CWTS
Meaningful metrics

Monitoring open access publishing of NWO funded research (2015–2020)

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CWTS B.V.
Centre for Science and Technology Studies, Leiden University

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Report for the Dutch Research Council (NWO)

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1. Introduction

NWO has requested CWTS to analyze the extent to which research funded by NWO is made openly accessible. In 2009, NWO introduced its first open access (OA) policy, stating that publications funded by NWO should be made openly accessible 'as soon as possible'. Following the Dutch OA ambitions presented by state secretary Sander Dekker in 2013, NWO turned its OA policy into a formal mandate in 2015. According to this mandate, all publications funded by NWO must be openly accessible at the time of publication, preferably through the gold OA route, although the green OA route is also supported.

To monitor NWO's progress in making the publications it funds openly accessible, this report presents statistics on the extent to which publications from the period 2015–2020 funded by NWO are openly accessible. A distinction is made between gold, hybrid, bronze, and green OA. The analyses presented in this report also cover publications funded by ZonMw. Some analyses report statistics for ZonMw separately from those for NWO, while other analyses report combined statistics for NWO and ZonMw. This report builds on an earlier report published in 2020 covering publications from the period 2015–2018.

Together with other research funding organizations participating in cOAlition S, NWO has developed Plan S, a plan that aims to realize full and immediate OA for all publications funded by the participating research funding organizations. The requirements of Plan S will apply to publications resulting from calls published by NWO or ZonMw from January 1, 2021 onward. Since the publications analyzed in this report are from the period 2015–2020, they are not subject to the requirements of Plan S. Nevertheless, the report aims to provide some insight into the extent to which recent publications funded by NWO or ZonMw do already meet the Plan S requirements.

Differences with VSNU open access statistics

VSNU provides an annual report on the overall progress of OA uptake in the Netherlands. For 2019, VSNU reported that 62% of all publications affiliated with Dutch institutions are openly accessible. Figures for 2020 have not yet been published. Importantly, the methodology used in the present report differs from the methodology used by VSNU. The OA statistics in the different reports therefore should not be directly compared. The statistics in the present report relate to publications funded by NWO only, which form a subset of the total publication output in the Netherlands. In addition, the statistics in the present report are based on a bibliometric approach using Web of Science data, while VSNU statistics are based on data from the internal registration systems of the Dutch institutions. The same caution applies to the OA statistics provided in the annual report of NWO.

2. Methodology

Below we first discuss the approach taken to identify publications funded by NWO or ZonMw (Section 2.1). We then discuss how the OA status of these publications was determined (Section 2.2).

2.1. Identifying publications funded by NWO or ZonMw

We used the Web of Science (WoS) database to identify publications funded by NWO or ZonMw.[1] Within the WoS database, the following three citation indices were used: Science Citation Index Expanded, Social Sciences Citation Index, and Arts & Humanities Citation Index. We considered only publications from the period 2015–2020 published in journals and classified as research article or review article in the WoS database. Books, publications in conference proceedings, and other types of publications in journals (e.g., letters, editorials, and book reviews) were not considered.

We determined the year in which a publication was published by the year in which the Crossref record for the publication was created. In exceptional cases, the journal issue in which a publication was published has an official publication date that precedes the year in which the publication's Crossref record was created. In these cases, we used the year in which the journal issue was published as the year in which the publication was published.

We identified publications funded by NWO or ZonMw by searching in the WoS database for publications that include a funding acknowledgment in which funding from NWO or ZonMw is reported. Authors of publications may refer to NWO and ZonMw in various different ways (e.g., using the full name of the funder or the abbreviated name). In order to obtain an accurate data set, we carefully identified the different ways in which authors refer to NWO and ZonMw.

Publications funded by NWO also include publications published by the NWO institutes. To identify these publications, we searched in the WoS database for publications that include an author affiliation mentioning an NWO institute. This was

[1] Researchers funded by NWO or ZonMw are requested to report the publication output of their projects. However, because of concerns about the quality and completeness of the data, we did not use the data for this report.

done separately for each NWO institute. We accounted for different ways in which authors may refer to an NWO institute (e.g., using the full name or an abbreviated name).

