Social media uptake of academic publications: Differences due to availability, subject and demographic parameters.

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The Queen (?) of social media in academia: the middle-age, sharing medicine and health scholar.

1 Abstract

In this study we evaluate the social media uptake of Norwegian articles for the years 2011-2015. We analyse the difference regarding open availability, subject, gender and age.

Our dataset consist of over 70000 publications taken from CERES the National Center for Systems and Services in Norway. The dataset from CERES provides a unique possibility to learn more about the differences in gender and age when it comes to social media uptake. It contains information about subject category, gender and age of contributing authors. Open availability is tested with Google Scholar and the information about social media uptake is taken from *altmetric.com*. We analyses the popular services Facebook and Twitter as well as blog posts and news outlets.

We find that open availability increases social media uptake. Articles within Medicine and Health sciences receive by far the highest coverage in social media followed by Natural sciences and Technology. Publications authored by women seem to receive more social media coverage but with a lower intensity. Well-established scholars receive most media attention, the differences with regard to gender and age are however very small.

Even though our study is limited to publications in Norway our study covers a wide range of fields, and we believe it is representative for other countries. Our results can be used to inform the research community on how to disseminate research findings, get visible and maximize research impact.

2 Introduction

In this study, we evaluate the social media uptake of Norwegian publications for the years 2011-2015. We hereby limit our study to one of the aggregators of social media mentions *altmetric.com*.

In the last decades scholarly communication appears to undergo a velvet revolution (Cronin, 2012). The way research is published and shared has changed (Bosman & Kramer 2015; Van Noorden 2014) as well the way it is evaluated. Scientists do no longer sit in their ivory tower, publishing their research in journals that only a minority can access, but a shift can be observed towards wider presence and heterogeneity. In particular, social media and online-based publication methods are new drivers for this development and will be examined here.

The way research is published has changed significantly during the last decades (Larivière et al. 2016; Rowlands et al. 2011; Sitek & Bertelmann 2014). For decades, research has been mainly published by research societies and their respective journals. In the 1960s and 1970s major publishing houses have taken over and started making profit (Guédon 2001). In those years, research journals were still published solely on paper while in the 1990s a shift to electronically publishing occurred. Particularly the development of World Wide Web made it possible to distribute publications more easily.

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Access to those journals was and mainly is until today based on subscriptions. Digital journals still mimic their print counterparts and publishing houses keep to make big profit (Larivière et al. 2016) . Not until the 2000s the idea of open access journals became more accepted (Sitek & Bertelmann 2014) and nowadays open access publishing, self-archiving in institutional archives, subject dependent archives or academic network sites have become more common (Mikki et al. 2018; Piwowar et al. 2018; Van Noorden 2014).

Academic networks sites such as ResearchGate, and the spread of universal social networks and tools, such as Twitter and Facebook, allow for utterly different ways of communication. While earlier research results were mostly only available for researchers they became available for everybody worldwide. Research articles still undergo a peer-review process but focus has shifted towards availability and dissemination.

Furthermore, the way research is being evaluated has changed. While previously it was strongly advocated for autonomy in science (Abramo & D'Angelo 2011; Bozeman & Youtie 2017; De Silva & Vance 2017; Owen et al. 2012; Thelwall et al. 2016), the focus nowadays lies on the societal benefit of science. However, a suitable method with which societal impact can be measured is still to be found, as societal impact can include many different aspects: It can be the impact on policy makers, business or culture (Khazragui & Hudson 2014) .

One way to measure societal impact is the coverage in social media. Parameters to measure this form of impact have been summarized under different terms such as infometrics (Bar-Ilan 2008), webometrics (Bjorneborn & Ingwersen 2004) or as altmetrics (Priem 2014). An extensive overview about the scholarly use of social media can be found in Sugimoto et al. (2017).

In this study we analyse the coverage in social media using data from one of the main aggregator of alt(ernative) metrics *altmetric.com*. The service counts and analyzes mentions of publications on platforms such as Facebook, Twitter, blog posts and news outlets. By analyzing the data from *altmetric.com* we want to examine the following research questions:

RQ1: How big is the uptake of Norwegian research articles in social media?

RQ2: How does open availability of research articles influence the social media attention?

RQ3: How does the subject influence the social media attention?

RQ4: How do demographic parameters such as age and gender influence the social media attention?

3 Methodology

3.1 Data

All scholarly publications in Norway since 2011 are registered by CERES the National Center for Systems and Services for Research and Studies. Nowadays SCOPUS is being harvested to automatically import publications and the data is manually quality checked. As institutional funding in Norway is to some extend dependent on the number and quality of registered publications, the data set can be assumed to be complete. To be counted as scientific

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publication the publication has to 1) present new insight 2) repeatable 3) published in a language and distributed in a way that makes it accessible for interested readers 4) has undergone a peer-review process (NSD Database for statistikk om høgre utdanning, 2017). The full dataset between 2011 and 2015 consists of 70882 articles, of which 54936 have on digital object identifier (DOI). Those with DOI are used to extract data about social media uptake from *altmetric.com*. Additional to the metadata from CERES our dataset contains demographic information such as gender and age.

3.2 Data Analysis

The DOIs provided by CERES had to undergo intense manual cleaning. The availability of documents has been tested with google scholar. The uptake in social media was testes with extracting information from *altmetric.com* the biggest aggregator of this kind of information. Below we describe the analysis steps in more detail.

3.2.1 Google scholar:

Based on the dataset from CERES we searched google scholar for the articles' full text and the number of citations. Where available the DOI was used. If no DOI was available or the search by DOI returned no results the title was used. We considered the article as freely available as long as google scholar provided a link to the full text. We did hereby not investigate the legal aspect of this access nor the actual availability. We performed this study off campus to avoid access through our library SFX link resolvers, which would have provided access to documents actually lying behind a pay wall. This analysis was performed in spring 2017. More information about this analysis and results can be found in Mikki (2017).

3.2.2 Altmetric.com

The Digital Object Identifier (DOI) was used as the linkage between CERES data and *altmetric.com* data. This analysis was also performed in spring 2017.

Our analysis was herby limited to the following social media tools:

Blogs : Information about blog mentions is based on a scan of over 9,000 academic and nonacademic blogs every day.
Mainstream media/ in form of news outlets: The mainstream media tracking gives insight where a document has attracted coverage in one of over 2,000 outlets around the world. Only outlets using English language are included which excludes all Norwegian newspapers.
Social media networks: Networks that are included in the analysis are the following

- **Facebook** (mentions on public pages only)
- **Twitter**

More information about the data sources can be found at the info pages form *altmetric.com* (2017)

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3.2.3 Applied indicators

As done in previous studies (Haustein et al. 2015) we focus on two main parameters to quantify the uptake in social media:

Coverage: the percentage of documents with at least one mention.

