mid 2019), however the increase is much more pronounced in the treatment group of corresponding authors with a German affiliation.

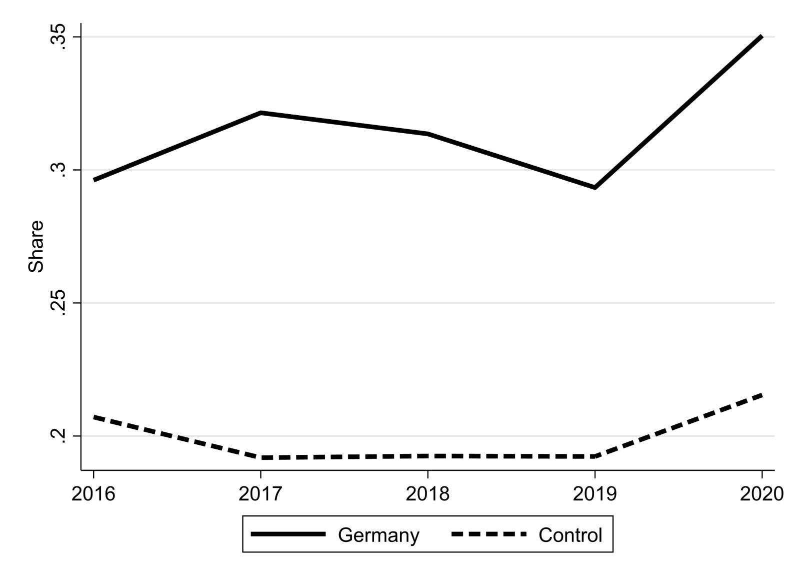


Figure 2: Yearly share of publications in DEAL journals over time distinguished between *treated* German institutions and all other institutions as *control*

4.3 Empirical Results

Table 3 shows summary statistics of DEAL-journals in German research institutions (treatment group) and all other research institutions (control group) distinguishing between pre-treatment and treatment period.[26] The treatment period is defined as of 1st July 2019 (beginning of phase 1)[27]. The share of publications from German research institutions in DEAL-journals between treatment period and pre-treatment period shows a difference of 5.29%, whereas the difference between periods for the

[25]The number of journals in the histograms is different to the number from the publishers and the number analysed as not all DEAL journals are ranked in Scimago and not all ranked journals are fully listed in Scopus. Additionally, Scimago defines "chemistry" different than the publishers such that some publications from adjacent fields are part of the distribution

[26]Further descriptive statistics for the sample are provided in the appendix.

[27]Even though Wiley's full OA journals became eligible in January 2019, we consider July as an appropriate starting point as from July on the hybrid journals fell under the DEAL conditions. These journal type makes up the lion's share and benefits from open access.

control group amounts to 3.40%. Both treatment and control groups show an increase between pre- and post-treatment period in the share of publications in journals subject to the German DEAL agreement. The increase for the treated German institutions is 1.89% higher, which is the difference-in-differences coefficient on the sheer means.

	Germany	Δ	Control	Δ	Δ DiD
Treatment Pre-Treatment	34.61% 29.32%	5.29%	22.09% 18.69%	3.40%	1.89%
N	48,744		1,186,967		1,235,711

Treatment period is as of 1st July 2019. Differences for the average share of publications from German institutions and others (*control*).

Table 3: Differences in sample means for the share of publications in DEAL journals

In order to control for potential other confounding factors, we purge the plain DiD coefficient from Table 3 in a set of regression analyses. Other factors such as country or year specific effects, but most crucially journal quality might induce the authors' journal schoice. The underlying research question is whether the academic community responses to publishing related incentives subject to the German DEAL contracts. In order to find empirical answers to this question we estimate the treatment effect on the treated using a heteroskedastic probit model. We restrict our analysis to the publication type "article" as only for scientific articles there are potential incentives for authors, if at all. The binary dependent variable takes on the value 1 if a research article is published in a DEAL-journal. The underlying question is, whether due to the DEAL contracts, authors eligible to the contracts more likely choose these journals for their publications.

