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Introduction

Knowledge is a rather new member of the "commons family". For quite a while, it has played a minor role in the research on commons and governance systems. However, since last decade, both its relevance and attention gained have tremendously increased. Open Access (OA) to (scientific) knowledge will play an increasingly important role in (the study of) the digital age. This paper focuses on the problems of collective action in the creation of an OA repository as a knowledge commons and thus contributes to this development.

The case of open access to scholarly knowledge is relevant not only because of its recent nature; it also shows the story of a good whose use has severely suffered from the impact of privatization. While academic journals have been the traditional forum for making scientific information and innovation known to peers and other audiences, this format has gone through two big institutional changes during the last 30 years. Firstly, the publishing rights and habits changed in a way that the ownership of more and more journals ended up in the hands of a few very big and influential publishing companies (e.g. Oxford University Press, Routledge). Secondly, the upcoming of the Internet made it much easier and less costly to disseminate publications (Suber 2007; Hess and Ostrom 2007). The combination of these two processes produced a system of enclosure and rising prices: between 1986 and 2000 the average price for journal subscriptions has tripled (Hess 2005).[1]

Open Access in the form of online repositories is an attempt to counter this enclosure and turn scientific knowledge from a club back to a public good (Kranich 2007; cp. Table 1). The governance of OA repositories is comparable to that of all other commons. In a way it depends on the organization of collective action. It is prone to social dilemmas as well. For knowledge commons, this dilemma does not so much come in the form of the famous "tragedy of the commons" (Hardin 1968), where the rationally induced overuse by individuals unavoidably leads to the destruction of a resource. Rather, OA repositories are likely to suffer from a social dilemma which the commons theorist Peter Suber labeled the "tragic stalemate" (2007:183). The tragic stalemate points to a situation of collective paralysis in which all potential users of a good would profit from its provision, but none of them wants to take the first step to provide it.

For the case studied in this paper, this stalemate means that it is problematic to attract scholars who submit their work to an OA repository and thereby contribute to the creation of the knowledge commons which would result from participation. Evidence shows, however, that this stalemate cannot be overarching or unavoidable, since the number and sizes of repositories rise steadily (Suber 2007). The question therefore is: if there is a tragic stalemate and individual scholars hesitate to make their work OA, why are some repositories still successful in attracting scholars to submit their work, while others are not?

Following the work by Elinor Ostrom, the answer to this question is assumed to lie in the repositories' institutional designs. It is assumed that the inclusion of community elements and the provision of explicit rules will help counter the tragic stalemate and thus pose a positive effect on the repositories' performance in attracting participation and contributions.

This paper is structured as follows: in order to test the effect of these two factors (community and rules), the institutional design of six OA repositories is analyzed in a comparative case study. Before

1 This development in skyrocketing prices for journal articles and subscriptions is also known as the "serial crisis" in academic publishing. For more information on this topic, see Hess 2005, Suber 2007.

the analysis, I give an introduction to the field of common goods in general, and knowledge commons in particular. I explain what OA is and how repositories function. This rather technical part is followed up by theoretical considerations on the collective action problem involved in the governance of OA repositories, and the possibility of institutional design as a way out.

1. The Influence of Institutional Design on the Performance of Open Access Repositories

This section shall give an introduction to and overview of the context of commons and commons research. Central concepts in this area shall be defined in order to locate their place and role in the theoretical considerations that follows.

1.1 The Governance of Open Access Repositories as a Collective Action Problem

Commons

Commons are a specific class of goods, and are referred to as common goods as well. Goods can be categorized by two dimensions: exclusivity and rivalry (Ostrom and Ostrom 1977). Exclusivity refers to the extent to which anyone can be hindered from consuming a good. In some cases it is almost impossible to exclude someone entirely, for example from breathing the air; in other cases it is simply too costly, for example to fence an entire forest. For all commons or common goods, it is difficult to exclude users. This makes them different from toll and private goods (see Table 1).

		Rivalry	
		Low	High
Exclusion	Difficult	**Public goods** Useful knowledge Air	**Common-pool resources (CPR)** Libraries Forests
	Easy	**Toll or club goods** Journal subscriptions Day-care centers	**Private goods** Personal computers Doughnuts

Table 1 Types of goods (Source: adapted from Hess and Ostrom 2007:8); commons are highlighted.

The distinction within the class of common goods is made by the second dimension: rivalry. Rivalry emerges when the actions of one consumer reduce the units of consumption for all other users. For example, when one farmer retrieves water from an irrigation system, then no other farmer can use the same unit of water to irrigate his or her fields. Elinor Ostrom famously labeled goods with these characteristics "common-pool resources" (CPR). In contrast, public goods are non-rivalrous in nature.

All commons are owned by a group of people (in many cases by everyone) rather than single individuals. This ownership arrangement makes commons vulnerable to social dilemmas. Thought, only CPR suffer from the direct threat of depletion - meaning that they can be destroyed by overused - public goods as well are prone to conflicts concerning the organization of their use. A special case of social dilemma is what Garrett Hardin (1968) named the tragedy of the commons. This special situation will be discussed at a later point of this paper.

