Appropriating the Commons: Firms in Open Source Software

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Appropriating the Commons: Firms in Open Source Software

Abstract:
Firms in open source software (OSS) are active in a field encompassing all the characteristics of a public good, given the non-excludability and non-rivalry nature of OSS. As the case of OSS demonstrates, the fact that many important inputs to the innovative process are public should not be taken to mean that innovators are prevented from capturing private returns. The objective of this paper is to explore how firms appropriate returns from innovations that are created outside the boundaries of firms and in the public domain using the case of OSS. To do so, the paper draws upon an explorative multiple case study of six small firms that attempt to appropriate returns from OSS, with rich empirical evidence from various data sources. The cases illustrate how firms try a variety of approaches to appropriate adequate returns and that selling services seem to be the dominant trend. Firm also balance the relative inefficiency of traditional means of intellectual property right such as patents by putting greater emphasis on first mover advantages and creating network externalities.

Key words:
Appropriability regimes, appropriating returns, public goods, collective action, open source software

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1. Introduction

The existence of firms in open source software (OSS) establishes a puzzling phenomenon. These organizations for-profit are OSS firms, and yet, are active in a field encompassing all the characteristics of a public good, given the non-excludability and non-rivalry nature of OSS. Indeed, OSS is mainly maintained and improved by developers and users that voluntarily divulge their efforts to others, and hence, have a joint and genuine interest in making the fruit of their labor free and publicly available. But, as authors such as Nelson (1989) and Callon (1991) correctly point out, knowledge is neither completely public nor private. Firms combine in-house expertise with the *inventive* activity in the OSS community to create *innovations*.

Therein lays the key to solving the mystery. As the case of OSS demonstrates, the fact that many important inputs to the innovative process are public should not be taken to mean that innovators are prevented from capturing private returns. But because the OSS community protects the commons from being depleted by commercial firms, firms that attempt to appropriate returns from OSS ought to use different strategies to appropriate returns than in private goods.

The objective of this paper is to explore how firms appropriate returns from innovations that are created outside the boundaries of firms and in the public domain using the case of OSS. Put differently, the paper will analyze the following research questions;

> Research question 1: How do firms involved in OSS appropriate returns?
> Research question 2: How are these strategies related to different ways of protecting knowledge?

This explorative study can give insight into the problems of appropriating returns from industries with blurred boundaries between public goods and private investments. To do so it builds upon case studies of six firms in Sweden and Finland that in various ways are active within OSS.

The paper is structured as follows. Section 2 gives a brief overview and history of the OSS phenomenon. Thereafter, Section 3 draws out the theoretical background with respect to blurred boundaries between private investments and collective action towards a public good, and the important issue of appropriation and appropriability. The research design and methodological choices are explained in Section 4, whereas Section 5 outlines the empirical results from the case studies. Section 6 discusses the findings in relation to the aim of the study and previous studies. Section 7 concludes.

2. A brief history of OSS

In OSS, the source code for a piece of software is made open and available for anyone to screen. Software developers write software in a source code and document it with explanations and clarifications of how it works. These lines of source code are compiled into binary form (machine instructions consisting of ones and zeros), which get the software to work on the computer. The binary code is much harder for developers to read and interpret, compared to the source code. Herein, is the difference between 'open' and 'closed' software, as OSS allows you to view the source code, interpret, make changes

and thereafter compile if needed. This is different from the proprietary way within the software industry where the source code among commercial vendors is protected by against modification by property rights as well as by their own code (Lessig 1999). In addition to that OSS is open and made public, the definition includes statements of the right to use and redistribute and that the license must not restrict other software and no discrimination against fields of endeavor (The Open Source Definition 2003).