Intensity: mean number of events per document excluding those without mentions.

We analyse differences regarding open availability, subject, gender and age.

For the analysis regarding open availability and subject we used full counting, while for the analysis regarding gender and age we used fractional counting, meaning a mention for a publication co-authored by 2 male and one female authors contributes as 1/3% female and 2/3 male.

The main subject categories used were defined by the Norwegian Association of Higher Education Institutions (Det Norske Publiseringsutvalget 2017): Medicine and Health, Social Sciences, Humanities and STEM subjects.

4 Results

This section is divided in 2 parts. First, we give a short general overview about the dataset as retrieved from CERES: How many of the documents are freely available, subject categories and a demographic overview (Section 4.1).

Second, we analyze the coverage (percentage) and intensity (mean number) of social media uptake according to *altmetric.com* and the differences in respect to open availability (4.2.1), subject (4.2.2), gender (4.2.3) and age (Section 4.2.4).

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4.1 Research output in Norway

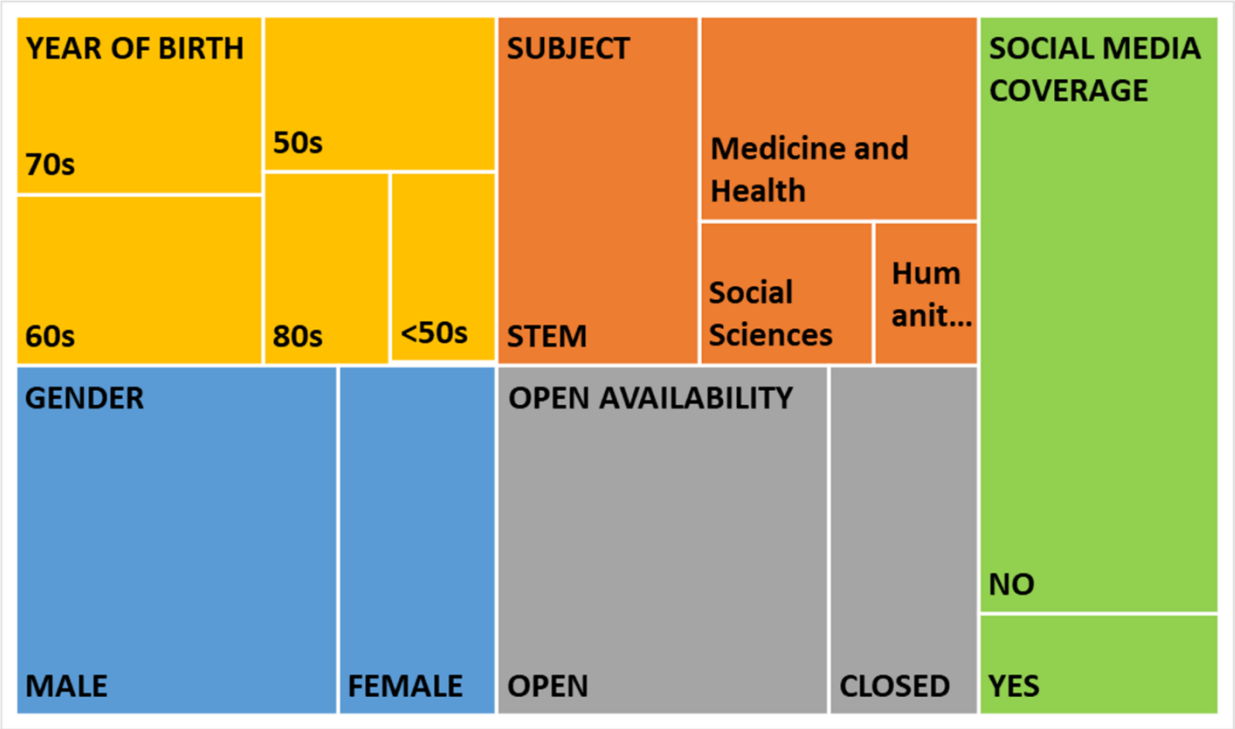

Figure 1: Research output in Norway from 2011-2015. Distribution of norwegian articles with respect to age, gender, subject, open availability and social media coverage.

Figure 1 shows the general distribution of Norwegian articles with respect to open availability, subject, gender, age and social media coverage.

For the years 2011-2015 CERES contains 70882 articles. For the investigated period the share of open available articles is 65 % and is increasing throughout the period (see Mikki 2017 for more details).

Following the definition by the Norwegian Association of Higher Education Institutions we evaluated the following categories: Medicine and Health, Social Sciences, Humanities and STEM subjects.The largest category is Medicine and Health.

The percentage of female authors contributing to the 70882 publications registered in CERES is 33%. Here we use fractional counting, meaning a publication with two male and one female author contributes as 2/3 male and 1/3 female.

Most of the contributing authors are born in the years from 1950s-80s, with the highest peak in the years 1960s-70s, meaning now in their late 40s or early fifties. Here again we use fractional counting.

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4.2 Social media uptake of Norwegian publications

In general the coverage in social media is about 15 %, for all the publications registered in CERES according to *altmerics.com*. This number only includes mentions in one of the four evaluated (social) media sources Facebook, Twitter, news outlets and blogs.

4.2.1 Dependency on open availability

4.2.1.1 Coverage:

The influence of open availability on social media coverage for the four evaluated services is shown in Fig. 2. Publications that are freely available have a higher coverage (> 17%) as those hidden behind a paywall (<10 %). This pattern can be observed for all the services separately. The networks most actively used are Twitter and Facebook.