Knowledge Commons

While many "traditional" commons are natural, knowledge commons - also referred to as intellectual, information or science commons - are human-made (Hess and Ostrom 2007:4). The prime example for a knowledge commons is the library.

Knowledge has traditionally been a public good, being non-exclusive and non-rivalrous

in nature. However, with the introduction and spread of copy-right on intellectual property and the commercialization of its dissemination, it has become more and more of a club or even private good. Making knowledge a commons again is a countermeasure to this increased enclosure and its accompanying commercialization (Kranich 2007). Knowledge is – like other goods - not naturally a commons. Whether or not it can be categorized as such depends heavily on how it is produced and managed.

Open Access and Open Access Repositories

Open Access to scientific literature is one such way of a commons-based production of knowledge that counters its privatization. The *OA Movement*, as it refers to itself, started already in the 1990s, and has gathered real momentum during the last decade (Hess 2005). It is led by a group of people labeled *informationists* by information scientist Rick Luce (2008). This group includes librarians, information experts, scientists as well as faculty staff and people with a general interest in the topic. Together, they paved the way to a barrier-free access to scientific knowledge online, and thereby allowed a "shift from product focus to process focus" in knowledge management (Luce 2009; cp. Suber 2007).

Open Access to scientific knowledge can be provided in two ways: 1) academic articles are directly published in special OA journals, or 2) articles published elsewhere are submitted to online repositories where they are freely accessible to all users with an Internet connection (Swan 2006). The first option is often referred to as *gold OA* (Poltermann 2009). It includes independent, or as Suber (2007) puts it, local peer-review. On the other hand, online repositories - often referred to as *green OA* - do not include peer-reviewing processes, but rather provide a platform to present and share material that is peer-reviewed elsewhere. Repositories usually accept preprints (working papers or other forms of not-yet published work) as well as postprints (articles already published in a journal). It is therefore rather a form of "self-archiving" than a form of publishing in the traditional sense. This paper will focus on green OA only.

Green OA usually comes either in the form of a thematic repository or an institutional repository (Ostrom and Hess 2007). The repository is started by either individuals or institutions asking for the submission of pre- or postprints by colleagues in order to liberate access and ease dissemination. While contribution to most thematic repositories is voluntary, many institutional repositories work with mandates (Knezo 2005; AERA 2010). This means that scholars of a certain institution - universities, departments or scholarly societies - are obliged to self-archive all (new) work in the repositories.

For the question of why some repositories are more successful in attracting contributions, these mandated repositories are not of interest, or rather would spoil the outcomes of the analysis. Therefore, this paper focuses on thematic OA repositories only.

1.2 Theoretical Considerations

As already indicated in the previous chapter, commons are goods without clear ownership. This can lead to conflicting situations in their provision and management. In other words, they create a need for collective action (Hardin 1968; Ostrom 1990a). Knowledge commons in general and OA repositories in particular are no exceptions. In the following part, some theoretical considerations on the emergence of and solutions to collective action problems in the context of commons-based production will be presented. These theoretical considerations form the basis for the case studies in Chapter 3.

Collective Action and the "Tragic Stalemate"

OA in contrast to market-regulated forms of disseminating scientific knowledge (e.g. via journal subscriptions) is a form of commons-based production (Hess and Ostrom 2007:5). Its provision is therefore achieved through cooperation and social mechanisms, rather than price signals or external regulation (cp. Benkler 2006). Furthermore, even if repositories are set up by librarians or individual scientists, they cannot fulfill their function properly or even survive if other scholars do not contribute to the commons by making their work OA and submitting it to the repository. In this line, Charlotte Hess, the founder of the *Digital Library of the Commons*, an OA repository for research on commons, and one of the main theorists in the field of knowledge commons admits: the single biggest obstacle to OA is author inertia or omission (Hess 2005 based on Suber 2004). Thus, without the participation of the community as a whole, the commons cannot be provided. Thus, collective action is what is needed.[2]

However, as theory and practice have repeatedly proven, initiating collective action often turns out to be problematic (e.g. Hardin 1968; Olson 1965; Ostrom 1990). A traditional danger with collective action is that only a few individuals share the burden of taking action, while many others free-ride on their accomplishments. The rational behaviour of individuals appears as an obstacle to reaching a collective goal. As such, Hardin's *tragedy of the commons* has taught us that even though collective action would benefit all consumers, no rationally-acting individual would commit him or herself to it. The reason for this is that the beneficial effect of sharing a good emerges only in the long-term, while the short-term benefits of shirking and acting individually are considerably higher. Because this individual behaviour in the short-term is based on rational reasoning and thus unavoidable, the resulting depletion of a good or resource is inevitable as well.

However, this is mainly the case for common pool resources (CPR), which are rivalrous and thus depletable. Knowledge commons are public goods, and thus non-rivalrous in their use. Therefore, there is no danger of Hardin's tragedy of the commons here. Rather, OA repositories are likely to suffer from a social dilemma, which commons theorist Peter Suber called the "tragic stalemate" (2007: 183).

The tragic stalemate refers to a situation, in which all participants (in this case the group which Luce labeled informationists) would benefit from the creation of a commons (free access to and dissemination of scientific literature in OA repositories), but none wants to take the first step to provide it. This individual hesitation leads to a collective paralysis ending in the non-provision of the desired good.