Some limitations of our approach need to be acknowledged. Most importantly, the WoS database provides a selective coverage of the scholarly literature, focusing on publications in international journals that meet certain standards determined by the producer of the database. As a consequence, some publications funded by NWO or ZonMw are not included in our analyses. Especially in the humanities and the social sciences, the WoS database provides only a limited coverage of the scholarly literature. Books and publications in conference proceedings are not included at all in our analyses. The lack of conference proceedings publications reduces the coverage of our analyses in particular in the field of computer science. Another limitation is that some authors may have failed to acknowledge funding from NWO or ZonMw in their publications, even though their research was in fact funded by these funders. Despite these limitations, the OA statistics in this report offer a reasonably complete overview of the extent to which publications funded by NWO or ZonMw have been made openly accessible.

2.2. Determining the open access status of publications

The OA status of publications was determined by linking the WoS database to the Unpaywall database. We used a snapshot of the Unpaywall database released in February 2021. For each publication funded by NWO or ZonMw, the Unpaywall database was used to determine whether the publication is OA or not. Four types of OA were distinguished:

- *Gold OA*. Publications in a fully OA journal.
- *Hybrid OA*. OA publications in a subscription journal.
- *Bronze OA*. OA publications without a clearly identifiable license.
- *Green OA*. Publications in a journal that are also available in an OA repository (e.g., in an institutional repository or on a preprint server).

Gold, hybrid, and bronze OA are mutually exclusive. Green OA may overlap with the other types of OA. For instance, if a publication in an OA journal is also available in an OA repository, the publication is both gold and green OA. In this report, we have chosen to classify a publication as green OA only if it is not gold, hybrid, or bronze OA. In this way, each OA publication is classified as exactly one of the four types of OA listed above.

Because bronze OA publications lack a clearly identifiable license, their inclusion in the OA statistics presented in this report might be considered debatable. We manually examined a random sample of bronze OA publications funded by NWO or ZonMw. Almost all publications in our sample seemed to be genuine OA publications, as opposed to, for instance, publications that are temporarily made openly accessible by publishers for marketing purposes. Based on this finding, we decided to include bronze OA publications in the OA statistics in this report.

Only publications made available through legal forms of OA publishing are considered in this report. Publications made available on academic social network platforms such as ResearchGate and Academia.edu or illegal websites such as Sci-Hub are not considered to be openly accessible.

There are three limitations that need to be acknowledged. First, there may be minor inaccuracies in the data from the Unpaywall database. For instance, a small share of the OA publications may be incorrectly classified as non-OA. Second, for most of the green OA publications included in our analyses, the Unpaywall data does not make clear when the publication became openly accessible. We therefore do not know whether publications were made openly accessible immediately at the time of publication in a journal or at a later time. Third, using Unpaywall data, the OA status can be determined only for publications that have a DOI in the WoS database. About 1% of the publications funded by NWO or ZonMw and indexed in the WoS database do not have a DOI.

3. Findings

We first present our general findings regarding the OA status of publications funded by NWO or ZonMw (Section 3.1). We then take a more detailed look at the licenses under which gold and hybrid OA publications have been published. For green OA publications, we examine which version of the publication (i.e., submitted, accepted, or published version) has been made openly accessible (Section 3.2). Finally, we analyze the extent to which funding metadata has been made openly available for publications funded by NWO or ZonMw (Section 3.3).

The data underlying the analyses presented in this chapter has been made openly available.[2]

3.1. Open access status of NWO-funded publications

For each year in the period 2015–2020, the top panel in Figure 1 presents a breakdown of publications funded by NWO by their OA type (i.e., gold, hybrid, bronze, green, or closed). The overall percentage of NWO funded publications that are OA has increased from 69% in 2015 to 85% in 2020. There has been a substantial increase in the percentage of gold OA publications, from 19% in 2015 to 27% in 2020. However, the largest increase can be observed for hybrid OA publications. The percentage of hybrid OA publications has increased from 15% in 2015 to 38% in 2018. This is due to the (transformative) OA agreements that in recent years were negotiated by VSNU with many of the larger publishers. The percentage of bronze OA publications has decreased from 13% in 2015 to 4% in 2020, suggesting that publishers have become more aware of the importance of attaching a clearly identifiable license to OA publications.

The bottom panel in Figure 1 presents the corresponding statistics for ZonMw. The overall percentage of OA publications is somewhat lower for ZonMw than for NWO. This percentage has increased from 65% in 2015 to 82% in 2020. Gold OA publishing is more common for ZonMw than for NWO (39% vs. 27% in 2020), while green OA publishing is less common (5% vs. 16% in 2020).

[2] The data is available in Zenodo: https://doi.org/10.5281/zenodo.5056043.