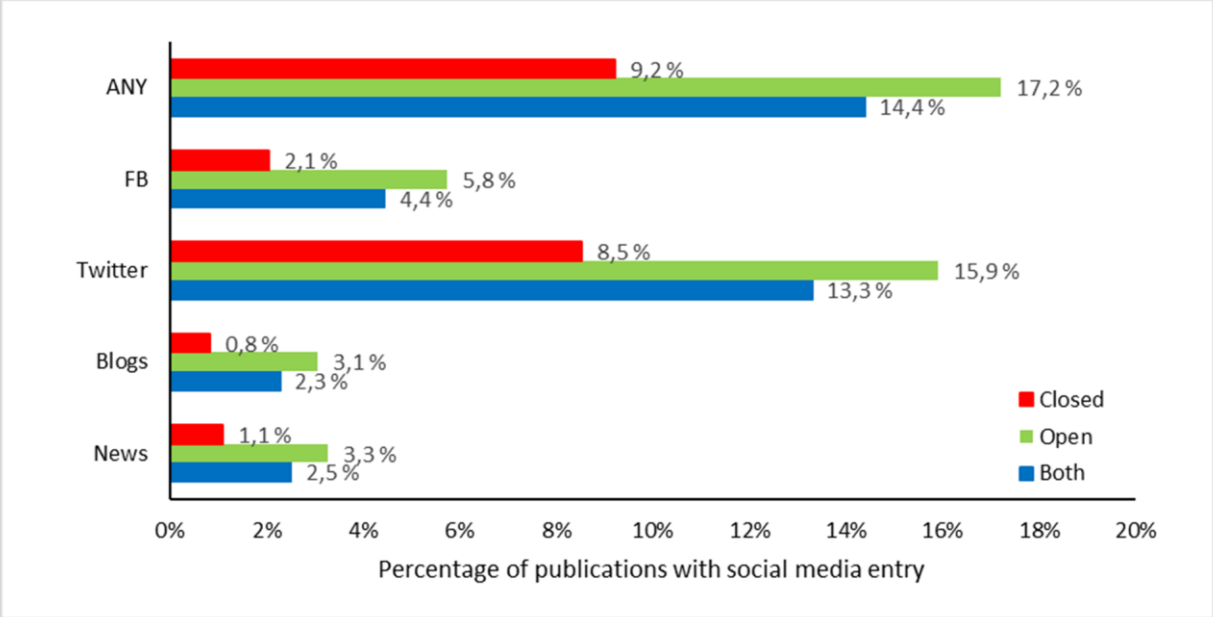

Figure 2: Influence of open availability on social media coverage. Percentage of publications with social media entry (coverage) in the analysed services, divided in open available, not open available (closed) and both combined.

4.2.2 Intensity

The mean number of events per document (intensity) per service is shown in Fig. 3 and Table 1.

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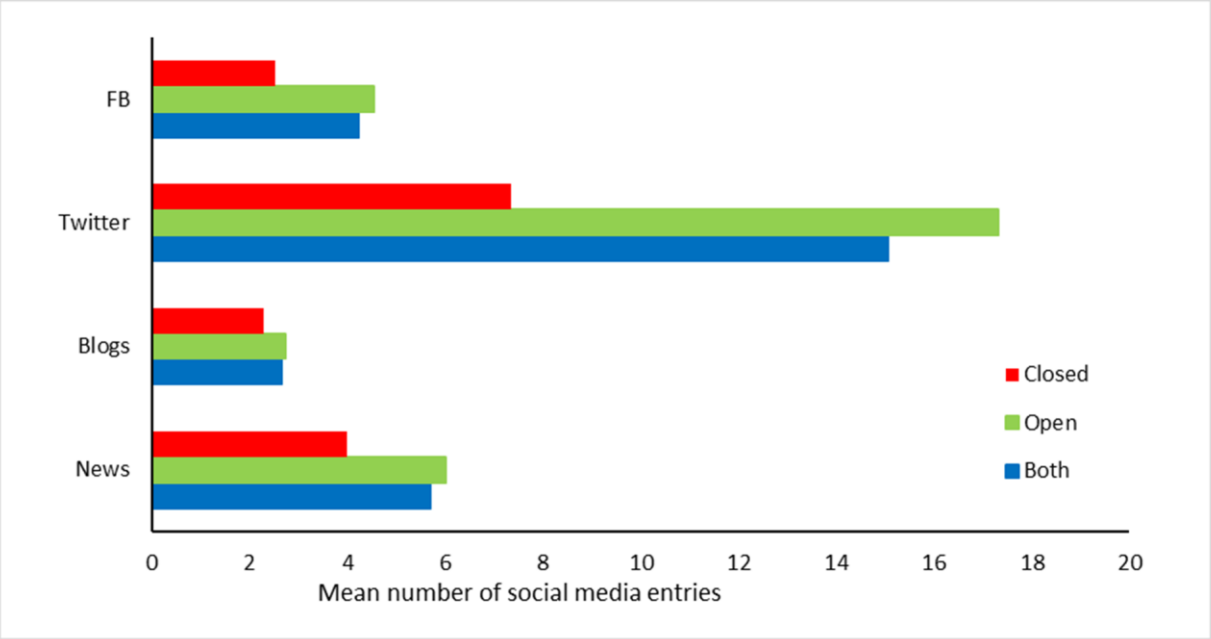

Figure 3: Influence of open availability on social media intensity. Mean number of social media entries (intensity) per publication in the analysed services, divided in open available, not open available (closed) and both combined.

Also the intensity is higher for articles that are freely available than for those hidden behind a paywall. The largest difference can be herby observed for Twitter and Facebook, where publications hidden behind a paywall receive 50 % (40 %) less mentions. The smallest difference can be observed for blog entries.

Table 1: Influence of open availability on social media intensity. Mean number of social media entries (intensity) per publication in the analysed services, divided in open available, not open available (closed) and both combined. Number in parentheses show difference to the mean (Both).

	News	Blogposts	Twitter	Facebook
Closed	*(-30,1%)* 4,0	*(-14,5 %)* 2,3	*(-51,3 %)* 7,3	*(-40,1 %)* 2,5
Open	*(+5,5 %)* 6,0	*(+ 2,1 %)* 2,7	*(+15,0 %)* 17,3	(+7,8 %) 4,6
Both	5,7	2,7	15,1	4,2

4.3 Dependency on subject category

4.3.1 Coverage

Figure 4 shows the influence of subject category on social media coverage. Publications published within the field of Medicine and Health Sciences receive the highest social media coverage, followed by STEM subjects, Social Sciences and Humanities. This pattern can be observed for all four evaluated services.

