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The Role of Gender and Coauthors in Academic Publication Behavior*

W. Benedikt Schmal† Justus Haucap‡ Leon Knoke§

March 2022

We use the negotiations for large-scale open-access agreements between German research institutions and leading academic publishers to study how changes in the attractiveness of various journals affect the publication behavior of researchers in economics and adjacent fields. First, as German universities canceled their subscriptions to Elsevier, we study how this affected German economists' incentives to publish in its journals. Second, Springer and Wiley entered into open-access agreements so that researchers in Germany are eligible to publish articles open-access without additional charges for them. Using 243,757 articles published between 2015 and 2022, we find a shift toward included journals, which is most pronounced among women. For Elsevier, the effect is negative and women have a higher tendency to opt out than men. In mixed teams, the dominant gender drives behavior. We conclude that men tend to seek reputation, women visibility. Thereby, female researchers contribute more to the public good of open science. Our findings provide a new explanatory channel of the academic gender gap.

JEL Classification: *A14, I23, J16, L86, Z11*

Keywords: *academic publishing, journal choice, gender differences, DEAL, Elsevier, Springer Nature, Wiley, transformative agreements*

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1 Introduction

Choosing an outlet for an academic paper is a high-stakes decision for researchers, as their careers depend to a large degree on publication success. It serves as a signal for the authors' unobservable ability and widely determines the reached audience and the subsequent reception of the actual content. While important across disciplines, economics puts a special emphasis on the ranking of the outlets a researcher's papers are published in (Fourcade et al., 2015; Heckman & Moktan, 2020).

We investigate the collective undertaking of virtually all German research institutions to counter the strong market power of the leading academic publishers Elsevier, Springer, and Wiley by urging them to conclude large-scale open-access agreements that replace the existing journal subscriptions. While the latter two publishers agreed, Elsevier did not. In response, German libraries canceled their subscriptions. Readers in Germany were cut off from the most recent articles published in Elsevier Elsevier journals, which still prevails today. For the individual scientist, the changes were exogenous. The situation provides us with two arguably natural experiments we exploit to study behavior in reaction to this variation in the attractiveness of the affected journals.

We identify gender and coauthors as crucial drivers for the choice of a publication outlet. These findings may contribute to a better understanding of the so-called research productivity puzzle (Cole & Zuckerman, 1984; Xie & Shauman, 1998; Prpić, 2002; Kelchtermans & Veugelers, 2013), namely that female researchers have at times been found to be less productive than their male colleagues. We show that female economists have a higher tendency to opt out of Elsevier journals, which are regularly higher ranked, but men remain attached to them. Furthermore, the publication behavior of single authors and groups differs more starkly for women. In general, men seem to choose journals more strategically for their own careers than women. We carefully conclude that men appear to put more emphasis on reputation while women emphasize the broad availability of their research. By switching toward open-access and out of the paywall-protected Elsevier outlets, they also contribute more to the public good of freely accessible research.

We study the so-called ‘DEAL’ contracts between the academic publishers Springer Nature and Wiley and the entirety of German academic institutions as well as the failed negotiations with the publisher Elsevier. These ‘transformative’ publication agreements are hitherto the largest in the world in terms of publications and institutions.[1] By and large, universities no longer pay for journal subscriptions but instead are charged a publication fee for every paper written by a scholar from that university. Researchers at affiliated institutions became eligible to publish in well-established subscription-based journals with an open-access option (so-called ‘hybrid’ journals) as open-access without any costs to the researchers. open-access exposes research to a potentially much larger audience. As the ‘DEAL’ concerns well-respected publishers, it circumvents the problem of the potentially lower reputation of pure open-access journals (McCabe & Snyder, 2005). Thus, publications of this group of authors should, all things equal, shift towards the included journals – especially below the top journals that are often widely accessible anyway.

While Springer Nature and Wiley closed DEAL agreements, the negotiations with Elsevier were suspended in the autumn of 2016. As a consequence, 74 institutions canceled their Elsevier journal subscriptions. After a short break, Elsevier decided to continue granting access to institutions without contracts. At the end of 2017, a further 110 institutions terminated their contracts. Again, Elsevier continued to provide access to its outlets. The conflict ended with the German research alliance announcing its withdrawal from the negotiations in July 2018.[2] In turn, Elsevier cut off all institutions without a contract from access to its journals (Borrego et al., 2021). This affected researchers working at German institutions directly and potentially indirectly via the negative publicity caused.[3]

[1] See https://deal-operations.de/en/here-is-the-deal/deal-approach.

[2] https://www.hrk.de/press/press-releases/press-release/meldung/deal-and-elsevier-negotiations-elsevier-demands-unacceptable-for-the-academic-community-4409/.

[3] Examples of leading Elsevier journals in economics are the Journal of Financial Economics, or

Both the escalated conflict between Elsevier, as well as the DEAL contracts, provide us with two experiments that allow us to elicit important drivers of publication behavior. We find gender and the types of authorships to make a difference, comparing single and coauthored papers as well as groups with different gender majorities. The latter relates back to the former as the differences between single authors and groups vary by gender. In contrast, we do not see that international collaborations or other observed differences between male and female researchers distort our findings of the variation in publication incentives. Looking at gender more granularly, we find that women leave Elsevier journals in the lower range of the quality distribution but see no clear trend in reputation in their shift toward DEAL-covered journals. At the same time, men also reduce their publications in lower-tier journals of Elsevier but actually *increase* publications in top-tier Elsevier outlets. This drives the publication records at the top of the discipline further apart. Our findings may add to the understanding of the 'productivity puzzle' in academia, as publications are decisive for academic careers.

We estimate a difference-in-differences model that looks at the effect of the varying publication incentives on the publication behavior of affected economists. Related work by Haucap et al. (2021) looks at the short-term effects of the 'DEAL' in chemistry. We substantially expand that study in multiple dimensions. We decompose our effects by gender and group type and look at the gender effect across the quality scale. Next, we introduce the Elsevier cut-off as a second natural experiment to contrast both arguably positive and negative publication incentives. Gender differences in management research have also been analyzed by Nielsen and Börjeson (2019), but they focus rather on differences in research topics.

We examine gender effects as many studies find evidence for gender differences in preferences (Croson & Gneezy, 2009). This may be also applicable to academia as the choice of journals involves a trade-off between the chance to be published and

Research Policy. Among the top 100 journals of the past decade ranked by RePEc, 42 journals are published by Elsevier, see https://ideas.repec.org/top/top.journals.all10.html.

a journal's rank and reputation. Overall, the presence of women in the discipline is still comparatively low (Auriol et al., 2022; Bayer & Rouse, 2016). This leaves an important desideratum as – apart from the already sketched 'productivity puzzle' – many gender differences exist in academia. Women in life sciences and STEM disciplines are underrepresented in prestigious journals (Graddy-Reed et al., 2019; Lerchenmueller & Sorenson, 2018; Holman et al., 2018). The latter find that the difference between female and male publications is larger for wealthy countries such as Germany than for poorer ones. In economics, papers are less cited if the corresponding author is female (Maddi & Gingras, 2021). Women are confronted with higher standards in publishing compared to men (Hengel, 2022), a more hostile environment (Dupas et al., 2021; Wu, 2018), and they are less well connected in their discipline, looking at the count of women compared to men in the acknowledgments of published papers (Rose & Georg, 2021).

The remainder of this paper is structured as follows. Section 2 provides an overview of the data and descriptive statistics of our research setting. Section 3 explains the mechanism we propose and the empirical strategy. Section 4 presents our findings and discusses their implications. Section 5 concludes.

2 Data and Descriptive Statistics

Construction of the dataset: We build a dataset of scientific publications in economics ranging from 2015 to 2022, which consists of three parts. First, we form a set of journals to be included in our analysis. For this purpose, we use the 'SCImago' journal rankings, a comprehensive database of the SCImago Lab that lists and ranks thousands of academic journals across disciplines. We use all journals assigned to the category 'economics, econometrics, and finance' in the year 2021.[4] To the best of our knowledge, the SCImago database is the largest and most comprehensive journal database publicly available. Still, the topic clusters of SCImago are slightly

[4]See https://www.scimagojr.com/journalrank.php?area=2000.

fuzzy. To tackle type I errors, we manually remove journals that are – according to their purpose description – a bad fit for an analysis of economics journals.[5]

For type II errors, we additionally make use of the journal ranking by the RePEc database, which is an abbreviation for 'Research Papers in Economics' and disseminates working papers and publications in economics. We use the aggregate ranking for the last 10 years to ensure we use journals currently important for the discipline.[6] We compare the top 200 journals with the SCImago list and add missing ones. Technically, we also exclude journals listed by SCImago but without an assigned SCImago Journal Rank (SJR) value. Overall, we cover a set of exactly 1,000 journals, which include journals with a focus on a broad range of economic policy in specific domains, finance, management, as well as social science or sustainability issues related to economic policy. The vast majority uses English as language but a few outlets also publish in, e.g., French or Spanish.[7]

Based on that list, we accessed the Scopus database using the 'pybliometrics' library for Python developed by Rose and Kitchin (2019).[8] Scopus is considered one of the three leading bibliographic databases besides Clarivate's 'Web of Science' and Google Scholar. However, the latter cannot be (legally) accessed to receive large-scale data on publications. In comparison to Web of Science, Scopus includes a larger set of publications in journals (Visser et al., 2021).

We combine the paper records with one-year lagged ranking scores using the Scimago Journal Rank (SJR) of each journal as mentioned beforehand. We do so

[5]We did this very carefully and only removed fully misplaced journals. Thus, our database also includes journals only partially related to economic questions. This is to ensure we cover the discipline in a broader sense, i.e., also researchers and institutions that do not belong to the leading Western economics departments in terms of geographic location but also their research agenda. Further, we removed journals with less than 10 publications in the dataset.

[6]IDEAS/RePEc Aggregate Rankings (Last 10 Years) for Journals: `https://ideas.repec.org/top/top.journals.all10.html`. Rankings were accessed in June 2022.

[7]A full list of included outlets is available as supplementary material.

[8]Based on our Scopus data, we are only able to study the likelihood of being published, which is not only dependent on the authors but also, e.g., editorial decisions or referee behavior. An analysis based on submissions would be cleaner. However, this is not part of our data and would be likely to cover only a few journals if one gets hands with such data at all. Conference submissions or working paper repositories are no remedy in our setting as we study the journal choice. Given that editorial boards are independent, we also do not suspect any effect driven by them.

because authors have some ranking of the outlets they want to submit to in their minds. The most recent we consider is one year prior to a publication.[9] By that, we can add to every publication an impact or else reputation measure of its respective outlet. The SJR has become an accepted quality measure that is highly correlated with a journal's H-Index (Braun et al., 2006) or the 'Journal Impact Factor' (Ahlgren & Waltman, 2014; Guerrero-Bote & Moya-Anegón, 2012). Other than the 'journal H-Index,' it has superior inter-temporal variation as it can be downward-adjusted.