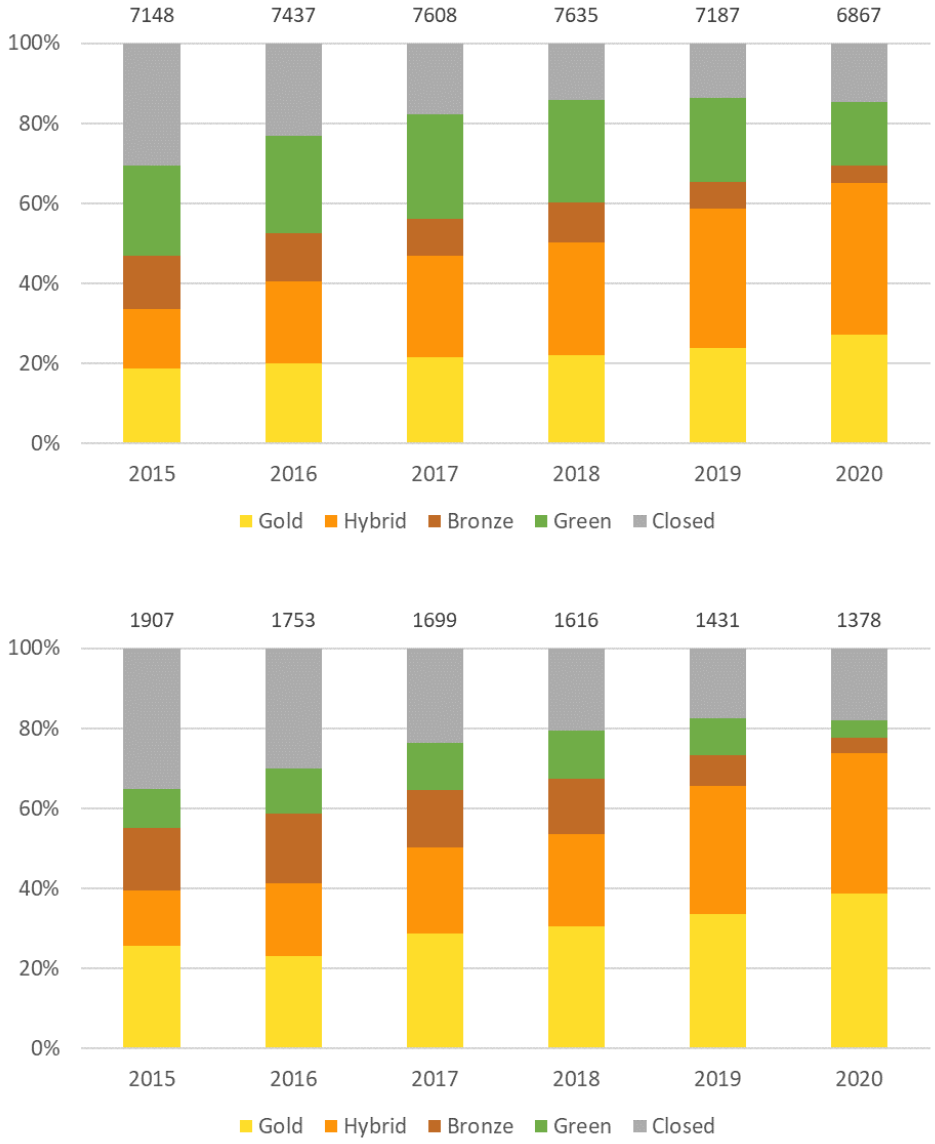

Figure 1. For each year in the period 2015–2020, the bar charts show the number of publications funded by NWO (top panel) or ZonMw (bottom panel) and the percentage of publications of the different OA types.

The OA statistics presented in this report show whether publications were openly accessible at the time of the release of the Unpaywall database (i.e., February 2021). They do not show whether publications were made openly accessible immediately at the time of publication. This means that time trends need to be interpreted with some care. Figure 1 shows that both for NWO and for ZonMw the percentage of green OA publications is lower in 2020 than in 2019. This is likely to be due to the

effect of embargoes imposed by many publishers. Publications from 2019 made openly accessible in a repository after the expiration of an embargo (or, alternatively, under the Taverne Amendment in the Dutch Copyright Act) are counted as green OA publications in our analysis, while similar publications from 2020 for which the embargo has not yet expired are counted as non-OA publications.

