PUBLIC FUNDING OF COLLABORATIVE RESEARCH AND THE ACCESS TO RESEARCH RESULTS

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Abstract  
Does public funding of collaborative research between academia and industry associate with the access to project outcomes and research results? To answer this question, we investigate the contractual terms of 312 publicly funded research projects in Norway. We provide an in-depth analysis of the terms on which the partners involved in a project agree to, concerning the ownership of research results, the distribution of rights to all commercial use of intellectual property, the provisions regarding the dissemination and publication of project results, and the degree of confidentiality. Overall, our results indicate a positive, even though weak, relationship between public funding and the various dimensions of access and openness, with the association being strongest with the ownership of research results. Moreover, we show that the institutional composition of the project determines the project’s openness and the access to the project’s research. Our study has implications for public funding bodies as well as science, technology and innovation policy.
Does public funding of collaborative research between academia and industry associate with the access to project outcomes and research results? To answer this question, we investigate the contractual terms of 312 publicly funded research projects in Norway. We provide an in-depth analysis of the terms on which the partners involved in a project agree to, concerning the ownership of research results, the distribution of rights to all commercial use of intellectual property, the provisions regarding the dissemination and publication of project results, and the degree of confidentiality. Overall, our results indicate a positive, even though weak, relationship between public funding and the various dimensions of access and openness, with the association being strongest with the ownership of research results. Moreover, we show that the institutional composition of the project determines the project’s openness and the access to the project’s research. Our study has implications for public funding bodies as well as science, technology and innovation policy.

Keywords: Collaborative research projects, public funding, openness, access, intellectual property
INTRODUCTION

Prior research has frequently shown that firms benefit in their innovation performance from collaborating with universities and research institutions (Howells, Ramlogan, and Cheng 2012, Steinmo, 2015). However, these collaborations may suffer from tensions related to different institutional logics, where firms often focus on innovation outcomes. University researchers, on the contrary, are primarily driven toward long-term outcomes and their publication reputations in the international arena (Becher & Trowler, 2001; Steinmo, 2015), i.e. toward disclosure and openness of research results. Researchers will focus on their autonomy and research freedom based on curiosity-driven research. Firms will try to regulate this freedom and drive researchers’ actions in the directions of the firms’ need (Ankrah & Al-Tabbaa, 2015; Perkmann, King, & Pavelin, 2011).

Previous research indicates that industry funding of academic research is preventing access to public research, especially publication and dissemination of research. It seems that industry prefers secrecy over disclosure to increase the appropriability of the returns from research performed in collaboration with public science (Gans & Murray, 2012). A key issue then is the regulation of access to research results. The firm will impose limitations on disclosure of research results, keep the results confidential and try to protect and control the knowledge developed (Bruneel, D’Este, & Salter, 2010). Thus, the contractual terms of university-industry collaboration agreements will frame and limit the exchange of knowledge, and thus the openness of and access to the research results.

However, studies of actual contractual terms and how these influence access and utilisation of research results are scarce. There is a dearth of studies on how access to research results is regulated in contracts between universities, public research institutions and industry
partners. Moreover, university-industry collaborative research is often sponsored by public funding bodies. Intuitively, we would expect an increasing share of public funding to be associated with a higher degree of the public’s access to the research results. However, little empirical evidence exists on this relationship despite its obvious interest and relevance for science, technology and innovation policy. This gap is also recognised in previous research as the need for research on real contracts regulating knowledge access is called upon (Perkmann et al., 2013).

This paper builds on unique data from 312 research projects and includes agreements between 2507 partners. These are projects funded by the Research Council of Norway, RCN. The degree of public funding in the 312 projects is between 19% and 100%. Our exploratory study investigates the correlation between the degree of public funding of collaborative research projects, the participation in the projects from academia and industry, and the extent to which restrictions to the openness of research results are imposed. We focus on four dimensions of access and openness: the ownership of research results, the distribution of rights to all commercial use of intellectual property, the provisions regarding the dissemination and publication of project results, and the degree of confidentiality.

Overall, our results indicate a positive, even though weak, relationship between public funding and the various dimensions of access, with the association being strongest with the ownership of research results. Moreover, we show that the institutional composition of the project determines the public access to the projects’ results. Specifically, we find access and openness to be driven by the number of industry partners and universities in the projects. Our results have implications for public funding bodies as well as science, technology and innovation policy.
BACKGROUND AND RELATED LITERATURE

In industry-university collaborative research projects, the tension between the institutional logics is reflected in the agreements they do for openness and access to the research results. Openness is a term for to what extent the knowledge is available, and not kept confidential. Access is a term for to what degree the parties can utilise the research results, commercially, for further research or in education. Collaborative research projects are framed by agreements with contractual elements regulating access. The agreements define different concepts, such as ownership to the results, the right to publish and the need to keep information secret. We see the tension between the parties reflected in how they agree on sharing, publishing and giving access to the knowledge (Thune & Gulbrandsen, 2014).