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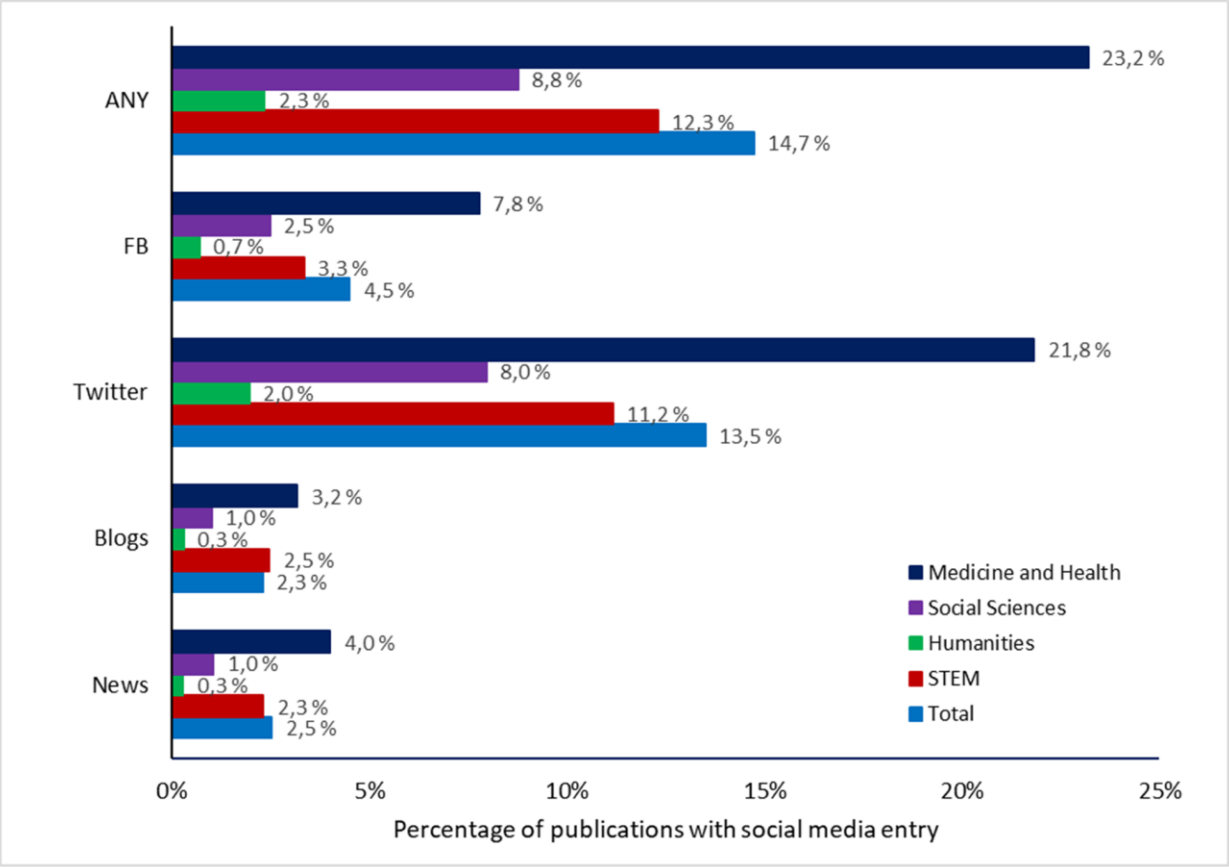

Figure 4: Influence of subject category on social media coverage. Percentage of publications with social media entry (coverage) in the analysed services, divided in different subject areas.

4.3.2 Intensity

The influence of subject category on the intensity of social media uptake is shown in Fig. 5 and Table 2.

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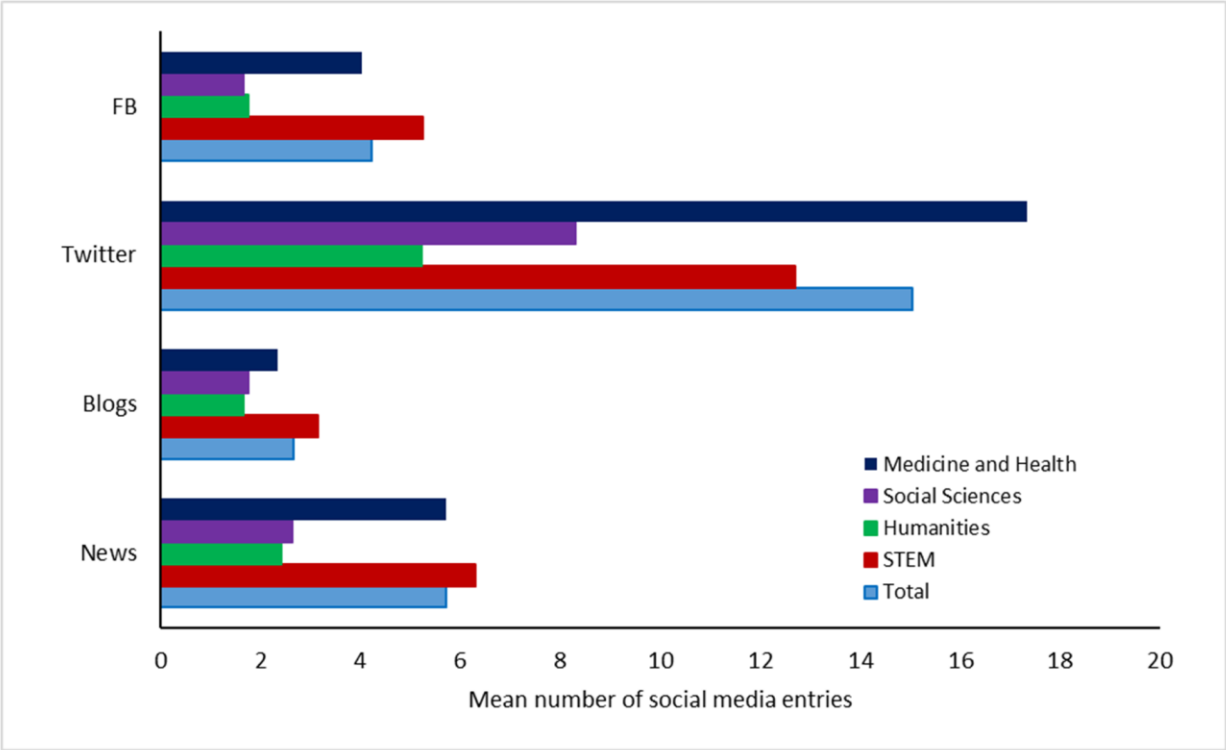

Figure 5: Influence of subject category on social media intensity. Mean number of social media entries (intensity) in the analysed services, divided in different subject areas.

As for the coverage the highest intensity can be observed for publications published in Medicine and Health Sciences, followed by STEM subjects, Social Sciences and Humanities. The same pattern can be observed for all four evaluated services.

Table 2: Influence of subject category on social media intensity. Mean number of social media entries (intensity) in the analysed services, divided in different subject areas. Numbers in parentheses show the difference to the mean (Total).