The main focus of our analysis rests on the behavioral differences by group size and gender. We apply the *Namsor Gender Guesser* algorithm which utilizes artificial intelligence to compute the probability of a person's gender based on their first name by considering an extensive library of country-specific, alphabetical, regional, and ethnic information. It has been proven reliable, for example, by Sebo (2021). It is also used by the already mentioned platform RePEc to track the share of female economists.[10] We predict the gender of each author and use a cutoff value of 70% calibrated probability. Based on that, we define male, female, and mixed teams.[11]

We restrict our sample to papers with one to four authors, which accounts for the lion's share of observations. While there is an ongoing development towards more authors, the average has been about 2.2 authors per economics paper in the recent past (Wohlrabe & Bornmann, 2022) and, by that, substantially below our upper cut-off of four. The core advantage of limiting the size of author teams is that we can limit the combinations of mixed-gender teams. For example, in a mixed group of five researchers, there might be one up to four women. Second, there is no reason to assume that omitting publications with five or more authors is not idiosyncratic. Last, we focus on scientific and review articles. As Table 6 in the appendix shows, these two types account for some 94%. Furthermore, only these

[9] This might collide with submissions that take several years to be published within a journal. As the rankings are correlated over time, we consider any potential distortion as negligibly small.

[10] See 'The RePEc Blog' entry on 7 March 2022: https://blog.repec.org/2022/03/07/2378/.

[11] We acknowledge that there may be authors with a non-binary gender in our sample. We would take this into account, however, the used name algorithm does not allow for that.

two types are covered by the DEAL contracts. Neglected types are, among others, book reviews or editorials. In total, we start with 332,243 papers. Narrowing the data to articles and reviews, we still have 312,794 observations. Hence, we consider this a very large sample for the time covered.

Regarding the identification of names, the spread between 50% and 70% together with the inability of the *Namsor* algorithm to identify some of the names leads to an inevitable decrease in the number of observations. The most important reason for the drop to 243,757 observations in total is the fact that often only the initials of an author's first name are registered. This makes any gender identification via the name impossible. As Table 2 later on and Table 7 in the appendix show, the missing values seem to be spread equally across years and publishers (in relative terms), which is reassuring that the loss due to missing first names is idiosyncratic. Additionally inspecting the distribution of papers across reputation of the final dataset highlights that the distribution of the whole dataset as well as the one with gender information is congruent as Figure 13 in the appendix shows.

Descriptive statistics: In general, the amount of publications faces steady growth over time. This is confirmed by Figure 1 for our sample. One can also see variation in gender representation. Publications from purely female teams only account for a quarter of the number of publications of fully male teams (both include single-authors). Furthermore, a trend towards collaboration is obvious given the steady increase in publications by mixed teams.

In terms of journal reputation, there exist notable differences. Using the logarithmic SCImago Journal Rank criterion, one can see in Figure 2 that the distribution of all female research groups has a much higher density in lower parts of the logged SJR range and fully male as well as mixed teams have a higher share of publications from a logged SJR value of approximately -0.75, which is equivalent to an SJR value of 0.47. Examples of journals with such a rating (in 2021) are the *Review of*

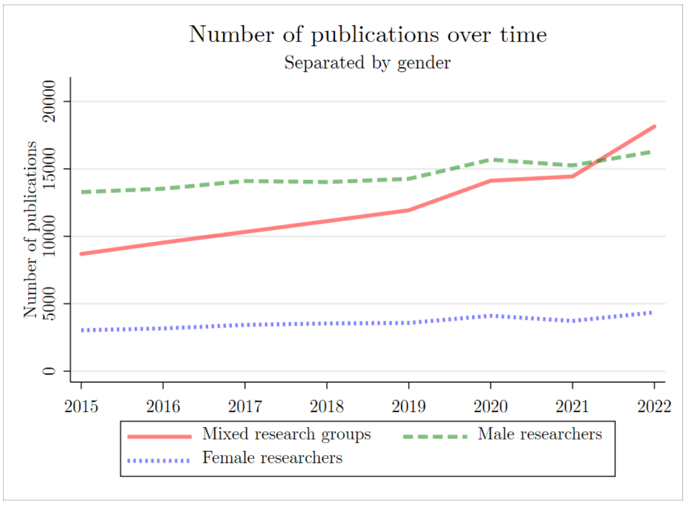
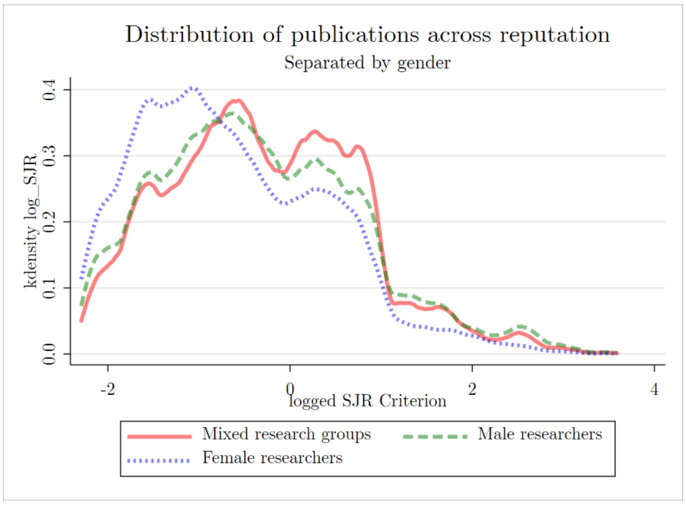


Figure 1: Publications over time by gender

Financial Economics or the *International Journal of the Economics of Business*. In terms of a ranking, this corresponds to #479 and #481 in the SCImago ranking based on the SJR criterion. For comparison, the RePEc ranking lists them on #393 and #450 using the aggregate rankings for journals.[12]



A higher SJR value implies a better journal ranking.

Figure 2: Distribution of publications across quality by gender

In turn, it implies that virtually all journals relevant to a career in academic economics are above this threshold. Hence, women are underrepresented in most of the *academically relevant* research publications. This does not mean that publications

[12]See https://ideas.repec.org/top/top.journals.all.html, last checked Jan 19, 2023.

by single female researchers or fully female teams are less important compared to those of their male colleagues but published in less influential outlets looking through the lens of a purely scientometric evaluation. The relevance for policymakers or the general public, for example, is usually not reflected in such rankings.

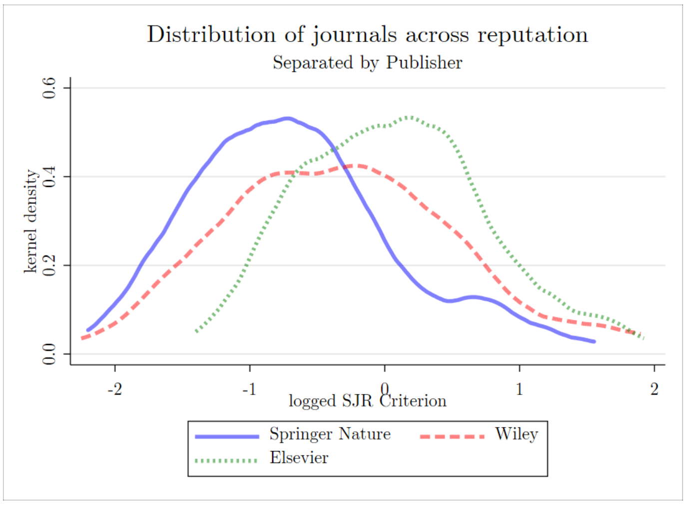
	National Collab.		Intl. Collab.		Single authors		Total
	Count	Share	Count	Share	Count	Share	
Mixed	18,642	18.96 %	79,696	81.04 %	–	–	98,338
Fully Male	18,036	15.49 %	50,182	43.10 %	48,224	41.41 %	116,442
Fully Female	2,958	10.21 %	8,845	30.52 %	17,174	59.27 %	28,977
Total	39,636	16.26 %	138,723	56.91 %	65,398	26.83 %	243,757

Table 1: Number of papers by gender and international collaborations

Another driver of differences might be the share of women in international collaborations as such research teams might exhibit publication patterns different from national ones. Table 1 shows this distinction by distinguishing national and international teams and, additionally, single-authored papers as those cannot be collaborative by definition. Looking solely at coauthored papers, one can see that the share of international collaborations among coauthored papers does not differ much between men and women (26.44% compared for 25.06%). However, papers from female authors are more than proportionally single-authored. We conclude that gender differences are unlikely to be driven by differences in international collaborations but rather by differences in the number of authors or their gender composition.

As the setting of our analysis uses publishers as main actors, their journal portfolios are particularly important. Figure 3 uses again the logarithmic SJR criterion and plots the empirical densities of the publishers Springer Nature and Wiley (which are part of the DEAL) and Elsevier, which left the negotiations and later cut-off the German research institutions. One can see that Wiley has a stronger representation at the top of the distribution (on the right side) than Springer Nature. Elsevier, however, exceeds both of them in terms of reputation.

Looking in Table 2 at the market structure in economics publishing, one can



Distribution of the weighted average logarithmic SJR criterion per journal weighted by the number of publications per year in each journal, i.e., for each journal j with N_{jy} in each year $y \in [2015, 2022]$, we compute $SJR_j = \frac{1}{N_j} \sum_{y=2015}^{y=2022} SJR_{jy}$ as the SJR varies per year.

Figure 3: Distribution of journals across quality by publisher

see that the 'big 3' Elsevier, Springer Nature, and Wiley in our sample account for almost half of all published papers. The following three publishers Taylor & Francis, Emerald, and Routledge together only account for a slightly higher share than Springer Nature alone. Furthermore, none of these six publishers is a society, university owned, or a full open-access publisher.

	all observations		**obs. w/ gender ident.**	
Publishers	Frequency	Share	Frequency	Share
Other	119,988	38.36 %	94,171	38.63 %
Elsevier	85,586	27.36 %	63,642	26.11 %
Springer Nature	36,883	11.79 %	29,015	11.90 %
Wiley	31,191	9.97 %	25,757	10.57 %
Taylor & Francis	15,652	5.00 %	12,029	4.93 %
Emerald	12,656	4.05 %	10,278	4.22 %
Routledge	10,838	3.46 %	8,865	3.64 %
Total	312,794	100 %	243,757	100 %

Table 2: Publications by publisher with and without missing gender identification

3 Contextualization and empirical strategy

Theoretical context: As proposed beforehand, we carefully draw from our findings that men put a higher emphasis on the reputation of the journals in which their work is published and accept that it might be hidden behind paywalls for many potential recipients. Women, in turn, tend to put more emphasis on the visibility of their research. We reach this conclusion from a higher uptake of the DEAL journals carrying immediate open-access and a stronger shift away from Elsevier for female researchers. This finding is consistent with evidence on gender differences in the provision of public goods. As Nowell and Tinkler (1994), Eckel and Grossman (1998), and Andreoni and Vesterlund (2001) have shown, women contribute more to public goods than men. This is in line with our findings as the idea of research being freely accessible to all members of society is clearly a public good. In contrast, reputation is a private good.