The projects in our study all relate to the project development process at the RCN as explained in figure 1.

[Figure 1 about here]

The figure explains the three typical phases of a research collaboration project funded by RCN. In the first phase, the project is established by agreeing on a framework between the different parties. Between the phase of establishment and the project phase, the collaboration agreements are discussed, negotiated, prepared and agreed before the project begins in the second phase. The third phase we have named “Dissemination and Use”. In this last phase, it will be of importance what the parties have agreed contractually in the collaboration agreements. However, what is agreed contractually might not be what the parties do. The focus of our study is the period between Establishment and the Project phases. This is when the partners negotiate the details of the collaboration agreements. Our study and models concerning what the parties agree contractually before the actual research collaboration has started. As such it is possible that
the degree of access evaluated in our study differ from the next two phases where the collaboration agreements are set into practice.

There is a rich literature on university-industry relations. A thorough review of academic engagement is in (Perkmann et al., 2013). These relations are broader than the contractual relations, the agreements, that we study. However, in our evaluation of the agreements, we focus on the managerial aspects and not on the agreement as a legal document. The agreements will have details on how the parties expect one another to act, who owns and control the research results, who may have access to results and background needed for utilisation, and how the parties will resolve possible conflicts. Research may have a high degree of uncertainty about the possible utilisation of the results. The agreements that we study can in many cases be part of a long relationship between the parties. The agreements are also records that “represent an ideal source of information but are not readily available because they are often considered commercially sensitive …” (Perkmann et al., 2013, p. 411).

The results from university-industry collaborations can be the basis for new industries and platform technologies. The access to the research results is balanced with the control mechanisms. The control can be in the form of appropriation mechanisms such as patents and trade secrets, and it can also be agreed contractually. As examples, this balance of control and access is discussed for the development of DNA technologies in (Cook-Deegan & Heaney, 2010) and the recent development of CRISPR-Cas9 in (Egelie, Graff, Strand, & Johansen, 2016). A difference between these two technologies is to what extent the universities had control over research results and how they gave access to others, e.g. by licensing to industry.

The industrial partners in university-industry collaborations may wish to restrict publication of the research results. They may thus use the contractual control to keep proprietary
benefits and reduce public access to the results. A survey-based study of German academic researchers shows that higher industry sponsorship means increased publication delay and secrecy (Czarnitzki, Grimpe, & Toole, 2015). That study looks at the industry sponsorship with reference to OECD showing a shift from public to the private sponsorship of research. This shift is an aggregated shift for all countries surveyed. Now, as examples, for Norway, Germany and the USA, government spending increase, whereas in Denmark there is increased industry sponsorship (OECD, 2017). For policymakers, it is then of interest to understand how the degree of funding relates to what extent the public gets access to the research results.

We opinion that there are instances where the active ownership of universities is crucial for the public benefit from research. An example is how the universities with control over the intellectual property managed the utilisation of technologies, such as the essential patents concerning rDNA and PCR, versus how the emerging CRISPR technology is managed (Egelie et al., 2016, p. 1025). Thus, in this study, we have assessed the universities ability to give the public access to research results. This does not mean that industry control is always negative for society. In some cases, industrial control over the research results is needed for the successful utilisation of the research results from university-industry collaborations. A measurement system for such collaborations, seen from the firms’ perspective, could include our way of assessing and scoring the agreements (Perkmann, Neely, & Walsh, 2011). Thus, our model proposes a tool that innovation managers can use for analysing collaborations.

Over the past decades, universities have widened their activities beyond teaching and academic research. University research provides knowledge inputs to private-sector innovation. Universities have implemented entrepreneurial activity, and commercialisation often referred to as their “third mission” (Etzkowitz, 1998; Salter & Martin, 2001). The source of funding for the
universities can have an impact. A study of German universities shows that industry funding has a positive impact on the quality of applied research, and a negative impact on quality and quantity of publications (Hottenrott & Thorwarth, 2011).

Transfer of knowledge and technology from higher education institutions to the private sector can be performed in several ways. Research conducted by university researchers for the industry is one such. The value of such collaborative research for the innovation performance of firms is considerable (Cohen, Nelson, & Walsh, 2002; Mansfield, 1995, 1998; Zucker, Darby, & Armstrong, 2002). Cohen et al. find that firms, therefore, are funding collaborative research projects to seek direct access to the universities’ knowledge. Policy makers may argue that the potential for universities to foster and accelerate industrial innovations is not yet fully exploited. The societal returns from academic research can be increased (Dosi, Llerena, & Labini, 2006): From a private-sector perspective, the benefits of collaborating with academia are found to be unambiguously positive, whereas the effects on the scientific sector are not as clear-cut.

