An Exploratory Account of Incentives for Underexploitation in an Open Innovation Environment

Piirainen, Kalle A.; Raivio, Tuomas ; Lähteenmäki-smith, Kaisa

Published in:
Proceedings of the DRUID Society Conference 2014

Publication date:
2014

Paper to be presented at the

DRUID Society Conference 2014, CBS, Copenhagen, June 16-18

An Exploratory Account of Incentives for Underexploitation in an Open Innovation Environment

Kalle Artturi Piirainen
Technical University of Denmark - DTU
DTU Management Engineering
kalpii@dtu.dk

Tuomas Raivio
Gain Consulting Ltd.
-
tuomas.raivio@gaia.fi

Kaisa Lähteenmäki-smith
Prime Minister's Office/Ramboll Management Consulting
-
anna-kaisa.lahteenmaki-smith@vnk.fi

Abstract
This paper presents an empirical account of incentives for underexploiting intellectual property in an open innovation setting. In this exploratory empirical account the phenomenon is observed in a research, development and innovation program where participants are required to share intellectual property rights within the consortium. In sum, our argument is that the observed underexploitation is induced by negative incentives for commercialization that follow from setting a coercive open innovation regime that will constrain appropriability of IPR. This phenomenon is named so graphically, because such an event is not only costly in terms of time and resources, but can in fact render IPR effectively worthless in terms of commercial exploitation and block innovation. This finding is pertinent to policy makers designing research, development and innovation instruments, as well as for managers who need to make choices how to implement open practices in innovation.

Jelcodes:M20,L51

An Exploratory Account of Incentives for Underexploitation in an Open Innovation Environment

Abstract:

This paper presents an empirical account of incentives for underexploiting intellectual property in an open innovation setting. In this exploratory empirical account the phenomenon is observed in a research, development and innovation program where participants are required to share intellectual property rights within the consortium. In sum, our argument is that the observed underexploitation is induced by negative incentives for commercialization that follow from setting a coercive open innovation regime that will constrain appropriability of IPR. This phenomenon is named so graphically, because such an event is not only costly in terms of time and resources, but can in fact render IPR effectively worthless in terms of commercial exploitation and block innovation. This finding is pertinent to policy makers designing research, development and innovation instruments, as well as for managers who need to make choices how to implement open practices in innovation.

Keywords: Open Innovation, Incentives; First-mover advantage; Tragedy of the Commons; Appropriability conditions

Introduction

Open innovation (OI) is a name coined and promoted by Chesbrough (2003) for a collection of ideas about information exchange and collaboration in innovation, which can be reduced to the main underlying argument that if enterprises would collaborate and share knowledge and thus share risk more readily in their research, development and innovation (RDI) they would be able to extract more value from their RDI. According to recent reviews (Dahlander & Gann, 2010; Huizingh, 2011; West & Bogers, 2011), Open innovation research has not focused on the relationship between external environment and open innovation benefits. This paper focuses on describing an exploratory empirical account that challenges tenets of open innovation.

The empirical account is from a publicly subsidized center of excellence program[1] set up to bridge the gap between (basic) research and innovation within key industries in Finland. The program has set-up virtual centers of excellence that govern bottom-up research programs implemented by co-opetitive[2] industry-academia networks. The program features mandated sharing IPR through non-exclusive and free license to original IPR within the consortium, forming what might be called a coercive open innovation regime. The data were collected from a cross section of industries in Finland during an evaluation of the program (Lähteenmäki-Smith et al., 2013). We label the tendency of the partners towards underexploitation of the results from open innovation in these networks the "reverse tragedy of commons" in open innovation. We propose that this underexploitation is driven by a set of factors, including organizational incentives, trust, and the co-opetitive setting.

The main contribution of this paper is that it outlines a new phenomenon, that is important both for research of innovation, especially in the open innovation research stream, and for business and public policy making. The research question is what the antecedents for the reverse tragedy of commons are.

The observation poses a great challenge for effectiveness of open innovation collaboration. The central problem is that the empirical account we present in this paper provides evidence that in fact IPR can become effectively worthless in terms of commercial exploitation if it becomes a public good. This finding is pertinent especially for designing RDI policy measures that aim to foster collaboration. This paper contributes to this nascent stream of research by considering the interplay between industry characteristics and open innovation practices.

The rest of the paper is organized as follows. The second section reviews relevant theoretical discussion to outline an explanation to the phenomenon. The third section describes methodology for data collection. The fourth section describes the findings, the fifth section presents discussions and the sixth section finishes the paper off with concluding remarks.

---

[1] We use the term "center of excellence" in the generic sense, not to be confused with the specific instance of Centres of Excellence e.g. funded by The Academy of Finland.

[2] 'Co-opetitive' is a portmanteau of the words competitive and cooperative, coined by Nalebuff and Brandenburger (1997). It implies that relations between enterprises are not, nor need to be, straightforwardly head-on competitive. Rather, in reality competitors in the same industry/market can collaborate on different levels in order to enlarge the market, rather than just try to undercut each other to gain a larger share.

The Literature Review

In this section we discuss two possible explanations for the reverse tragedy of commons. First, we examine the relationship between the tragedy of the commons and knowledge as a source of competitive advantage of the enterprise. Second, we discuss the so-called first mover advantage and the incentives for exploiting public goods commercially.

Tragedy of commons and knowledge

In the context of this paper we focus on information or knowledge, and specifically exploitation of intellectual property rights (IPRs). Published information or knowledge is essentially a public good in the economic sense (Stiglitz, 1999); it is first of all non-excludable in the sense that reproduction of information once it is produced is generally cheap through modern communications technology and use of information does not exclude others using it insofar it is possible to reproduce the original. It is also non-rivalrous when made public, as using and digesting information does not exclude other from doing so. These conditions apply especially to codified and public knowledge, i.e. patents, scientific and technical papers and books. However, information is not depleted in the same sense as pastures, fisheries or mineral deposits. Resource depletion in this context means that IPRs are 'depleted' by public disclosure and/or spill-over effects associated with exploitation, which more or less gradually lead to the information being a public good, and thus it no longer is exploitable commercially. Arguments can be made that non-codified and/or unpublished information cannot be readily transferred, which is a fair point. However, collaborative RDI programs conceivably form a condition where it is difficult not to transfer technical knowledge and other signals between the consortium (Bresser, 1988).

Traditionally enterprises have to a large extent relied on sticky and private information as a source of competitive advantage and innovation, however much they collaborate in their RDI and supply chain. Especially the resource based view of the firm (RBV) posits that the competitive advantage of an enterprise is built on proprietary resources, including tangible physical resource, knowledge, and routines (Amit & Schoemaker, 1993; Winter, 2003; Zollo & Winter, 1999). The well know VRIO/N-framework proposes that at any given time the competitive position or advantage of an enterprise is based on resources that are Valuable, Rare, In-imitable and Organized and/or Non-substitutable, or in other terms excludable and rivalrous (e.g. Peteraf & Barney, 2003). Additionally, building on the notion of resources as a basis of competitive advantage, it is further proposed that the so-called dynamic capabilities that enable developing and exploiting the VRIO resources are the foundation of sustained competitive advantage (Eisenhardt & Martin, 2000; Teece, Pisano, & Shuen, 1997; Teece, 2007; Winter, 2003).