The tensions between property right claims, the OSS community and firms can be seen in the history of OSS at universities and government laboratories in the US, where open code was the norm. After a commercial firm changed the previously freely and openly available operating system UNIX to become proprietary software, the very talented programmer Richard Stallman founded the GNU (recursive acronym for GNU's Not UNIX) project in 1984. This was a reaction of the tension between the advocates of open source and commercial firms that wanted to use the code in proprietary software. Stallman and others started the free software foundation (FSF) to ensure that the GNU-project remained publicly available and it was clearly stimulated by how the academia works with scientific research, peers that evaluate progress, and diffusion of ideas (Raymond 1999). The individuals within the free and open source movement have thus used legal and normative mechanisms to ensure that the code remained free and publicly available (O'Mahony 2003), and thereby hinder that firms make small changes in the software and sell it to a third party. These legal mechanisms include licenses which states how the software can be used and non-profit foundations that governs projects. The most commonly used license is the General Public License (GPL), but a multitude of different licenses exists that to a varying degree allows the user to fit the code after the purposes and commercialization of follow-on inventions (Lerner and Tirole 2002). The programmers of a new piece of software can decide which conditions that follower users and developers have to obey. Even though it is possible to create own licenses, the vast majority of the projects use one of the well established licenses. The GPL-license is very strict in terms of its requirement for asking developers to release the source code of derived work. Therefore there exist other licenses that are more designed to allow commercial interests. Many successful projects in OSS also have a non-profit foundation to which copyrights are assigned and govern the effort of the project with a more formal organization structure.

The software industry has evolved at a rapid pace to become one of the largest industries in the world economy (Campbell-Kelly 2003). After its birth at universities and government laboratories, the industry grew to attract a mass-market of consumers for business as well as recreational software. This and the fact that OSS has diffused rapidly among users and developers in many niches has resulted in that many firms are interesting in how OSS evolves. Some well-known successful examples of OSS are in operating systems (GNU/Linux), web servers (Apache), programming languages (Perl), mail forwarding (Sendmail) and databases (MySQL).

3. Theoretical framework

The framework builds upon three building blocks. First, two models that describe the innovation process - private investment and collective action – are outlined to explain the

role of firms where the boundaries between these models are blurred. Second, the appropriation of returns is discussed. The third and last building block outlines appropriability and how firms can protect knowledge and information.

3.1. Private investment and collective action

The literature on innovations distinguish between two major models which describe how innovations are encouraged – the private investment model and the collective action model. The private investment model as formulated by Demsetz (1967) suggests that innovations are attained by private investments and that private returns can be appropriated. Societies have realized that technological progress is the primary engine of growth, and intellectual property rights (IPR) have been created to encourage private investments in R&D (Granstrand 1999). IPRs create incentives for firms to engage in innovations, but give rise to a society loss because all created knowledge cannot be utilized. In contrast to this model, is the collective action model which suggests that innovators freely give away their innovations and contribute to a public good (defined by non-rivalry and non-excludability in consumption). By giving away what is created for free and contributing to a common resource, the collective action model overcomes the problem that not all knowledge that is created can be used, but this approach is nonetheless without problems. When institutional infrastructure is absent to co-ordinate and facilitate collaboration, individuals are believed to maximize their own well-being, rather than the collective (Ostrom 1990), which might raise a tragedy of the commons issue (Hardin 1968). Rather than contributing themselves, beneficiaries can wait for others to contribute and free-ride on the work of other (Olsen 1967). In many cases, however, individuals are willing to contribute in the creation and nurturing of a communal resource despite the possibility to free-ride. The social norms and impact of signaling effects make innovators contribute (see e.g. Hertel et al. 2003; Lakhani et al. 2002). In many industries, such as OSS, the distinction between private investment and collective action model is often blurred (Nelson 1989). Firms often divulge information for free and can be active in industries where the end is a public good. The question, however, is how firms try to appropriate adequate returns to survive in industries where the boundaries between the private investment model and collective action model are blurred.

3.1. Appropriation and appropriating returns

It is commonly argued that the primary objective for firms is to maximize the returns from the resources a firm possess over time (Barney 1991). Possible ways of knowledge protection and thereby appropriate future returns influence the firms' incentive to induce investments in strategic innovation (Liebeskind 1996). Appropriation therefore plays a crucial role in innovation studies as it creates economic value from innovations and new ideas (Levin et al. 1987). In fact, the term *invention* is sometimes used when an opportunity is discovered and *innovation* when it is commercialized and the returns are appropriated.

Firms can rely on different ways of going to the market and appropriate returns – by selling products or services. In both cases, firms have to heavily invest in building a market presence and reputation and in many industries with rapidly changing knowledge-bases, there is a great uncertainty of what works. Product companies in addition have to

build up manufacturing plants, or cooperate with actors that have that resource.

Table 1 gives the frame which was used in the study to analyze how firms appropriate returns. Detailed sub-categories of how firms rely on services and products were unknown but emerged from the empirical data. Five primary ways were used - 1) consultancy, 2) education, 3) support, 4) licensing, and 5) black-box. Table 2 outlines the main categories – products and services – and the respective sub-categories that emerged in the study, with a brief explanation of they are used in OSS.