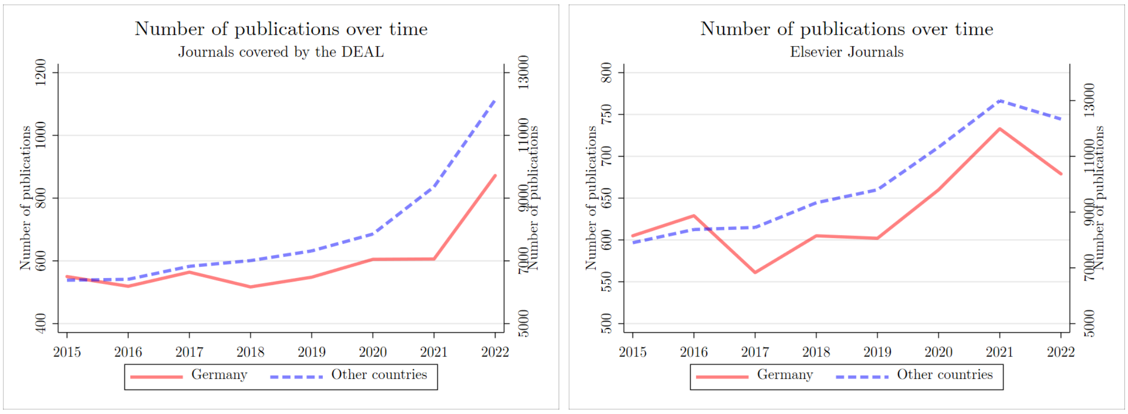
The higher tendency toward public good provision among females may also coincide with variation in risk aversion as women have been found to be more risk-averse than men (Booth et al., 2014; Borghans et al., 2009). While there exists a theoretical risk of a complete server shutdown, open-access articles imply free access without any temporal limitation. Articles published in outlets requiring a subscription are locked behind a paywall once the respective subscription is canceled. There is an overall call to shift toward open-access journals as well as continued dissatisfaction with Elsevier's pricing policy. The outlets of the latter come with the sword of Damocles that further institutions cancel their subscriptions. While subscriptions lock out the general public per se, canceled subscriptions by universities would further decrease visibility. Experimental research has shown that men are more interested in conspicuous consumption than women (Clingingsmith & Sheremeta, 2018). It may explain both the stickiness of male authors with Elsevier which publishes higher ranked journals and the varying tendency towards DEAL-covered journals, which we observe.

Both developments together may trigger a vicious circle for female researchers. A more risk-averse journal choice will lead, ceteris paribus, to a lower reputation for their work in the discipline. Further discouraged by the additional obstacles they face (see introduction), they may continue to select journals suboptimal for their careers. Weaker outlets may also lead to less project funding or collaborations with other researchers, which may harm future research outputs, and eventually may result again in publications with lower impact. These considerations are perfectly in line with Kelchtermans and Veugelers (2013, p. 273), who find that "women have a significant lower probability of reaching top performance for the first time in their career, . . . but there is no evidence for a gender bias hindering repeated top performance." It hints at the existence of such a vicious circle that reduces the chances of women reaching the top.

Empirical approach: We employ a difference-in-differences approach using a linear probability model. The dependent variable is a binary dummy indicating whether a paper is published in a journal (later) covered by the DEAL or else in an Elsevier journal. Even though this setting may suggest a logit or probit estimation (as in Haucap et al., 2021), the linear probability model is well-suited for the reliable estimation of marginal effects (see, e.g., Heckman & Snyder, 1997).

We set the point of treatment for the DEAL contracts on 1 July 2019, when the bulk of the Wiley journals became part of the contract. Only slightly later on 1 January 2020, the hybrid journals of Springer Nature joined the 'DEAL' as well. For the academic brawl with Elsevier, we use 5 July 2018 as treatment day, as this was the day the German research alliance announced the suspension of all negotiations with the publisher. An objection to this approach is the long paper turnaround times in economics (Hadavand et al., forthcoming). However, shifting the point of treatment forward in time would bear non-negligible arbitrariness. Furthermore, it does not capture that the knowledge of the contract's benefits disperses spontaneously and unfocused among researchers. In addition, having three post-treatment years in our data, we are confident to pick up the majority of publishing delays.

Our identification rests on the arguably unanticipated cut-off from access to Elsevier journals as well as the introduction of the DEAL conditions. It is unrealistic that researchers actively sought employment at German institutions due to this changed environment. One objection might be that the Elsevier conflict was in place way before German institutions were locked out. Put differently, the academic publishing market is in motion and there may be other developments going on in parallel. Figure 4 shows the number of publications by authors from Germany and all other institutions. The left panel shows the number of papers for journals covered by the DEAL and the right one those appearing in Elsevier outlets. The numbers are scaled differently to allow for a better visual comparison.



Left panel: DEAL journals, right panel: Elsevier journals. In both panels, the left y-axis shows the number of publications by German authors, the right one those by authors from all other countries.

Figure 4: Number of publications over time differentiated whether coming from Germany

One can see that the trends for the DEAL journals follow the same path. For Elsevier, this holds as well for the years from 2017 on. Beforehand, we see a drop from 2016 to 2017 for German authors that is not reflected in the overall development apart from Germany. To validate that this anomaly does not affect our analysis, we compute the results for our core finding on gender differences in publications in Elsevier journals for a subsample without the years 2015 and 2016. The results remain qualitatively unchanged (see Tables 23 and 24 in the appendix).

To preserve sufficient statistical power and because we want to mainly study gender differences, we focus on a canonical pre/post difference-in-differences setting as a year by year analysis of behavioral patterns may not be able to add anything to the analysis in our case of publication behavior. The outcome of interest on the left-hand side is the probability that a paper appears in a journal covered by the DEAL or else in an Elsevier outlet. Precisely, we measure whether more papers in the treated journals are (co)authored by researchers from Germany. Assuming that there is no parallel shock in the quality of the submissions from this group, it implies that these researchers submit more often to the affected outlets. Ideally, we would like to measure submissions. However, there is no data available and we consider our setup a sufficient approximation.

$$Pr(Pub. = 1) = \mathbb{1}_T + \mathbb{1}_{GER} + \mathbb{1}_T \times \mathbb{1}_{GER} + X' + \epsilon \tag{1}$$

In eq. 1, we compute the canonical difference-in-differences setting: $\mathbb{1}_T$ is a binary pre/post treatment indicator and $\mathbb{1}_{GER}$ is an indicator for an affiliation with a German institution.[13] $\mathbb{1}_{DiD}$ is the difference-in-differences (DiD) indicator, i.e., $\mathbb{1}_T \times \mathbb{1}_{GER}$. X' are covariates that are added without any interaction terms, namely gender and SJR. We use this specification to identify baseline results. Here, we compute doubly-robust estimators as suggested by Sant'Anna and Zhao (2020) in their DiD correction specification. Second, we run a more involved difference-in-differences model that allows for interactions of covariates with the plain treatment effect.

$$\begin{aligned} Pr(Pub. = 1) = g + SJR + g \times SJR + \mathbb{1}_{GER} + \mathbb{1}_{DiD} + \mathbb{1}_{DiD} \times g \\ + \mathbb{1}_{DiD} \times SJR + \mathbb{1}_{DiD} \times g \times SJR + y + m + \epsilon \end{aligned} \tag{2}$$

On the right-hand side, g represents gender and SJR the SCImago journal rank,

[13] The affiliation of the corresponding author must be in Germany. If the the paper is coauthored by someone from a German institution, but he or she is not the corresponding author, the paper is not eligible to the DEAL conditions. For the Elsevier cut-off, we do not have this binding constraint. To have a consistent set-up, we stick to the approach of only coding those papers 'German' for which at least the corresponding author is affiliated with a German institution.

measured in quartiles to enable the interaction terms, i.e., it captures the respective quartile of the journal distribution. We interact gender and reputation (measured by the SJR quartile) to account for the differences in publication behavior shown in the previous section. Here, quartile 1 implies the lowest reputation as the SJR is increasing in quality. y and m describe the time fixed effects for the year and the month of a publication (as the treatments happen within a year). In this specification, we rely on the canonical differences-in-difference design, as the correction models do not allow for treatment interactions.

A peculiarity of our binary design is that the choice for one journal is, inevitably, a choice against all other outlets. In robustness checks, we exclude the years 2020 onward from the analysis of the Elsevier cut-off to account for the introduction of the DEAL and find the results to be qualitatively the same. For the analysis of the DEAL treatment, we run a separate regression excluding the Elsevier publications. Here, we observe qualitatively different results. This is not a weakness of our design but actually evidence for the direction of the switch out of Elsevier toward journals from Springer and Wiley.

Last, our time window for the analysis coincides with the global COVID-19 pandemic. There are not only direct effects on productivity by the infection (Fischer et al., 2022) but the pandemic and the public health measures also induced a bigger wedge in the academic gender gap. Women's and, in particular, mothers' research was significantly reduced by surging care work necessary due to closed kindergartens and schools (Deryugina et al., 2021; Ucar et al., 2022). This may have led to two different reactions: Either female researchers reduced their number of projects or they reduced the effort devoted to their projects. In both cases, our empirical setting using a difference-in-differences design nets out these changes as they affected women in academia in general. Hence, any effect should appear in both treatment and control group, such that, by construction, it cannot affect our results.

4 Results

The DEAL treatment: First, we look at the change in publication behavior due to the introduction of the DEAL agreements. Table 3 shows the average marginal effect (AME) on the treated group of scientists, i.e., those eligible for open-access publishing under the DEAL contracts. A paper from authors based in Germany has on average a 4.67% higher probability to be published in an eligible journal in the discipline of economics and adjacent fields. As shown in Table 9 in the appendix, the correction specification confirms significance and magnitude of this effect.

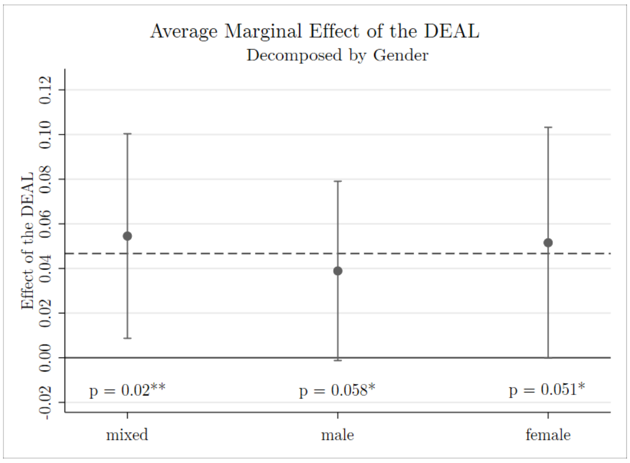
AME	Std. Err.	t-value	p-value	95% CI	
0.0467	0.0198	2.36	0.018	0.0079	0.0855

Standard Errors heteroskedasticity-robust and clustered on the journal level. $N = 243{,}757$.

Table 3: Average Marginal Effect of the DEAL on publishing in an eligible journal

The positive estimates show that economists – on average – react to the positive publication incentive of free and uncomplicated open-access in well-established journals. The overall effect seems to be partially driven by a shift away from Elsevier outlets, because the AME not only diminishes but becomes fully insignificant after excluding Elsevier outlets from the regression as Table 11 in the appendix shows. We address this with our complimentary analysis of the Elsevier cut-off, since the findings are suggestive evidence that the move toward the DEAL journals is at least to some extent fueled by the move away from Elsevier.

Next, we distinguish the marginal effect by gender. As discussed earlier, we assign every paper to gender-mixed, fully male, and fully female authorship (including both teams and single authors). The marginal effect for mixed groups, in which the corresponding author is based in Germany, is significant on the 5% level. For male and female teams, we find a slight violation of this cut-off. Due to the lower number of observations, especially for women, we consider this still as sufficiently explanatory. While the coefficients are not significantly different from each other due to the large error bands, is is still notable that the female point estimate exceeds the male one by approximately 1/3. There seems to be a larger response to the positive open-access incentive by women compared to men.

