The circular economy, openness, and dispersed access to research results

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ABSTRACT
Many initiatives aimed at achieving a circular economy are based on collaborations between industry and universities. However, these partners often engage in collaborative research without a clear understanding of who will have access to the research results and under which conditions. Such engagement may limit their ability to apply the results to the circular economy. The research project's contractual terms regulate whether access in the form of licensing will be exclusive to a few or non-exclusive and available for the many in open innovation. We demonstrate a novel method for analysing the contractual agreements of research partnerships to investigate whether and to what extent the outcomes of research partnerships will be accessible. For research funding organizations, research managers and policymakers, the method can be used on a single project or a portfolio of collaborative projects to assess ex-ante whether research results will help promote a circular economy.

Keywords: University-industry collaboration, circular economy, open innovation, IP strategies, access, licensing, open science

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Introduction

A circular economy aims at eliminating waste by using resources continually (Esposito, Tse, & Soufani, 2018). As a consequence, participants in a circular economy need to engage in transactions aimed at exchanging knowledge, resources and other materials. These transactions are all regulated by contracts and intellectual property rights. Our concern is the very formation of these circular chains of transactions: How access and openness to new knowledge from publicly sponsored research affect the circular economy. We define openness as a continuum from no openness at all, that is, the research results are trade secrets[1], to full openness as published and indexed knowledge. Openness can be measured in terms of publication restrictions and secrecy provisions[2]. Research results may be published and free for all to read, but without the possibility for using the results, due to, for example, patents or database rights. Access to those results would remain limited. Thus, if the access is restricted, and not dispersed, the benefit for the public of the publicly sponsored research is reduced to spillover effects only. If the research results are secret, then there are no spillover effects. These issues are often overlooked in discussions on the public value of science and discussions on research policy (David, Hall, & Toole, 2000; Rothaermel & Thursby, 2005).

Understanding where an innovation project is heading, in terms of openness and access, is crucial for the circular economy. If the intellectual property rights and the contractual arrangements for the research results are open, then search is facilitated (Grimpe & Sofka, 2016). Others can find the results, and further research is encouraged. If the results are also dispersed in terms of ownership and contractual regulations, then collaboration, competition and diversity in innovation can be enhanced (Rosenkranz & Schmitz, 2003). Then, in addition, there is the standardization that in circular economies serve both as a framework for implementing and measuring life cycle costs[3], but more importantly, as a means for ensuring that the physical re-use of goods is possible. Benachio, Freitas, and Tavares (2020) review the literature on the circular economy in the construction industry and point to standardization as a research gap. In construction, re-use of materials can be impossible if safety standards are not met or if, for example, a door to be re-used does not fit the opening in the new building. Standards can emerge as consensus on the best way to produce goods or services, such as indicated in the concept "dominant design" (Srinivasan, Lilien, & Rangaswamy, 2006). However, many standards are actively formed. When the parties that wish to ensure future standardization come together to agree, a prerequisite is that the knowledge is open and that ownership is dispersed (Ho & O'Sullivan, 2019; Papachristos & Kaa, 2021; Podszun, 2019; Teece, 2018). Recently, Chakrabarti, Henneberg, and Ivens (2020) discuss the term "open sustainability" where standards have a crucial role.

In the early phase of innovation, the terms of agreements in research consortia can be so complicated and entangled that they hinder collaboration and re-use of the research results. Nor can such complicated terms inform policymaking and management that seek to foster sustainability (Jarvenpaa & Välikangas, 2014, pp. 72,73). Policymakers may lack the tools for spotting emerging knowledge monopolies if research results are kept secret and inaccessible. They then provide public sponsorship to research without governing future openness and access to the knowledge flow. Research managers in both industry and universities may engage in collaborative research without a clear understanding of the agreed access to, or the openness of, the research results. We discuss how collaborative research projects between universities and industry agree on the openness and access to their results. We then outline how this understanding may profoundly impact the governance of collaborative research aiming to be a part of the circular economy. Such governance includes both how managers see the scope of the research projects and how a public funding body or an organization view their portfolio of collaborative research projects.

We conceptualize such reconsideration and apply a novel method for managing access and openness, as we spot possible knowledge monopolies ex-ante and ask what characteristics promote openness and dispersed access (Egelie, Lie, Grimpe, & Sørheim, 2019). As an illustrative example, we demonstrate how we applied the method to an institute-led Horizon2020 project comprising universities and industry. In that sense, our research question asks how openness and access in collaborative research can be governed in order to contribute to the transition towards circular economy solutions.