For three main fields of science, Figure 2 presents a breakdown of publications funded by NWO or ZonMw by their OA type. The statistics are based on publications from 2020. The three main fields are Natural Sciences, Biomedical and Health Sciences, and Social Sciences and Humanities.[3]

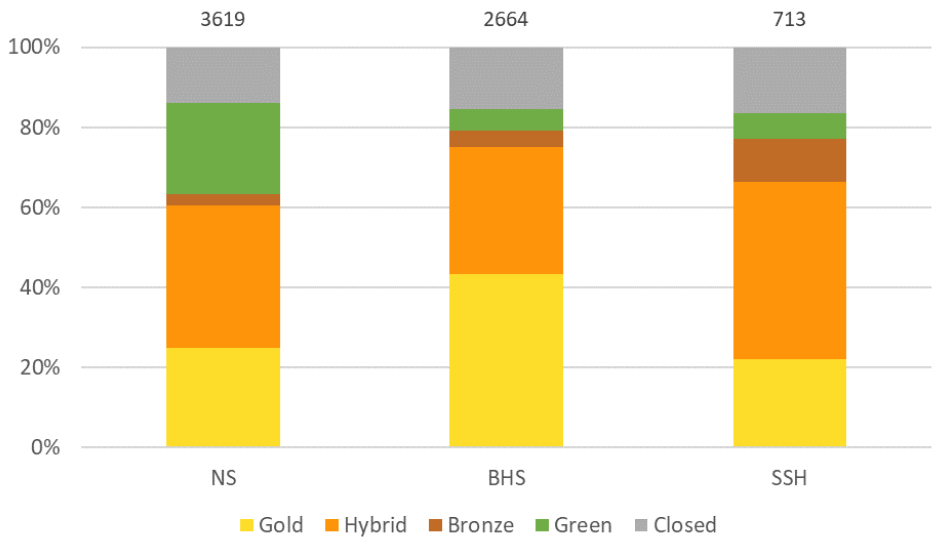

Figure 2. For each main field, the bar chart shows the number of publications funded by NWO or ZonMw and the percentage of publications of the different OA types. Only publications from 2020 are considered. NS: Natural Sciences; BHS: Biomedical and Health Sciences; SSH: Social Sciences and Humanities.

The overall percentage of OA publications is quite similar for the three main fields, ranging from 83% in the Social Sciences and Humanities to 86% in the Natural Sciences. Gold OA publishing is much more common in the Biomedical and Health Sciences (43%) than in the Natural Sciences (25%) and the Social Sciences and

[3] The field definitions were obtained from the CWTS Leiden Ranking. Natural Sciences combines the Leiden Ranking fields Physical Sciences and Engineering, Mathematics and Computer Science, and Life and Earth Sciences.

Humanities (22%). Green OA publishing plays only a modest role in the Biomedical and Health Sciences (5%) and the Social Sciences and Humanities (6%). It plays a much more important role in the Natural Sciences (23%), reflecting the long tradition in some of the natural sciences of posting publications on preprint servers such as arXiv.

Most publications funded by NWO or ZonMw are authored by researchers affiliated with Dutch universities, including the university medical centers. For each of the Dutch universities, Figure 3 presents a breakdown by OA type for publications funded by NWO or ZonMw and published in 2020. The overall percentage of OA publications is relatively similar for all universities, ranging from 80% for Eindhoven University of Technology to 89% for Leiden University and Wageningen University. However, there are substantial differences between universities in the way in which they make their publications openly accessible. In particular, the large differences in green OA publishing are noteworthy. The percentage of green OA publications ranges from 3% for Wageningen University to 22% for Leiden University.