The Triple Helix is a model explained as a relationship between universities, industry, and government, to generate new knowledge, innovation, and economic development (Etzkowitz & Leydesdorff, 2000; Ranga & Etzkowitz, 2013). The creation and flow of knowledge will often be regulated in collaboration agreements similar to those we study.

There are few examples of research on how contractual agreements on the interface between organisations affect research and development. In the study “Government Support Programmes to Promote Academic Entrepreneurship”, the researchers (Rasmussen & Gulbrandsen, 2012) uses the framework of Agency theory to analyse contractual relationships. The analysis gives an understanding of the roles of the parties and how they decide on funding.
Templates for written agreement are used in many countries’ framework for funding of university-industry research collaborations (Eggington, Osborn, & Kaplan, 2013, p. 33). Together with policies and regulations, this constitutes the formal framework for university-industry collaborations. For our study, it is the Norwegian framework, as managed by the Research Council of Norway, that governs the projects we study.

The Norwegian innovation policy changed in 2003 by new legislation corresponding with the trends internationally and in the USA. The Norwegian change was inspired by the Bayh-Dole Act in the USA. In the article “Technology transfer and public policy: a review of research and theory” there is a thorough review of the following evolution of the Technology Transfer Organizations (TTO) that the universities set up as a result of the policy changes (Bozeman, 2000).

There is a typology of university-industry links in (Perkmann & Walsh, 2007, p. 263, table 2), which discusses the organisation and management of collaborative research. Transfer, e.g., licensing of intellectual property is categorised as a low relational involvement. Relationships, e.g., research partnerships imply a high involvement. Our study regards the framework to the access for the results from these high involvement research partnerships.

(Nelles & Vorley, 2010, p. 173) discuss the implications of funding schemes on universities. They address the need for models to be able to understand how public funding schemes are influencing such university-industry collaborations.

There have also been investigations on the relationship between industry sponsorship and restrictions on disclosure in research collaborations between university and industry. The studies of Czarnitzki & al. support the perspective that industry sponsorship jeopardises public
disclosure of academic research (Czarnitzki, Grimpe, & Pellens, 2015; Czarnitzki, Grimpe, & Toole, 2015). These two studies use individual-level data on German academic researchers. The studies indicate that there is a lack of understanding of the mechanisms in the actual contracts. Joint research projects involve the sharing of research knowledge and potentially withholding or even banning the publication of research results by academics. Contract research involves only the sharing of well-defined research information. As a result, firm employees and academics may have different preferences for the types of collaboration.

Access to the intellectual property is one of the possible indicators when evaluating the output from research collaborations (Bozeman & Dietz, 2001, p. 390). The conclusion from (Perkmann & Walsh, 2007, p. 275), citing the previous paper, is that “Research is also needed on the appropriate indicators and measures to account for the impact of [research] partnerships both organizationally and for society as a whole.”

As indicated by the literature there is a need to understand the mechanisms of how university-industry collaboration projects funded by the public are performing, and how public funding schemes are acting on these collaborations. It is interest from the cited literature to develop models that can evaluate the impact of regulations and policies on the access to knowledge created in collaborative research. However, as the literature indicates, there is a lack of models for measuring how contract regulations influence the access to knowledge in industry-university research collaborations. As explicitly stated by (Czarnitzki, Grimpe, & Toole, 2015, p. 255 note 4): “…we did not find any studies that systematically analyze the contractual terms of scientific or military-oriented contracts from state sponsors or private foundations.”
The literature points to academic engagement being distinct from the commercialisation of research, e.g. there are different priorities. In collaborative research, the parties negotiate the terms of the projects and contractually agree on the priorities. This negotiation includes the control over the research results. Regulations and policies, from the participating and the funding parties, frame and influence the agreements.

The industrial partners in university-industry collaborations may want to restrict publication of the research results. They can then use a contractual control to keep proprietary benefits, appropriate the innovation and reduce public access to the results. The university partners may want to use such control to increase public access, allow for publication of all results and thus for use in further research and education. There is an overview of such measures in (Perkmann, Neely, et al., 2011 table 2). These measures can be used by university and industry managers alike. There is a systematic review of the literature on university-industry collaboration in (Ankrah & Al-Tabbaa, 2015). Both these articles synthesise theoretical literature, and their conclusions call for empirical studies to validate their models. Our study addresses these calls with data from collaborative research with public funding.

**DATA AND METHODS**

**Data**

We used data from 312 collaborative research projects funded by the Research Council of Norway (RCN) during the period from 2008 to 2017. Norway is a wealthy country in Scandinavia, with around five million inhabitants. Norway is not a part of the European Union but participates in the European Research Area. The RCN annually funds research with one
billion EUR per year given to around 5000 projects. In 2016, public allocations to research comprised more than one percent of Norway’s gross domestic product.