	News	Blogs	Twitter	Facebook
Medicine and Health	*(+0,3)* 5,7	*(+58,1 %)* 2,3	*(-57,7 %)* 17,4	*(-4,6 %)* 4,0
Social Sciences	*(-53,6 %)* 2,6	*(-65,2 %)* 1,8	*(-37,5 %)* 8,3	*(-60,5 %)* 1,7
Humanities	*(+57,3)* 2,4	*(-37,5)* 1,7	*(-65,2 %)* 5,2	*(-58,1 %)* 1,8
STEM	*(+10,3)* 6,3	*(+18,3)* 3,2	*(-15,1 %)* 12,7	*(24,5 %)* 5,3
Total	5,7	2,7	15,1	4,2

4.4 Dependency on gender

For this part, only articles and authors are included where information on gender is available. In general, authors not affiliated to a Norwegian institution lack information on gender and age. We

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use fractional counting, meaning a publications co-authored by two female and one male author, contributes as 2/3 female and 1/3 male.

4.4.1 Coverage

The influence of gender on social media coverage is shown in Fig. 6.

The coverage in Twitter and Facebook is higher for publications authored by female researchers. For Facebook, 5 % of all publication co-authored by female researchers are mentioned, while the coverage reaches 4,2 % for men. For Twitter the coverage is higher with 14,5 % for publications co-authored by female researchers and 12,7 % for men. For blog post and news outlets only a small difference with respect to gender can be observed.

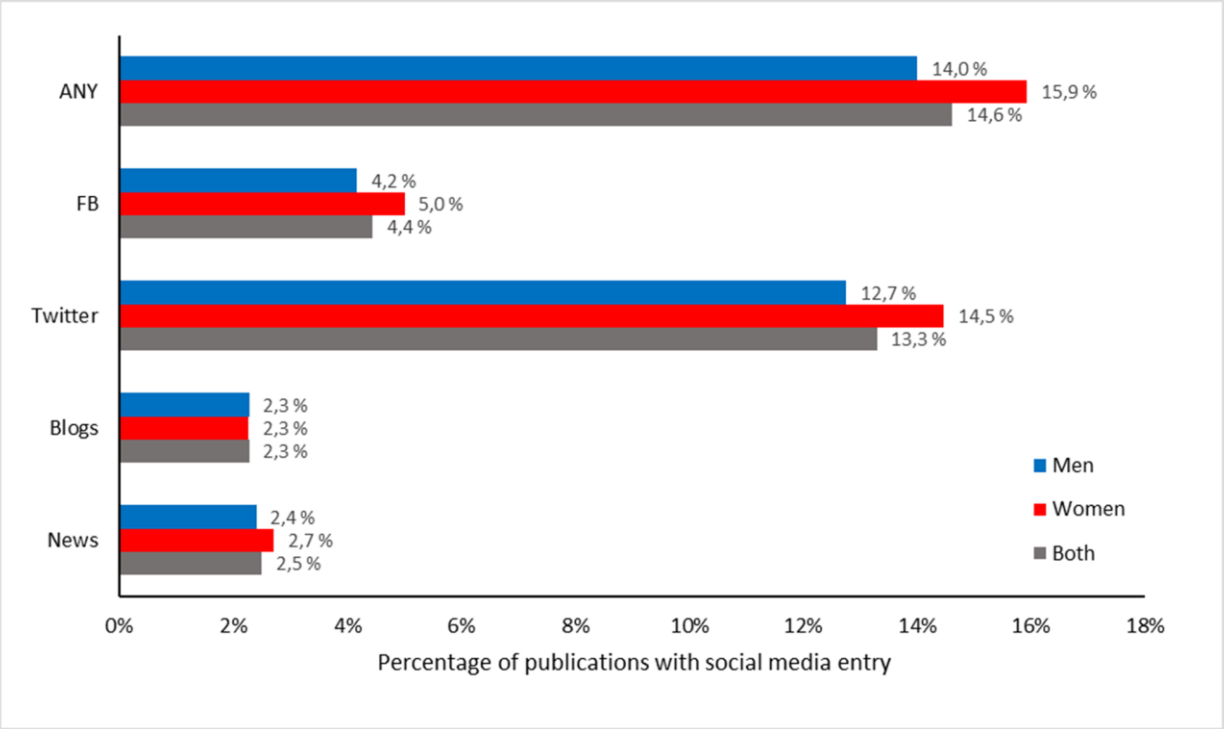

Figure 6: Influence of gender on social media coverage. Percentage of publications with social media entry (coverage) in the analysed services, divided in men, women and both combined (Both).

4.4.2 Intensity: Mean number of events

The influence of gender on the intensity of social media coverage is shown in Fig. 7 and table 3.

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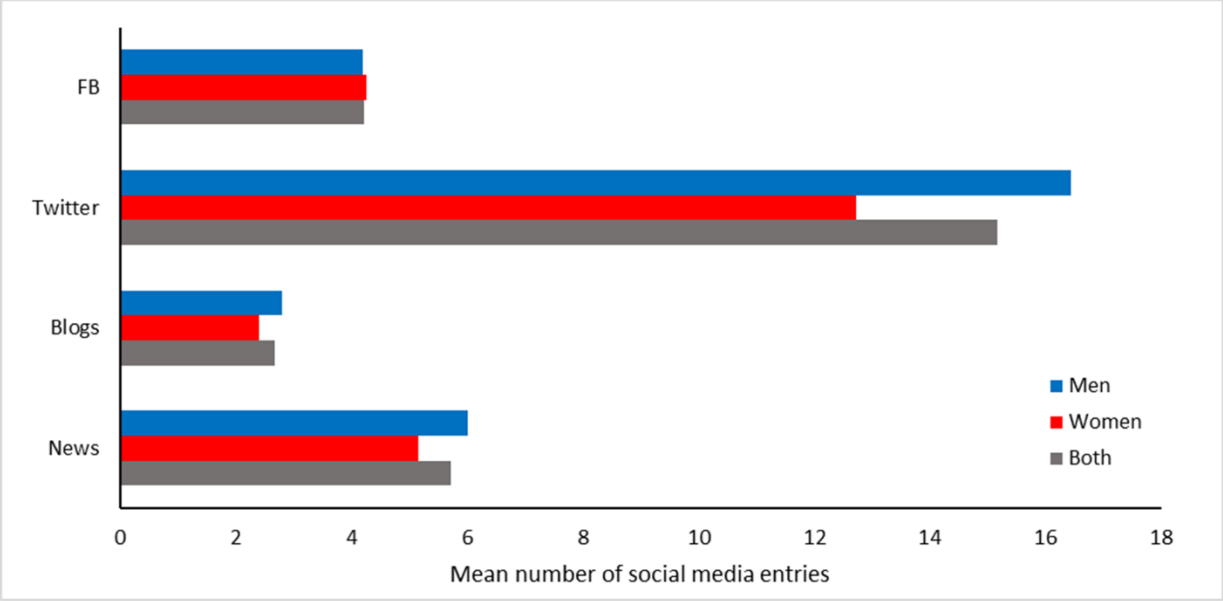

Figure 7: Influence of gender on social media intensity. Mean number of social media entries (intensity) in the analysed services, divided in male and female authors.