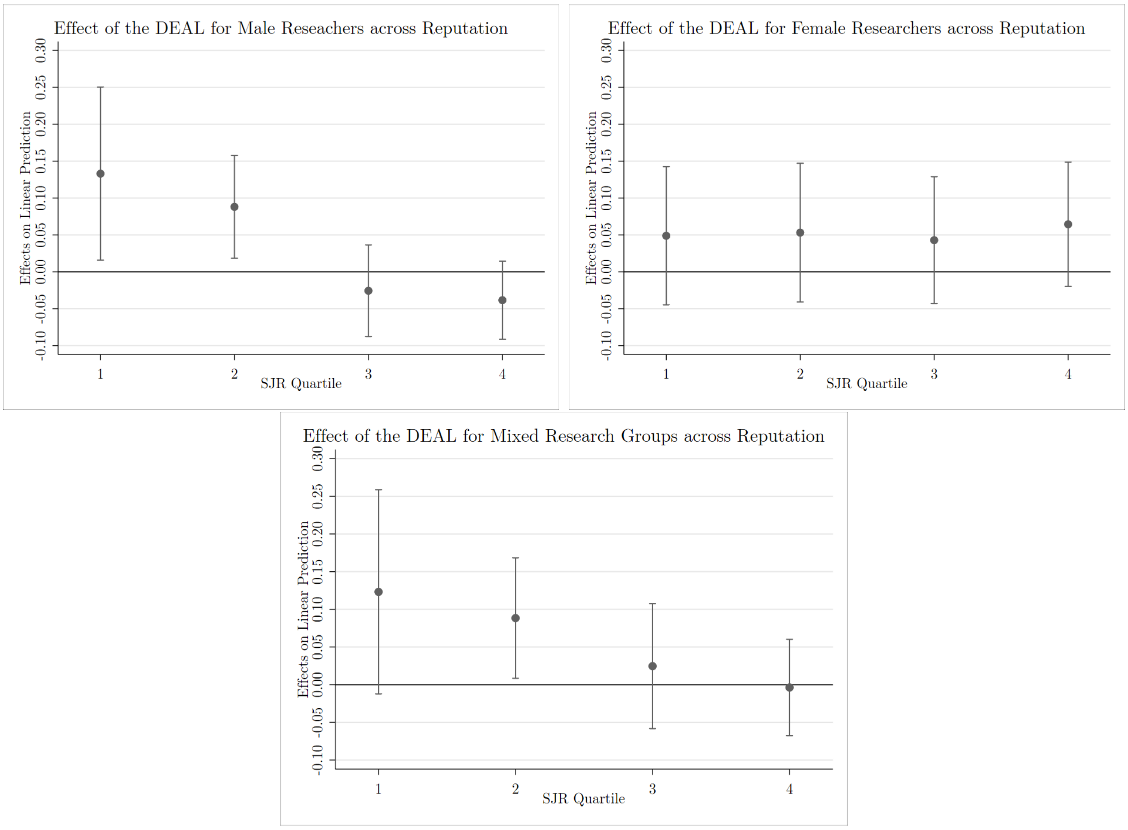


Standard Errors heteroskedasticity-robust and clustered on the journal level. $N = 243{,}757$. Dashed line: Average effect as shown in Table 3. See Table 10 in the appendix for details on the estimates.

Figure 5: Effect decomposed by Gender of the researcher group

By disentangling the effect across the SJR ranking criterion, we can gain additional insights into gender differences. Note that the quartiles are increasing in quality. Thus, quartile 1 comprises the weakest journals (relying on the SJR) while quartile 4 contains the top 25%. The upper two panels in Figure 6 show the choices of male and female researchers, both single authors and teams. The lower panel displays the effect for gender mixed groups. Disintegrating the effects further also means that we run into significance issues as the gender decomposition was already only significant on the 10% level for mixed research groups and men. We still find some effects and interpreting the patterns may also be enlightening.

For male authors as well as for mixed gender research groups, Figure 6 presents a downward trend in the treatment effect. Both groups significantly opt into journals in the second quartile of the quality distribution and men also in the weakest quartile 1. Women, in contrast, do not show a significant effect at all. We also see no trend in the estimates. The former might be caused by the low number of observations.



Average marginal effects for each SJR quartile computed holding each of the three gender groups fixed. Standard Errors heteroskedasticity-robust and clustered on the journal level. $N = 243{,}757$. 90% confidence bands provided. Details are shown in Table 12 in the appendix.

Figure 6: DEAL Effect decomposed by Gender and Reputation

Turning again toward males, we find that they choose the free and easy open-access benefit of the DEAL journals for work in weaker journals. This is reasonable and maybe even the most promising part of the SJR range since these journals are typically less often purchased by libraries around the globe. Therefore, open-access to articles in such outlets may strongly increase the potential readership and, by that, foster citations, which is an important measure in the evaluation of an academic's output. (McCabe & Snyder, 2014).

The Elsevier cut-off: We further examine the gender differences in publication behavior by turning towards our second natural experiment – the cut-off from all Elsevier publications at nearly all German research institutions. How should this affect behavior? While it was more difficult for German researchers to access Elsevier publications, other countries remained unaffected. Furthermore, researchers usually substitute final publications with working paper versions, approach authors directly for copies, or rely on predatory repositories.

Hence, the deterioration of the publisher's journals should be negligible especially given the only slightly decreased availability and the more relevant fact that the academic reputation remained unchanged. However, the cut-off was accompanied by public debates about it.[14] Fraser et al. (2021) have conducted a descriptive analysis of this cut-off and found a decrease of papers from German authors in Elsevier journals, but they do not apply econometric methods of causal inference and neglect the gender dimension. Furthermore, a surge in uncertainty regarding permanent availability of the papers may have been another driver of this behavior. By that, the actual treatment may have happened through a change in expectations, which may have affected female behavior the most. Last, Elsevier continued to publish research behind a subscription paywall by default.

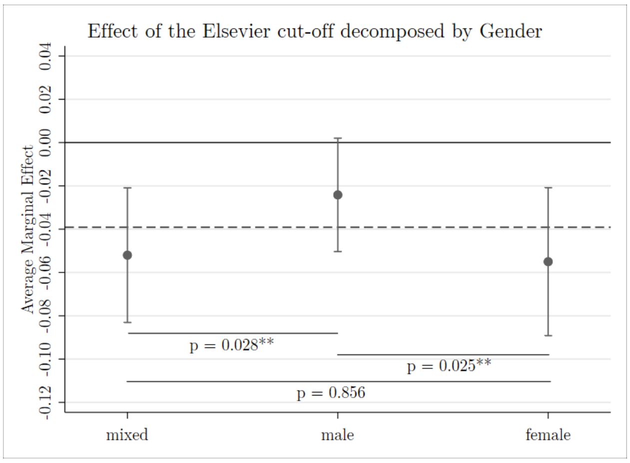
AME	Std. Err.	t-value	p-value	95% CI	
-0.0391	0.0129	-3.02	0.003	-0.0645	-0.0137

Standard Errors heteroskedasticity-robust and clustered on the journal level. N = 243,757.

Table 4: Average Marginal Effect of the Elsevier cut-off

In Table 4, we see a negative baseline effect for the whole sample subsequent to the cut-off of Elsevier from most German universities and institutions. With a decrease of -3.91% it has only a slightly smaller magnitude than the DEAL effect in absolute terms, which is somewhat surprising given the smaller actual impact of the cut-off. Again, the estimates of the DiD correction model (shown in Table 13 in the appendix) are highly equivalent to the baseline effect of the interaction specification that we apply throughout the following analysis.

[14] See, e.g., the critique by the German pharmacologist Josef Pfeilschifter (https://www.tagesspiegel.de/wissen/im-krahwinkel-der-wissenschaft-3976471.html) or the review by Astrid Herbold (https://www.tagesspiegel.de/wissen/gesperrte-lekture-5533225.html).

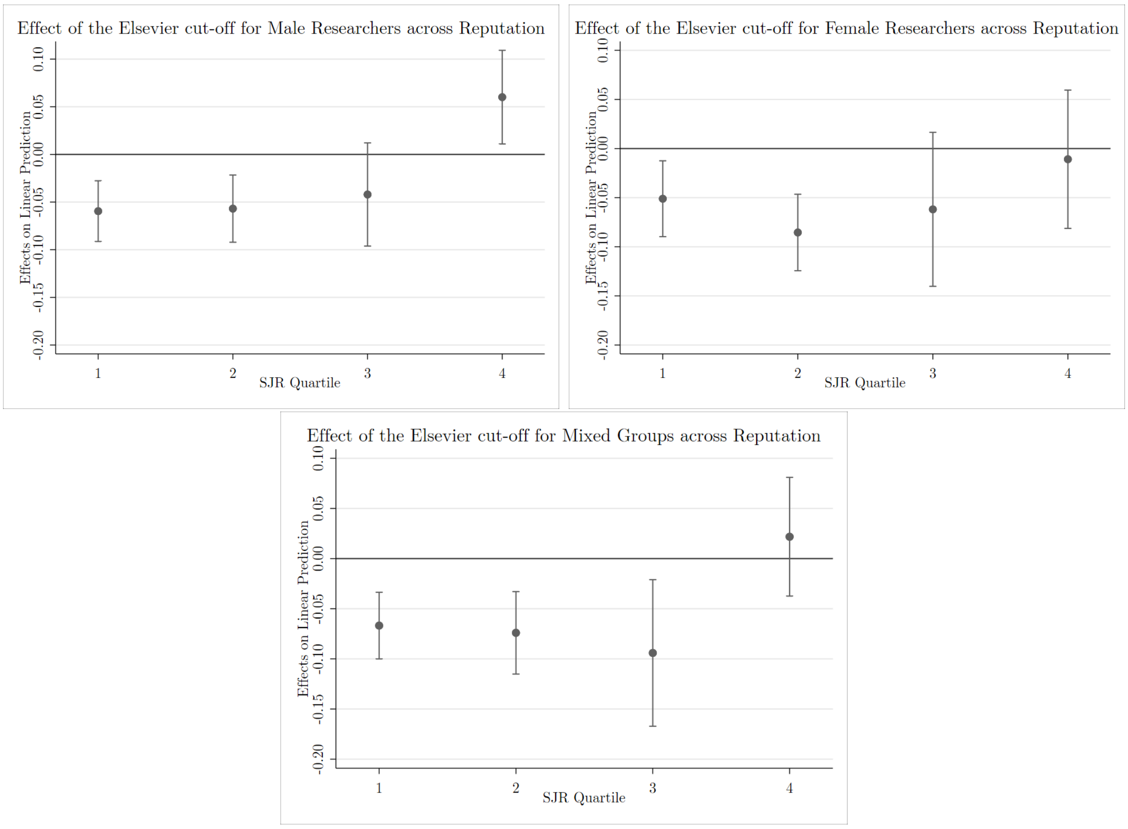


Standard Errors heteroskedasticity-robust and clustered on the journal level. 95% confidence bands. $N = 243{,}757$. p-values are drawn from Wald tests for equality of the coefficients. Dashed line: Average effect as shown in Table 4. Table 14 in the appendix provides further details on the estimates.

Figure 7: Effect of the Elsevier cut-off decomposed by gender

Analyzing this effect by gender reveals notable differences as Figure 7 highlights. There is a null effect for male researchers (on the 5% significance level), but we find a significantly negative reaction for both female and mixed-gender teams. While statistically not different from the mixed group effect, the coefficient for female researchers is the largest in absolute terms with a value of -5.5%, which is more than twice the size of the male effect and 41% larger than the baseline estimate. And even though the confidence bands overlap, the effect for females ($p = 0.025$) significantly differs from the null effect for males.