Our sample is randomly drawn from a total population of 21838 projects funded by the RCN during that period. A criterion for selection was that the project would have at least one university and one industrial partner. We have been granted access to the full data that the RCN keeps on those projects, including the participants, the funding amounts and the collaboration agreements that the partners have signed with the RCN and among each other. Research institutes are identified separately. We use “academic partner” as a term for universities, university colleges and other public educational institutions. Industrial partners also encompass some public bodies that mainly have an operational focus, and some companies set up to research profit. RCN is the public sponsoring body for all the projects and the source for all the collaboration agreements. Institutes are defined as an organisation endowed for doing research for a particular defined purpose, usually organised as a foundation or as part of the government.

All these research programs are subjected to the RCN contract management program. This management includes a policy document, general terms and several template agreements for collaborative research projects. Our study investigates the results of contract management in RCN projects. We understand the agreements as a mechanism to govern public access to research results. Collaboration agreements in public research projects are central mediators in exchange of data and research results. Such agreements may restrain or facilitate sharing and access to data and research results. In the context of research policy and knowledge management, we aim to investigate the role of agreements in publicly funded research projects as a mechanism for establishing robust and sustainable access to research results and knowledge in the context of
the responsibility of the public to disseminate knowledge broadly through both education, research, and entrepreneurial activities.

*The structure of projects and agreements in our data set*

The agreements are managed by a project owner that is responsible vis-à-vis the RCN, and that manages the collaboration contract among the involved partners. The RCN does not review or monitor the content of the consortia project agreements (between participants), except for a few large and prestigious projects [identifying reference omitted]. The agreements are confidential, as is the identity of the projects we have studied. Our research needed special permission from the Norwegian Ministry of Education and Research. A premise is that the selection of projects and contracts in the study is only known to the principal investigators. Contact with the project participants is not allowed.

We selected projects across multiple research programs that span over the last decade. There were several practical difficulties in finding and accessing the agreements, due to archival issues. As a result, we removed projects we initially had selected because the agreements were in poor quality or not available from the archive. Also, we discarded a small number of selected projects, as they were not real research collaborations, but other grants.

In the case of projects involving partners, the project owner must enter into written collaboration agreements with all partners. Collaboration agreements are to be completed at the latest within three months after RCN has sent the contract to the project owner. RCN will not disburse any funds until they receive the collaboration agreements.

Agreements based on contract templates constitute a large body of our data set. Such templates are often initiated by the RCN or the academic institution as well as the industry
The basis for drawing up collaboration agreements

The collaboration agreements are to regulate the reciprocal rights and obligations of the project owner and partners in the project. RCN communicates directly with the project owner alone and is not a party to the collaboration agreements. RCN does not stipulate special requirements for the content of the collaboration agreements, except about certain aspects involving the distribution of rights in the project. It is up to the parties to determine the appropriate format for and content of the collaboration agreement for the individual project. Unless otherwise specified, the project owner may choose to draw up one common collaboration agreement or individual collaboration agreements for projects with multiple partners. The project owner is responsible for ensuring that the collaboration agreements comply with the terms and conditions of the contract. Partners are institutions, companies and other types of enterprise (as well as any designated individuals) that RCN, in its contract with the project owner, has stipulated are under obligation to provide professional or financial resources for the implementation of the project. The partner is responsible vis-à-vis the project owner, and the project owner is responsible vis-à-vis the RCN (The Research Council of Norway, 2015).

Regulation of rights to project results

The Research Council stipulates specific requirements for the regulation of ownership and rights to project results in a collaboration agreement. These requirements build on the Principles for the Research Council of Norway’s Policy on Intellectual Property Rights and are set out in Sections 7.2 and 7.3 of the General Terms and Conditions for R&D Projects. Figure 2
shows the RCN contract management framework. The figure describes how the RCN contract management framework creates a baseline with its General Terms and conditions, the policy on IPR and contract templates. This is seen in relation to the subsequent collaboration research project agreement framework where the parties are creating its own set of collaboration agreements intentionally based on the RCN baseline.

[Figure 2 about here]

*The agreement framework of the RCN*

After a research project has been granted a pledge of funding, contract negotiations will be initiated between the Project Owner and the Research Council. The contract sets out the terms and conditions for the use of the research funding and the parties’ rights and obligations about the implementation of the project. It is frequently the case that certain aspects of the grant application must be revised and updated before a contract can be signed. The contract between the Research Council and the recipient of the research funding consists of the following documents at a minimum:

- an **agreement document** that contains specification of the project’s objectives, management, budget, financing, progress plans and reporting requirements;
- the **project description** that was submitted by the Project Owner together with the final, often a revised, version of the grant application;
- the **General Terms and Conditions for R&D Projects**, which are the Research Council’s standard terms and conditions.