The caveat in RBV is that knowledge is not perfectly appropriable in real conditions and thus the favorable competitive position that stems from resources is diminished by competitive imitation and learning (Dierickx & Cool, 1989; Kortelainen, Piirainen, Kärkkäinen, & Tuominen, 2011; Peteraf, 1993). Already Teece (1986) proposed the seminal notion that when imitation is easy, i.e. when appropriability is low or information is a public good, benefits from IPR tend to shift for enterprises with 'complementary assets' instead of the innovator or inventor, which is consistent with what RBV and FMA literature (see below) predict (Finney, Lueg, & Campbell, 2008). Complementary assets in this context are manufacturing and supply chain capabilities and bargaining power as well as complementary technologies, products and services that support the innovation. Thus it is generally assumed that organized RDI is one of the mechanisms to replenish resources and keep a favorable 'asset position', i.e. sustain the competitive advantage (Dierickx & Cool, 1989; Kortelainen et al., 2011).

Thus an enterprise that aims to develop a sustainable competitive advantage has the incentive to appropriate its knowledge, at least as far as it is linked to the main value creating activities. On the contrary, any attempt to commercialize products or services built on public information risks strong competitive response and unpredictable result varying with path dependent complementary assets and capabilities (Teece, 1986). In this view, building on a public good is a contradiction in terms. This creates a basic tension between the interest to create economic rents by appropriating and leveraging the knowledge assets an enterprise possesses and sharing the knowledge for a common good, as once public the knowledge becomes a public good and ceases to be a unique source of advantage. However, given a strong enough incentive, an enterprise may be compelled to take a risk and share information if it sees that the probable return is greater than the probable damage (Simeth & Raffo, 2013). The incentive may be for example risk sharing in terms of the uncertainty of the outcomes of RDI activity, as proposed or the possibility to tap into new complementary knowledge assets through collaboration (H. W. Chesbrough, 2003; Enkel, Gassmann, & Chesbrough, 2009). Based on the discussion above, we argue that the risk taking is moderated by trust in the partnership as well as the perceived asset position and perceived level of capabilities, i.e. the perceived risk and ability to recover.

First mover advantage and escalation of competition

The so called first mover advantage (FMA) is the proposition that the first enterprise to introduce a new product category to a new market holds a significant advantage over the followers in terms of market share and return on investment. An early review of FMA, in consumer product markets, concludes that FMA is created by the fact that consumer preferences are shaped by the first innovator around its offering, making it a preferred brand and creating a 'lock-in' effect (Robinson, Kalyanaram, & Urban, 1990).

However, others have labeled FMA as a 'half-truth', as not all market conditions permit acquiring FMA (F. Suarez & Lanzolla, 2005). In fact Golder and Tellis show quite convincingly that in most cases the 'pioneer' or first mover does not hold an advantage, but rather the second mover or 'early leader' (Golder & Tellis, 1993; Tellis & Golder, 1996). It is proposed that probability of gaining FMA is most likely in stale markets with slow technology progress, but if the market is stable and technology changes fast, FMA is less likely as each successive product generation poses the risk that the late movers out-innovate the pioneer. Also when markets are changing fast, FMA is less likely even if the technology would be stable, and acquiring it may need significant resources. (F. F. Suarez & Lanzolla, 2007) Other studies have shown for example that in the context of process innovation (quality improvement) low R&D cost may induce a 'race' to be the pioneer, but when the costs are high, the conditions may lead to a 'waiting game' to seek second-mover advantage (Hoppe & Lehmann-Grube, 2001).

Another aspect to innovation is that it may introduce escalation of competition. To an extent, the anticipated return to RDI investment, and commercial rationality of such an investment, depends on the ability to harvest rents from the markets. In other words "[a] bit of monopoly power in the form of structural concentration is conducive to invention and innovation" (Cadot & Lippman, 1995; orig. Scherer, 1980). However, when the (possibility of) competition precludes monopoly power or makes it very short lived Pacheco-de-Almeida (2010) has proposed that market leaders may displace themselves from leadership as RDI investments are more risky. Further aversion towards innovation is likely exaggerated by high R&D combined with competition, as it raises the risk and innovation may be perceived as a strenuous and costly expedition back to the same competitive situation (Hoppe & Lehmann-Grube, 2001).

The reverse tragedy of commons in open innovation

To summarize, if we propose that the market-dependent possibility for creating FMA, likelihood of escalation of competition and R&D cost may create a disincentive for innovation, effectively creating a waiting game where enterprises wait to see if any of the other will commercialize the public IPR, ready to follow if the first mover's effort is successful. Based on the literature, the likelihood for this condition rises when the markets and/or technology are volatile and develop fast, when entry barriers are low and when R&D costs are high. The likelihood for escalation of competition, despite negative incentives, rises if the competitors are well resourced in terms of knowledge and financial resource and are determined to compete each other out. We propose that, while generally it is believed that public goods tend to be overexploited, the reverse may be true due to the fact that competition creates 'perverse' incentives for commercialization. More specifically we propose that:

> *P1: the reverse tragedy of commons is enabled by the information and IPR produced in collaboration becoming a public good.*

The rationale for the proposition is the discussion on the competitive advantage of the firm and RBV. Basing one's competitive advantage on a public good is contrary to the tenets of RBV, as a public good by definition is not VRIO/N. Further, as public information is easily copied and transferred, one cannot appropriate it by trying to privatize the resource. Thus the only advantage would be to develop new products faster and try to retain as much of the market as possible through marketing and bargaining power. This would then significantly raise the likelihood of competitive escalation. However, based on the latter discussion on FMA and escalation of competitions, the likelihood of the reverse tragedy correlates positively with the likelihood of competition escalating. Thus we further propose the following:

> *P2: the reverse tragedy is exacerbated by risk of escalation of competitions associated with*
>
> > *P2a: fast moving technology and short product cycles,*
> >
> > *P2b: volatile markets,*
> >
> > *P2c: high R&D cost and*
> >
> > *P2d: an industry that consists of well-resourced enterprises.*

If we examine the second proposition it can be argued that in environs that are already hypercompetitive, the second proposition is invalid. However, we argue that the logic holds, because the enterprises do not necessarily have an incentive to further escalate competition. However, a more fundamental limitation to the propositions is that the underlying assumption is a degree of risk averseness. That is contrary to the usual underlying assumption in much of economics that enterprises engage in competition straightforwardly without a second thought.

Methodology [3]

Study design

The methodology for this research is exploratory case study research. Based on the theoretical discussion we derive an analysis framework for the cases, following the best practices (Eisenhardt & Graebner, 2007; Yin, 2003). Yin (2003) argues that the research design, based on the research problem is the fundamental base of the study which guides collecting and interpretation of evidence and provides a “logical model of proof that allows the researcher to draw inferences concerning causal relations among the variables under investigation”. The model is elaborated below in table 1.