In contrary to the coverage, the mean number of social media entries (intensity) is in general higher for publications co-authored by male authors than female authors. This can be observed for Twitter, blogs and news outlets, while we find no difference with regard to Facebook. The difference is largest for Twitter where articles authored by male researcher receive over 8 % more mentions than on average (Both).

Table 3: Influence of gender on social media intensity.

Mean number of social media entries per publication in the analysed services, divided in male and female authors. Numbers in parentheses show the difference to the mean (Both).

	News	Blogs	Twitter	Facebook
Women	*(-9,9 %)* 5,1	*(-10,3 %)* 2,4	(-16 %) 12,7	*(0,8 %)* 4,3
Men	*(+5,1%)* 6,0	*(+4,8 %)* 2,8	*(+8,4 %)* 16,4	*(-0,5 %)* 4,2
Both	5,7	2,6	15,2	4,2

4.5 Dependency on age

We divided all authors in different age classes: those born before 1950, in the 50s (1950-1959), 1960s, 1970s, 1980s, and after 1990. As only a minor fraction of authored was found to be in that last group, this group is not shown.

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4.5.1 Coverage

The influence of age on social media coverage is shown in Fig. 8.

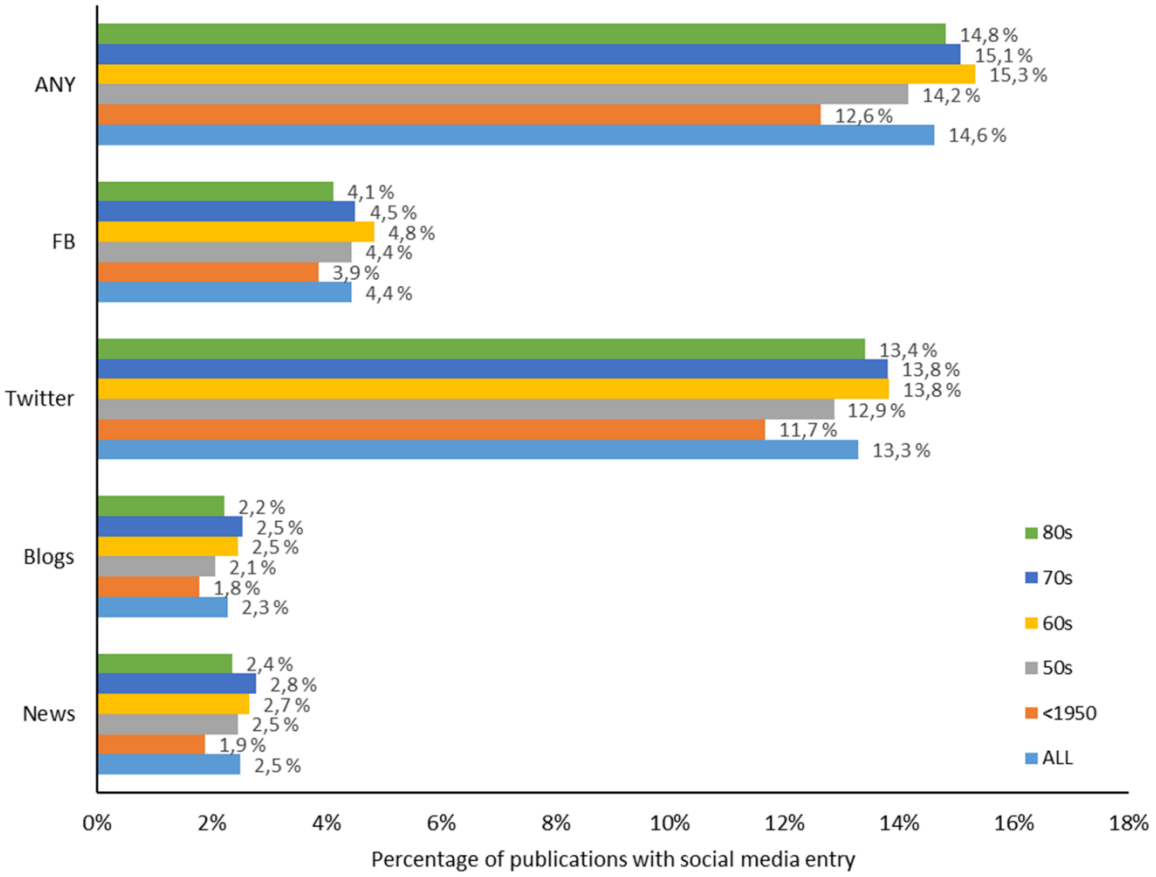

Figure 8: Influence of age on social media coverage. Percentage of publications with social media entry (coverage) in the analysed services, divided in different decades of birth.

For all services the highest social media coverage can be observed for publications (co-) authored by researchers born in the 1960-1970s (meaning authors now in their 50s or 60s. However, the differences between the age fractions are very small.

4.5.2 Intensity

The influence of age on the intensity of social media uptake is shown in Fig. 9 and Table 4.