Table 1: Frame for analyzing means of appropriating returns

Category	Sub-categories	Explanation of how it works in OSS
Products	Licensing	Licensing the right to use the software i.e. adding a proprietary part to the open code or by allowing the customer to use the source code how they wish
	Black-box	Bunching several pieces of OSS in a hardware solution
Services	Consultancy	Consultancy work based on an area of expertise, be it a product that the firm release or a community established project.
	Education	Education based on an area of expertise, be it a product that the firm release or a community established project.
	Support	Support based on an area of expertise, be it a product that the firm release or a community established project.

Given the role of appropriating returns, it is important to understand the possible means of protection or the logic behind that firms voluntarily divulge information.

3.2. Appropriability and means of protection

Appropriating value from knowledge and information is more difficult than other resources because knowledge, unlike land and labor, is non-rivalrous in its usage and can be used by many people, without diminishing its productivity for any user. Expropriation, or illegal imitation, is therefore hard to detect (Liebeskind 1996).

Appropriability is defined as the possibility the owner of a resource has to capture a return equal to more than the value created by that resource. The appropriability regime governs an innovator's ability capture the profits generated by an innovation (Teece 1986) and therefore influences the incentive for knowledge creation and innovation. Appropriability regime is related to the features of the core knowledge in the innovation and the possibilities of institutional protection, and is said to be 'weak' when the asset is hard to protect and 'tight' or 'strong' where it is relatively easy. These are not two extremes cases but rather the possibility to appropriate future rent streams range from 0 to 1. One can say that the closer to 0, the harder to appropriate revenues and vice versa. With weak appropriability regimes, profit margin will be driven to zero (Katz and Shapiro 1985; 1986) and in the absence of appropriability, firms have to rely on speed to market, timing and luck (Teece 1986).

The IPRs that have been created can be ineffective depending on the type of innovation and the knowledge involved. Patents and copyrights do not always apply as good protection on intellectual property as they are costly and time-consuming to enforce. Empirical work in the US (Levin et al. 1987, Cohen et al. 1998) and Europe (Arundel et al. 1995) has shown that the effectiveness of patents as protection of knowledge differ across and even within industries. Innovation, however, takes place despite the weak institutional protection. Some firms rely on secrecy (Arundel 2001) or other means of protecting knowledge and information to appropriate returns from

innovations.

Following Teece (1986), an outstanding innovation is not a guarantee to successfully commercialization, but this process requires complementary assets i.e. those assets that need to be used in conjunction with the knowledge about the innovation, such as distribution, service, manufacturing etc. By having access to these assets, the probability of successfully commercializing increases.

In some cases, network effects can be an advantage in those products and services where the benefit a user derives increases with number of other people using it (Katz and Shapiro 1985). New users are therefore influenced of what previous users have chosen, which causes a path-dependency (Arthur 1989; David 1985). Firm in such industries can therefore appropriate returns by building a large user base and create a lock-in. Firms give away and signal their work to get a head start (Nelson 1989). Related to this is the discussion about lead time and first-mover advantages. Lieberman and Montgomery (1988, 1998) argue that pioneering firms can gain a first-mover advantage by acquire superior resources and capabilities, by entering the market in an early phase. These firms gain access to distribution channels, gain reputation, create linkages to other firms, which can create an advantage compared to later entrants.

This leads us to a deeper understanding of the complexity in terms of different ways of protecting knowledge. Firms can rely on several means of protection and that differs depending on the industry in which the firm is active in, as well as the specific situation of the firm.

Table 2 gives the frame for analyzing how appropriating of returns are related to different means of protection. Four categories and their sub-categories are outlined as the frame for analyzing means of protection.

Table 2: Frame for analyzing means of protection in OSS

Category	Sub-categories	Explanation of how it works in OSS
Intellectual property rights (IPR)	Patents, copyright	Institutional protection in terms of temporary monopoly granted to novel, useful and non-obvious innovations
		Institutional protection that grant creators exclusive right to reproduce, prepare derivative works, distribute, perform and display the work publicly
Secrecy		Keeping secrets within the firm, primarily by closing the code
First-mover advantages	Network externalities, first-mover advantages	Early entry to the market which can create advantages by acquire superior resources and capabilities
		Getting a large user base
Complementary assets		Using complementary assets such as distribution, marketing in conjunction with the innovation.