If the provisions of the various contract documents conflict with one another, the agreement document will take precedence over the General Terms and Conditions for R&D Projects and the project description. When it comes to the parties to the contract, they are the Research Council and the Project Owner (The Research Council of Norway, 2015).
Measures

*Dependent variables - building an ontology and scoring model*

We use four dependent variables that we argue to reflect the openness of a collaborative research project: the ownership of research results (“Ownership”), the distribution of rights to all commercial use of intellectual property (“Foreground IP”), the provisions regarding the dissemination and publication of project results (“Publication”), and the degree of confidentiality (“Confidentiality”). The variables are the result of a scoring model which in turn is based on an initial ontology derived from a subset of the research data. The variables capture dimensions related to the extent of openness and are defined on an ordinal scale from 1 (no openness) to 5 (full openness).

The term ontology has two connotations. The first is that of the philosophy of science. Here an ontology deals with what exists. It is a broader term than taxonomy, which means mere classification. In this first sense, (Courvisanos, 2007, p. 53) discuss and ontology of innovation in the view of critical realism. The objective is to develop a model of innovation decision-making and action.

The practical application of ontology in information science is the second connotation. Here academics describe an ontology in the form of formal statements and computer languages, with diagrams that show how the terms of the ontology are associated. A well-known example from management science is the ontology of the Business Model Canvas (Osterwalder, 2004). Such ontologies are also used in law, in knowledge management, and innovation studies. A thorough review and ontology for innovation management is provided by Bullinger (2009).

[Figure 3 about here]
Figure 3 describes the relations of all the different elements of an openness ontology in relation to a university-industry research collaboration framework. We extracted contractual terms from templates, sample agreements, bilateral and consortium agreements. These terms are related to access to research results in different ways. Based on this we built an ontology. An ontology is a sound basis for a scoring model. The ontology makes it clear what the different concepts and terms in the scoring model encompass. Also, the orthogonality of the terms, to what extent they overlap or interconnect, will be more precise. The scoring model uses concepts from the ontology. We followed the three-step methodology from (Rosemann, Green, & Indulska, 2004).

We base our ontology on common terms and expressions used in research collaboration agreements between the university and industry parties. We used our own dataset from projects funded by RCN. Also, we investigated common clauses, terms and terminology used in template agreements from public collaboration agreements used within the European Research Area:

- EU Horizon 2020, EU Framework 6 and 7, DESCA model templates (DESCA, 2017)
- The Lambert Toolkit, as discussed in (Eggington et al., 2013)
- University collaboration agreements known to us, [identifying reference omitted]
- RCN agreement templates (The Research Council of Norway, 2015)

The ontology was then adapted to a scoring model. The scoring model included parameters we found in RCN project agreements, parameters that are related to our research question and the wider concept of “access”. We initially chose eight concepts we found in collaboration agreements that all are related to openness in their broad definition. We defined these openness concepts as briefly discussed in the following clauses.
An example of the discussions is that the definition for IPR (Intellectual Property Rights) is not a definition in legal terms, and is not ontologically unambiguous. First, we merged the terms IP and IPR. From a legal theory point of view, there is a distinction between the property and the rights to the property. There could be one invention, one property, covered by several IPRs, e.g. patent and copyright and design rights. Then we considered existing legal ontologies. As an example, the ALIS ontology shows that there are nine types of legal, moral rights, such as the “rights to reconsider right to or withdraw assignment to exploitation” (Cevenini, Contissa, Laukyte, Riveret, & Rubino, 2008, p. 173). Our decision was not to detail the evaluation at this level. Another example is that one RCN template uses the term “academic rights” as something the university or researcher will keep (The Research Council of Norway, 2015 "Simple Collaboration Agreement"). The term has no legal definition but is connected to the discussion on academic freedom (Wright, 2016, p. 70). We decided to leave it out of the ontology. As the difference between IP and IPR makes little difference on the discussion on access, we decided to treat the terms as equivalents, and use IP. We then defined IP and IPR, in line with many contractual definitions as:

“Intellectual Property” “IP” or “Intellectual Property Rights”, “IPR” means all industrial property and property rights including patents, utility models, rights in inventions, registered designs, rights in designs, trademarks, copyright and neighbouring rights, database rights, moral rights, trade secrets, and rights in confidential and proprietary information, all whether registered or unregistered and including any renewals and extensions thereof, and all rights or forms of protection having equivalent or similar effect to any of these which may subsist anywhere in the world and applications for registrations of any of the foregoing.
We need these types of formal and normative descriptions in a complete ontology, but we do not need them in full for our discussion here. The important concepts are therefore briefly described further. “Access rights” is a term related to IP. The term means those rights (e.g., licenses or user rights) to use knowledge or Background IP given by the owners of the knowledge or pre-existing knowledge to others. Another term for this is the right to “Utilisation”. We used that term, as it better gives associations to rights for commercial and educational use, as well as for further research.