This is the key obstacle in the provision of knowledge commons and the problem central to this paper: if there is a tragic stalemate and individual scholars hesitate to make their work OA, why are some repositories still successful in attracting scholars to submit their work, while others are not?

Building on the work on managing CPR by Elinor Ostrom and her late colleagues (e.g. Ostrom 1990; Ostrom et al. 1999), the answer to this question is assumed to lie in the repositories' institutional design.

The Role of Institutional Design

Ostrom has proved that, with an appropriate management system, CPRs do not necessarily have to suffer from the tragedy of the commons. There are robust ways of governing the commons as she showed in many cases of field research (Ostrom 1990c). These cases showed a considerable degree of self-governance by the communities sharing the commons in question.

2 Collective action is when "two or more individuals (are) needed to work together in order to accomplish an outcome" (Hess and Ostrom 2007:5).

While Hardin saw the only way out of the tragedy of the commons in either external monitoring or privatization (cf. Hardin 1968), Ostrom countered that neither of them was necessary – or even desirable – for the sustainable management of CPR. Contrary to the assumption of many earlier rational choice theorists, first of all Mancur Olson, Ostrom did not reject that rational individuals could take long-term results into consideration, rather than only caring about short-term costs and benefits (cf. Ostrom 1990b). Thus, rationality could also mean thinking about the future and acting upon it in the presence.

Furthermore, Ostrom argued that the (rational) decision of any individual to join the creation and management of a commons depends heavily on how the management system is designed. Although she advices against a pre-defined set of institutions as being the panacea for all CPR problems, her analysis brought up eight design principles (see Box 1), which were present in all of the most robust cases she studied and absent in those that failed (Ostrom 1990c).

1. Clearly defined boundaries should be in place.
2. Rules in use that are well matched to local needs and conditions.
3. Individuals affected by these rules can usually participate in modifying the rules.
4. The right of community members to devise their own rules is respected by external authorities.
5. A system for self-monitoring members' behavior has been established.
6. A graduated system of sanctions is available.
7. Community members have access to low-cost conflict resolution mechanisms.

Box 1 Design principle for robust, long-enduring CPR institutions as defined by Elinor Ostrom (Source: adapted from Hess and Ostrom 2007:7; cf. Ostrom 1990b).

In their seminal work *Understanding Knowledge as a Commons*, Hess and Ostrom (2007) did not automatically assume that these design principles will hold for the management of knowledge commons as well. However, neither do they reject it and ask for further research instead. What can be learned from Ostrom's work in general is that there is a positive relationship between the institutional design of a system created to manage the commons and its performance.

Institutional Design in the Case of OA Repositories

Due to their implicit focus on the governance of natural commons, it can be assumed that not all of the eight design principles can be relevant in the analysis of knowledge commons in general and OA repositories in particular. For this paper, the design principles shall, therefore, be summarized and translated into two single variables. These variables will be tested in a comparative case study in Chapter 4. The variables summarizing the two factors central to all of Ostrom's design principles will be called 1) *community* and 2) *rules*.

1) The factor of *community* in this case circumscribes the importance of involvement of individual consumers or users of a good in its management. This roughly combines Ostrom's second and third design principles, but goes beyond them. A strong sense of community gives credit to the act of self-governance and commons-based production (cp. Ostrom 1990b; Hess and Ostrom 2007). In the context of knowledge commons it is Nancy Kranich, who is pointing to the importance of peer production in their management: the "process by which many individuals, whose actions are neither coordinated by managers nor by price signals in the market, contribute to a joint effect that effectively produces a unit of informational or culture" (Kranich 2007: 93; for the concept and its original application see Benkler 2006).

Furthermore, the aspect of being part of a process of self-governance or peer production when contributing to an OA repository is accompanied by the dynamics of community communication. Peter Suber (2007) names this as one of the most important tools in promoting OA and thus making scholars willing to contribute to the creation of the commons. Community in this sense emerges from the possibility to exchange experiences and information amongst its members.

Based on these considerations it can be expected that a high degree of community has a positive effect on the repositories' performance in attracting scholars to submit their work and thus contribute to the creation of the commons.

2) CPR research has taught that rules are essential for the management of all commons (Ostrom 1990). Indeed, seven of Ostrom's eight design principles implicitly or explicitly concern the setting up and application of rules. Rules are in place in order to regulate the relations amongst the resource-sharing group members and to protect the commons from being destroyed or depleted. However, since knowledge commons are public goods rather than CPR, they are not directly threatened by depletion. Free-riding for example, as outlined above, is not possible in the case of OA repositories, since the commons created is meant to be used by anyone, whether the person has contributed to the production or not, as Hess (2005) puts it: "the more quality information, the greater the public good".

Therefore, rules for OA repositories have a different function than in the case of Ostrom's CPR. Peter Suber stresses the point that scholars hesitate to make their work OA because they fear copy-right conflicts with their (journal) publishers and plagiarism (Suber 2007). A clear and transparent information policy is the best way to counter these threats. The provision of clear rules as to what happens with the submitted works, which rights rests with the repository, which with the author and so on, and what actions might be taken in the case of violation of rules and misuse of the repository, are part of this need for a clear information policy.