Table 1: Elements of research design summarized

Design elements	**Questions**
RQs	What are the antecedents of the reverse tragedy of commons
Propositions	*P1: the reverse tragedy of commons is enabled by the information and IPR produced in collaboration becoming a public good.* *P2: the reverse tragedy is exacerbated by risk of escalation of competitions associated with* *P2a: fast moving technology and short product cycles,* *P2b: volatile markets,* *P2c: high R&D cost and* *P2d: an industry that consists of well-resourced enterprises.*
Unit of analysis	Organizational behavior
Logical link between data and propositions	The observations of behaviors within the SHOK program may refute of confirm the reverse tragedy The interview data may offer further explanation to the phenomenon
Criteria for interpreting findings	If there is observed anomalies in output and commercialization from collaborative RDI, data conforms with P1. If the opposite is true, P1 is refuted. If the program participants and characteristics of their industries conform with P2, the proposition is supported. If the opposite is true, P2 is refuted

We examine ‘Strategic Centres of Science Technology and Innovation’ (SHOKs[4]) as cases and conduct analysis within and between cases. The data were gathered between May and September 2012 during an

[3] After the COREQ framework for reporting qualitative research (Tong, Sainsbury, & Craig, 2007)
[4] SHOK is a Finnish acronym, from ‘Strategisen Huippuosaamisen Keskittymä’, literally Strategic Center of Expertise/Excellence

evaluation of the SHOK program, commissioned by the Finnish Funding Agency for Technology and Innovation (Tekes). The data collection was executed by a consortium of researchers and consultants, with a professional background in innovation systems and RDI policy research and consulting. The dominant sampling logic was purposive, more specifically stakeholder and expert sampling (Palys, 2008), in the sense that the interviewees were selected based on their assumed ability to give informed answers regarding the evaluation questions from different stakeholder groups. The data have been re-examined and re-coded for the purposes of this paper to explore the incentives for participation.

Table 2: Details of data

Data source	Sampling and collection	Coding and interpretation
Documents	A documents database of annual reports, monitoring data and other relevant materials from the SHOKs compiled by Tekes for the purposes of the evaluation.	
Semi-structured interviews	A series of interviews with SHOK personnel, participants of the research programs and stakeholders. The responsible evaluator for each SHOK compiled a list for interviewees comprising program participants, SHOK employees, SHOK board members and stakeholders. The interviews were semi structured, administered either at the interviewees premises/place of work or over the phone and noted down in field notes. Interviews were conducted until data saturation was reached, in practice between May and Spetember 2012	The data was coded by each SHOKs responsible investigator.
A cross-sectional panel survey	The survey explored the expectations, perceptions and experiences with the SHOK instrument among the companies and research organizations involved. The sample was compiled from the project database of Tekes, complemented by the contact details made available by the SHOKs. The database was built on the Tekes and Academy of Finland databases and complemented with contacts from the SHOKs, representing their project and program participants, key stakeholders and members of governance bodies. Pre-test was done between 1st and 4th of June, with the questionnaires adapted in the following week and implemented between the 11th and 21st June, with an extension to the 29th June. The survey targeted two separate groups First, the representatives of companies and research organizations with a position allowing judging the strategic significance and the possible linkages between SHOK strategy and the strategy of the organization in question. And, second, all participants with experience of SHOK program / project activity. Together the surveys gauged the views of over 2000 persons, with the activity survey achieving 1580 responses (27% response rate) and the strategic survey 676 (25% response rate).	
Group interviews	A series of group interviews conducted during a series of peer review panel meetings (each made up of 5 experts, with the facilitated by consultants) The interviews were lead by the five-person panels	

	composed of leading academics in the field of the SHOKs invited by Tekes and the Academy of Finland The interviewees were SHOK program managers and participants	

Empirical context[5]

Background and program context

According to Lähteenmäki-Smith et al. (2013) the background of SHOKs is on one hand in a 2004 study colloquially known as "the Globalization Report" which outlines the opportunities and challenges for Finland in the Global Economy, and on another in the perceived need to keep developing the Finnish innovation system; that is institutions and policy instruments, to support continuous knowledge based growth. The aims for the program include establishing public-private partnerships to speeding up innovation processes and renewing the Finnish industrial clusters by creating new expertise and achieving an enhanced level of internationally competitive competence, as well as radical innovations. The program is expected create new patterns of cooperation, co-creation and interaction.

Currently there are six SHOKs in operation: CLEEN Ltd (in the environment, energy and 'cleantech' industry), FIMECC Ltd (in the machinery industry), SalWe Oy (in health and well-being), DIGILE (in the ICT and digital services industry, previously known as TIVIT) RYM Ltd (in the built environment/construction industry) and Finnish Bioeconomy Cluster FIBIC Ltd (forest-based industry, previously Forest Cluster Ltd.).

Overview to program output

Between 2008 and September 2012, Tekes funded the SHOKs and their programs with a total of over 343 MEUR. An average of 40% of the research conducted in the SHOKs is, or will be, co-funded by the companies involved. Thus the SHOK program has become one of the main instruments of Finnish innovation policy and perhaps even its 'flagship' program in the last five years.

The program intended to create open innovation platforms, bridging disciplines, industrial areas as well as basic and applied research and resulting in both excellence in research and create a bridge for transferring the research excellence to applied research, development and innovation in enterprises. When measured and assessed quantitatively in their Key Performance Indicators (KPIs) and qualitatively, measured with the participants experiences and satisfaction, it was obvious that in most SHOKs the collaboration had remained between the previous confines and in established fora. Amongst the long list of SHOK KPIs (around 20 reported in total), the commercialization activities were relatively modest. The highest achiever in terms of the number of invention announcements and patents secured, FIBIC reported a total 34, while the highest number of licenses sold was reported by FIMECC (46). Extremely few spin-offs were reported, 3 in the case of FIMECC representing "best-in-class" in this regard.

Judging by the program volume, the activities have produced relatively few commercial outputs and the objective for new business benefits was only partly met. In terms of IPR sharing within the open innovation regime, few new actors and stakeholders had been involved in the consortia, there were very few signs of transgressions in terms of IPR, and yet the trust did not seem to be sufficient to achieve really open exchange of ideas and IPR.

[5] The description of empirical context is based on (Lähteenmäki-Smith et al., 2013)

Terms and Conditions for the Coercive Open Innovation Regime

One of the interesting features in of the SHOK program is that seems to be built on an ideal of open innovation. As Tekes is by far the largest public funder for the SHOK programs and during the period of the data collection, all the research programs had used Tekes funding we use the general terms and conditions (hereon forwards T&C, "General Terms and Condition for SHOK Research Programme Funding," 2012) as a surrogate to outline the coercive open innovation regime.

The novel feature of the SHOK model is that while the material and immaterial rights remain with the inventor, the T&C mandate an unlimited and perpetual access right to the results and IPR to all participants of the program. Further, the access rights will cover all companies within the same group of companies as the participant of the research program. If a participant leaves the program, its access right to IPR will remain in force, but it will lose preferential treatment in access to background or results materials owned by other participants. There is in principle open access to results and IPR, shared by all parties involved in the research (program, project or task). In case of a public sector participant, title and ownership is retained if the entity has generated the results while subcontracting for enterprises. The inventor has the right to protect its IPR, but has to bear the associated costs.

Additionally, all the results are published according to the T&C. The consortium has the possibility choose between wide or limited publicity model, which will affect the fraction of cost eligible for public funding. In the wide publicity model all the participants shall release all results of the program, including description of work and results materials, such as laboratory diaries, measurement results or source codes, and scientific background necessary to implement the program. Under limited publicity model, research organizations will have to publish all results, while enterprises will have to publish only project/work package name, amount of public funding, research intensity and an overview to the substance and results. The exceptions to the rule of publicity are that immediate publication may be delayed for e.g. reasonable period to allow for protection by registering IPR or industrial rights if publication is in conflict with the owners "direct, legitimate interests". Publicity of the results is also subject to case by case consideration in individual cases for "extremely pressing reasons".