In order to purge the treatment effect from journal quality, we control for journal quality by the one year lagged H-Index.[28] As a higher ranked journal should be more attractive for publication on average, we expect the corresponding coefficient to be positive and significant. We control for country and year fixed effects in order to purge the post-treatment interaction effect with German institutions from other country specific or time specific factors. This is especially crucial for the validity of the underlying DiD estimation using the interaction of treated entities (*Germany*) and treated time period ($Post_{Treat}$) by the very construction. Furthermore, we control for month fixed effects as the data show a notable skewness of dates of publication towards the January of a respective year, suggesting that in general publications are reported to be published in January of a respective year if the exact

[28] See e.g. Bornmann and Daniel (2007) for an overview of this measure.

date of publication is not made available on Scopus. In the main results, observations from January 2016 were removed as the shares of publications in DEAL-journals appear unusual. The correlation of pre-treatment shares between authors affiliated with treated institutions and control institutions is considerably higher if January 2016 is excluded. With January 2016 included the pre-treatment correlation between treated and control amounts to 0.72, whereas excluding only the month January 2016 from the dataset, this correlation rises considerably to 0.85 rendering the common trend assumption of a DiD estimator much more plausible. In a robustness check, in which these observations are included, the main results show to be robust (see Table 11 and Figure 4 in the appendix).

$Post_{Treat} \times Germany$		0.0649025***	(0.0124)
$Post_{Treat}$		0.117702***	(0.0060)
$log(H\text{-}Index)_{t-1}$		0.0585023***	(0.0023)
lnsigma			
$log(H\text{-}Index)_{t-1}$		-0.1001853***	(0.0036)
$LR\text{-}test\ of\ lnsigma = 0$	$\chi^2(1)$	711.00***	
Fixed Effects			
$Year$	$\chi^2(4)$	557.33***	
$Month$	$\chi^2(11)$	12523.67***	
$Country$	$\chi^2(69)$	9092.47***	
$Wald$	$\chi^2(87)$	43698.62***	
N		1,235,711	

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Standard errors in parentheses. Variable for modelling variance: $log(H\text{-}Index)_{t-1}$.

Table 4: Results of the heteroskedastic probit model.

Table 4 shows the results from a heteroskedastic probit model, which is a generalization of the probit model accounting for potential bias caused by heteroskedasticity.[29] We suspect heteroskedasticity to stem from a considerable variation in journal quality as measured by the H-index. The likelihood ratio test on homoskedasticity is rejected significantly throughout. The coefficient of interest, the interaction of the post-treatment period after 1st July 2019 and eligible institutions (Germany) is positive and statistically highly significant. The corresponding average marginal effect amounts to 2%. That is, authors from treated institutions are subject to a 2%

[29] As the probit model is non-linear, present heteroskedasticity causes bias in the point estimates rather than only wrong standard errors as in linear models such as OLS. Following Harvey (1976), the variance is modelled explicitly.

higher likelihood to choose a DEAL-journal for their publications in the treatment period on average.[30]

Phase 1 × *Germany*		0.0205626	(0.0204)
Phase 2 × *Germany*		0.0415773*	(0.0277)
Phase 3 × *Germany*		0.0648614**	(0.0275)
Phase 1		0.1146191***	(0.0059)
Phase 2		0.2049734***	(0.0093)
Phase 3		-0.0623442***	(0.0065)
$log(H\text{-}Index)_{t-1}$		0.0557025***	(0.0023)
Trend		0.1940178***	(0.0097)
$Trend^2$		-0.0356295***	(0.0019)
lnsigma			
$log(H\text{-}Index)_{t-1}$		-0.0972883***	(0.0036)
LR-test of lnsigma = 0	$\chi^2(1)$	665.32***	
Fixed Effects			
Month	$\chi^2(11)$	12334.42***	
Country	$\chi^2(69)$	9109.88***	
Wald	$\chi^2(89)$	43375.31***	
N		1,235,711	

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Standard errors in parentheses. Variable for variance modelling: $log(H\text{-}Index)_{t-1}$. Phase 1 as of 1st July 2019. Phase 2 as of 1st January 2020. Phase 3 as of 1st August 2020. Time-fixed effects are controlled for by means of a quadratic polynomial of the underlying time trend as suggested in Carter and Signorino (2010) and Gösser and Moshgbar (2020).