“Ownership” is regulations about who owns the relevant Foreground IP. “Foreground IP” means IP or project results generated or developed during the lifetime of the project. The term used for EU-funded research is now “Result”. “Publication” regulates the partners’ ability to publish information and results from a collaboration project. Academic researchers publish the results of their work to disseminate knowledge to the public. Universities rigorously want to protect the rights of its researchers to publish. On the other hand, companies may be concerned that publishing could reveal their confidential information or cause a loss of IP, such as patents or trade secrets, resulting from the research. “Confidentiality” regulates what information is deemed to be confidential and what is not. Clauses on confidentiality will regulate the time frame the confidentiality obligations will be in force, and what clauses will survive the termination of the agreement.

**The scoring model**

We grade each of the parameters in the scoring model from 1 to 5 according to different descriptions of the ontology terms. The details of the four main ones are in Table 1, below. A score of 5 represents the highest degree of openness. The university will own the results, and they will be public available. This does not preclude patents owned by the university. It may,
however, preclude the universities from using trade secrets as an appropriation mechanism unless the industry partners agree.

A score of 3, indicates a balanced situation. All foreground IP is jointly owned. It will normally be published, but the university can agree to it being kept secret. There are no provisions on further use in education and research, as the university is a joint owner. (Note that the laws on joint ownership of intellectual property are very different from country to country, see (Belderbos, Cassiman, Faems, Leten, & Van Looy, 2014) for a discussion and references.)

A score of 1 indicates that the industry has ownership and can require that all results are kept confidential forever. The university partners are liable if a confidential result is published.

[Table 1 about here]

Scoring

We analysed the projects over a period of six months and scored according to Table 1. The agreements were extracted in batches by RCN employees from the RCN archives. The initial selection was random. We then selected programs with projects extending over around ten years. We selected programs spanning different topics and technologies, such as energy, aquaculture, and nanotechnology. Around half of the projects selected initially were not available or could not be scored due to lack of contracts, erroneous files scanned or unreadable scans. Due to constraints on confidentiality, we could not go to the archives and look them up manually, nor could we contact the project managers or parties to get their copy of the agreement.

In parallel with developing the ontology, we initially scored a small number of projects. We discussed the scores and updated the scoring guides. We then worked individually. Both principal investigators are researchers who are familiar with contracts and contract terms. They
both have more than fifteen years of experience with IP and contracts. Each project has an average of around ten parties. Many of the agreements are similar, but each must be checked. First, we evaluated all projects to see how many had individual, bilateral contracts, and how many had similar consortium agreements signed by all parties. In this review, we also removed some projects where the agreements were only formal declarations without content, e.g., “We hereby agree to be a partner in this project”. We then read and scored the agreements of the 312 projects.

**Explanatory variables**

We use several explanatory variables that we assume to be associated with the extent to which the project data and outcomes are publicly accessible. First, we include the total project budget (in millions of NOK) to capture the overall size of the project. The project budget includes the funding provided by the RCN and the contributions by all project participants. Second, we include the share of the total budget that was funded by the RCN (in percent) to investigate the role of the degree of public funding for accessibility. Third, we are interested in the institutional composition of the consortia and include the number of industry partners as well as the number of universities in the consortium while taking the public research institutes as the reference group. Additionally, we include the squared terms of these two variables to investigate a potentially curvilinear relationship. Finally, we control for technology area of the project (biotech, energy, ICT, ocean, with other technologies being the reference category) and the year in which the project started.

**Model**

Since the dependent variables are measured on an ordinal scale that can range from 1 to 5, we estimate ordered probit regressions for the relationship between the dimensions of
openness and the explanatory variables. We cluster the standard errors by RCN research program, which is organised around technologies such as biotech, energy, ICT, health and ocean.

RESULTS

Table 2 shows the descriptive statistics for the 312 projects under study while Table 3 shows the pairwise correlations. The correlation coefficients and the mean variance inflation factor (VIF) of 1.55 do not indicate that our data analysis is complicated by multicollinearity problems (Belsley, Kuh, & Welsh, 1980).

[Table 2 about here]

[Table 3 about here]

The four variables measuring the dimensions of openness take integer values between 1 and 5, and their mean values vary closely around 3. Hence, the variables indicate that projects exhibit on average a moderate degree of openness. The average project budget is 32 million NOK (around 3.3 million EUR). There are also considerably smaller and larger projects. 58% of that budget is on average provided by the RCN. The projects include on average 4.6 industrial partners, but there are also projects with many more industrial partners and projects without any firms. Moreover, there are on average 2.2 universities in the consortia, with a minimum of no and a maximum of 11 universities. Most projects are in the energy area, followed by biotech and other areas, and most projects started in the years 2013 and 2014.