T&C in effect set up a coercive open innovation regime, in the sense that the consortium members cannot choose what to share if they want to participate in the programs. One can argue that the regime is not coercive as participation is voluntary, but the sheer volume of available funds and the fact that the country's leading enterprises all participate provides a very strong incentive to participate at least in name only to monitor the activity.

Description of cases

The relatively meager output of the program poses the question what is the underlying mechanism that explains this poor performance. As we discussed above, we propose to explore the behaviors that lead to this poor performance. The longest running SHOKs are Finnish Bioeconomy Ltd. that represents forest-based industries since 2007 and DIGILE that represents IT and telecom since 2008.

The common features that are pertinent to this analysis are that SHOK research programs were, at the time of the data collection, large (up to 4 year in duration and budgeted up to 20MEUR per year) and included broad-based co-opetitive (up to 20 participants) consortia. Further, the research programs were based on Strategic Research Agenda created through a consensus process and approved before funding application by a Board of Directors that consists of key industry players and academics. The key differences are related to industry and SHOK governance, which will be explained below case by case.

Case A: FIBIC

Forestcluster Ltd (FIBIC from 07/2012) is the SHOK of the Finnish forest industry cluster. It was founded in 2007 as the first SHOK with the idea of renewing the forest cluster by new forms of networking and boosting high quality research and innovation.

Unlike in the fields of many other SHOKs, in forest industry the cluster and its value chains have existed a long time, key constituents are multinational enterprises, research infrastructures and professorships exist, research traditions are strong and research funding considerable. The key challenges in forest industry are related to the profitability of the existing industry and secondly to the renewal of the forest sector, business reorientation and consequently research reorientation.

The practical work has been carried out through three sets of research programs: one set of programs aimed at rapid results in incremental research of traditional forest industry, whereas the second set pursued towards the new concept of future biorefining. The third program set is an umbrella for marketing and business model innovations.

Due to the structure of the sector and the age of FIBIC, the research has already advanced to a point where there are tangible results in the form of ideas, invention reports, publications and patents. However, at the moment there is no clear pathway for these results out of the programs. In the analysis conducted for the evaluation of FIBIC (Lähteenmäki-Smith et al., 2013), the utilization of the results was seen highly problematic due to IPR issues by almost every company interviewee.

Many of the industry interviewees were of the opinion that because of common rights to results, there is no incentive for companies to commercialize the results, and there is a serious threat that many of the results obtained in the programs will *not* be taken further. This is exactly the reverse tragedy of commons that is enabled by commonly produced IPR becoming a public good (P1).

It can even be stated that in the radical renewal sector of the industry (biorefining etc.) four out of five factors proposed to exacerbate the reverse tragedy, hold, namely:

- Technology is moving fast (P2a)
- Markets are highly volatile (P2b)
- R&D costs are high (P2d)
- Enterprises are, on the average, well resourced (P2e).

A further explaining factor for the situation is the total absence of first mover advantage. First, forest companies are reluctant to commit to new technologies and products as the markets are still unclear. A better strategy is to wait and see how the rival will succeed. Chemical and equipment suppliers, on the other hand, cannot exploit the FMA since they do not even know what their clients wish to produce in the future.

They also hold for new productions methods and products in the conventional forest industry, like nanocellulose and foam forming. For incremental development in conventional fields, only P2e and partly P2d are accentuated.

Besides the reverse tragedy of commons, the situation also has other consequences. First, unclearly perceived and unresolved IPR issues also hinder new openings in interesting matters – companies do the research rather by themselves. In the interviews there was clear evidence that due to common exploitation of the results, most important topics from the competitive edge point of view are not brought to the common table. Consequently, heavy competition over the best available research resources takes place behind the scenes. This competition naturally affects also SHOK research since best groups cannot necessarily participate in common research programs.

Second, the situation drives the research easily from pre-competitive to commercializable research. Namely, the results of pre-commercial research produce competitive effects in companies only with a certain probability and a lag of several years. Company representatives, especially those lower in value chains, seem to find it increasingly difficult to justify the SHOK activities to their top management as year after year there are no tangible results. Therefore, proving the true relevance of the results inside the company is difficult, and the temptation to move to applied research is evident. This exacerbates the reverse tragedy of commons further.

To summarize, it was stressed by numerous interviewees that IPR issues are a major obstacle for the possible commercialization of results. The fact that results are usable by every programme partner indefinitively means that there is no incentive for commercialization. Some promising results may even become not utilized. The problems are accentuated by the diminishing number of companies in the business. On the other hand, it is possible that companies see the added value of the SHOK too narrowly, being only the IPR.

Finally, it should be noted that these conclusions are most likely not in any relation to how FIBIC has been managed. They seem to relate more to FIBIC’s maturity and the structure and cycle of the business. Hence, unless the reverse tragedy of commons is somehow resolved, similar challenges will most likely be finally met in all of the other SHOKs, too.

Table 3: Summary on interviews

<table>
<tr><th>Informant/source</th><th>Statements relevant IPR, incentives and commercialization</th><th>Emerging themes</th></tr>
<tr><td>Large forest enterprises</td><td>• Once a research program is running, how does one spin out common IPR? These difficulties may prove critical as companies want to have results for themselves.
• Truly interesting research is done by companies themselves
• Behind the scenes, there is fierce rivalry on best research resources..</td><td rowspan="5">• Clear IPR underutilization and its possible consequences:
• Lack of commitment
• Avoiding truly interesting topics in common research</td></tr>
<tr><td>Chemical and equipment suppliers</td><td>• Shok concept has proven less efficient than expected
• Real development is not brought into Fibic but is done elsewhere
• IPR issues are a nightmare and bottleneck No1. Common ownership of results does not work.
• This also reflects to general commitment, as the concept must be sold internally to the top management each year.
• Too much openness hinders commercialization which is, per se, the most difficult part.</td></tr>
<tr><td>Academia</td><td>• They do not see the IPR as an issue – but have been forced to learn the rules so as not to break them.
• Protection by publishing [which in fact worsens the situation]
• Companies do not bring topics relevant to competitive edge into Fibic</td></tr>
<tr><td>FIBIC</td><td>• Cartel history one significant source of challenges in the level of cooperation
• Companies are reluctant to tell what they really do
• There are IPR issues. One should develop a mechanism how to utilize patents and invention reports arising from common research. Free license to utilize does not work.
• The step from research programme to company based activities is difficult</td></tr>
<tr><td>Panel meetings, five senior researchers, interviewing SHOK managers, program directors, researchers and boards members in separate sessions. (Altogether approximately 20 interviewees plus 5 panelists)</td><td>• It is not clear how to move from pre-competitive to competitive research objectives within the FIBIC SHOK
• The IPR issues seem not to have been resolved completely.</td></tr>
</table>

Case B: DIGILE

At the time of the data collection DIGILE, then TIVIT, was running six programs with similar consortia made up of enterprises large and small and research institutes. The distinguishing feature in DIGILE is that each program has its own Strategic Research Agenda it aims to implement. (for details of the programs, please refer to the publicly available evaluation report Lähteenmäki-Smith et al., 2013)