Table 5: Results from heteroskedastic probit model with different time phases

In a robustness check we distinguish the three phases of the German DEAL contracts with Wiley and Springer Nature shown in table 5. Here we interact the three different phases with treated institutions (Germany). Phase 1 takes on the value 1 as of 1st July 2019 to present, otherwise 0. Phase 2 takes on the value 1 as of 1st January 2020 to present, otherwise 0. Phase 3 takes on the value 1 as of 1st August 2020 to present, otherwise 0. Average marginal effects along with 95% confidence bands from this regression are shown in Figure 3. Note that the effect of phase 2 amounts to the sum of the coefficients of phase 1 and phase 2. Accordingly the effect of phase 3 is the sum of the coefficients of phase 1 to phase 3. Figure 3 shows the corresponding average marginal effects of these transformations along

[30] Alternative specification as OLS model and as homoskedastic probit model can be found in Tables 12 and 13 in the appendix.

with 95% confidence intervals obtained by the delta method. The marginal effects show a significant increase in the treatment effect over the three phases, from an insignificant effect in phase 1 to increasing effects over phase 2 and phase 3 of about 2% and 4%, respectively. Note that as of phase 2 both contracts, the Wiley and the Springer Nature contract become effective. An increase in the treatment effect cannot be solely attributed to an increase over time, but also to the increase in scope of the treatment. Against the backdrop of the very short time period at our disposal for this early empirical test, the shown results might suggest a lower bound of a development yet to be unfold.

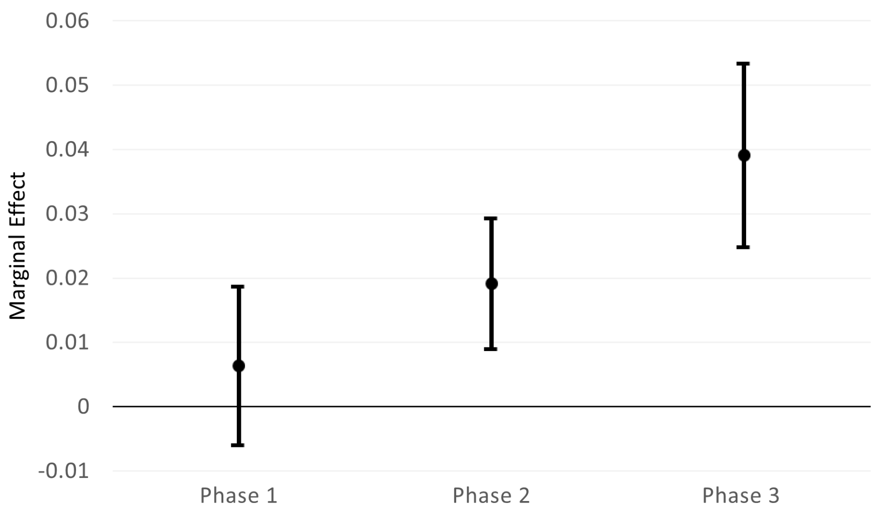


Figure 3: Average marginal effects of heteroskedastic probit model for the three phases as shown in Table 5. Point estimates along with 95% confidence intervals. Phase 1 as of 1st July 2019. Phase 2 as of 1st January 2020. Phase 3 as of 1st August 2020.

As a further robustness check we perform a placebo test using French research institutions as placebo treatment group. Results from this placebo test are shown in Table 14. The results suggest no significant effect on the likelihood to publish in treated journals for authors affiliated with French research institutions in the treatment period. France is especially suitable for such a placebo test due to its considerable similarity in terms of output frequency. In turn, French research institutions are not subject to collective contracts with academic publishers, similar to the German DEAL.

5 Implications for competition among journals

The empirical analysis has found a positive effect of the DEAL on publication behaviour in the field of chemistry, even though the evaluation period has been rather short so far. This finding suggests that smaller publishers' concern that journals covered by the DEAL agreements may have an advantage in attracting authors may not be irrelevant. This is of concern for market competition in the journals market, as the DEAL consortium has not engaged in negotiations with smaller publishers. While the reason may well be capacity constraints and transaction cost considerations on the buyer's side (see Mittermaier, 2017), leaving out small publishers carries the risk of further strengthening the dominance of large commercial publishers and their bundling practices. In a different context, McCabe (2002) has voiced the concern that bundling of large journal portfolios of commercial publishers, while reducing transaction costs for libraries, may negatively affect new entry as well as pricing (McCabe, 2002). This effect may – inadvertently – be even strengthened by the DEAL agreements for two reasons: firstly, libraries may be left with less money and incentives to pay for both subscriptions and open access publishing in non-DEAL journals and, secondly, DEAL journals appear to have an advantage in attracting authors. While the two-sided market logic already suggests that positive indirect network effects between authors and readers can lead to market concentration, the DEAL agreements may even spur this concentration process.