An objection might be the already discussed inherent disadvantage of our setting that a publication of a paper in one journal implies that it cannot appear in any rival journal as well. In the case of the DEAL treatment, it implies that a paper additionally attracted by the attractive publication conditions implies one paper less, e.g., for Elsevier journals. Hence, a negative effect at Elsevier journals might be just technically caused by the pull factor of the DEAL. To rule this out, we conduct a separate analysis that is restricted to the years 2015 - 2019. By that, it has only a slight overlap with the DEAL, which should be negligibly small given the publication lag. Table 15 and the related Figure 14, both in the appendix, show that the baseline effect as well as the decomposition by gender remains the same even though we lose 43.6% of the observations. The effect for females is even slightly higher in absolute terms, now amounting to a decrease of -5.98% and still highly significant ($p = 0.014$). Thus, not only the baseline effect but also the gender patterns are already present and strong in the short run.



Standard Errors heteroskedasticity-robust and clustered on the journal level. $N = 243{,}757$. 90% confidence bands provided. Table 17 in the appendix provides further details on the estimates.

Figure 8: Elsevier Effect decomposed by Gender and Reputation

Disentangling the effect (for all years) again in both dimensions, journal reputation and gender of the authors, we find a 'hockey stick' effect for all three gender groups, meaning that we detect a relatively flat pattern among the point estimates for the first three quartiles but a rather steep 'jump' in the highest 4th category. Starting again with the mixed gender groups shown in the lower panel of Figure 8, one can see that the move away from Elsevier takes place across three of the four quartiles but becomes fully insignificant in the top quartile 4. Women in the right upper panel significantly decrease publications only in both the first and the second quartile but not in any other one. This implies that female researchers and research groups prefer to opt out of Elsevier outlets for less sophisticated work and publish it somewhere else, but for leading journals their behavior remains unaffected.

Male researchers, react somehow different to the Elsevier cut-off as the plain gender effect already suggested. While the overall effect turned out to be insignificant for this gender, we find a move away from the publisher for journals in the lower half of the quality distribution just as we do for female and mixed teams. Somewhat surprisingly, we detect a a highly significant but *positive* effect of +6.0% ($p = 0.044$) on the strongest quartile of Elsevier journals for men. Its magnitude is larger than the baseline effect, but here in absolute terms. All things equal, after the cut-off, male researchers from Germany have published more often in the highest-tier Elsevier journals. While we have no 'smoking gun' proof, why this may be the case, it could be related to a higher perceived probability to be published in such an outlet as the public uproar might have suggested a shift away from Elsevier journals.

This behavior has important implications for gender differences in the discipline. More than in other scientific disciplines, economics has a highly convex valuation of journals, i.e., an extreme emphasis on the so-called 'top 5' journals and, then, the top field journals as well as a notable wedge between an outlet's reputation and its relevance (Heckman & Moktan, 2020; Haucap & Muck, 2015). Any shift away from reputed journals may be related to a loss in the recognition of one's own work.

Disentangling the mixed gender groups for both events: Digging deeper into the gender gap, we decompose the mixed-gender group further. In particular, we split it into three subgroups that capture a male majority, equal representation, and a female majority. We define a group of researchers as 'mostly' female or male in case 2 out of 3 or else 3 out of 4 persons of a team have arguably the same gender as computed by our name-matching algorithm. In the 'equally mixed' group remain teams with equal shares of genders (1:1 in two-person teams and 2:2 in four-person teams). The fully male and female groups remain unchanged. Table 5 shows the distribution across these five groups.

This task bears the additional challenge of partially identified research groups. Take for example a group of three, in which one author is female, one is male, and for one, we cannot identify the gender with a probability > 70%. Up to now, we have assigned such a group to the 'mixed' category, but now the third gender matters. To avoid lowering the bar, we decide to code these publications as 'unidentified' and restrict our analysis to those publications in which all gender probabilities exceed the 70% threshold. Doing so, we lose 21,082 or 8.65% of our observations.[15]

Gender Group	**Frequency**	**Share**	**Cumul.**
Unidentified	21,082	8.65 %	8.65 %
Fully Male	116,442	47.77 %	56.42 %
Mostly Male	33,884	13.90 %	70.32 %
Equally Mixed	30,471	12.50 %	82.82 %
Mostly Female	12,901	5.29 %	88.11 %
Fully Female	28,977	11.89 %	100.00 %
Total	243,757	100 %	

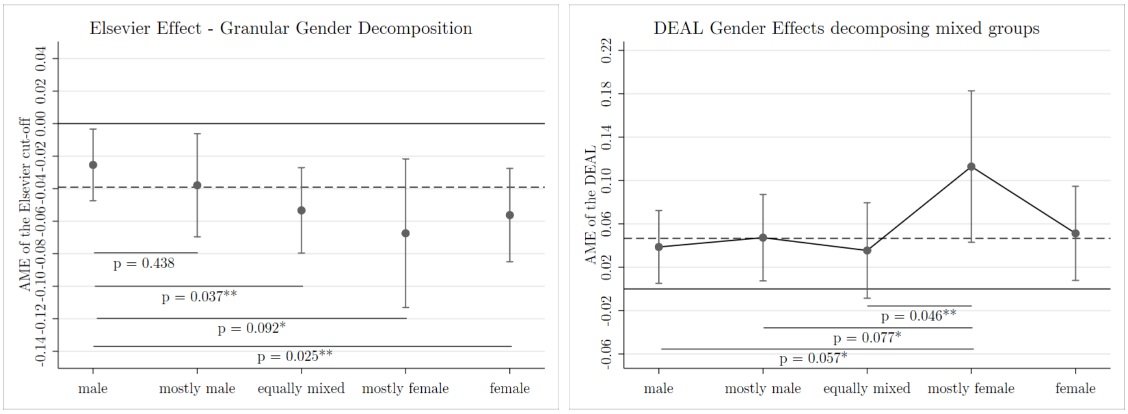
Table 5: Publications separated by the gender composition of the group of authors

Assuming a 'one person, one vote' principle within a team for the decision where to submit a paper, we can disentangle whether women in mixed teams are the driver of this significant negative effect.[16] Figure 9 plots the disentangled and sorted from fully male to fully female authorship for both the Elsevier cut-off (left panel) as well as the DEAL (right panel). Even though this is not a dynamic computation, connecting the point estimates for Elsevier on the left highlights the most interesting finding: A nearly steady downward slope the 'more female' a research group

[15]We have conducted robustness checks for the plain effects and the baseline gender decomposition excluding these unidentified observations. The results (to be found in Table 18 in the appendix) are highly similar and qualitatively the same.

[16]Note that such an approach sets aside hierarchical structures such as junior researchers collaborating with a tenured professor, whose vote may have more influence in such a decision.

becomes. This effect is robust to the exclusion of the years 2016 and 2017 as mentioned beforehand and shown in Table 24 in the appendix.

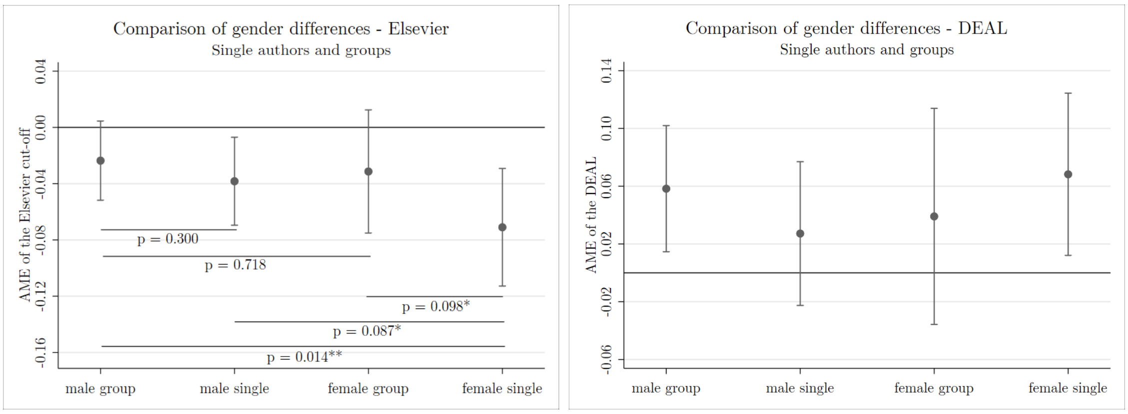


The left panel shows the marginal effects for the Elsevier cut-off, and the right panel shows those for the DEAL contracts. Dashed line: Overall AME as shown in Tables 3 (DEAL) and 4 (Elsevier). Standard Errors heteroskedasticity-robust and clustered on the journal level. 90% confidence bands. N = 222,675. Tables 19 (Elsevier) and 20 (DEAL) in the appendix provide further details on the average marginal effects shown here.

Figure 9: Marginal Effects of the granular gender decomposition

The estimate for fully male teams is significantly negative but closest to zero. Already a minority of one woman within a research group of three or four members slightly lowers the point estimate. However, it is indistinguishable from the fully male estimate. The effect for equally mixed teams is already statistically different from the one for fully male teams. The same holds for mostly female and fully female teams. Thus, once men lose the numerical majority within a team, submission behavior significantly differs from fully male author groups with respect to Elsevier. Additionally, we have run this more granular gender decomposition also for the positive incentive of the DEAL contracts. The results are shown in the right panel of Figure 9. We do not see an inverse pattern but still higher point estimates for mostly and fully female teams. Surprisingly, the coefficient for groups with a majority of women in it differs significantly from equally mixed, mostly, and fully male teams. We carefully state a partially opposite statement to the one on Elsevier: Once there exists a female majority, the uptake of the DEAL is higher.

Group size effects: In the last step of this analysis, we look at how groups and single authors within the two single-gender categories behave. We do this for both events. Figure 10 shows the results for the Elsevier cut-off in the left panel and those for the DEAL introduction in the right panel. In each, the left two coefficients display the difference between male single authors and author groups and vice versa for females on the right. Other than for the granular decomposition by gender, we find major differences also for the introduction of the DEAL contracts, but now separating between single authors and author groups of the same gender.



The left panel shows the marginal effects for the Elsevier cut-off, and the right panel shows those for the DEAL contracts. Standard Errors heteroskedasticity-robust and clustered on the journal level. 95% confidence bands. N = 222,675. p-values obtained with Wald tests. Tables 21 and 22 in the appendix provide further details on the effects shown here.