Background - openness versus access

The term "openness" has been used in many connotations. "Open innovation", "open science", "open business models", "open source", and lately "open access" are some of the concepts that claim openness. Bogers et al. (2017) review the open innovation concept and point to how it has evolved from a firm centric distributed innovation process managed across organizations to become a term for a wide range of related concepts that include public governance, ecosystems and human behaviour. Still, a managed and distributed flow of knowledge is the core of open innovation. However, the knowledge that flows in open innovation needs not to be open. It could, for example, be licensing that includes trade secrets. Bogers (2011) describes the tension field between collaborators in open innovation as a balancing act between knowledge sharing and protection. Laursen and Salter (2014) point to the same paradox of openness. They connect the firms' openness to the appropriability mechanisms managers use and how that use orients the firm towards external innovation process actors.

In legal terms, more specifically, the terms used in contractual regulations, one vital distinction between openness and access is how patents and copyright may provide control of access to open knowledge. Even if the knowledge can be found, read and understood, it may not be accessible for commercial use[4] (Long, 2001; Walsh & Huang, 2014). An often-used clause in university and public research funding organization agreements concerns further freedom to research and disseminate the research. Public open access is essential and for universities, even trumps commercial use and possible commercial profits. The term "Open Access" coins this differentiation in that an open access publication can be found and read and that the copyright licence is open, so it allows royalty-free reproduction. The unrestricted right to reproduce the verbatim text and figures is a sort of access to the research results. However, if the research results are technical, there might be patents or other intellectual property to stop the research results' commercial utilization. Thus, an open-access publication implies openness, but not necessarily access.

Egelie et al. (2019) address openness in research results and propose a typology based on a study of contracts in publicly funded life science research projects. They score the contractual provisions in terms of openness and access opportunities. Openness refers to whether the results are unrestricted, that is published, or restricted and thus confidential. Access is either concentrated or dispersed. Dispersed is typically non-exclusive licensing; concentration could be a patented technology that is not shared. Both openness and access can be combined cross-tabulated, leading to four typical situations that we will outline. This method builds on collaborative research projects, but it could be applied to any set of research or development projects.

Behind this model is the debate on the transformative technology CRISPR. The clustered, regularly interspaced, short palindromic repeats (CRISPR) and the associated protein (Cas9) system is a powerful new technology platform for genome editing. One possible use is for improving fungal biotechnology that enables the production of biofuels and food. Access to and utilization of the technology depend on the intellectual property management and contractual terms devised by the technology owners. Thus, the agreement terms for research collaborations between universities and industry are essential for academic knowledge to be used in the circular economy. Industry benefits from accessing scientific knowledge that they can use to anticipate future research problems in new technological areas. The technology owners' identity, the technology coverage of their appropriation mechanisms, such as patents that have been filed for different components, and the geographical distribution of those appropriation mechanisms all influence future access to the technology. Patents and unknown future licensing models are issues with the CRISPR platform that affect the research results' public utility. There is an ongoing patent dispute involving exclusive licensing creating uncertainty about the eventual license terms and how they can fit into a circular economy. They no longer license fundamental technologies that were developed by universities. Instead, they offer surrogate licenses through intermediate commercial licensing companies (Egelie, Strand, Johansen, & Myskja, 2018; Graff & Sherkow, 2020; Meyer et al., 2020; Sherkow, 2017).

There are differences between industries in how openness is managed. In the information and communication technology (ICT) industry, the 5G technology platform (the fifth-generation mobile network, the basis for the "Internet of Things, IoT) uses a model from the previous collaborative efforts of developing networks. Technology ownership is handled through extensive cross-licensing through patent pools. The regime has invented new mechanisms such as the definition of "Standard Essential Patents" (SEPs)[5] and licences under "Fair, Reasonable and Non-Discriminatory" terms (FRAND)[6]. The system regulates openness and access, but not without tensions (Heiden, 2017; NGMN Alliance, 2015; Teece, 2018).

Another example is in the energy sector. There is an evolution where the network market effects that guide the ICT sector now become more prominent[7]. The Smart Grid, where energy production is a system involving products and services from many actors, is a technology platform that relies on standardization. Both public and private actors are engaged (Ho & O'Sullivan, 2019). The effect of standards is not only present in high-tech industries but also in, for example, agriculture. Manning and Reinecke (2016) show how private standard-setters such as the Rainforest Alliance and Fairtrade affect agriculture and the coffee-sector. Standardization allows for regulations on soil conservation practices and the abolition of child labour. Other industries have yet to introduce sustainability in their standardization processes. Future standards on mobile networks could address sustainability. If universities hold SEPs, they could require adherence to sustainability terms for a license. A prominent example could be to follow the coffee industry and deny a license if a manufacturer depends on the use of child labour[8].