The first finding is that the DIGILE programs have produced relatively few IPRs compared to other public RDI interventions of the same volume. In the case of DIGILE for example, the preceding Tekes program for the IT and telecom industry has a similar volume and runtime, and produced a considerably larger amount of IPRs. The SHOK evaluation notes that the "Tekes technology programme 'GIGA – Converging Networks' (2005–2010)63, GIGA had a similar volume (Tekes funding to the program was 99 MEUR out of total 279MEUR volume, that is 20MEUR per year, roughly equivalent to [DIGILE, formerly TIVIT] funding from Tekes) and many of the same actors as [DIGILE], yet it produced more outputs than [DIGILE] for the same funding; during its six years GIGA programme resulted in excess of one thousand patents, and some of the largest enterprise projects alone generated up to one hundred patents, while TIVIT research has resulted in five invention disclosures and patents in 2011 and 2012." (Lähteenmäki-Smith et al., 2013, p. 186)

The main explanation offered for this observation was that SHOK program was set to bridge the gap between academia and industry, and thus the bulk of the RDI activities would be in the precompetitive and pre IPR registration phase. However, the DIGILE documents, and interviewees across the board from within DIGILE itself to stakeholders indicated that the programs are innovation-oriented as opposed to research focused. Further, the program participants indicated that they knew of cases where enterprises ran private self-funded or publicly subsidized RDI programs to develop innovations based on the ideas from the actual SHOK programs. Thus the explanation in internally conflicting and supports the suggestion that there are incentive problems.

In general if we look at DIGILE, the propositions are to a large extent supported, as:

- Technology is moving fast (P2a)
- Markets are volatile (P2b)
- R&D costs are high (P2d)
- Several well-resourced enterprises are involved (P2e).

However, in DIGILE we cannot find a clear cut case of the reverse tragedy of the commons. While not a direct support to the phenomenon, it provides reinforcement to the notion that the coercive open innovation regime does pose incentive problems for the enterprises. The response of the perceived challenge posed by T&C in terms of IPR are handle by faux-collaborative behaviors in the programs. The interviews suggest that the programs exhibit one or several of the following behaviors; nominal investment to a program or participation-in-name-only, who are perceived by other partners as 'Trojan horses' installed to acquire interesting IPR; staffing the collaborative project with second tier RDI employees; and running private parallel projects to enable private elaboration of interesting research directions in an appropriable format.

Table 4: Summary on interviews

Informant/source	Statements relevant IPR, incentives and commercialization	Emerging themes
DIGILE	• Programs have a position in creating platforms/scalable ecosystems • IPRs less sensitive as activities focused outside daily business • IPRs are more sensitivite for small-to-medium enterprises (SMEs), which may depend on one invention	• The T&C that set-up a coercive open innovation regime pose perverse incentives for both registering IPR and commercialization • The issue is sensitive for SMEs, because they rely on narrow IPR base, and for large enterprises because of the risk unwanted spill overs • The competing interests for research agenda and co-opetitive relationships within consortia amplify the IPR issue
Funding organizations	• Suggestions that the programs serve as a venue for idea exchange and RDI is done privately • There is a risk that large (multinational) enterprises gather IPRs and spread them around	
Large enterprises	• T&C for IPR is challenge for committing enterprises • The T&C are a strong disincentive for contributing to the RDI, the present terms do not allow any appropriability • The model does not handle competing interests in the consortium; works as long the consortium is aligned behind one interest • The terms inhibit especially SME participation	
RDI director and SHOK program participants (2 persons), SME software and service	• Large enterprises dominate the agenda, every participant have their own agendas, programs are focused on things that would not be developed otherwise (non-core RDI) • Freeloading is common in the programs (participants commit in name only, with a few working days to monitor programs and get a license to whatever IPR emerges) • Commercialization is challenging duo to the joint venture –nature of RDI	
Academia	• The SHOKs operate uncomfortably close to commercialization, enterprises do not share their best ideas and efforts in the programs • IPRs are a constant source of friction in the programs	
Panel meetings, five senior researchers, interviewing SHOK managers, program directors, researchers and boards members in separate sessions. (Altogether approximately 20 interviewees plus 5 panelists)	• The panel concluded based on hearings that IPR registration, if not creation was substantially hampered by mandatory IPR sharing	

Cross Case Analysis and Findings

Output of the program

These findings suggest that there is an incentive problem for producing IPR and/or commercializing the results of the collaborative RDI. The finding that coercive open innovation regime introduces perverse incentives for participation is robust across the examined cases. However, as we have observed, the information-as-a-public-good problem has not created a reverse tragedy of the commons in all the SHOKs. In the case of DIGILE, the 'waiting game' has been avoided as the partners have engaged in their own side projects to commercialize aspects of the collaborative research. It seems that FIBIC stakeholders adhere more strictly to the letter and spirit of the Terms and Conditions of the program, and thus have run into the incentive problem head on.

One explanation for the difference between the SHOKs may be that the balance of power in the programs. The DIGILE programs for the period have been generally built around a lead enterprise i.e. a network engine, according to the interviews, and the individual programs do not involve large enterprises which are in direct competition. On the contrary several of the FIBIC programs involve large multinational enterprises who are in direct competition in their core business areas and their mutual suppliers and technology partners. It seems that in this case, the major drivers for the reverse tragedy of the commons are the co-opetitive relationship between the enterprises and the resulting first mover advantage problem. We may go so far as to suggest that the risk of the tragedy of the commons invokes the reverse tragedy. The more moderate instance of the "tragedy" in DIGILEs case can be also partly attributed to the behaviors to circumvent the IPR problem.

Other explanations for the differences between SHOKs may be path dependence, general perception of risk and ability to take risk. First, IT industry is generally more RDI intensive that forest-based industries, technology and product/service cycles are shorter and new businesses are created more often. Second related factor is risk perception and magnitude, namely taking for example programs Future Biorefinery (FIBIC) and Future Innovative Services (DIGILE) the investment to commercializing the concepts developed and tested in RDI differs by not one, but by two or even several, orders of magnitude.

Based on these findings, we argue that the features of the programs are one facet of explanation, as the co-opetetitive setting together with the coercive open innovation regime creates disincentives for commercialization. In essence we argue that as the consortium members have an unlimited access to the IPR, even if it would be owned by a single partner or a group of partners, any attempt to commercialize inventions would require additional investments with a risk of failure. Further as noted in the case of FIBIC, is that even though IPR transfer would be possible, the clause that such transaction should be made at "market price" is quite tricky in the case of really new innovations as there might not be a market to determine the price.

Industry characteristics

As discussed, the so-called first mover advantage depends on market and technology change, and any first mover especially in a totally new business area faces a large risk of failing altogether and in any case bears the significant cost of trying to create a market. However, if one partner would try and succeed in creating a proven new business or product category, there is a significant risk that other consortium members follow with competing product to share the market. These followers first of all benefit from the first movers efforts to create a new segment, and secondly they can benchmark the initially dominant design and improve based on initial customer experience.

In the case of FIBIC the forest-based cluster and its value chains have existed a long time, key players are large multinational enterprises, research infrastructures and academic seats exist, research traditions are strong (but traditionally rather efficiency related RDI topics than creation of new business areas due to the fierce competition in the traditional forest industry markets) and investments to RDI are considerable. This also indicates that the core technology and business are mature. In this sense, the role of the SHOK is fundamentally different compared to younger industries: whereas these SHOKs even have to struggle with cluster formation and research infrastructure creation, the key challenges in forest industry are related to the profitability of the existing core business and secondly to the renewal of the forest sector, business reorientation and consequently research reorientation. The maturity of industry might indicate a 'stale' situation where first mover advantage would be attainable in principle, but in even in FIBICs case there are really new or radical concepts, especially in the Future Biorefinery project, which exhibits significant technological and market risk, creating a perfect storm of circumstances to introduce a 'waiting game' between the partners.