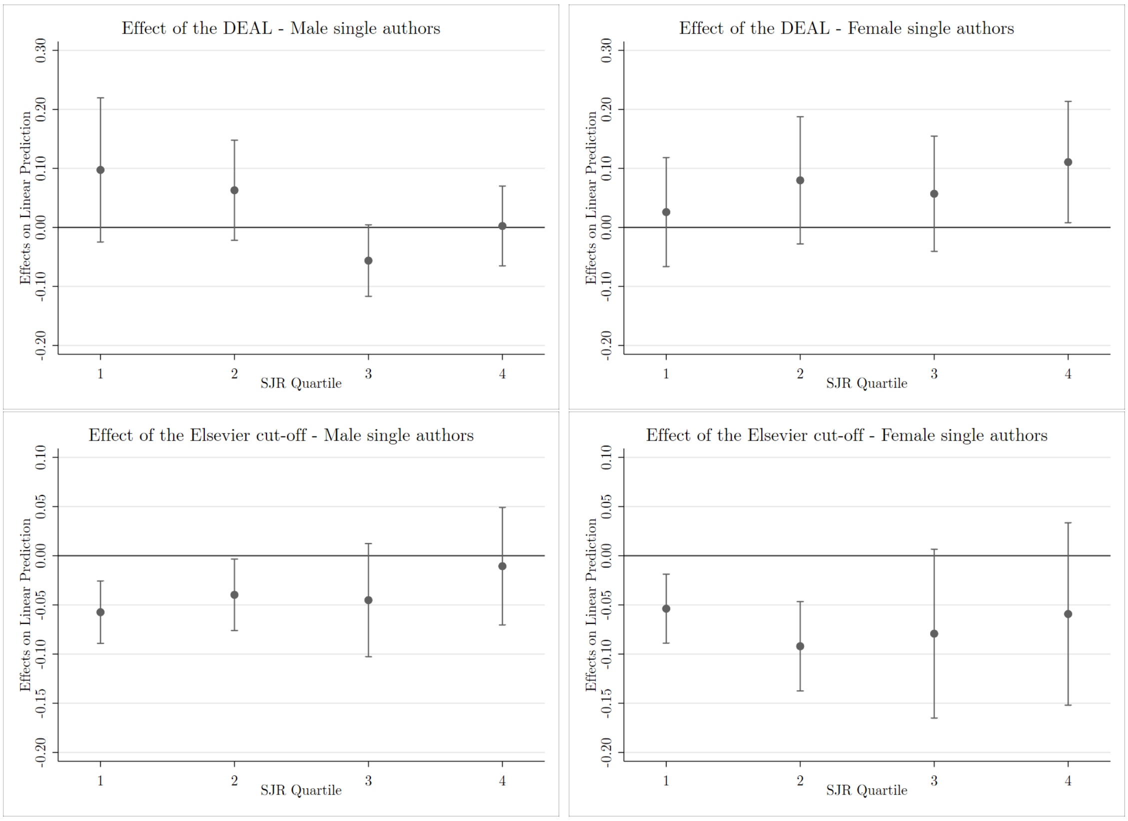
Figure 10: Marginal Effects of the distinction between groups and single authors

There exist notable variation between single authors and same-gender groups for Elsevier. The marginal effect for male single authors is significantly negative while the one for male groups is indistinguishable from zero, but both do not differ significantly from each other. The same pattern holds for women, but here, the estimates are significantly different. As an additional dimension of heterogeneity, we also find differences between male and female single authors (p = 0.087) but not for groups. Hence, the heterogeneity across genders seems to stem from single authored papers. Put differently, the negative effect for Elsevier appears to get washed out once a paper is coauthored, which also vanishes gender differences.

The right panel shows the decomposition for the DEAL. Here, we detect a different pattern: While male groups opt into eligible journals, male single authors do not. In contrast, papers single authored by a woman are published more often in DEAL outlets but groups of female researchers do not react at all. All confidence intervals are larger than those for the Elsevier regression. Also, no estimate is significantly different from each other, such that we abstain from reporting p-values for Wald tests in the right panel.

Single female authors seem to react to both the negative and the positive incentives quite heavily. But once they team up with other female researchers for a joint publication, both effects – the positive DEAL as well as the negative Elsevier reaction – disappear. Among men, we observe no opt-out of Elsevier among groups but for single authors. However, we see a positive reaction to the DEAL only among groups. Hence, for both genders, we find behavioral differences when the decision is made in a group or individually.

Last, in Figure 11 we look closer at the reaction of single authors to both events. Here we know that group effects correcting individual behavior cannot be present. For male authors, we find no effect at any quartile for the DEAL. Women, however, do not only opt significantly into DEAL journals but do so only at the top quartile of the quality distribution. The benefit is ambiguous from a purely self-centered perspective. As said, the leading journals are often subscribed to anyway by most research institutions. Therefore, open-access hardly overcomes any access barriers. Furthermore, even in the top quarter, journals covered by the DEAL tend to be weaker than those from Elsevier (on average). Regarding the Elsevier cut-off, we find negative effects for the weaker two quartile among both men and women. But while the effect for the lowest impact journals is nearly the same, the shift away from the second quartile amounts to -9.2% for women ($p = 0.001$) but only to -3.97% ($p = 0.072$) for men. Hence, the effect for female single authors is much more pronounced.



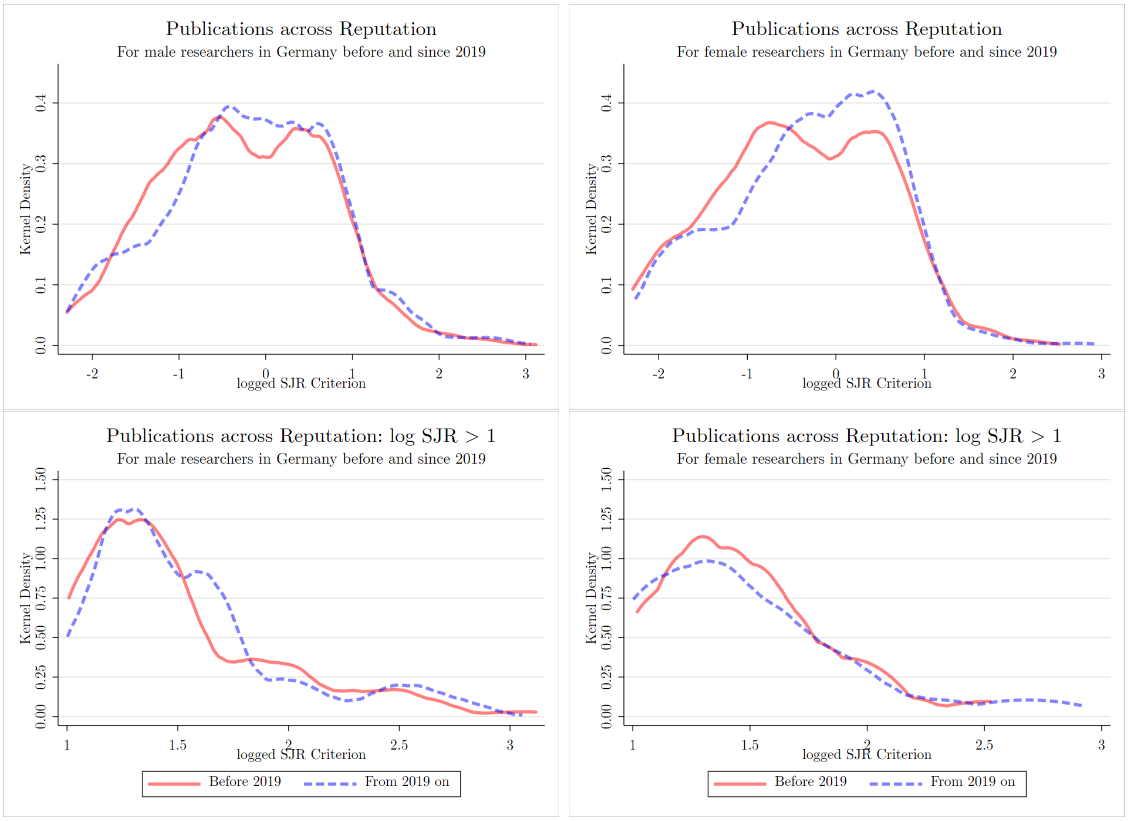
90% confidence bands. $N = 222,675$. Left panels: Male researchers, right panels: Female researchers. Upper panels: Marginal effects for the DEAL across reputation, Lower panel: Marginal effects for the Elsevier cut-off across reputation. Table 25 in the appendix provides further details.

Figure 11: Effect decomposition for single authors by gender and reputation

Interpretation of the findings: The latter findings may relate to the research on differences in decision-making between individuals and groups who decide jointly. In the experimental economics literature exists a lot of evidence that groups in many settings act closer to a rational benchmark than individual decision makers (Bornstein & Yaniv, 1998; Charness & Sutter, 2012; Cooper & Kagel, 2005; Kocher & Sutter, 2005). Related to our case, an aversion against Elsevier as the publisher of a journal may be washed out for both women and men.

Charness and Rustichini (2011) experimentally show that women cooperate more often when observed by other women. It might be that within a research group, they set aside a potential antipathy against Elsevier and take into account the potential career opportunities of their coauthors. It corresponds to our finding that the shift away from Elsevier increases the higher the share of women in a research group. The hypothesis also fits our finding that author groups with a majority of women or fully female tend to opt into the DEAL more often than male groups.

In general, the cancellation of Elsevier subscriptions may have only little impact on the accessibility of publications since this holds only for many institutions in Germany but not the rest of the world. Furthermore, these at most small losses (if existent) are likely to be more than offset by the loss in reputation as shifting away from established Elsevier outlets may negatively affect a researcher's career.



Distribution of publications from German research institutions separated by gender and time. Left panels: Male researchers (single and teams), Right panels: Female researchers (single and teams). Upper panels: Distribution across the whole range of the logged SJR criterion. Lower panels: Distribution restricted to values of log SJR >1.

Figure 12: Distribution of publications separated by gender and time

Figure 12 summarizes this. It shows the density of publications from economists at German institutions across quality and separated by gender and time. We separate the sample at the end of 2018, i.e., we take the median date between July 2018 (Elsevier cut-off) and July 2019 (start of the DEAL). For women, we see a notable increase in publications in the middle of the quality distribution, accompanied by a shift away from lower-tier outlets. This may be related to the DEAL and its journals, mostly to those from Springer-Nature as its outlets publish more papers and are located in weaker locations than Wiley journals.

The main difference happens at the top end of the distributions. For journals with a logarithmic SJR >1, the density of publications by female researchers is for the later years nearly always lower than before. For men, the opposite is true. For the interval [1.5, 1.75], there are much more publications. The same holds again at the very top from a logarithmic SJR value of >2.5. Given the high sensitivity of the journal choice especially in economics, this may affect the chances of female researchers to get promoted compared to their male colleagues.

The behavior of single female authors particularly corresponds to broader findings on gender differences in public good provision. The 'DEAL' was often communicated as a 'game changer' that leads to substantial improvements in the academic publishing market. The incumbent subscription-based system has been criticized by the DEAL organizers as "untenable", while the open-access encompassed by the DEAL has been praised: "To qualify its human capital through education, power new discoveries, and enable society ... to prosper, German research must be ... available for everyone ... in its final published form."[17] This is a statement of the DEAL officials, but its tonality is representative. Other critiques are even harsher: "Academic publishers make [Rupert] Murdoch look like a socialist."[18] Thus, women might not only be more worried about the broad availability of their research but also more attracted to support the ideal of open science embodied by the DEAL and, at the same time, might want to penalize the business conduct of Elsevier. Only when it

[17]See https://web.archive.org/web/20230103182448/https://deal-operations.de/en/here-is-the-deal/change-the-system (both quotes – this is a back-up from the web archive).

[18]See https://www.theguardian.com/commentisfree/2011/aug/29/academic-publishers-murdoch-socialist.

comes to research groups, these social preferences are leveled out in accordance with previous research. However, as women write single-authored papers more often than men, antipathies toward Elsevier are less often erased.