Thus, it is expected that the provision of explicit rules as a part of its institutional design has a positive effect on the repositories' performance in attracting scholars to submit their work and thus contribute to the creation of the commons.

To summarize: the situation to be explained in this study is why, in spite of the tragic stalemate, some OA repositories perform more successfully than others in attracting contributions. As an attempt to explain this puzzle, it is assumed that the two factors - *community* and *rules* - in the repositories' institutional designs have a positive influence on their performance. This research setting will be translated into a comparative case study, shown in the following chapter.

2. Methodology

2.1 Dependent Variable: Performance of Thematic OA Repositories

Conceptionalization

Performance is conceptualized as the degree of successfulness in attracting scholars to submit their work to the repository, and thus contributing to the creation of the knowledge commons. The performance varies between successful, medium and unsuccessful.

Operationalization

The performance will be operationalized by using the repositories' size as an indicator.

Measurement

In order to measure the dependent variable, I will rely on the operationalization and measurement of a 2010 webometric study of OA repositories (Aguillo et al. 2010). This study is carried out by the Cybermetrics Lab situated in Madrid.[3] Originally, the Cybermetrics Lab studied the performance of universities based on their activities on the web; primarily in the form of publications in online journals (cf. Aguillo et al. 2008).

Their 2010 study, however, is focused on Open Access repositories, and ranks them based on two variables: visibility and size (Aguillo et al. 2010: 480). The impact variable is operationalized as measuring the visibility of a repository on the web by counting the number of external links leading to it. The size variable is measured by three different indicators: size in general (the number of pages from Google, Liver Search and Yahoo); the number of rich files (pdf files; excluding e.g. word documents); and an indicator Aguillo et al. call "scholar", meaning the number of entries in Google Scholar, which indicates the number of citations (cp. Aguillo et al. 2010: 479-480). The indicators are summarized in Table 2.

Original variables	Indicators and weight (in percentage)
Size	Number of pages (20)
	PDF files (15)
	Scholar (15)
Visibility	External links (50)

Table 1 Indicators used to measure the dependent variable (Source: Author's depiction)

For this paper, neither whether the repositories are actually used to find literature by other scholars, nor whether they are easy to find (visibility), is interesting. The only interest here is how well they perform in attracting contributions in the form of papers handed in (size). Therefore, only the second set of webometrics indicators will be used.

The webometrics study used a sample of 1184 repositories, institutional as well as thematic (see Aguillo 2010 et al.: 478). Only repositories with full text (preprints as well as postprints) were included.

The study not only offers the final ranks but also informs about each rank based on the single indicators as well. Therefore, it has been possible to take only the performance based on the size variable

3 http://repositories.webometrics.info/en/About_Us, last retrieved on 20/3/2013.

into account. However, since there is no coherent ranking based on the complete size variable, the outcomes of the three indicators had first to be combined into one measurement. Additionally, Aguillo et al. allocated different weights to the two variables and their indicators respectively (see Table 2). This division of weight will retain when merging the three ranking spots into one measurement (see Box 2).

(rank in *number of pages* (40%) + rank in *pdf files* (30%) + rank in *scholar* (30%)) = measure of size (DV) Example: (20 x 0.4) + (350 x 0.3) + (444 x 0.3) = 246.2**

Box 2 Calculation of measure for dependent variable
* Since the second variable used by Aguillo et al. 2010 has been removed, the individual weights have doubled (cp. Table 2).
** All sums will be converted to a round figure by rounding up (,6 - ,9) or down (,1-,5).

The maximum score for each indicator is 1184 (the worst possible rank, because there are 1184 repositories in the webometrics ranking), while the minimum score is 1 (the best possible rank). Based on the formula presented in Box 2, the outcomes will be translated into an ordinal measurement of values of the DV using a 3-point Lickert-scale ranging from unsuccessful, medium, to successful. The corresponding ranks to these values can be found in Table 5 in the appendix.

2.2 Independent Variable 1: Degree of Community

Conceptualization

The degree of community is conceptualized as the degree to which a repository's institutional design allows for active user involvement as a part of commons-based production (Hess and Ostrom 2007). The degree of community varies among high, medium, to low.

Operationalization

The degree of community will be measured by the following two indicators: a) possibility for all users to participate in the repository's management (in short: *management*); and b) communication tools for inter-user exchanges (in short: *communication*).

Management measures whether the repositories' users have a possibility of involvement beyond the autonomous submission of work. This includes the possibility for individual users to support the repositories with new ideas, software innovations, promotion activities, the possibility to support other members or any other form of active participation. *Communication* measures whether a chat function, a blog, a forum or other forms of peer communication is included in the repositories' institutional design.

2.3 Independent Variable 2: Explicitness of Rules

Conceptualization

The explicitness of rules is conceptualized as the degree to which a repository's institutional design provides its users with information on how the repository works; what is and is not allowed within its boundaries; and what happens in the case of misbehavior or misuse. The explicitness varies among values high, medium, and low.

Operationalization

The explicitness of rules will be measured by the following two indicators:

1. The presence of a clear set of guidelines of how to use the repository and how to behave within its boundaries (*guidelines*);
2. The presence of sanctions against misuse or misbehavior (*sanctions*).