4. Methodology

4.1. A multiple case study approach

Appropriation in OSS has rarely been analyzed previously in the literature and there is too little empirical work to understand the process, context, and specific phenomena. Under these circumstances, multiple case studies are fruitful (Eisenhardt 1989; Miles and Huberman 1984) to discover novel constructs and achieve theoretical advances. The paper therefore builds upon a explorative multiple case study of six firms in Sweden and

Finland that attempt to appropriate returns from the joint effort of users and developers in the OSS community. Based on maximum variation logic to identify common patterns across the cases as well as differences (Miles and Huberman 1984), the cases were chosen based on the a priori information that the firms had different means of relations to the OSS community. There are currently no complete database existing on the number of firms in OSS in Sweden and Finland, so much effort was made in selecting relevant firms through screening as many firms as possible. Given the magnitude of data collected of each firm, a reasonable number of cases had to be chosen to see patterns across the cases as well as differences.

4.2. Data collection and analysis

The study uses both quantitative as well as qualitative data sources in order to create a valid study (Eisenhardt 1989; Uzzi 1997) which allows for triangulation of evidence. Therefore, several data collection approaches were used (Maxwell 1996) in two major steps. In the first step, secondary resources were gathered on all firms from annual reports, company directories, business and specialist press and homepages. Information about the firms was stored in separate directories. All information was used to get an idea of the competitive environment and the perception of outsiders. Moreover, a comprehensive study of mailing-lists, newsgroups and forums were used to analyze the firms' relations with developers and users in the OSS community. In the second step, semi-structured face-to-face interviews were carried out at the firms. Two pilot interviews were carried out with two skilled individuals that worked in OSS firms in order to learn how to use the interview manual and test the relevance of the questions and how to introduce the study. These interviews are not used in the results.

The interviews in the case studies lasted between 0.5-3 hours and included questions about from where the company get revenues and the rationale for changing that strategy over time and the underlying mechanisms. Because of the small size of the firm and the informal organization, it is impossible to mention one title that the respondent had. It was discussed with the firm who was most suitable to answer the questions. In most cases it was the founder and the CEO. After asked for permission, the interviews were recorded and transcribed within two days. In three cases, the respondent was reluctant to having the interviews taped and these interviews were instead documented through extensive and careful note-taking. A draft of the empirical results was sent to the respondents for them to comment upon and ensure that the technical details were interpreted correctly, which ensures validity (Yin 1984). This procedure was complemented with telephone conversations and correspondence via email if needed. Table 3 outlines a summary of the interviews and the general characteristics of the cases.

Table 3: Summary of the interviews

Name of firm	Geographical location	Number of employees 2003	Number of interviews
Firm A	Uppsala, Sweden	55	2
Firm B	Linköping, Sweden	12	4
Firm C	Linköping, Sweden	10	2
Firm D	Helsinki, Finland	30	3
Firm E	Gothenburg, Sweden	6	2

Table 3 shows that five of six firms in the sample are based in different locations in

Sweden, whereas one firm is based in Helsinki, Finland.

The data was analyzed by first building individual case studies from the material focusing on relevant aspects such as the history of the firm, decisions making in relation to appropriation etc. Thereafter, the cases were compared and contrasted and the most important points in respect to the aim were analyzed in detail.

4.3. The firms in the sample

The firms studied here all serve different markets such as web-servers, thin-clients etc. using different approaches to appropriate returns. They are all relatively young and were founded in the 1980:ies or later. The age therefore span between 1 to 13 years. The firms are small and the number of employees ranges from 19 to 58. The firms are owned by entrepreneurs and sometimes in combination with venture capitalists (VC). The firms act in a fast changing market so the financial situation changed in some cases after the end of the financial year 2002 reported in the annual reports. Firm D, for example, made a major change during the first 3 quarters of 2003 and became profitable.