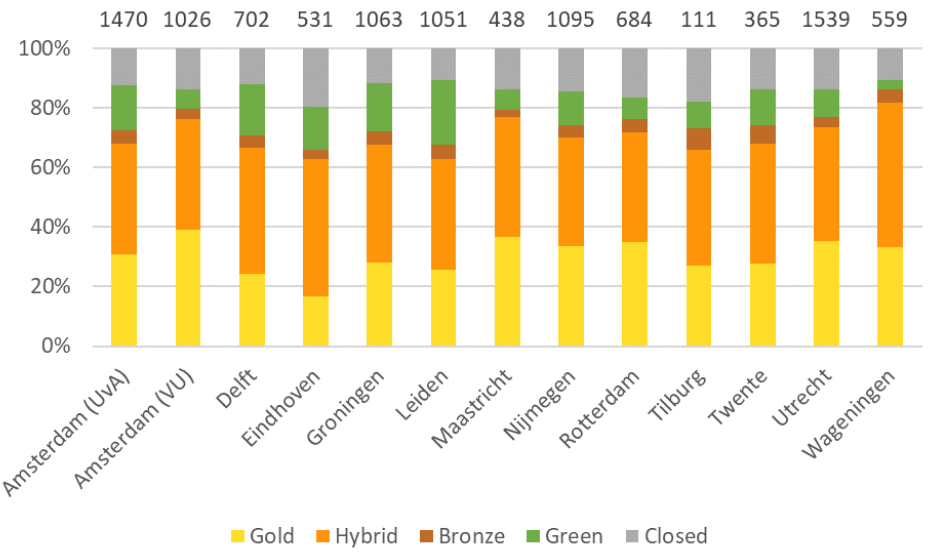

Figure 3. For each Dutch university, the bar chart shows the number of publications funded by NWO or ZonMw and the percentage of publications of the different OA types. Only publications from 2020 are considered.

We now turn to statistics at the level of publishers, focusing on the 15 publishers that published the largest number of publications funded by NWO or ZonMw in

2020. For these publishers, Figure 4 presents a breakdown of publications funded by NWO or ZonMw by their OA type. The figure includes three gold OA publishers, MDPI, Frontiers, and PLOS, for which all publications are openly accessible. For the other publishers, the percentage of OA publications ranges from 60% for Wolters Kluwer to 98% for EDP Sciences. The effects of the (transformative) OA agreements negotiated by VSNU with many of the larger publishers are clearly visible. In the case of Elsevier, which published the largest number of publications funded by NWO or ZonMw, 25% of the publications are still closed, but this percentage can be expected to decrease in the coming years as a result of the agreement reached by VSNU and Elsevier in 2020. In the case of Taylor & Francis, the high percentage of bronze OA publications (47%) is remarkable and may need further attention. Oxford University Press, American Physical Society, and EDP Sciences all have more than 90% OA publications, but the majority of their publications (between 51% and 66%) are green OA.

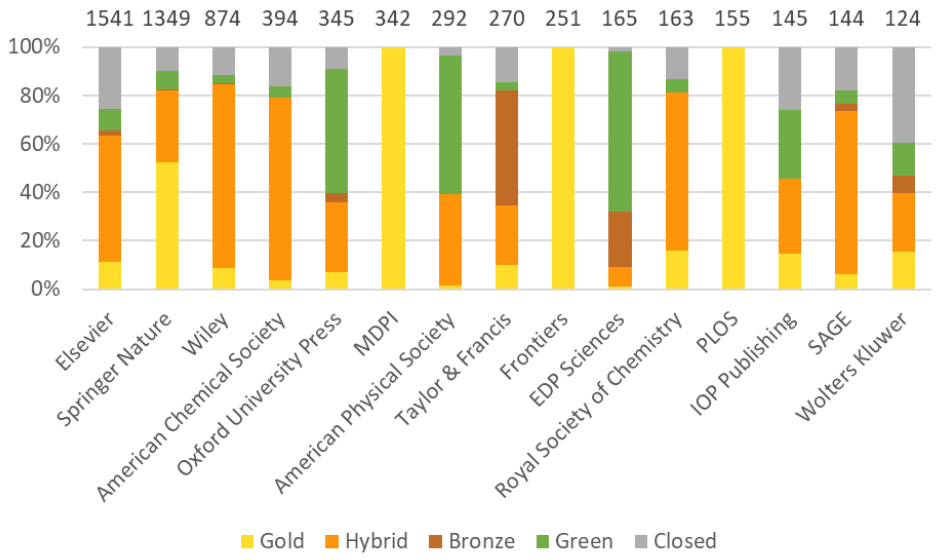

Figure 4. For each publisher, the bar chart shows the number of publications funded by NWO or ZonMw and the percentage of publications of the different OA types. Only the 15 publishers with the largest number of publications funded by NWO or ZonMw are included in the chart. Only publications from 2020 are considered.

Agreements negotiated by VSNU with publishers typically apply only to publications that have a corresponding author affiliated with a Dutch university. 76% of the publications funded by NWO or ZonMw and published in 2020 have a corresponding

author affiliated with a Dutch university or some other organization in the Netherlands. Looking specifically at non-OA publications, this is the case for 63% of the publications. Hence, non-OA publications are somewhat more likely to have a foreign corresponding author, who may not be subject to an OA policy. However, the difference is relatively small, so the country of the corresponding author plays only a minor role in explaining why publications have not been made openly accessible. Of the green OA publications, only 55% has a Dutch corresponding author, suggesting that foreign corresponding authors depend more strongly on the green OA route to make publications openly accessible.