Both guidelines and sanctions may be found in the form of a policy or FAQ section or any other equivalent form of presentation.

2.4 Measurement of Independent Variables

The measurement of all single variables will be nominal, either present or absent. For example, the indicator management of IV1 measures whether there is a possibility for all users of a repository to be involved in its management. The indicator will be coded with the score 1 (=present) or 0 (=absent). Whether there are several ways of management possibility or only one, and whether these possibilities are strong or weak, do not matter. Only the presence or absence of a possibility is relevant.

The indicators for each variable will be combined into a final value. This means that each variable can score a value of 2 (both indicators show presence), 1 (only one does) or 0 (neither does). These measurements will be translated into a 3-point Lickert-scale, ranging from high (2), medium (1), to low (0). While only the two total value of IV1 and IV2 will be relevant for the analysis and conclusion, the individual scores for each indicator will be reported in the appendix (p. 25).

2.5 Hypotheses

Based on the theoretical considerations in Chapter 2, the expected relationships of IV1 and IV2 with the dependent variable are as follows:

H1: The higher the degree of community anchored in the institutional design of a thematic repository, the more successful the repository is likely to be in attracting scholars to submit their works.

H2: The more explicit the rules stated in the institutional design of a thematic repository, the more successful the repository is likely to be in attracting scholars to submit their works.

Either hypothesis will be rejected if the value of the respective independent variable matches the value of the dependent variable in less than 50% of the cases (<0.5). In other words, either hypothesis is confirmed only when the value of the respective independent variable matches the value of the dependent variable in more than half of the cases (>0.5).

2.6 Data Collection

All data for the analysis will be collected from the repositories' respective websites, or in a few cases and only upon mentioning, from websites directly linked to the repository. The method of data collection is thus document analysis.

2.7 Case Selection

The source for case selection is the online database *The Directory of Open Access Repositories*

(www.opendoar.org). The search in OpenDOAR was restricted to thematic repositories that focused on journal articles (rather than e.g. grey literature or conference proceedings). OpenDOAR lists 113 of these repositories. In order to be included into the final sample for this study, the repositories should additionally:

1. be completely Open Access rather than having restricted areas for special users,
2. be facilitated in English,
3. guarantee that the majority of the items is available in full-text, and
4. be included in the webometrics sample of Aguillo et al..

Following these additional restrictions, the final sample of possible cases includes 30 repositories.

With a low number of cases (small-n), it would not be advisable to use some methods of random selection, since all values of the variables should be presented at least once (Babbie 2007). Thus, in order to have the highest possible variation concerning the two independent variables, the following six cases have been selected from the sample:

- Aquatic Commons (marine science),
- Cogprints (cognitive sciences),
- HTP Prints (history and theory of psychology),
- E-ms (social medicine),
- Munich RePEC Personal Archive (Economics), and
- OpenMed (Medicine).

2.8 Methodological Reflections

Not all weak points of this research design can or must be named at this point. However, a few points shall be discussed briefly.

The measurement of the dependent variable is based on the webometrics study by the Cybermetrics Lab. Using their specific operationalization and measurement of OA repositories' size has helped make the measurement of this study much more valid than it would have been possible with indicators created specifically for this paper. Still, the way the outcomes of the webometrics ranking are used at this point implies several weaknesses.

First, there was no possibility to work with the webometric raw data, since it is not available on the public website. Instead, the final ranks have been used in order to determine the size of a repository and thus the degree of success in its performance in attracting contributions. The raw data would have been more exact.

Second, there has been no (not too costly) way of excluding all institutional repositories from the complete sample of 1184. Thus, the ranks included repositories that were not in the sample of this paper. This circumstance might possibly have biased the final outcomes.

Third, the practicability of using the webometric indicators instead of creating new ones pushed the study in the direction of using size as the only indicator for successful performance. However, the research question might have been better served by a study that took the number of individual contributors into account as well. Using size only, leaves the uncertainty that big shares of the contributions in a repository may be made by a few individuals or its creator(s) alone.

Furthermore, the indicator only serves to test contribution, not commitment. Ostrom identified commitment as one of the three big obstacles to sustainable self-governance (the other two being

monitoring and supply, Ostrom 1990d). However, commitment has a long-term character, pointing to the question of whether consumers of a commons will remain contributing to its production. Size can only measure how much contribution has been made at a fixed point of time, but cannot say anything about the way it develops.

Finally, based on this indicator it is impossible to say whether scholars really submit their work voluntarily or merely as a reaction to some sort of mandate. The restriction to thematic repositories rather than including institutional ones was meant to counter this threat, but is not sufficient to foreclose it completely.

3. Analysis

3.1 The Institutional Design of Selected Thematic OA Repositories

Aquatic Commons[4]

Aquatic Commons is a repository for natural marine, estuarine/brackish and fresh water environments. It was founded in 2006 by the International Association of Aquatic and Marine Science Libraries and Information Centers (IAMSLIC). Since 2010 the management has changed and it is now hosted by the International Oceanographic Data and Information Exchange (IODE) in Oostende, Belgium.

The repository is open to everybody, but maintained by an institution. Simple users have no chance to join the management of the repository or take part in local decision-making. There are no tools for internal communication on the repository's website itself. Therefore, the Aquatic Commons scores low on the *community* variable.