Table 5: Market analysis

Market factors that risk escalation of competition	**FIBIC**	**DIGILE**
Main target market for the RDI outputs	Bio-based products, including liquid fuels "bio-fuels"	Digital business and consumer services, digital service infrastructures
P2a: fast moving technology, short product cycle	Bio-technology is science-based and R&D intensive. R%D cycle is long, but move relatively fast compared to the industry standard	Historically technology development has been fast
P2b: volatile markets	The market size is hard to predict, however it is assumed to be growing	Overall the market for IT is growing steadily, fast changes within and between segments
P2c: high R&D cost	Moderate-high R&D cost, high investment cost	Moderate R&D cost, low to moderate investment in digital services
P2d: well-resourced enterprises	Many large multinational enterprises	Large multinational enterprises, SMEs

Discussions

To summarize the findings, both of the examined cases exhibit traits that support the rise of the reverse tragedy of commons. Our argument in essence is that when an open innovation network shares IPRs for all RDI results and there is a risk for escalation of competition, the incentives may result in a 'stalemate' or a 'waiting game' where the partners are averse toward commercializing the results because of expected low return on risk. The empirical findings are that the coercive open innovation regime creates a condition where IPRs are effectively public goods, at least within the consortium, which in turn creates a disincentive for producing IPR in the first place, and commercializing it. Also the market conditions in both cases conform to the propositions for conditions where the reverse tragedy may arise. However the two cases differ slightly in their response to these conditions. We propose that that the difference may be explained by consortium characteristics. Comparing FIBIC and DIGILE, in the latter case the programs have less equally strong direct competitors, and there are more indications of behaviors to circumvent the reverse tragedy.

The alternative explanations for this behavior might be e.g. difficulties of overcoming organizational inertia, e.g. the not invented here –syndrome, integrating the RDI results to internal RDI, strategic alignment between consortium research and internal RDI and corporate strategy (e.g. Dahlander & Gann, 2010; West & Bogers, 2011; West & Gallagher, 2006). This exploratory account cannot comprehensively rule out all alternative explanation, but the findings presented above suggest that the IPR appropriability is the major explanation, as the enterprises engage in behaviors to appropriate the results and while the IPR issues arose as a major theme in the interviews, there we not indications that organizational inertia would be the reason for not commercializing.

An acid test for the findings is to ask the question "why would rational decision makers enter into the agreement knowing the terms and conditions, and then not reap the benefit for the investment to RDI?" One explanation for this seemingly unrational behavior lays the development path of the program. In the interviews of officials who were knowledgeable of the founding of the program indicated that the program and the T&C took shape after initial commitment. The decision makers operated with the best knowledge they had at the time while the instruments was still shaping, not necessarily possessing full knowledge of what the instrument turned out to be. 'Promises were made' and so forth and, according to the interviews, the notification of the funding instrument in European Commission[6] was not an easy one and has likely had an impact to the T&C. Another, related explanation is in the national context the exceptional (originally intended and later largely realized) funding volume and commitment of several industry players have likely created a strong pressure to join the program, not unlike the 'feeding frenzy' for biotech in early 2000s (DeFrancesco, 2003). Thus it is likely these circumstances have created a situation where enterprises have committed to an agreement before knowing exactly what the exact terms would be, paving the way to the observed dilemma.

Additional factors that have induced commitment to the SHOK program are illuminated by the interviews. One is an observed attitude that because in the circumstances described above the key enterprises from the respective industries committed early, others "could not afford" not to join the network in the fear that

[6] Under European Union legislation, particularly the Treaty on the Functioning of the European Union Article 108 (European Council, 2008) and the associated Council Regulation (European Council, 1998) as well as the State Aid Framework for Research & Development & Innovation (European Commission, 2006), all public funding interventions to functioning of markets including RDI instruments have to be notified to the Commission to ensure their adherence to the TFEU Rules on Competition.

others can develop a competitive edge. Another is that one of the fundamental objectives for the SHOK program was to bridge scientific research and commercial development, and some participants were genuinely hopeful to get a competitive advantage through new RDI initiatives and networks. .Thirdly we may hypothesize that the sheer volume of funding in itself acted as an incentive as well. Typically it seems that the SMEs and less RDI intensive enterprises have joined for the first reason, while some of the large enterprises primarily for the latter two.

Another acid test is to ask the question “are the result of the RDI projects truly valuable?” We have interpreted the findings from the cases with the assumption that the RDI investment has resulted in commercially valuable outputs. The self-reported data support the proposition that the outputs are valuable. However, the additional question is that are they valuable enough compared to the counterfactual situation where the same knowledge would have been created in private RDI. Namely, based on the theoretical discussion, we can hypothesize that co-owned or open RDI would have to be more valuable than private precisely because it is open and thus the risk/return equation is unbalanced from a commercial point of view. We can propose additionally that when it comes to commercializing the results there might be organizational friction in implementing inbound open innovation, including the ‘not invented here’-syndrome, lack of absorptive capacity or search routines and processes to integrate outside knowledge to internal RDI (Chiaroni, Chiesa, & Frattini, 2010; Dahlander & Gann, 2010; Spithoven, Clarysse, & Knockaert, 2011) or just common timing in view of corporate strategy and existing RDI pipeline. However, these factors do not overturn the reverse tragedy of commons, but rather illuminate another path to finding an explanation for it in the organizational behavior.

Further reinforcement for the empirical account can be found from similar or adjacent conclusions presented by Annala and Ylä-Jääski (2011a, 2011b), who evaluated the SHOKs under the auspices of the Confederation of the Finnish Technology Industries (Teknologiateollisuus), and concluded that handling IPR in broad-based SHOK consortia is a challenge and to some extent inhibits participation. The alternative responses to these challenges they observed include also non-participation altogether especially in projects that run close to core business or core competence, in addition to the ones discussed above. These findings reinforce conclusions about the incentive problem posed by the coercive open innovation regime, i.e. mandated IPR sharing.

The present research has, until quite recently (e.g. Felin & Zenger, 2013), scarcely recognized the relationship between appropriability conditions and nature of technological and market change and benefits from open innovation. West and Bogers (2011) go as far as writing that research on “potential moderators of inbound open innovation success is almost non-existent” after conducting an extensive review of the published literature. The bulk of open innovation research has concentrated on describing open innovation instances through historical or cross-sectional analysis of collaboration and particularly on the benefit or promise of open innovation, and lately also defining the ‘rich’ but vague concept of open innovation (Dahlander & Gann, 2010; Huizingh, 2011; West & Bogers, 2011). The aggregate findings are that open innovation, especially inbound open innovation i.e. acquisition of knowledge and resources from partners provides leverage for internal RDI, but outbound open innovation, i.e. revealing or licensing, happens when an enterprise cannot commercialize or otherwise utilize the IPR (Dahlander & Gann, 2010; Leiponen & Helfat, 2010). Our findings are more related to governance of (Felin & Zenger, 2013) and incentives for open innovation (Simeth & Raffo, 2013).

Even though the findings of benefits from open innovation seem to be robust across different contexts (H. Chesbrough & Brunswicker, 2013; Dahlander & Gann, 2010; Laursen & Salter, 2006; van de Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009), based on this exploratory account, it seems that at least incentives to engage in open collaboration depend on these industry conditions and it is likely that the impact of opening up innovation will as well. The implication to research is that the industry conditions may moderate the benefits of opening up innovation process and affect what are the optimal forms of open innovation.