Thus, industries differ in how to develop platforms and control these in terms of intellectual property. For some platform technologies in, for example, biotechnology companies, trade secrets are potentially their most powerful form of innovation appropriation (Sherkow, 2016). For other industries, platform innovation interaction is critical, and intellectual property control requires other mechanisms (Gawer, 2014).

Applying the model to circular economies

Developing a conceptual framework

During a collaborative research project, the parties assemble knowledge controlled by intellectual property rights through contractual agreements and provisions. The results are likely to be used in the next phase of an innovation process or become part of a platform that can spawn many new products and services. The intellectual property rights will then be reassembled in another form. However, before that can occur, the initial project must disassemble the rights and make them available for the next phase of innovation (Granstrand & Holgersson, 2014). That is, there must be access to the research results in a form that allows a circular economy. In the model by Egelie et al. (2019), "Access" is seen as either concentrated or dispersed. Access is controlled by ownership and specific use rights to the research results, such as the right to use a part of it or use it for a given purpose, often education or further research. A technology platform usable in the circular economy must then have dispersed access. However, one actor could keep a technology exclusive and create a sustainable service or product. An obvious question for the managers of public sponsorship is then if such innovation should be financed by the public.

To determine the conditions that are conducive for a circular economy, we need to focus on those projects that are both open and have dispersed access to research results. Projects, where the results are kept secret and access is only for the participants, can be knowledge monopolies that may not be part of a circular economy. The study by Egelie et al. (2019) provides us with a conceptual framework to study the provisions of collaborative projects. In this regard, access is defined as dispersed ownership or dispersed use rights (that is, the commercial rights to use of the foreground, the research results). Concentrated ownership and use rights on the side of industry or university lead in that sense to inaccessible results. Openness is defined as publication opportunities and the absence of confidentiality rules.

Figure 1 shows the results of the conceptual model when access and openness dimensions are combined. Egelie et al. (2019) demonstrated how this model could be used on a portfolio of projects sponsored by the public. Policymakers and research managers can analyze the portfolio in terms of the number of projects where the agreements on openness and access could lead to the formation of knowledge monopolies. They could then, for example, investigate further whether a knowledge monopoly is needed to commercialize the research results and to what extent that should be sponsored.

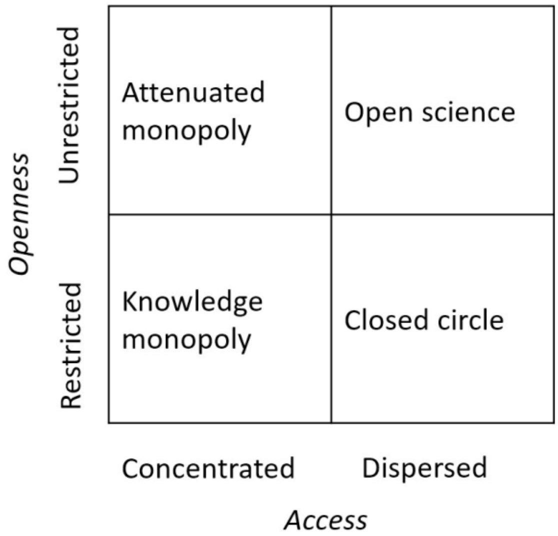

Figure 1 Conceptual model

Analyzing the agreements for a single research consortium

The framework we developed is also of value for the governance and management of a single collaborative research project, as we illustrate in the case of an EU-funded project. AlSiCal is a research and innovation project aiming at making the mineral and metal industry more sustainable and environmentally sound. The consortium will research and develop a new technology platform. Two of the consortium partners have, as the starting point, patented a novel process. This process gives no CO_2 emissions and no problematic by-products as compared to the current process. There are 16 partners from nine countries in the consortium. Four of the partners are universities, three research institutes, two industry associations, and seven commercial firms. The EU's Horizon2020 programme funds 100% of the AlSiCal project with 5.8 million euro over four years, beginning in 2019 (Aranda, 2019).

We scored the consortium agreement that uses the DESCA template (DESCA, 2017). The ownership and use rights to the results are dispersed. The openness is restricted, as there are confidentiality clauses that could limit the flow of knowledge out of the project. However, within the project, there are non-disclosure clauses that ensure a free flow of knowledge between the parties. Using the two-by-two matrix of Figure 1, we placed the project within the "Closed circle" quadrant. However, we drew an arrow towards the "Open science" quadrant. The arrow indicates that the project steering group may, within the consortium agreement's scope, decide to make the project results available to the public without restrictions. If the patents that are part of the background information in the project, together with the research results, are licensed out on FRAND-like terms, and no results are kept a secret, then the research results would qualify as “Open science”.