As to the explicitness of rules, the picture looks rather different: the Aquatic Commons repository includes a detailed policy section, which clearly defines who is allowed to use the repository, under what conditions, as well as what happens if these rules are disregarded (the item in question will be retrieved from the public and the submitter will be contacted). Therefore, the Aquatic Commons scores high on the *rules* variable.

Cogprints[5]

Cogprints is a repository for research on cognitive sciences.

The website does not mention anything concerning the creation of the repository. Besides an e-mail address for technical support, there is no possibility to get in contact with the people managing the repository. Furthermore, it does not offer any form of community communication. Cogprints therefore scores low on the *community* variable.

The repository does neither possess a FAQ section, nor any other provision of guidelines or sanctioning procedures. It therefore, scores equally low on the second independent variable.

HTP Prints[6]

HTP Prints is a self-archiving repository for the community of scholarly historians and theoreticians of psychology.

It is stated that the repository is edited and directed by an individual professor and his team at the History & Theory of Psychology Program at York University (Toronto, Canada). Whether he founded the repository is unclear, although it could be assumed. The administration does not give any possibility for the repository users to become involved in its management. Nor does it provide any possibility for community communication. HTP Prints, therefore, scores low on the *community* variable.

The picture looks differently concerning rules. HTP Prints possesses an extensive FAQ as well as an explicit policies section. Here, guidelines are set for how to submit papers, which kind of papers fall outside the repository's spectrum and what has to be done concerning copyright issues before posting any item. Besides the fact that the publishers will screen all papers as to their applicability to

4 http://aquaticcommons.org/, last retrieved on 20/3/2013.
5 http://cogprints.org/, last retrieved on 20/3/2013.
6 http://htpprints.yorku.ca/, last retrieved on 20/3/2013.

the repository's thematic focus and hold the right to reject submissions, there is no mentioning of any consequences concerning rule-breaking. HTP Print thus scores medium on the rules variable.

E-ms[7]

E-ms is a repository for research output in social medicine. It actively supports and stresses users' active participation in the OA movement. The repository was founded in 2005 as the result of a project conducted by the Istituto Italiano di Medicina Sociale at Rome. There is an editorial board as well as technical assistants working for the repository. All staff members are listed on the website.

E-ms actively invites other librarians, institutes and organizations to join them in managing and developing the project. It is even mentioned that the Internet makes it possible to manage the repository from any place in the world and any country should have its own editors. With this the repository scores high on the management indicator. There is, however, no tool for community communication. Thus, E-ms scores medium on the *community* variable.

The repository possesses an extensive offer of advice and guidelines, including an FAQ section, a section on user's privacy rights, submission policy and copyright issues. The guidelines of the repository's use are therefore clearly stated. Although there is a considerably more developed screening process for submitted items than in other cases presented so far, there is again no mentioning of how rule-breakings might be treated. Therefore, E-ms scores medium too on the *rules* variable.

Munich RePEc Personal Archive[8]

The Munich RePEc Personal Archive, or MPRA for short, is the branch of the wider RePEc initiative (Research Papers in Economics) for submissions by individual scholars rather than institutions. The MPRA was founded in 2006 by an individual researcher from Munich as a response to the lack of personal self-archiving within the RepEc network.

The Archive is managed by Munich University Library, but is supported by a decentralized team of editors all around the world. It is possible to join the team of editors and thereby influence the direction and quality of the archive. This openness towards individual involvement indicates some degree of self-management, which is supported by a decentralized character of the local RePEc archives in general and the ability to easily join the network. One section of the site informs about the opportunities to volunteer at RePEc. This positive sense of community is strengthened by the availability of a RePEc blog, where community members can not only exchange their ideas on the subject, but also explicitly discuss their experiences with the online archive.[9] The MPRA therefore scores high on the *community* variable.

Next to the community features, the repository offers a high extensity of guidelines on how to and how not to use the repository. Next to a FAQ section on MPRA, the user is directly linked to the guidelines of RePEc in general and more general information on how to make use of OA and online archives. Again, as in other cases, there are no clear guidelines of what happens in the case of rule-breaking. The MPRA therefore scores medium on the *rules* variable.

OpenMed[10]

OpenMed@NIC is a repository for medicine and allied sciences for any sort of peer-reviewed

7 E-MS went offline in 2012, for further information please refer to http://roar.eprints.org/462/, last retrieved on 06/05/2013.

8 http://mpra.repec.org/, last retrieved on 20/3/2013.

9 http://blog.repec.org/, last retrieved on 20/3/2013.

10 http://openmed.nic.in/1262/, last retrieved on 20/3/2013.

scientific and technical documents. Although OpenMed has its origin in India, it wants to and must be understood as an international archive. The repository is hosted at and administrated by the Bibliographic Informatics Division at National Informatics Centre (NIC) in New Delhi.

Like E-ms and RePEc, OpenMed works by a decentralized team of editors. Furthermore, it actively states to be "open to collaboration with other organizations and institutions worldwide". Though less intensive than E-ms and RepEc, OpenMed is open to members' involvement in community management. Additionally, it provides a feature of IndMed forum.[11] This forum provides the possibility for repository users to exchange ideas on and experiences with the archive. OpenMed therefore scores high on the *community* variable.