While one cannot readily derive what ought to be from what is, the main implication to practice would be to consider the external industry conditions side by side the internal conditions of technology path, absorptive capacity, integration of external knowledge and other facets of managing open innovation (Felin & Zenger, 2013; van de Vrande et al., 2009; West & Bogers, 2011) when deciding how to engage in open innovation. Similar findings have been presented by Simeth and Raffo (2013) who examined Open Science[7] practices and concluded that appropriability regime is an important consideration when deciding on disclosure.

These findings and their direct implications are of course primarily limited to coercive open innovation regimes set up by RDI or industrial policy. In purely voluntary industrial networks these behaviors are less likely. However there may be special cases where some of the observed behaviors may arise in voluntary open innovation as well, we propose that if one enterprise is substantially larger than its network partners and others “cannot afford” not to deal with the network engine.

As for the implications to practice or policy, the problem is that substantial resources, time, money, human resources, are committed to activity that does not lead to innovation and thus the partnership may actually hinder the industry in the short to medium term. Further, in the examined cases the outputs of research are not completely public goods outside the consortium, they are still exclusive for outsiders, which makes the problem all the deeper as the partial appropriability excludes the outputs from public consumption and thus negates positive externalities. Thus the first implication primarily for policy is that while setting up open innovation regime is a worthy goal, there are severe challenges. The immediate alternatives would be either completely open of closed models.

In completely open model, where all results materials are public, the externalities are the greatest even if there would be the least direct impact. However, going back to the discussion on competitive advantage, it may be unrealistic to expect industry participation on completely open innovation networks and the participants would have all the less incentive to conduct core research in an completely open program and further to commercialize the research outputs. In fact we may suggest that the traditional system of public research and private R&D constitutes such an environment in the broad sense and it has been generally recognized that the IPRs that are public goods are not effectively utilized by the industry.

In the other end of the spectrum, closed consortia organized around one value chain are likely the most effective in terms of impact as the incentives are best aligned for collaboration and commercialization.

---

[7] Open Science in general is a concept similar to open innovation, but applied to the scientific field, aimed to promote transparency of research and public dissemination, including practices such as data sharing and sharing of primary record of research ‘open notebook science’ as well as open access publishing (Gezelter, 2009). In this context t entails scientific publishing of results from privately funded research in public scientific outlets.

However this model has the least externalities and conceivably can lead to creation of local monopolies or at least oligopolies if we assume that the policy instruments are effective in the first place and the subsidies are not distributed randomly and or evenly across value networks within the economy.

Conclusion

This paper presented an exploratory empirical account of incentives for underexploitation in an open innovation setting. The stakeholders do not exploit the resource or underexploit it, because of its properties as a public good. In sum, our argument is that when information or IPR is a public good between the co-opetitive stakeholders and the industry conditions give rise to risk of escalation of competition and thus extensive risk, stakeholders tend to prefer not commercializing results. These conditions then will induce the reverse tragedy of the commons, named so graphically, because such an event is not only costly in terms of time and resources, but can in fact render IPR effectively worthless in terms of commercial exploitation. This occurrence can effectively block innovation between the partners in the short to medium term.

These propositions found support from the empirical observation of open innovation regimes set by a centers of excellence program[8], branded the Strategic Centres of Science, Technology and Innovation, set up to bridge the gap between (basic) research and innovation within key industries in Finland.

The main contribution of this paper is that it outlines a new phenomenon, that is important both for research of innovation, especially in the open innovation research stream, as well as for business and public policy making. Open innovation (OI) is a name coined and promoted by Chesbrough (2003) for a collection of ideas about information exchange and collaboration in innovation, which can be reduced to the main underlying argument that if enterprises would collaborate and share knowledge and thus share risk more readily in their research, development and innovation (RDI) they would be able to extract more value from their RDI.

Recent reviews of open innovation literature, much of the research has discussed the (potential) benefits of open innovation in general, described cases, and tried to define the concept. In terms of the process the focus has been largely on the effectiveness of acquiring and integrating external knowledge to RDI (Dahlander & Gann, 2010; Huizingh, 2011; West & Bogers, 2011). We contribute to the nascent stream of governance of open innovation in organizations (Felin & Zenger, 2013), highlighting the importance of industry conditions in general and appropriability in particular as a determinant for open innovation success.

This finding is pertinent especially for designing RDI policy measures that aim to foster collaboration. It seems that depending on the industry characteristics and market conditions, forcing knowledge sharing on partners will not have a positive effect on innovation. As for managerial implications, the findings highlight the need to include industry, market and technology conditions into the decision how to commit to open innovation.

---

[8] We use the term "center of excellence" in the generic sense, not to be confused with the specific instance of Centres of Excellence funded by The Academy of Finland.

References

Amit, R., & Schoemaker, P. J. H. (1993). Strategic assets and organizational rent. *Strategic Management Journal*, *14*(1), 33–46. doi:10.1002/smj.4250140105

Annala, K., & Ylä-Jääski, J. (2011a). *The Strategic Centres for Science , Technology and Innovation (SHOKs) CLEEN, FIMECC, Forestcluster and TIVIT from the Company Perspective - Executive Summary*. Helsinki, FI: The Federation of Finnish Technology Industries.

Annala, K., & Ylä-Jääski, J. (2011b). *Strategisen huippuosaamisen keskittymät CLEEN, FIMECC, Metsäklusteri ja TIVIT yritysnäkökulmasta* (p. 52). Helsinki, FI: The Federation of Finnish Technology Industries.

Bresser, R. K. F. (1988). Matching Collective and Competitive Strategies. *Strategic Management Journal*, *9*(4), 375–385.

Cadot, O., & Lippman, S. A. (1995). Barriers to Imitation and the Incentive to Innovate. *INSEAD Working Papers*. Fontaineblau, FR.

Chesbrough, H., & Brunswicker, S. (2013). *Managing Open Innovation in Large Firms - Survey Report - Executive Survey on Open Innovation* (p. 40). Stuttgart, DE: Fraunhofer Verlag.

Chesbrough, H. W. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology* (p. 227). Cambridge, MA: Harvard Business Press.

Chiaroni, D., Chiesa, V., & Frattini, F. (2010). Unravelling the process from Closed to Open Innovation: evidence from mature, asset-intensive industries. *R&D Management*, *40*(3), 222–245. doi:10.1111/j.1467-9310.2010.00589.x

Dahlander, L., & Gann, D. M. (2010). How open is innovation? *Research Policy*, *39*(6), 699–709.

DeFrancesco, L. (2003). Little science, big bucks. *Nature Biotechnology*, *21*(10), 1127–9. doi:10.1038/nbt1003-1127

Dierickx, I., & Cool, K. (1989). Asset Stock Accumulation and Sustainability of Competitive Advantage. *Management Science*, *35*(12), 1504–1511. doi:10.1287/mnsc.35.12.1504

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory Building from Cases: Opportunities and Challenges. (A. M. Huberman & M. B. Miles, Eds.)*Academy of Management Journal*, *50*(1), 25–32. doi:10.2307/20159839

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: what are they? *Strategic Management Journal*, *21*(10-11), 1105–1121. doi:10.1002/1097-0266(200010/11)21:10/11<1105::AID-SMJ133>3.0.CO;2-E

Enkel, E., Gassmann, O., & Chesbrough, H. (2009). Open R&D and open innovation: exploring the phenomenon. *R&D Management*, *39*(4), 311–316. doi:10.1111/j.1467-9310.2009.00570.x

European Commission. Community framework for state aid for research and development and innovation. , C 323 Official Journal of the European Union 1–26 (2006). European Union: EUR-LEx.