3.2. Licenses and versions of open access publications

For gold and hybrid OA publications funded by NWO or ZonMw and published in 2020, Figure 5 presents a breakdown by license. 70% of the publications has a CC-BY license. The remaining publications almost all have a CC-BY-NC or CC-BY-NC-ND license. There are a few publications that have a CC-BY-SA or CC-BY-NC-SA license or a publisher-specific license.

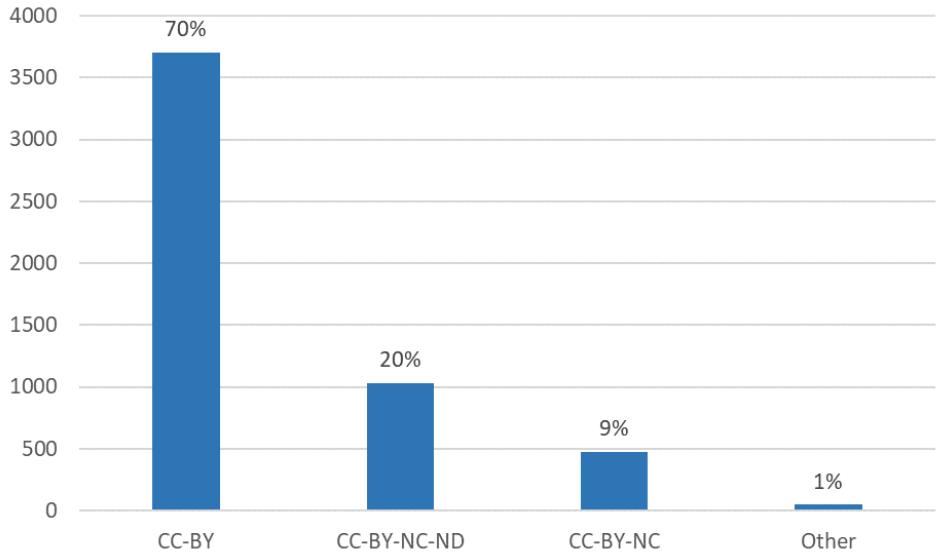

Figure 5. Bar chart showing a breakdown by license for gold and hybrid OA publications funded by NWO or ZonMw and published in 2020.

The CC-BY-NC license and its more restrictive variants are not compliant with Plan S. Publishers for which a substantial share of the publications have a CC-BY-NC license,

or a more restrictive variant of this license, include American Chemical Society, Elsevier, Oxford University Press, Royal Society of Chemistry, SAGE, Taylor & Francis, and Wiley.

In the case of the green OA route, Plan S requires the accepted version ('author accepted manuscript') or the published version ('version of record') of a publication to be made openly accessible in a repository. According to Unpaywall data, for 31% of the green OA publications funded by NWO or ZonMw and published in 2020, the published version has been made available in a repository. For 11%, the accepted version has been made available. For the remaining 58%, only the submitted version has been posted in a repository, which is not compliant with Plan S. We note that these statistics need to be interpreted with some caution, since Unpaywall may not always be able to accurately distinguish between the submitted, accepted, and published version of a publication.

Plan S requires green OA publications to be made available in a repository immediately upon publication in a journal. Embargo periods are not permitted. Unfortunately, we were unable to determine when publications were made available in a repository and whether the requirement of immediate OA was met. The Unpaywall database does not yet provide sufficiently complete data to determine this in a systematic way. In the future, the Unpaywall database will provide more complete data on the date at which publications were posted in a repository, and we then expect it to be possible to determine the degree to which the requirement of immediate OA is met.

3.3. Openness of funding metadata

The analyses presented in this report make use of metadata on scholarly publications obtained from the WoS database. This is a closed database that provides a selective coverage of the scholarly literature. For future analyses, we consider it preferable to work with an open and non-selective source of publication metadata. Crossref offers an important infrastructure for open publication metadata. In this section, we explore the extent to which Crossref can serve as an alternative to the WoS database.

For each year in the period 2015–2020, Figure 6 presents the percentage of publications funded by NWO or ZonMw that do or do not have openly available funding metadata in Crossref. For publications that have openly available funding metadata in Crossref, a further distinction is made between publications that do or

do not have a persistent identifier (i.e., a DOI) in their funding metadata linking to NWO or ZonMw. The statistics presented in Figure 6 are based on publications (both OA and non-OA) for which the WoS database includes a funding acknowledgment reporting funding from NWO or ZonMw. Publications published by the NWO institutes are not included in the statistics, unless they have an NWO or ZonMw funding acknowledgment in the WoS database. We note that open availability of funding metadata is mandatory in Plan S. The use of persistent identifiers for funders is strongly recommended.