OpenMed possesses a document acceptance policy, in which all guidelines concerning the submission of items are clearly stated. Besides, it has a deposit agreement, which spells what rights and duties users have when submitting their work. However, even in spite of this clear agreement, the repository does not spell out what happens in the case a user disregards these rules. In conclusion, OpenMed scores medium on the *rules* variable.

3.2 Outcomes and Discussion[12]

IV1 Degree of Community

Summarizing the analysis' outcomes based on the first independent variable, two repositories scored high, one medium and three low. Thereby, four out of six cases scored as predicted by the theory (see Table 3). The first hypothesis "the higher the degree of community anchored in the institutional design of a thematic repository, the more successful the repository is likely to be in attracting scholars to submit their work" can therefore be confirmed (0.66>0.5).

Thus, evidence shows that repositories with a higher degree of community are more successful in attracting contributions. In a broader theoretical perspective, this means that if a repository designs its institutional setup in a way that its users are actively involved in the process of not only creating but also managing the commons, it will be more successful in attracting contributors. The provision of community, as the realization of a process of peer production, can therefore help overcome the collective action dilemma of tragic stalemate (Suber 2007).

IV2 Explicitness of Rules

On the second independent variable one case scored high, four scored medium, and one scored low. Thereby, two out of six cases scored as predicted by the theory (see Table 3). The second hypothesis "the more explicit the rules stated in the institutional design of a thematic repository, the more successful the repository is likely to be in attracting scholars to submit their work" is, therefore, rejected (0.33<0.5).

Following this outcome, explicit rules do not help overcome the dilemma of tragic stalemate. It was expected that, with the help of a repository, many uncertainties that hinder scholars from taking action and making their work OA could be reduced and the repositories' performance in attracting contributions could be more successful. Building on the evidence of this study, this seems not to be the case.

11 http://health.groups.yahoo.com/group/indmed-forum/, last retrieved on 20/3/2013.

12 The outcomes for the dependent variable are displayed in Table 6 in the appendix. Table 7 in the appendix summarizes the outcomes of all three variables.

		IV1 Degree of Community			IV2 Explicitness of Rules		
Repositories		Value IV1	Expected DV	Measured DV	Value IV 2	Expected DV	Measured DV
	RePEc	high	successful	successful	medium	medium	successful
	OpenMed	high	successful	successful	high	successful	successful
	E-ms	medium	medium	medium	medium	medium	medium
	HTP Prints	low	unsuccessful	unsuccessful	medium	medium	unsuccessful
	Aquatic Commons	low	unsuccessful	successful	medium	medium	successful
	Cogprints	low	unsuccessful	successful	low	unsuccessful	successful

Table 3 Summary of outcomes
The table shows the values of both independent variables for all repositories studied, the expected value, and the measured value for the dependent variable. Cases, where the hypothesis is confirmed are marked green, while cases where the hypothesis is rejected are marked red.

However, this picture looks a bit different when considering the two indicators for IV2 separately (Table 4). This shows that while all but one of the repositories provided its users with guidelines (Indicator 1), five out of six did not provide any information as to what happens in the case of rule-breaking (Indicator 2). Thought, this skewed distribution of outcomes might simply be coincidence, due to the low number of cases, it is more likely that the indicator was badly chosen and has no power to predict the value of the variable. There are two obvious reasons why the choice of indicators was probably unsuitable for the analysis of rules in the cases studied: 1) no repository has the capacities to actually monitor what happens with items in their collections and it is therefore very unlikely that sanctioning procedures are included in the institutional design in the first place; and/or 2) the items in a repository are protected under general copyright law anyway, thus there is no need for further, repository-specific sanctioning. The evidence hints at possibility 2), since some of the repositories referred to the copyright law being in force. Option 1) can, however, also not be rejected at this point. The influence of rules and the possible inapplicability of sanction systems for the governance of knowledge commons (beyond copyright) require further research.

	Indicator 1: Guidelines	Indicator 2: Sanctions	Total 0 = low, 1= medium, 2= high
Aquatic Commons	1	1	2
Cogprints	0	0	0
HTP Prints	1	0	1
E-ms	1	0	1
RePEc	1	0	1
OpenMed	1	0	1

Table 4 Detailed outcomes for independent variable 2 "explicitness of rules"

On the other hand, the high amount of positive scores on the presence of guidelines (Indicator 1) could mean that rules, even more when coming in an FAQ section, are so much taken for granted, rather than being seen as a positive bonus, by which people decide whether to contribute to a repository or not.

It becomes clear that the outcomes for IV2 are much more ambivalent than for IV1. Without further inquiry and a change in indicators, it is impossible to draw reliable conclusions concerning the effect of the explicitness of rules on the performance of OA repositories.

Conclusion

Knowledge can be considered a rather new member of the "commons family". In the research canon on commons and governance systems, it has long been neglected. However, with increased possibilities for digital publishing and research of the past decade, its relevance has grown and attention paid to it has increased. Open Access to (scientific) knowledge will play an increasingly important role in (the study of) the digital age. This paper focused on the problems of collective action in the creation of a knowledge commons and thus contributed to this development.