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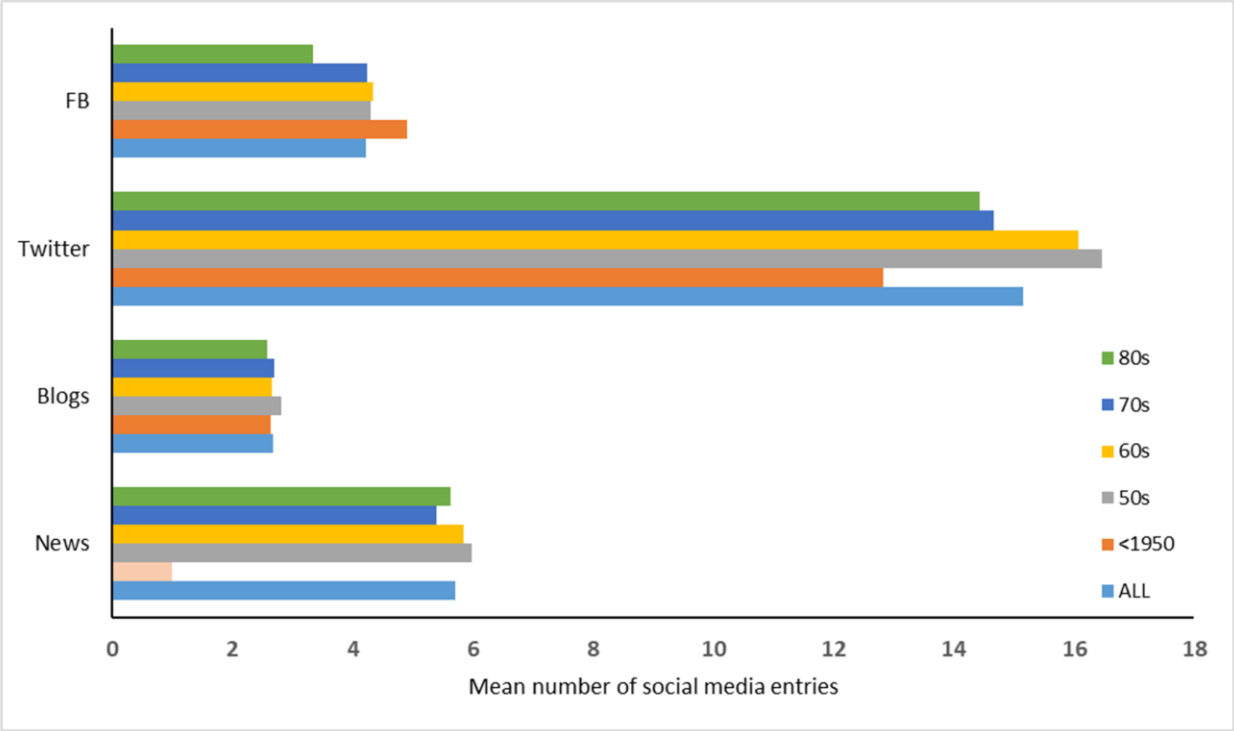

Figure 9: Influence of age on social media intensity. Mean number of social media entries per publications (intensity) in the analysed services, divided in different decades of birth. Numbers in parentheses show the difference to the mean (All).

The intensity of social media coverage is highest for publications (co-) authored by researchers born in the 1950s and 1960s (yellow and grey in Fig. 9), meaning that those publications have more senior authors that those receiving the highest coverage. The differences between the age fractions regarding intensity are bigger than those regarding coverage, but still rather small. The largest variation can be observed for Twitter (see Table 4).

Table 4: Influence of age on social media intensity.

Mean number of social media entries per publication (intensity) in the analysed services, divided in different decades of birth. Numbers in parentheses show the difference to the mean (All).

	News	Blogs	Twitter	Facebook
50s	*(+4,6 %)* 6	*(+4,7 %)* 2,8	*(+8,5 %)* 16,5	*(1,9 %)* 4,3
60s	*(2,3 %)* 5,8	*(-1,3 %)* 2,6	*(- 6,0 %)* 16,1	*(2,9 %)* 4,3
70s	*(-5,8 %)* 5,4	*(0,7 %)* 2,7	*(-3,3 %)* 14,7	*(-10,9 %)* 4,2
80s	*(-1,7 %)* 5,6	*(-3,7 %)* 2,6	*(-4,8 %)* 14,4	*(2,6 %)* 3,3
All	5,7	2,7	15,2	4,2

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5 Discussion and final remarks

Our four research questions can be answered as follows:

A1) Open availability increases the chance of social media uptake both in regards to coverage and intensity.

A2) Coverage and intensity in social media is clearly highest for publications published in the field of Medicine and Health Sciences, followed by STEM subjects.

A3) Small differences in gender can be observed, slightly higher coverage for articles (co-) authored by female authors. However, those articles how a slightly lower intensity in social media uptake.

A4) Social media coverage is highest for publications (co-)authored by researchers in the 1960s and 1970s, while the intensity is higher for even older researchers.

Our results regarding open availability support previous findings. For example Wang et al. (2015) reported, the probability of getting either tweeted or mentioned on Facebook is twice as high for open available documents as for documents behind paywalls. Also Nuredini et al. (2017) found a higher coverage for open access journals compared to those hidden behind a paywall, but a lower intensity. The term "open availability" is however not clearly defined, absolute numbers are therefore difficult to compare.

Our results regarding the differences in subject, partly support and partly contradict previous findings: Costas et al. (2015) found a similar social media uptake for Medicine, while he found a much higher uptake within the social sciences and humanities (22%) compared to us. For STEM subjects in turn they found a much lower uptake in social media.

Previous studies analyzing the gender disparity in social media show that scholarly communication is rather male dominated. The dominance could be particularly observed for blog authorship (Mahrt & Puschmann 2014; Shema et al. 2012) and microblogging such as Twitter (Birkholz et al. 2015; Tsou et al. 2015). However, here again the methodologies differ making it difficult to compare absolute numbers. The ambiguity between coverage (higher for female authors) and intensity (higher for male authors) could be explained by the fact that woman indeed use more social media for dissemination but receive less attention. This pattern can also be observed for citations, meaning that articles with women in dominant author positions receive fewer citations than those with men in the same positions (Lariviere et al. 2013)

Regarding the dependency of scholarly communication on age mixed results have been found: Some studies report higher use by older scholars (Procter et al. 2010), some by younger (Bowman 2015) and some show no difference in age (Hadgu & Jäschke 2014; Rowlands et al.

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2011). However, here again the methodologies differ, making it difficult to compare absolute numbers.

A limitation of our study is the lack of a temporal analysis, meaning an evolution of social media uptake over time. We did further not analyse who is tweeting, blogging, etc. and the content of the entries. We did therefore not obtain information if those tools are used for self-marketing or scientific discussion. It is also legitimate to questions the use of altmetrics as an indicator of impact, either societal or scientific. As reported, 9% of tweets to arXive articles indexed in WoS were generated automatically (Haustein et al. 2016; Sugimoto et al. 2017).

However besides being relevant in itself our result can be used to give useful advice for future studies and interpretations: In general we found the largest dependency on subject category and availability (which is also subject dependent, see Mikki (2017)) and not demographic parameters such as gender and age. Future studies evaluating demographic parameters should therefore take into account the differences in subject before making conclusions about differences with respect to age or gender. Further our results can be used to inform the research community on how to disseminate research findings, get visible and maximize research impact.