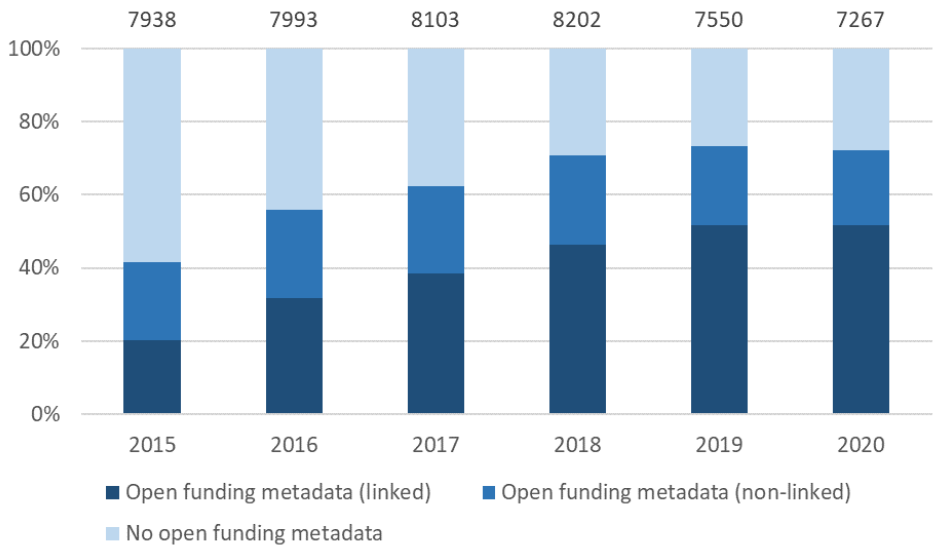

Figure 6. For each year in the period 2015–2020, the bar chart shows the number of publications funded by NWO or ZonMw and the percentage of publications that do or do not have openly available funding metadata in Crossref. A further distinction is made between publications that do or do not have a persistent identifier in their funding metadata in Crossref that links to NWO or ZonMw.

In the period 2015–2020, the percentage of publications funded by NWO or ZonMw that have openly available funding metadata has increased substantially, from 42% in 2015 to 72% in 2020. 52% of the publications from 2020 have openly available funding metadata that includes a persistent identifier linking to NWO or ZonMw.

There are substantial differences between publishers in the percentage of publications with openly available funding metadata. Looking at publications funded by NWO or ZonMw and published in 2020, this percentage is close to 100% for American Chemical Society, American Physical Society, and Royal Society of

Chemistry. It is 0% for Cambridge University Press and just slightly above 0% for Wolters Kluwer. For most publishers, the percentage is somewhere between these extremes. Of the three largest publishers, the percentage of publications with openly available funding metadata is substantially higher for Elsevier (87%) and Wiley (81%) than for Springer Nature (62%).

4. Conclusions

We have analyzed the extent to which publications funded by NWO or ZonMw, including publications of the NWO institutes, are openly accessible. 85% of the NWO publications that appeared in 2020 are openly accessible. This is the case for 82% of the ZonMw publications. This is a substantial growth relative to 2015, the first year covered by our analyses. Less than 70% of the NWO and ZonMw publications from 2015 are openly accessible. Most OA publications are openly accessible on the platform of the journal publisher (i.e., gold, hybrid, and bronze OA). A smaller share of the OA publications have instead been made openly accessible in a repository (i.e., green OA). The green OA route is relatively popular in the natural sciences. It is used less often in the biomedical and health sciences and the social sciences and humanities. Further growth in the percentage of OA publications can be expected as a result of recent developments, such as the agreement between VSNU and Elsevier that was reached in 2020, the membership of NWO and ZonMw of Europe PMC that started in 2021, and the implementation of the rights retention strategy developed by cOAlition S.

We have also taken a more detailed look at the way in which publications funded by NWO or ZonMw have been made openly accessible. 70% of the gold and hybrid OA publications funded by NWO or ZonMw and published in 2020 have a CC-BY license. The remaining gold and hybrid OA publications almost all have a CC-BY-NC or CC-BY-NC-ND license. 4% of the publications published in 2020 are bronze OA publications. These publications are openly accessible in the journal in which they have been published, but they lack a clearly identifiable license.[4] For 42% of the green OA publications published in 2020, the version that has been made openly accessible in a repository is the version that has been accepted or published by a journal. For the remaining green OA publications, it seems that only the version submitted to a journal has been made openly accessible.