Table 4 shows the results of the ordered probit models. The first four models include the full set of explanatory variables while models 5 to 8 additionally include the squared terms of the two institutional composition variables measuring the number of industry and university partners. We find a statistically significant positive relationship between the degree of funding
from the RCN and the ownership, foreground IP, and publication scores. While small in size for all three outcome variables, the association is strongest for the ownership score, indicating that higher public funding is associated with more open ownership of the project results. Overall, this finding shows that public funding indeed facilitates openness. In turn, this finding is consistent with prior research that substantiates a positive relationship between the degree of industry funding and the restrictions in the form of publication delay or secrecy imposed by industry sponsors (Czarnitzki, Grimpe, & Pellens, 2015; Czarnitzki, Grimpe, & Toole, 2015).

Next, we turn to the institutional composition of the consortia. We find no statistically significant relationship between the number of industry partners and the openness scores. However, we find a significant positive relationship between the number of university partners and the ownership and confidentiality scores. For these two dimensions of openness, more university participants apparently propel openness – a finding that reflects the universities’ traditional mission to promote open science.

This picture changes once the squared terms are taken into the models. We find a U-shaped relationship between the number of industry participants and the publications score. Openness in that regard is highest with a low and with a high number of industry partners while an intermediate number of industry partners seems to be associated with restrained openness. We attribute this finding to coordination problems within the consortium. When a higher number of industrial partners is involved, individual firms will have difficulties restricting access and steering the project in a direction that mostly benefits their commercial interests. The industrial partners in the consortium are more likely to agree on common interests and consequently also on non-exclusivity of the results so that openness increases.
Contrary to this, we find inverse U-shaped relationships for the number of university participants and the ownership and publications scores. Nevertheless, the coefficients suggest the relationship to be rather concave than inverse U-shaped. In that sense, openness increases with increasing participation of universities.

We do not find a systematic relationship between the total amount of project funding and the four openness scores, indicating that the budget size itself is not a relevant determinant of openness. Concerning the different scientific areas, we find a few statistically significant relationships between energy and ICT area projects and openness. However, these only concern the scores for the use of foreground IP and publications. Finally, we find the year dummies to be jointly significantly related to the openness scores. There are indications for an increasing extent of openness over time. Particularly projects started in 2014 turn out to be associated with a higher openness which may indicate that the university administration has become more aware of the need publicly to disclose project data and results over time.

[Table 4 about here]

CONCLUSIONS AND IMPLICATIONS

There are limitations to our study. One limitation is that we have used only Norwegian data. Another limitation is that the data set may be skewed. We still do not know the reasons for some agreements being unavailable to us. The lacking agreements may be due to, e.g. scanners not working from time to time, and affecting the data randomly, or there could be systematic errors.

The study uses Norwegian projects only. There are foreign parties to several of the agreements, but the project responsible is Norwegian in all the projects. The agreements are in
English or Norwegian language, with standard European contract terms. Some are inspired by English or US contract tradition. Almost all are using Norwegian law. However, the method and the ontology use common English terms and expressions for intellectual property regulations. The method can thus be adapted to similar future research, also in other countries.

The collaboration agreements regulate fall-back positions if the practical cooperation between the R&D partners breaks down. The persons working on the project will hardly consult the agreement whenever knowledge is exchanged within the project. Nor will the agreements reflect every possible situation or problem that can arise. Our scores do not reflect the actual access to the results and the background, but the idealised position in case of further negotiations.

Furthermore, the study concerns innovation management, intellectual property management and results from initial negotiations of contractual terms. We do not follow up the results of the research projects and how that is used further in research or utilisation.

With reference to figures 1 and 2, we show that it is possible for a funding agency to evaluate the results from a policy that favours public access. Our method for evaluation opens for funding policies that can reward negotiations that end with a high degree of public access, or that can reward high access for industry partners. Our ontology and the scoring model can be developed further and become practical tools for contract management. Such tools can also be used in evaluations of the effect of policies for funding agencies.

The agreements and contracts are where researchers best can initially study the intentions of the parties and the framework of the project results. Further research can study how and when restrictions are created and their impact on the actual results.
The statistical analysis of our data confirms prior research results on the correlation between funding and publication of research results. We have used a very different method from (Czarnitzki, Grimpe, & Toole, 2015), but we see similar conclusions: There is a positive correlation between the degree of public funding and public access. We see variation across technology areas, but more restrictions on use rights than restrictions from ownership. Our results indicate that the budget size of a research project itself is not correlated to access.

As we did not find a systematic relationship between the total amount of project funding and the four access and openness scores, this indicates that total funding of projects does not matter significantly for neither ownership, foreground IP, publication or confidentiality. However, we find significant results for the RCN funding share with the different score variables. This shows that the model we developed is useful for investigating a relationship between the degree of public funding and the ownership, foreground IP, and publication scores. The association is strongest for the ownership score, indicating that higher public funding is associated with more open ownership of the project results.