5 Conclusion and Outlook

Our paper studies gender and coauthor differences in publication behavior, whereas the latter links back to the former. We look at two events related to the negotiations between all German research institutions and the leading academic publishers Elsevier, Springer Nature, and Wiley. We exploit two plausibly exogenous events for researchers: The positive one are the DEAL agreements that grant researchers open-access free of charge for the papers published in nearly all of their journals. This includes prestigious, still subscription-based outlets. We find relevant differences between female, male, and mixed-gender research teams in the uptake of this benefit. While male researchers show the lowest interest in the change, women shift the most to eligible outlets. We find a similar pattern in our granular decomposition of mixed teams into balanced ones and those with a majority of one gender.

The response to the Elsevier cut-off has more striking differences. The German research institutions and the publisher discontinued their negotiations with a loud uproar. Some hundred universities and colleges terminated their subscriptions and in July 2018, Elsevier cut off these institutions from access to its journals. This caused a good amount of publicity, but the actual effect on a paper published in such an outlet is low: The rest of the world remained unaffected. Researchers from German institutions are likely to be able to circumvent the newly erected paywalls. However, the uncertainty of whether other countries would emulate this decision may have surged. Furthermore, it highlighted that Elsevier is willing to stick with the subscription-based business model instead of dedicating itself to shifting toward open-access publications by default as Springer Nature and Wiley did later on.

All-female research groups with an author from a German institution as well as teams with a majority of women in it significantly reduced their publications in Elsevier journals. Their male colleagues, in turn, only reduced publications in lower-tier journals but published actually more often in the *top* quarter of the quality distribution.

Disentangling the single-gender categories into single authors and single-gender teams, we detect important differences also in this dimension. While among males, individuals tend to opt out of Elsevier and into DEAL journals, author groups seem to 'correct' this behavior. Similarly, female single-authored papers are published differently than papers from female author groups. Individual females heavily withdraw from Elsevier, and coauthored papers of women do not show any reaction. In contrast, such groups do not opt into the DEAL, while single female authors do. This reflects earlier findings on gender differences in social preferences and differences between individual and group decision-making.

The implications of these behavioral differences are twofold and especially in academia potentially severe. If one proposes the objective of transforming the market for academic publications, the 'Elsevier experiment' raises doubts about to which extent male researchers – who are predominant in most academic disciplines – contribute to this goal. Even though we observe a tendency toward open-access in the lower ranks of the quality distribution, the behavior at the top appears to perpetuate not only the role of Elsevier but the position of incumbent journals and publication patterns more generally. Especially in light of the enormous profits of commercial publishers (Larivière et al., 2015) and the opportunities of the digital dissemination of research, large movements such as the 'Plan S' try to overcome subscription-based pay-walls for academic publications.[19] In light of the observed patterns, it remains an open question whether such initiatives will turn out to be successful.

Sticking to the status quo bears important advantages: Shifting away from well-

[19] See https://www.coalition-s.org/why-plan-s/.

off outlets may affect the comparative career opportunities of women. In economics, publishing in the highest-ranked journal possible is of high importance. Excluding a publisher that hosts many influential journals may ultimately backfire. It is even more severe as publications have a larger impact on the careers of women than of men (Lutter et al., 2022) and because women publish less than men (Xie & Shauman, 1998; Prpić, 2002). It may cause what we call a 'vicious circle' that hinders women to pursue the same careers as men. To break it down, already disadvantaged, women do contribute more to the public good of open science but may pay a higher price for it. This service to the profession is likely to add to the gender gap instead of closing it. It is particularly applicable to single-authored papers as these are often job market or early career publications, which are important for academic careers.

It remains an open question to which extent these imbalances may change when a journal's reputation is not the sole criterion for research evaluation anymore. While there is an overall push towards more open-access, initiatives such as the 'Coalition on Reforming Research Assessment' (CoARA) call for further-reaching reforms in the way academic research is evaluated. For example, CoARA calls for ranking measures such as the SJR or the H-index to be abandoned.[20]

Once such criteria increase in relevance, male researchers might follow their female colleagues in adjusting their publisher choice towards those that set a stronger focus on open science. Until then, they seem to benefit at the expense of the more pro-social behavior of their female colleagues.

Declaration of competing interest: *The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.*

[20]See the 'agreement on reforming research assessment, 20 July 2022: https://coara.eu/app/uploads/2022/09/2022_07_19_rra_agreement_final.pdf. This initiative has been signed by 441 organizations (12 January 2023).

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6 Appendix

Type	Frequency	Share	Cum.
Article	299,973	90.29 %	90.29 %
Review	12,821	3.86 %	94.15 %
Book chapter	6,209	1.87 %	96.01 %
Editorial	4,089	1.23 %	97.25 %
Note	3,759	1.13 %	98.38 %
Conference Paper	3,113	0.94 %	99.31 %
Erratum	1,107	0.33 %	99.65 %
Letter	548	0.16 %	99.81 %
Short survey	463	0.14 %	99.95 %
Undefined	127	0.04 %	99.99 %
Retracted	28	0.01 %	100 %
Data paper	5	0.00 %	100 %
Book	1	0.00 %	100 %
Total	332,243	100 %	

Table 6: Types of publications in the data

	all observations		**obs. w/ gender ident.**	
Year	Frequency	Share	Frequency	Share
2015	30,484	9.75	25,012	10.26 %
2016	32,052	10.25	26,244	10.77 %
2017	34,497	11.03	27,869	11.43 %
2018	36,433	11.65	28,695	11.77 %
2019	38,461	12.30	29,780	12.22 %
2020	44,803	14.32	33,924	13.92 %
2021	45,963	14.69	33,423	13.71 %
2022	50,101	16.02	38,810	15.92 %
Total	312,794	100 %	243,757	100 %

Table 7: Publications by year with and without missing gender identification

Year	Mixed Gender		Male Res.		Female Res.		Total
	Freq.	Share	Freq.	Share	Freq.	Share	
2015	8,694	34.76%	13,280	53.09%	3,038	12.15%	25,012
2016	9,538	36.34%	13,532	51.56%	3,174	12.09%	26,244
2017	10,330	37.07%	14,103	50.60%	3,436	12.33%	27,869
2018	11,127	38.78%	14,024	48.87%	3,544	12.35%	28,695
2019	11,934	40.07%	14,264	47.90%	3,582	12.03%	29,780
2020	14,124	41.63%	15,687	46.24%	4,113	12.12%	33,924
2021	14,439	43.20%	15,256	45.65%	3,728	11.15%	33,423
2022	18,152	46.77%	16,296	41.99%	4,362	11.24%	38,810
Total	98,338	40.34%	116,442	47.77%	28,977	11.89%	243,757

Table 8: Publications by gender and year

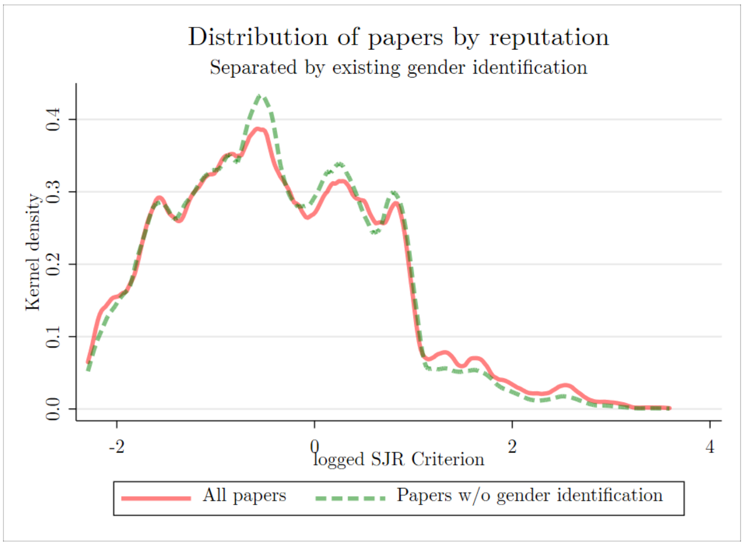


Figure 13: Distribution of publications across quality – missing gender identification

	AME	Std. Err.	t-value	p-value	95% CI	
Plain using eq. 1	0.0237	0.0185	1.28	0.199	-0.0125	0.0599
w/ SJR	0.0398	0.0189	2.11	0.035	0.0028	0.0768
w/ SJR, gender	0.3900	0.0187	2.08	0.037	0.0023	0.0756

Estimation using eq. 1: Outcome model with weighted least squares, treatment model with inverse probability tilting. Standard Errors heteroskedasticity-robust and clustered on the journal level. $N = 243{,}757$.

Table 9: Average Marginal Effect of the DEAL – using a DiD Correction Model

	AME	Std. Err.	t-value	p-value	95% CI	
Mixed	0.0545	0.0234	2.33	0.020	0.0087	0.1003
Male	0.0389	0.0205	1.90	0.058	-0.0013	0.0791
Female	0.0515	0.0263	1.96	0.051	-0.0001	0.1032

Estimates for the results shown in Fig. 5. Standard Errors heteroskedasticity-robust and clustered on the journal level. N = 243,757.

Table 10: Average Marginal Effect of the DEAL separated by gender

	AME	Std. Err.	t-value	p-value	95% CI	
Plain Effect	0.0270	0.0243	1.11	0.266	-0.0206	0.0747
Mixed	0.0344	0.0290	1.18	0.237	-0.0226	0.0913
Male	0.0270	0.0252	1.07	0.285	-0.0225	0.0765
Female	0.0064	0.0301	0.21	0.831	-0.0527	0.0655

Standard Errors heteroskedasticity-robust and clustered on the journal level. N = 180,115. Regression for the DEAL effect excluding Elsevier publications-

Table 11: Average Marginal Effect of the DEAL separated by gender w/o Elsevier journals

	AME	Std. Err.	t-value	p-value	95% CI	
Gender: Mixed						
SJR q1	0.1232	0.0823	1.50	0.135	-0.0383	0.2846
SJR q2	0.0884	0.0485	1.82	0.069	0.0069	0.1836
SJR q3	0.0246	0.0504	0.49	0.625	0.0743	0.1235
SJR q4	0.0037	0.0388	-0.10	0.923	0.0799	0.0724
Gender: Male						
SJR q1	0.1330	0.0712	1.87	0.062	-0.0067	0.2728
SJR q2	0.0881	0.0422	2.09	0.037	0.0052	0.1710
SJR q3	-0.0256	0.0376	-0.68	0.496	-0.0995	0.0483
SJR q4	-0.0384	0.0321	-1.19	0.233	-0.1014	0.0247
Gender: Female						
SJR q1	0.0489	0.0569	0.86	0.391	-0.0627	0.1605
SJR q2	0.0532	0.0571	0.93	0.352	-0.0589	0.1652
SJR q3	0.0429	0.0522	0.82	0.411	-0.0594	0.1453
SJR q4	0.0645	0.0511	1.26	0.208	-0.0358	0.1647

Standard Errors heteroskedasticity-robust and clustered on the journal level. N = 243,757. Estimates for the plots in Figure 6.