6 Acknowledgements

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References:

Abramo G, and D'Angelo CA. 2011. Evaluating research: from informed peer review to bibliometrics. *Scientometrics* 87:499-514. 10.1007/s11192-011-0352-7

Altmetric.com. 2017. Sources of Attention. *Available at https://www.altmetric.com/about-our-data/our-sources/* (accessed 27.11.2017).

Bar-Ilan J. 2008. Informetrics at the beginning of the 21st century—A review. *Journal of informetrics* 2:1-52. 10.1016/j.joi.2007.11.001

Birkholz JM, Seeber M, and Holmberg K. 2015. Drivers of Higher Education Institutions' Visibility: A Study of UK HEIs Social Media Use vs. Organizational Characteristics. ISSI.

Bjorneborn L, and Ingwersen P. 2004. Toward a basic framework for webometrics. *Journal of the American Society for Information Science and Technology* 55:1216-1227. 10.1002/asi.20077

Bosman J, and Kramer B. 2015. 101 Innovations in Scholarly Communication: How researchers are getting to grip with the myriad of new tools. *Impact of Social Sciences Blog*.

Bowman TD. 2015. Differences in personal and professional tweets of scholars. *Aslib Journal of Information Management* 67:356-371. 10.1108/Ajim-12-2014-0180

Bozeman B, and Youtie J. 2017. Socio-economic impacts and public value of government-funded research: Lessons from four US National Science Foundation initiatives. *Research Policy* 46:1387-1398. 10.1016/j.respol.2017.06.003

Costas R, Zahedi Z, and Wouters P. 2015. The thematic orientation of publications mentioned on social media Large-scale disciplinary comparison of social media metrics with citations. *Aslib Journal of Information Management* 67:260-288. 10.1108/Ajim-12-2014-0173

De Silva PU, and Vance CK. 2017. Assessing the Societal Impact of Scientific Research. *Scientific Scholarly Communication*: Springer, 117-132.

Guédon J-C. 2001. *In Oldenburg's long shadow: Librarians, research scientists, publishers, and the control of scientific publishing*: Association of Research Libr.

Hadgu AT, and Jäschke R. 2014. Identifying and analyzing researchers on twitter. Proceedings of the 2014 ACM conference on Web science: ACM. p 23-32.

Haustein S, Bowman TD, Holmberg K, Tsou A, Sugimoto CR, and Larivière V. 2016. Tweets as impact indicators: Examining the implications of automated "bot" accounts on T witter. *Journal of the Association for Information Science and Technology* 67:232-238. 10.1002/asi.23456

Haustein S, Costas R, and Lariviere V. 2015. Correction: Characterizing social media metrics of scholarly papers: the effect of document properties and collaboration patterns. *PloS one* 10:e0127830. 10.1371/journal.pone.0127830

Khazragui H, and Hudson J. 2014. Measuring the benefits of university research: impact and the REF in the UK. *Research Evaluation* 24:51-62. 10.1093/reseval/rvu028

Larivière V, Haustein S, and Mongeon P. 2016. Big Publishers, Bigger Profits: How the Scholarly Community Lost the Control of its Journals. *MediaTropes* 5:102-110.

Lariviere V, Ni C, Gingras Y, Cronin B, and Sugimoto CR. 2013. Bibliometrics: global gender disparities in science. *Nature* 504:211-213. 10.1038/504211a

Mahrt M, and Puschmann C. 2014. Science blogging: An exploratory study of motives, styles, and audience reactions. *Journal of science Communication* 13:A05.

Mikki S. 2017. Scholarly publications beyond pay-walls: increased citation advantage for open publishing. *Scientometrics* 113:1529-1538. 10.1007/s11192-017-2554-0

Mikki S, Gjesdal ØL, Strømme TE, and Eikefjord I. 2018. Grades of openness. Open and closed articles in Norway *(to be published)*.

Norsk Publiseringsutvalget. 2017. Fagfeltoversikt. *Available at https://npi.nsd.no/fagfeltoversikt* (accessed 27.11.2017.

Nuredini K, Latif A, and Peters I. 2017. Case study on open access journals in Economics and Business Studies and their engagement on the Web. 10.5281/zenodo.891225

Owen R, Macnaghten P, and Stilgoe J. 2012. Responsible research and innovation: From science in society to science for society, with society. *Science and public policy* 39:751-760. 10.1093/scipol/scs093

Piwowar H, Priem J, Larivière V, Alperin JP, Matthias L, Norlander B, Farley A, West J, and Haustein S. 2018. The State of OA: A large-scale analysis of the prevalence and impact of Open Access articles. *PeerJ* 6:e4375. 10.7717/peerj.4375

Priem J. 2014. Altmetrics. In: Cronin B, and Sugimoto CR, eds. *Beyond bibliometrics: Harnessing multidimensional indicators of scholarly impact*: MIT Press.

Procter R, Williams R, Stewart J, Poschen M, Snee H, Voss A, and Asgari-Targhi M. 2010. Adoption and use of Web 2.0 in scholarly communications. *Philosophical Transactions of the Royal Society a-Mathematical Physical and Engineering Sciences* 368:4039-4056. 10.1098/rsta.2010.0155

Rowlands I, Nicholas D, Russell B, Canty N, and Watkinson A. 2011. Social media use in the research workflow. *Learned Publishing* 24:183-195. 10.1087/20110306

Shema H, Bar-Ilan J, and Thelwall M. 2012. Research blogs and the discussion of scholarly information. *PloS one* 7:e35869. 10.1371/journal.pone.0035869

Sitek D, and Bertelmann R. 2014. Open Access: a state of the art. *Opening science*: Springer, 139-153.

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Sugimoto CR, Work S, Lariviere V, and Haustein S. 2017. Scholarly Use of Social Media and Altmetrics: A Review of the Literature. *Journal of the Association for Information Science and Technology* 68:2037-2062. 10.1002/asi.23833

Thelwall M, Kousha K, Dinsmore A, and Dolby K. 2016. Alternative metric indicators for funding scheme evaluations. *Aslib Journal of Information Management* 68:2-18. 10.1108/Ajim-09-2015-0146

Tsou A, Bowman TD, Ghazinejad A, and Sugimoto CR. 2015. Who tweets about science? Issi.

Van Noorden R. 2014. Online collaboration: Scientists and the social network. *Nature* 512:126-129. 10.1038/512126a

Wang X, Liu C, Mao W, and Fang Z. 2015. The open access advantage considering citation, article usage and social media attention. *Scientometrics* 103:555-564.

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