While the DEAL agreements may solve researchers' current trade-off between publishing in well-reputed journals and publishing open access (see Armstrong, 2015), there can be unintended side effects of erecting barriers to entry for small publishers and further increasing the ongoing market concentration process. While this risk may be negligible if we only consider the German DEAL contracts in isolation, the implications may be much more far reaching if other countries negotiate similar deals (also see Hunter, 2018). For example, Olsson et al. (2020) critically evaluate the Swedish pilot agreement with Springer Nature and consider it expensive, raising the concern that libraries may be left with less money for both subscriptions of smaller publishers' journals and financing open access publications in these journals. In fact, researchers may find it more difficult to obtain funding for open access publications in smaller open access journals, as librarians and faculty administrations may point towards the large DEAL portfolio. In the German case, the DEAL journal portfolio comprises some 4,000 different journals. In addition, since the DEAL agreements significantly lower transaction costs for open access publications in the journals covered, researchers in Germany may also prefer to submit to these journals just to save the hassle or transaction costs.

In order to avoid potentially negative side effects of further increasing market power in the academic journal market, DEAL negotiating consortia should rapidly expand their offer to smaller publishers.

6 Conclusion

The German DEAL agreements between German universities and research institutions on the one side and Springer Nature and Wiley on the other side facilitate easy open access publishing for researchers located in Germany, while simultaneously giving them access to the publishers' extensive journal portfolio. While these DEAL agreements appear attractive at first sight, there can be severe unintended side effects for market competition in the long term.

As our empirical analysis reveals, even in the short period following the conclusion of DEAL agreements with Wiley and Springer Nature in 2019, researchers' submission behaviour in the field of chemistry has changed to some degree, as eligible researchers have increased their publications in Wiley and Springer Nature journals at the cost of other journals. While the effect is not overly large yet, its is statistically significant and it may increase over time, as the agreements become even more well known among scientists. Hence, journals covered by the DEAL agreements appear to have a competitive advantage in attracting authors. Given the two-sided market logic that good authors and papers attract readers which in turn attract authors, the competitive advantage of the DEAL agreements may even be underestimated in the short-run.

Overall, two competition concerns arise, as the DEAL consortium has only engaged in negotiations with the large commercial publishers, namely Elsevier, Springer Nature and Wiley, while it does not appear to be willing to engage in similar negotiations with smaller publishers. While no agreement was reached with Elsevier, smaller publishers were not even given the option to sign any form of agreement. Given that DEAL agreements are now in place with Springer Nature and Wiley, two related competition concerns emerge: First, academic libraries may be, at least in the long run, left with fewer funds and incentives to subscribe to non-DEAL journals published by smaller publishers or to fund open access publications in these journals. Secondly, eligible authors may, therefore, prefer to publish in journals included in the DEAL agreements, thereby giving DEAL journals a competitive advantage over non-DEAL journals in attracting good papers. Given the two-sided market nature of the academic journal market, these effects may both further spur the concentration process in the academic journal market. Hence, research institutions and academic libraries should rapidly also start negotiations with smaller academic publishing houses.

The concerns identified in our analysis also go beyond the academic publishing sector. In fact, they concern many platform driven markets. A recent example is the global cooperation of news publishers with Google[31] or with Facebook in the US (Newton, 2019) and in Australia. In fact, industrial economists such as Gans (2021) have voiced very similar concerns with respect to the new Australian News Media Bargaining Code where platforms such as Google and Facebook prefer to negotiate with large media corporations only, leaving out smaller publishers. Similarly, if national science and library organisations only enter into negotiations with large publishers, small publishers may vanish and barriers to entry may be even hight than before in the academic journal market. Hence, national science and library organisations should also offer DEAL-like agreements to smaller publishers in order to avoid further market concentration and an increase in the large publishers already substantial market power.