NWO and ZonMw participate in Plan S, which aims to realize full and immediate OA for all publications funded by the participating research funding organizations. The requirements of Plan S will apply to publications resulting from calls published by

[4] The notion of bronze OA was introduced by Piwowar and colleagues in a research article published in 2018. We refer to this article for a further discussion of bronze OA.

NWO or ZonMw from January 1, 2021 onward. A substantial share of the publications classified as OA publications in our analyses do not meet the requirements of Plan S. This applies to gold and hybrid OA publications that have a CC-BY-NC license, or a more restrictive variant of this license. It also applies to hybrid OA publications that have been published in a journal without a transformative arrangement. Bronze OA publications do not meet the Plan S requirements at all, since license information is missing for these publications. Green OA publications meet the Plan S requirements only if the accepted or published version, not just the submitted version, has been made openly accessible in a repository, and only if the publication is posted in a repository immediately at the time of publication in a journal (i.e., no embargoes).

We do not have enough information to calculate the percentage of publications funded by NWO or ZonMw that already meet the Plan S requirements. However, based on the information presented in this report, we estimate that less than 50% of the publications published in 2020 meet the core requirements of Plan S. This percentage is even lower when the technical requirements of Plan S, such as openness of metadata, are taken into account as well.

To further increase the percentage of publications funded by NWO or ZonMw that are openly accessible, there seems to be room to make better use of the green OA route. The rights retention strategy developed by cOAlition S provides further support for green OA publishing. Experiences of other funders[5] show that stricter compliance monitoring is also likely to increase the percentage of OA publications. Improvements in the open availability of high-quality metadata on scholarly publications could significantly simplify the process of compliance monitoring.

4.1. Recommendations for improved monitoring of open access publishing

As discussed in Chapter 2, the methodology for monitoring OA publishing used in this report has a number of limitations. To address these limitations, we offer a few recommendations for improved monitoring of OA publishing:

- Plan S mandates publishers to make high-quality metadata on scholarly publications openly available, and it strongly encourages the use of persistent

[5] Examples of these funders are NIH in the US and Wellcome Trust in the UK. For more details, see this analysis by Larivière and Sugimoto of researchers' compliance with funders' OA mandates.

identifiers. We recommend to NWO to strictly monitor compliance with these requirements and to include the mandatory use of persistent identifiers in future negotiations by VSNU with publishers. The metadata should include data on funders, grants, institutions, and licenses. Ideally, it should also include links between the different versions of a publication (i.e., the version published in a journal and versions posted in a repository). The metadata should be made openly available through Crossref (or other similar infrastructures). High-quality open publication metadata will greatly simplify monitoring of OA publishing, especially when persistent identifiers are used. The use of open publication metadata is also recommended in a recent briefing paper on OA monitoring published by Science Europe.

- We support the recommendation made in the recently published NWO Persistent Identifier Strategy to adopt persistent identifiers for grants and to make metadata for grants openly available through Crossref. Publishers can then be requested to use these persistent identifiers in the metadata they deposit in Crossref. This will simplify monitoring of compliance by grantees with NWO's OA policy.
- Monitoring OA publishing based only on external data sources such as Crossref or WoS will inevitably give an incomplete picture, because grantees do not always properly report the funding of their research in their publications. The quality of OA monitoring can be improved by combining the use of external data sources with the use of an internal data source. NWO has an internal database in which grantees are required to register the publications resulting from their NWO funded projects, but the quality and completeness of the data are uncertain (see the box below). For future monitoring of OA publishing, we recommend to NWO to improve the internal infrastructure for registering publications (and other outputs) resulting from NWO funded projects. We also recommend to consider the possibility of integrating such an infrastructure into an Open Knowledge Base for Dutch research organizations.
- We recommend that CWTS and NWO will reconsider the use of the WoS database in future OA monitoring studies. The selectivity of the WoS database has advantages (e.g., exclusion of predatory journals), but it also has important disadvantages. This selectivity leads to the exclusion of certain publications and therefore yields an incomplete picture of OA publishing. It also creates a divide in the scholarly publishing system between journals that

are indexed in the WoS database and journals that are not indexed. This divide inhibits innovation in scholarly publishing because newly established journals, which are essential for innovation, by default are not indexed in the WoS database. As an alternative to the WoS database, we suggest to consider the possibility of using publication metadata made openly available by Crossref, possibly complemented with metadata from other non-selective data sources such as Dimensions or Microsoft Academic.