As the project started in late 2019, they do not know how the coming research results may be of best use to society. It could be that a closed circle is a preferred way of launching a new platform technology, creating a technology platform and then eventually launch standards that enable a circular economy. The technology that AlSiCal develops is disruptive in that it seeks to replace the current dominant process that goes back to an invention by the chemical company Bayer in 1888 (Habashi, 1995). If the AlSiCal project succeeds, they may form an ecosystem that gives a greener mineral and metal industry. The parties to the project may benefit from understanding the project as being a closed circle with the option of moving towards open science. Policymakers and public sponsors may use this insight to orchestrate further efforts to develop a new ecosystem, with the needed standards for technology and sustainability.

Discussion and conclusion

When considering a portfolio of research projects regarding the public benefit from the research results, then openness could matter more than access. If the research results are secrets, such as trade secrets, then they are not accessible to others other than those who belong to the project consortium, simply because the secrets cannot be found by search. If the access is restricted, but the knowledge is available to the public, such as for patented technology in an attenuated monopoly, then the government can introduce measures to make the technology available. One example is through financial incentives, where a public body rewards licensing, for example, through standards. Another example is that most jurisdictions have laws on compulsory licenses for copyright or patents. Thus the government could interfere if a needed technology is unavailable for a critical circular economy. However, Henry and Stiglitz (2010) point to how *the* implementation of trade agreements, such as TRIPS, have hindered developing countries in using compulsory licenses. A question is then how trade agreements will support sustainability and circular economies. A similar broad question is asked by Ballardini, Kaisto, and Similä (2021): In private law in the EU that concerns both tangible and intellectual property, “issues related to environmental sustainability have largely been ignored”. An example is how intellectual property rights can limit the possibilities to repair goods – or, as we discuss here, to use research results.

In the AlSiCal-case, ownership of the results is dispersed, and the consortium agreement allows for trade secrets. Thus, the research results fall into the closed circle category. A critical modifier is that this possibility for trade secrets is not a secret by itself. The consortium is open vis-à-vis the public sponsors. The agreements allow that they choose trade secret licencing if this for a period is the optimal way of transferring the knowledge and initiating the change to a greener industry. In that way, the research results’ openness is already high and in line with the EU Commission’s objectives when they sponsor a project 100 per cent. Keeping the option for trade secrecy ensures the possibility of a meaningful renegotiation between the parties.

In the AlSiCal case, we showed how analysis of the consortium agreements using the discussed two-by-two matrix might assist the project manager and the steering group in creating an open technology platform for a circular economy. Similarly, the model from Egelie et al. (2019) allows for the analysis of a portfolio of projects in a firm, research institution or sponsoring organization. The case example illustrates essential issues related to the stimulation of innovation for a circular economy: 1) There will often be a need for a consortium to establish a closed circle of knowledge in order to facilitate situations where the innovations can be developed among the partners and 2) After a “grace” period, the agreements must open for more sharing of the knowledge and solutions created in the consortium. The two-by-two typology in Figure 1, as applied in our illustrative case, shows how consortia ex-ante could guide the development of innovations to be beneficial for partners and society in the search for circular innovations. Further research could see if such ex-ante and ex-post typologies can be aligned, improving the evaluation of research results and the resulting technologies’ contribution to sustainability.

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NOTES

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[1] Trade secrets imply secrecy for commercial reasons. Other reasons, that we do not discuss, could be privacy or national security.

[2] We use secrecy and confidentiality as synonyms. In a contract the heading of the clause that defines the parties' right to require information being secret, is often "Confidentiality".

[3] An example is a European standard that specifies how to calculate Life Cycle Assessment (LCA) of a building, "Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method" EN 15978:2011

[4] Firms may take their chances and not bother with other's intellectual property rights. It can make make sense startegically to infringe, and prepare for a possible infringement lawsuit that may never come.

[5] SEPs are patents that in important markets cover one or more essential function of a standardised technology. The patent claims will read on one or more specified and mandatory parts of the standard.

[6] A FRAND declaration is a voluntary commitment from the SEP owner to a standardisation body that license terms will follow common rules on non-exclusive non-discriminatory licensing. In the case of disagreement for example on the value of the patented technology in a mobile phone, a court of law may consider this commitment and for example refuse a preliminary injunction to stop the sales of the phones.

[7] The systemic value of the network increases with a squared function of the number of users, as for communication networks. Metcalf's Law states that the value of a network grows as the square of the number of users. The growth of for example the value of Facebook has followed this law (Metcalfe, 2013).

[8] Cobalt is vital in the Lithium-Ion batteries in mobile phones. Most cobalt is mined in the Democratic Republic of Congo. Amnesty International reports that the government there will eliminate child labour in the mining industry by 2025. Phone manufacturers now list the sources of their cobalt (Amnesty International, 2017).