[31] See e.g. https://blog.google/outreach-initiatives/google-news-initiative/google-news-showcase/

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7 Appendix

7.1 Descriptive Statistics

Year	2016	2017	2018	2019	2020
No. of Articles	244,216	250,940	266,121	284,691	275,750
Annual Growth		+2.75%	+6.05%	+6.98%	−3.14%

The decrease in 2020 could be due to missing publications in the sample as the year was not completed when the sample has been received. Also, the COVID-19 crisis could have affected this.

Table 6: Published articles per year and related annual growth ($N = 1,321,718$).

No. of Authors	No. of Articles	Percentage Share	Cumulative Share
1	505,840	38.27%	38.27%
2	416,992	31.55%	69.82%
3	224,666	17.00%	86.82%
4	99,604	7.54%	94.35%
≥5	74,616	5.65%	100.00%
Total	1,321,718		

Table 7: Amount of papers by the number of authors

No. of Authors	No. of Articles	Percentage Share
2	112,045	40.82%
3	102,291	37.27%
4	60,117	21.90%
Total	274,453	100.00%

Table 8: Amount of articles from research groups (2-4 members) with at least one difference in national affiliations

Number of authors	No. of Articles	2 authors with the same national affiliation		3 authors with the same national affiliation		4 authors with the same national affiliation	
2	416,992	304,947	73.13%				
3	224,666	203,618	90.37%	122,375	54.47%		
4	99,604	95,735	96.12%	62,491	62.74%	39,487	39.64%

Table 9: Share of research groups with authors having the same national affiliation

National affiliation of the first author	No. of Articles	National affiliation of the first author	No. of Articles
China	407,746	Israel	4,457
United States	138,300	Argentina	4,337
India	83,231	Finland	4,219
Japan	56,145	South Africa	4,193
Germany	52,097	Viet Nam	4,069
South Korea	45,136	Indonesia	3,621
France	38,856	Iraq	3,559
Russian Federation	38,714	Hungary	3,478
Iran	37,943	Greece	3,301
United Kingdom	31,881	Colombia	3,299
Spain	28,488	Serbia	3,267
Italy	25,698	Hong Kong	3,015
Brazil	24,131	Algeria	2,911
Poland	20,892	Norway	2,749
Canada	20,345	Chile	2,670
Australia	18,664	Tunisia	2,628
Turkey	15,999	Nigeria	2,106
Taiwan	14,941	Ireland	1,971
Egypt	10,676	New Zealand	1,835
Switzerland	9,677	Slovenia	1,767
Saudi Arabia	9,518	Morocco	1,737
Netherlands	9,222	Bulgaria	1,604
Singapore	8,859	Slovakia	1,520
Mexico	8,673	UAE	1,519
Pakistan	8,474	Croatia	1,505
Malaysia	7,677	Qatar	1,419
Czech Republic	7,656	Lithuania	1,295
Romania	7,573	Bangladesh	1,106
Belgium	7,084	Kazakhstan	1,078
Sweden	7,001	Jordan	929
Portugal	6,213	Belarus	926
Thailand	5,958	Estonia	753
Austria	5,334	Macao	651
Denmark	4,730	Ecuador	628
Ukraine	4,609	Ethiopia	616

Table 10: Number of papers per country measured by the affiliation of its first author. Cut-off at the 99% quantile of all scientific articles ($N = 1,321,718$).

7.2 Alternative Model Specifications

Phase 1 × *Germany*		-0.0253142	(0.0204)
Phase 2 × *Germany*		0.0406241	(0.0250)
Phase 3 × *Germany*		0.0655914**	(0.0277)
Phase 1		0.1171935***	(0.0059)
Phase 2		0.1993404***	(0.0091)
Phase 3		-0.0615337***	(0.0065)
$log(H\text{-}Index)_{t-1}$		0.054166***	(0.0023)
Trend		0.1868165***	(0.0094)
$Trend^2$		-0.0338797***	(0.0018)
Sigma			
$log(H\text{-}Index)_{t-1}$		-0.0945141***	(0.0035)
LR-test of lnsigma = 0	$\chi^2(1)$	658.34***	
Fixed Effects			
Month	$\chi^2(11)$	13689.76***	
Country	$\chi^2(69)$	9820.15***	
Wald	$\chi^2(89)$	46586.21***	
N		1,308,879	

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Standard errors in parentheses. Variable for modelling variance: $log(H\text{-}Index)_{t-1}$. Phase 1 as of 1st July 2019. Phase 2 as of 1st January 2020. Phase 3 as of 1st August 2020. Time-fixed effects are controlled for by means of a quadratic polynomial of the underlying time trend.