There are differences between technology areas in our study. In energy and ICT, there are significant relationships between a larger degree of access and openness for the public when it comes to using of foreground IP and the freedom to publish the results. This finding is in particular relevant for projects starting in 2014 and after. It may indicate more matureness within the universities’ administrations to negotiate the contractual elements that are of more importance for further research. To explore this further, we need to study the post-project period.

Finally, we see indications that grants to the large, prestigious research centres, implies a higher correlation between public funding and public access. These are topics for further research, as is our most interesting result, the U-shaped correlations: There is a U-shaped
correlation between the numbers of industry participants and the public access to the results.

There is also an inverted U-shaped correlation between the number of participating universities and the public access.
REFERENCES


Dosi, G., Llerena, P., & Labini, M. S. (2006). The relationships between science, technologies and their industrial exploitation: An illustration through the myths and realities of the so-


Osterwalder, A. (2004). *The Business Model Ontology-a proposition in a design science approach*. (Docteur en Informatique de Gestion), UNIVERSITE DE LAUSANNE,


Table 1: Details of the scoring model

<table>
<thead>
<tr>
<th>Access Grading</th>
<th>Ownership</th>
<th>Foreground</th>
<th>Publication</th>
<th>Confidentiality</th>
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<tbody>
<tr>
<td>1</td>
<td>Industry owns all IPR and project results</td>
<td>Industry has exclusive user rights to all commercial use of IPR and project results.</td>
<td>All dissemination of project results is strictly controlled. No publications allowed.</td>
<td>All Information is by default confidential if not already public. No specified time limits or other limitations.</td>
</tr>
<tr>
<td>2</td>
<td>A specific party owns Project Results if based on own background, dominating contribution or own commercial interests. Otherwise jointly owned.</td>
<td>All parties have by default exclusive (within specified field of use) or non-exclusive, worldwide, royalty free User Rights to any utilization of all the Project Results.</td>
<td>Project results must be published but could be delayed according to participants needs. Not specified publication veto for academics.</td>
<td>All Project results and background information disclosed is by default confidential if not already public, limited in time.</td>
</tr>
<tr>
<td>3</td>
<td>All Project results are jointly owned. Separate agreements for Access rights</td>
<td>All parties granted non-exclusive user rights to all Project results to be able to utilize own Project result.</td>
<td>Results shall be published, but publication must be sent to Steering committee which could object and request modifications before publication.</td>
<td>Project Results and Background information is confidential if marked and justified for particular reasons and limited both in content and/or time.</td>
</tr>
<tr>
<td>4</td>
<td>Ownership of all Project Results is individually owned. Where several Parties have carried out work generating Project Results and where share of the work cannot be ascertained, they have joint ownership.</td>
<td>All parties have royalty free user rights, but only during the project period to results that are needed to perform utilization of own Project result, further user rights may be given upon request.</td>
<td>Publications could be delayed due to patent or other justified grounds, but according to Norwegian laws. Must be clearly stated that results must be published within a time frame.</td>
<td>Project partners have to specifically call for confidential information. Must be marked Confidential, time limited and approved by a Project Board. Parties could refuse.</td>
</tr>
<tr>
<td>5</td>
<td>Academic institution owns all Project results.</td>
<td>Only academic partner has specified user rights of Project results.</td>
<td>No publication restriction. Specified that results must be published</td>
<td>No confidentiality conditions specified</td>
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Table 2: Descriptive statistics

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<th>Std. Dev.</th>
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<td>Confidentiality score</td>
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<td>100</td>
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<td>7</td>
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<td>0.08</td>
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Table 4: Ordered probit regression results for the dimensions of access

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<tr>
<th></th>
<th>Ownership</th>
<th>Foreground</th>
<th>Publications</th>
<th>Confidentiality</th>
<th>Ownership</th>
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<th>Confidentiality</th>
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<td>0.010***</td>
<td>0.006**</td>
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<td>0.009***</td>
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<td></td>
<td>(0.003)</td>
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<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.004)</td>
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<td>-0.004</td>
<td>0.016</td>
<td>-0.029</td>
<td>-0.059**</td>
<td>-0.021</td>
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<td>(0.030)</td>
<td>(0.014)</td>
<td>(0.013)</td>
<td>(0.036)</td>
<td>(0.045)</td>
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<tr>
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<td>0.047</td>
<td>0.048</td>
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<td>0.252**</td>
<td>0.136</td>
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<tr>
<td>partners (sq.)</td>
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<td>(0.042)</td>
<td>(0.042)</td>
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<td>(0.101)</td>
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<td>0.000</td>
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<td>(0.001)</td>
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* p<0.10, ** p<0.05, *** p<0.01
Our study concerns the phase between establishing and running the project.
FIGURE 2

The RCN contract management framework and baseline and the subsequent collaboration research project agreement framework
FIGURE 3

The Ontology creation with contracts, access concepts and the research problems