European Council. Council Regulation (EC) No 994/98 of 7 May 1998 on the application of Articles 92 and 93 of the Treaty establishing the European Community to certain categories of horizontal State aid. , 142 Official Journal of the European Union 1–4 (1998). European Union: EUR-Lex.

European Council. Treaty on the Functioning of the European Union - Part Three: Union Policies and Internal Actions - Title VII: Common Rules On Competition, Taxation And Approximation Of Laws - Chapter 1: Rules on competition - Section 2: Aids granted by States. , 115 Official Journal of the European Union 92 (2008). European Union: OPOCE.

Felin, T., & Zenger, T. R. (2013). Closed or open innovation? Problem solving and the governance choice. *Research Policy*. doi:10.1016/j.respol.2013.09.006

Finney, R. Z., Lueg, J. E., & Campbell, N. D. (2008). Market pioneers, late movers, and the resource-based view (RBV): A conceptual model. *Journal of Business Research*, *61*(9), 925–932.

General Terms and Condition for SHOK Research Programme Funding. (2012). Helsinki, FI: Finnish Funding Agency for Technology and Innovation - Tekes.

Gezelter, D. (2009). What, exactly, is Open Science? *The OpenScience Project*. Retrieved November 12, 2013, from http://www.openscience.org/blog/?p=269

Golder, P. N., & Tellis, G. J. (1993). Pioneer Advantage: Marketing Logic or Marketing Legend? *Journal of Marketing Research*, *30*(2), 158. doi:10.2307/3172825

Hoppe, H. C., & Lehmann-Grube, U. (2001). Second-Mover Advantages in Dynamic Quality Competition. *Journal of Economics & Management Strategy*, *10*(3), 419–433. doi:10.1111/j.1430-9134.2001.00419.x

Huizingh, E. K. R. E. (2011). Open innovation: State of the art and future perspectives. *Technovation*, *31*(1), 2–9. doi:10.1016/j.technovation.2010.10.002

Kortelainen, S., Piirainen, K., Kärkkäinen, H., & Tuominen, M. (2011). Dependency between learning and profitability in different industry conditions: a system dynamic simulation. *International Journal of Business Innovation and Research*, *5*(2), 229–253. doi:10.1504/IJBIR.2011.038783

Laursen, K., & Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, *27*(2), 131–150. doi:10.1002/smj.507

Leiponen, A., & Helfat, C. E. (2010). Innovation objectives, knowledge sources, and the benefits of breadth. *Strategic Management Journal*, *31*(2), 224–236. doi:10.1002/smj.807

Lähteenmäki-Smith, K., Halme, K., Lemola, T., Piirainen, K., Viljamaa, K., Haila, K., … Georghiou, L. (2013). *"Licence to SHOK?" - External Evaluation of the Strategic Centres for Science, Technology and Innovation* (No. 1/2013). *MEE Publications* (p. 405). Helsinki, FI: Ministry of Employment and the Economy.

Nalebuff, B. J., & Brandenburger, A. M. (1997). Co-opetition: Competitive and cooperative business strategies for the digital economy. *Strategy & Leadership*, *25*(6), 28–35. doi:10.1108/eb054655

Pacheco-de-Almeida, G. (2010). Erosion, time compression, and self-displacement of leaders in hypercompetitive environments. *Strategic Management Journal*, *31*(13), 1498–1526. doi:10.1002/smj.896

Palys, T. (2008). Purposive Sampling. In L. M. Given (Ed.), *The Sage Encyclopedia of Qualitative Research Methods* (Vol. 2, pp. 697–698). Thousand Oaks, CA: Sage Publications.

Peteraf, M. A. (1993). The cornerstones of competitive advantage: A resource-based view. *Strategic Management Journal*, *14*(3), 179–191. doi:10.1002/smj.4250140303

Peteraf, M. A., & Barney, J. B. (2003). Unraveling the resource-based tangle. *Managerial and Decision Economics*, *24*(4), 309–323. doi:10.1002/mde.1126

Robinson, W. T., Kalyanaram, G., & Urban, G. L. (1990). First-Mover Advantages from Pioneering New Markets: A Survey of Empirical Evidence. *Review of Industrial Organization*, *9*(1), 1–23. doi:10.1007/BF01024216

Scherer, F. M. (1980). *Industrial Market Structure and Economic Performance* (2nd ed.). Chicago, IL: Rand McNally.

Simeth, M., & Raffo, J. D. (2013). What makes companies pursue an Open Science strategy? *Research Policy*, *42*(9), 1531–1543.

Spithoven, A., Clarysse, B., & Knockaert, M. (2011). Building absorptive capacity to organise inbound open innovation in traditional industries. *Technovation*, *31*(1), 10–21. doi:10.1016/j.technovation.2010.10.003

Stiglitz, J. E. (1999). Knowledge as a Global Public Good. In I. Kaul, I. Grunberg, & M. Stern (Eds.), *Global Public Goods: International Cooperation in the 21st Century*. New York, NY: Oxford University Press. doi:10.1093/0195130529.003.0015

Suarez, F. F., & Lanzolla, G. (2007). The Role of Environmental Dynamics in Building a First Mover Advantage Theory. *Academy of Management Review*, *32*(2), 377–392.

Suarez, F., & Lanzolla, G. (2005). The Half-Truth of First-Mover Advantage. *Harvard Business Review*, *83*(4), 121–7, 134.

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy*, *15*(6), 285–305.

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*(13), 1319–1350. doi:10.1002/smj.640

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509–533. doi:10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

Tellis, G. J., & Golder, P. N. (1996). First to Market, First to Fail? Real Causes of Enduring Market Leadership. *Sloan Management Review*, *37*(2 (Winter 1996)), 65–76.

Tong, A., Sainsbury, P., & Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*, *19*(6), 349–57. doi:10.1093/intqhc/mzm042

Van de Vrande, V., de Jong, J. P. J., Vanhaverbeke, W., & de Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, *29*(6-7), 423–437. doi:10.1016/j.technovation.2008.10.001

West, J., & Bogers, M. (2011). Profiting from External Innovation: A Review of Research on Open Innovation. In *9th International Open and User Innovation Workshop*. Vienna, AT. doi:10.2139/ssrn.1949520

West, J., & Gallagher, S. (2006). Challenges of open innovation: the paradox of firm investment in open-source software. *R&D Management*, *36*(3), 319–331. doi:10.1111/j.1467-9310.2006.00436.x

Winter, S. G. (2003). Understanding dynamic capabilities. (C. E. Helfat, S. Finkelstein, W. Mitchell, M. A. Peteraf, H. Singh, D. J. Teece, & S. G. Winter, Eds.)*Strategic Management Journal*, *24*(10), 991–995. doi:10.1002/smj.318

Yin, R. K. (2003). *Case Sudy Research* (3rd ed.). Thousand Oaks: Sage Publications.

Zollo, M., & Winter, S. G. (1999). From organizational routines to dynamic capabilities. *Working Paper of the Reginald H Jones Center*. Philadelphia, PA: The Wharton School, University of Pennsylvania.