Similar to other public goods, the provision of knowledge commons depends on collective action and is thus prone to social dilemmas (cp. Hess and Ostrom 2007). OA repositories cannot function without the contribution of many participants, since only this makes them a valuable commons. However, this need for contribution by individual scholars is exactly a weak spot. OA repositories suffer from what Peter Suber (2007) called the "tragic stalemate". A situation of collective paralysis in which all actors involved would benefit from the provision of a common good, but all hesitate to take the first step for fear that others might fail to follow or might just free ride. Based on the achievements by Elinor Ostrom in the field of CPR management, this study assumed that repositories are able to help overcome this tragic stalemate by including factors 1) *community* and 2) *rules* in their institutional design.

1) Designing the creation of a knowledge commons, in this study an OA repository, as a community action, was expected to have a positive influence on the performance of a repository in attracting contributions. The hypothesis was: the higher the degree of community anchored in the institutional design of a thematic repository, the more successful the repository is likely to be in attracting scholars to submit their work. This relation could be confirmed by the case study.[13] Repositories which have a possibility of self-governance, thus the opportunity for users to take an active role in management (for example by acting as an editor or local support for other users), and provide the users with a communication platform for exchanging ideas and experiences with OA, were potentially more successful in attracting participation, than those which do not.

2) The results for the impact of the explicitness of rules on the successfulness of a repository in attracting scholars to submit their papers were ambiguous. The second hypothesis, "the more explicit the rules stated in the institutional design of a thematic repository, the more successful the repository is likely to be in attracting scholars to submit their work", had to be rejected. Only two of the six cases studied showed the predicted outcome.

Several aspects of OA and OA repositories have not been touched in this paper. Most of them were left out in order to simplify and sharpen the analysis; others could have led the paper into a different direction than intended by its overall theme set by the seminar. Many of these aspects would serve as an interesting point of departure for further research. Two of them shall be briefly discussed in the following for examples.

The focus of this paper was on the institutional design of OA repositories and their influence on their performance in attracting participation in creating a knowledge commons. Viewed from a different angle, it would be interesting to test some endogenous factors on the decision-making process of individuals that lead them to take part in the collective action. This would mean to restrain from Ostrom's approach and instead take the direction of rational behavior intended by Olson. Such an approach would ask for a completely different research design, since the units of observations would

13 The six selected cases were: Aquatic Commons, HTP Prints, E-ms, RePEc, OpenMed and Cogprint.

no longer be the OA repositories institutional designs, but the individual scholars instead. Incentives, or the perception of benefits and costs for individual actors would be analyzed.

This paper has focused on scientific knowledge in the form of journal articles. As outlined above, this kind of knowledge does not suffer, or rather benefits, from being made OA, because it is royalty-free (Suber 2007). It is assumed that scholars do not produce this good in order to earn money, but to earn impact. The case is slightly different with royalty-producing goods. In the context of knowledge in the form of books, even if most scholars do not become rich from books, they expect some sort of revenue from them and are more hesitant when it comes to copy-right issues. This last point is undergirded by the discussion that emerged around Google-books some years ago. It would be interesting to find out how these goods behave in the context of OA. They are still knowledge, but whether and how they could become commons is a question (cp. Suber 2007).

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Appendix

Rank	Value
1184-790	unsuccessful
789-395	medium
394-1	successful

Table 2 Measurement of dependent variable: translation from webometrics rank into ordinal measure based on a 3-point Lickert scale

Repository	Size (0.4)	Rich files (0.3)	Scholar (0.3)	Total	Value 3 point Lickert
Aquatic Commons	543	303	200	368	successful
Cogprints	84	158	275	164	successful
HTP Prints	988	792	877	896	unsuccessful
E-ms	656	405	394	502	medium
RePEc	49	17	29	33	successful
OpenMed	264	216	271	252	successful

Table 3 Measurement of dependent variable

		IV 1 Degree of Community			IV2 Explicitness of Rules			DV
		Indicator 1 Management	Indicator 2 Communication	Total IV1 (Maximum 2)	Indicator 1 Guidelines	Indicator 2 Sanctions	Total IV2 (Maximum 2)	
Repositories	Aquatic Commons	0	0	low	1	0	medium	successful
	Cogprints	0	0	low	0	0	low	successful
	HTP Prints	0	0	low	1	0	medium	unsuccessful
	E-ms	1	0	medium	1	0	medium	medium
	RePEc	1	1	high	1	0	medium	successful
	OpenMed	1	1	high	1	0	medium	successful

Table 4 Summary of all measurements

CV – Wiebke Wemheuer-Vogelaar

Wiebke Wemheuer-Vogelaar is a PhD student at the Berlin Graduate School for Transnational Studies (BTS). Before joining BTS in September 2012, she studied European Studies for her B.A. at the University of Twente, the Netherlands, and completed her Master's degree in International Relations in a joint programme at Freie Universität Berlin, Humboldt-Universität zu Berlin and the University of Potsdam. In her PhD, Wiebke deals with the global spread of International Relations Theories and the question of whether IR scholarship is different in different places. For this purpose, she studies citation patterns in IR journals from all over the world, and has a general interest in the processes of academic publishing and peer-review.

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