Table 11: Results from heteroskedastic probit model with different time phases using all observations including January 2016.

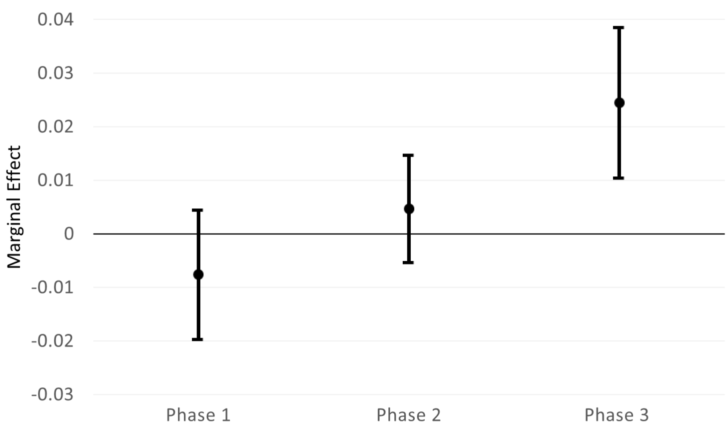

Figure 4: Average marginal effects of heteroskedastic probit model for the three phases as shown in Table 11. Point estimates along with 95% confidence intervals.

$Post_{Treat} \times Germany$		0.0182729***	(0.0047)
$Post_{Treat}$		0.0280286***	(0.0018)
$log(H\text{-}Index)_{t-1}$		-0.0026596***	(0.0004)
Fixed Effects			
$Year$	$F(4, 1, 235, 623)$	81.35***	
$Month$	$F(11, 1235623)$	1540.77***	
$Country$	$F(69, 1235623)$	210.75***	
$F\text{-}Statistic$		440.19***	
N		1,235,711	

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Robust standard errors in parantheses.

Table 12: Results of the OLS model.

$Post_{Treat} \times Germany$		0.0236792*	(0.0134)
$Post_{Treat}$		0.1086095***	(0.0064)
$log(H\text{-}Index)_{t-1}$		-0.0104202***	(0.0017)
Fixed Effects			
$Year$	$\chi^2(4)$	395.77***	
$Month$	$\chi^2(11)$	18927.64***	
$Country$	$\chi^2(69)$	14609.34***	
$\chi^2(87)$		38341.34***	
N		1,235,711	

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Standard errors in parentheses.

Table 13: Results of the homoskedastic probit model.

	w/ German interaction			w/o German interaction		
$Post_{Treat} \times Germany$		0.0644886***	(0.0125)			
$Post_{Treat} \times France$		-0.0125459	(0.0152)		-0.0157657	(0.0152)
$Post_{Treat}$		0.118079***	(0.0060)		0.1208574***	(0.0060)
$log(H\text{-}Index)_{t-1}$		0.0584603***	(0.0023)		0.0572053***	(0.0023)
lnsigma						
$log(H\text{-}Index)_{t-1}$		-0.1001079***	(0.0036)		-0.0978423***	(0.0036)
LR-test of lnsigma $= 0$	$\chi^2(1)$	709.38***		$\chi^2(1)$	685.67***	
Fixed Effects						
Year	$\chi^2(4)$	556.81***		$\chi^2(4)$	548.79***	
Month	$\chi^2(11)$	12520.93***		$\chi^2(11)$	12611.78***	
Country	$\chi^2(69)$	9072.99***		$\chi^2(69)$	9740.51***	
Wald	$\chi^2(88)$	43688.31***		$\chi^2(87)$	43347.11***	
N		1,235,711			1,235,711	

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Standard errors in parentheses. Variable for modelling variance: $log(H\text{-}Index)_{t-1}$.

Table 14: Results of a heteroskedastic probit model: Placebo test on France with and without the German interaction term.

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ISSN 2190-992X (online)
ISBN 978-3-86304-359-9

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