Table 12: Average Marginal Effect for the DEAL decomposed by gender and SJR

	AME	Std. Err.	t-value	p-value	95% CI	
Plain using eq. 1	-0.0181	0.0154	-1.17	0.240	-0.0484	0.0121
w/ SJR	-0.0402	0.0149	-2.70	0.007	-0.0693	-0.0110
w/ SJR, gender	-0.0383	0.0148	-2.59	0.010	-0.0674	-0.0093

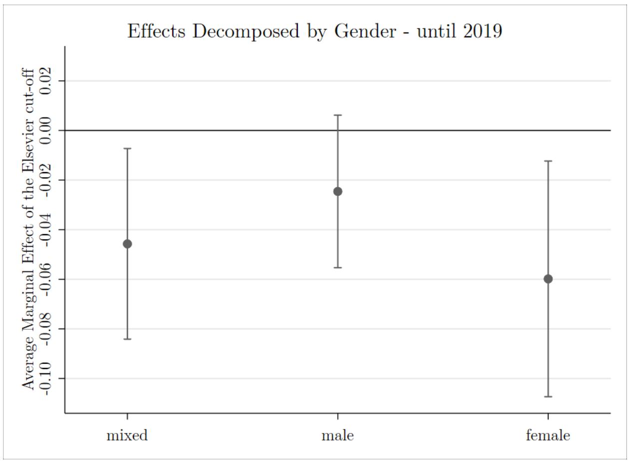
Estimation using eq. 1: Outcome model with weighted least squares, treatment model with inverse probability tilting. Standard Errors heteroskedasticity-robust and clustered on the journal level. $N = 243{,}757$.

Table 13: Average Marginal Effect of the Elsevier cut-off - using a DiD Correction Model

	AME	Std. Err.	t-value	p-value	95% CI	
Mixed	-0.0520	0.0158	-3.28	0.001	-0.0831	-0.0209
Male	-0.0242	0.0133	-1.81	0.071	-0.0504	0.0020
Female	-0.0550	0.0174	-3.16	0.002	-0.0892	-0.0208

Standard Errors heteroskedasticity-robust and clustered on the journal level. $N = 243{,}757$. Estimates for the average marginal effects shown in Figure 7.

Table 14: Average Marginal Effect of the Elsevier cut-off separated by gender



Standard Errors heteroskedasticity-robust and clustered on the journal level. 95% confidence bands. $N = 141{,}348$. Time span covered: 2015-2019. Treatment date: July 5, 2018. Table 15 below provides further details on the average marginal effects in this plot.

Figure 14: Effect of the Elsevier cut-off decomposed by Gender until 2019

	AME	Std. Err.	t-value	p-value	95% CI	
Plain Effect	-0.0368	0.0144	-2.56	0.011	-0.0650	-0.0086
Mixed	-0.0457	0.0196	-2.34	0.020	-0.0842	-0.0073
Male	-0.0246	0.0157	-1.57	0.117	-0.0553	0.0062
Female	-0.0598	0.0242	-2.47	0.014	-0.1073	-0.0123

Standard Errors heteroskedasticity-robust and clustered on the journal level. N = 137,600. Time span covered: 2015-2019

Table 15: Average Marginal Effect for Elsevier until 2019

Germany	Mixed	Male	Female	Total
No	27,978	26,416	4,723	59,117
Yes	1,661	2,568	296	4,525
Total	29,639	28,984	5,019	63,642

Table 16: Publications in Elsevier journals separated by gender and nationality

	AME	Std. Err.	t-value	p-value	95% CI	
Gender: Mixed						
SJR q1	-0.0668	0.02018	-3.31	0.001	-0.1064	-0.0272
SJR q2	-0.0740	0.0250	-2.96	0.003	-0.1230	-0.0250
SJR q3	-0.0941	0.0444	-2.12	0.034	-0.1812	-0.0070
SJR q4	0.0218	0.0359	0.61	0.544	-0.0487	0.0923
Gender: Male						
SJR q1	-0.0595	0.0194	-3.08	0.002	-0.0975	-0.0216
SJR q2	-0.0569	0.0214	2.65	0.008	-0.0989	-0.0148
SJR q3	-0.0420	0.0329	1.28	0.201	-0.1066	0.0225
SJR q4	0.0601	0.0298	2.01	0.044	0.0015	0.1186
Gender: Female						
SJR q1	-0.0511	0.0234	-2.18	0.030	-0.0971	-0.0051
SJR q2	-0.0854	0.0236	-3.61	0.000	-0.1318	-0.0390
SJR q3	-0.0619	0.0476	-1.30	0.194	-0.1553	0.0316
SJR q4	-0.0109	0.0428	-0.25	0.799	-0.0948	0.0730

Standard Errors heteroskedasticity-robust and clustered on the journal level. N = 243,757. Estimates for the plots in Figure 8.

Table 17: Average Marginal Effect for Elsevier decomposed by gender and SJR

	AME	Std. Err.	t-value	p-value	95% CI	
			DEAL			
Plain Effect	0.0448	0.0195	2.30	0.022	0.0066	0.0830
Mixed	0.0519	0.0231	2.25	0.025	0.0066	0.0973
Male	0.0385	0.0204	1.89	0.059	-0.0015	0.0785
Female	0.0511	0.0264	1.94	0.053	-0.0007	0.1028
			Elsevier			
Plain Effect	-0.0381	0.0128	-2.97	0.003	-0.0633	-0.0129
Mixed	-0.0509	0.0154	3.31	0.001	-0.0810	-0.0208
Male	-0.0252	0.0134	-1.88	0.060	-0.0514	0.0011
Female	-0.0560	0.0174	-3.21	0.001	-0.0902	-0.0218

Standard Errors heteroskedasticity-robust and clustered on the journal level. N = 222,675.

Table 18: Average Marginal Effects excluding 'unidentified' granular gender category

	AME	Std. Err.	t-value	p-value	95% CI	
Fully Male	-0.0254	0.0134	1.90	0.058	0.0516	0.0008
Mostly Male	-0.0379	0.0193	-1.97	0.049	-0.0757	-0.0001
Equally Mixed	-0.0534	0.0159	-3.35	0.001	-0.0846	-0.0221
Mostly Female	-0.0674	0.0277	-2.43	0.015	-0.1218	-0.0130
Fully Female	-0.0562	0.0174	-3.22	0.001	-0.0905	-0.0220

Estimates for the plot in Figure 9. Standard Errors heteroskedasticity-robust and clustered on the journal level. N = 222,675.

Table 19: Effects for Elsevier using the granular gender decomposition

	AME	Std. Err.	t-value	p-value	95% CI	
Fully Male	0.0387	0.0204	1.90	0.058	-0.0013	0.0787
Mostly Male	0.0473	0.0241	1.96	0.051	-0.0001	0.0948
Equally Mixed	0.0355	0.0267	1.33	0.185	-0.0170	0.0880
Mostly Female	0.1129	0.0424	2.66	0.008	0.0297	0.1961
Fully Female	0.0513	0.0264	1.94	0.052	-0.0005	0.1031

Estimates for the right plot in Figure 9. Standard Errors heteroskedasticity-robust and clustered on the journal level. N = 222,675.

Table 20: Effects of the DEAL with granular gender decomposition

	AME	Std. Err.	t-value	p-value	95% CI	
Male group	-0.0236	0.0143	-1.65	0.100	-0.0518	0.0045
Male single	-0.0383	0.0159	-2.40	0.017	-0.0696	-0.0070
Female group	-0.0313	0.0223	-1.41	0.160	-0.0751	0.0124
Female single	-0.0710	0.0213	-3.33	0.001	-0.1128	-0.0292

Estimates for the plot in Figure 10. Standard Errors heteroskedasticity-robust and clustered on the journal level. N = 222,675.

Table 21: Effect for Elsevier differentiating gender by single and multiple authors

	AME	Std. Err.	t-value	p-value	95% CI	
Male group	0.0583	0.0223	2.62	0.009	0.0146	0.1019
Male single	0.0272	0.0254	1.07	0.284	-0.0226	0.0770
Female group	0.0391	0.0381	1.02	0.306	-0.0357	0.1139
Female single	0.0683	0.0286	2.38	0.017	0.0121	0.1244

Estimates for the plot in Figure 10. Standard Errors heteroskedasticity-robust and clustered on the journal level. N = 222,675.

Table 22: Effect for the DEAL differentiating gender by single and multiple authors

	AME	Std. Err.	t-value	p-value	95% CI	
Plain Effect	-0.0268	0.0144	-1.86	0.063	-0.0550	0.0015
Mixed	-0.0390	0.0171	-2.27	0.023	-0.0726	-0.0054
Male	-0.0115	0.0147	-0.78	0.434	-0.0404	0.0174
Female	-0.0438	0.0182	-2.41	0.016	-0.0794	-0.0082

Estimates for the baseline effect and the gender decomposition for Elsevier journals excluding the years 2015 and 2016. Standard Errors heteroskedasticity-robust and clustered on the journal level. N = 192,501.

Table 23: Effect for Elsevier decomposed by gender, years 2017 – 2022

	AME	Std. Err.	t-value	p-value	95% CI	
Fully Male	-0.0080	0.0147	-0.54	0.588	-0.0368	0.0209
Mostly Male	-0.0194	0.0209	-0.93	0.354	-0.0604	0.0216
Equally Mixed	-0.0347	0.0173	-2.01	0.045	-0.0687	-0.0008
Mostly Female	-0.0496	0.0278	-1.78	0.075	-0.1043	0.0050
Fully Female	-0.0400	0.0181	-2.21	0.028	-0.0755	-0.0044

Estimates for the granular gender decomposition for Elsevier journals excluding the years 2015 and 2016. Standard Errors heteroskedasticity-robust and clustered on the journal level. $N = 174{,}593$.

Table 24: Effects for Elsevier using the granular gender decomposition, years 2017 – 2022

	AME	Std. Err.	t-value	p-value	95% CI	
Effect of the DEAL: Male single						
SJR q1	0.0974	0.0742	1.31	0.190	-0.0482	0.2430
SJR q2	0.0630	0.0515	1.22	0.222	-0.0381	0.1641
SJR q3	-0.0563	0.0368	-1.53	0.127	-0.1285	0.0160
SJR q4	0.0024	0.0411	0.06	0.954	-0.0782	0.0830
Effect of the DEAL: Female single						
SJR q1	0.0259	0.0561	0.46	0.644	-0.0842	0.1361
SJR q2	0.0798	0.0655	1.22	0.223	-0.0487	0.2083
SJR q3	0.0570	0.0593	0.96	0.337	-0.0593	0.1734
SJR q4	0.1107	0.0624	1.77	0.077	-0.0118	0.2332
Effect of the Elsevier cut-off: Male single						
SJR q1	-0.0574	0.0193	-2.98	0.003	-0.0952	-0.0196
SJR q2	-0.0397	0.0221	-1.80	0.072	-0.0831	0.0036
SJR q3	-0.0452	0.0349	-1.29	0.197	-0.1137	0.0234
SJR q4	-0.0106	0.0363	-0.29	0.769	-0.0819	0.0606
Effect of the Elsevier cut-off: Female single						
SJR q1	-0.0538	0.0213	-2.53	0.012	-0.0956	-0.0120
SJR q2	-0.0920	0.0276	-3.34	0.001	-0.1462	-0.0379
SJR q3	-0.0793	0.0521	-1.52	0.129	-0.1816	0.0230
SJR q4	-0.0593	0.0563	-1.05	0.293	-0.1698	0.0513

Standard Errors heteroskedasticity-robust and clustered on the journal level. $N = 222{,}675$. Estimates for the plots in Figure 11.

Table 25: Average Marginal Effect for the DEAL decomposed by gender and SJR

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