Table 4: Overview of the firms

	Firm A	Firm B	Firm C	Firm D	Firm E
Founded	1995	1992	1994	1991	2002
Owners	Private, VC	Private, VC	Private, VC	Private, VC	Private
Revenues 2002	5257	857	1217	946	N/A
Revenues 2001	514	2433	3301	N/A	N/A
Employees 2002	32	19	58	N/A	N/A
Employees 2001	12	39	58	N/A	N/A
Profits 2002	-1610	-106	-4715	-506	N/A
Profits 2001	-884	-372	-3385	N/A	N/A

Data from annual report and other secondary data. All numbers in 1000 €

The OSS firms are rather young and it is hard to do generalization about firms within OSS at large. As common in multiple case studies, generalization is made to theory, rather than to the population at large, and just as quantitative studies cannot explain all variance, qualitative studies have difficulties in reporting all the richness of the data. Nonetheless, they provide useful insight about how firms attempt to appropriate returns in OSS over time, and the underlying mechanisms for changing way of appropriating returns. This can be used as insights for further research and to develop more accurate hypothesis about the OSS phenomenon.

5. Results

The results answer the two research questions;

> Research question 1: How have firms involved in OSS appropriated return over time?
> Research question 2: How are their methods of appropriating returns related to different ways of protection?

Each of these questions will be analyzed in turn by highlighting the variety across the

cases and summarize these into tables.

5.1. Appropriating returns

The theoretical framework outlined a frame for analyzing how firms appropriate returns in OSS with categories and their respective sub-categories with brief explanations. This table was used to categorize the cases into Table 7.

Table 1: Frame for analyzing ways of appropriating returns

Category	Sub-categories	Explanation of how it works in OSS
Products	Licensing	Licensing the right to use the software i.e. adding a proprietary part to the open code or by allowing the customer to use the source code how they wish
	Black-box	Bunching several pieces of OSS in a hardware solution
Services	Consultancy	Consultancy work based on an area of expertise, be it a product that the firm release or a community established project.
	Education	Education based on an area of expertise, be it a product that the firm release or a community established project.
	Support	Support based on an area of expertise, be it a product that the firm release or a community established project.

The firms can rely on one or more approaches to appropriate adequate returns to survive. Table 1 also illustrates current situation with respect to how the firms try to appropriate returns divided into the five possible ways of creating revenues. In the present situation, all firms sell consultancy hours to their customers. Education services are sold by three out of six firms. Licensing own products is used by two of the firms, whereas selling black-boxes (combining OSS with hardware) is used in one case. Interestingly, even within each category outline in Table 5, there is great variety in the approaches to appropriate returns. Each case will therefore be discussed in more detail, which is summarized in Table 7.

Firm A

Firm A develops a database which is known world-wide for its technical features and usability. Even though a number of competitors exist, it has become world-wide known. It locates its headquarters in Uppsala Sweden and has several offices in other countries. The mission is to make superior data management available and affordable for all. Compared to its competitors it drastically cuts cost. According to a manager at the firm, it is a so called “second generation” open source company with a dual licensing strategy. The product is licensed under the GPL-license and a firm specific license which enables do not get forced to reveal its code as stated under the GPL-license. One of the interviewees perceived that as supporting open source values and methodology in a profitable, sustainable business. The database is downloaded approximately 35000 times a day, which makes it one of the most popular used databases. The company gets its revenues from several sources. Online support and subscription services are sold at the website to all users of the product. Given the vast size of users and developers that use the product, it generates revenues among those that need on-going support and service. The support is divided to different niches, depending on the type of support you need and how frequently. Moreover, the firm also uses a franchising model, in which partners can use the brand and sell the product to others. The product has so many potential users, that the firm benefit from having an external sales organization that sells the product. Training

programs and other means of education in relation to the product also generates revenues. In addition, the firm can help with customizing the product after the customers need i.e. sell consultancy hours.

Firm A has made a number of major changes in their ways to appropriate returns. The firm was founded by two persons that were influenced by the free software foundation. It was founded at a time where web servers increased rapidly and databases were expensive to buy, so the database of the company rapidly became a large player competing with established database solutions such as Oracle and DB2 (IBM). In the web server segment, the database is probably the most common database used, whereas in other segments the larger competitors are stronger. Until two years ago, the company had one firm specific license that regulated whether a customer had to pay for using the database or not. After that Firm A decided to use a dual licensing strategy – the GPL license and a firm specific license. In that way, users are allowed to use the product under the ordinary GPL license, but if the customer does not want to make their own code available as stated in the GPL license, they can buy the other license. A person claimed that

> "it was previously hard to tell whether you had to paid for our product or not. We felt that some were misusing our license and used it in ways we did not intend. They closed the code or packaged the database with other software so we had to change that. We wanted to combine the many positive sides with OSS, but be able to build a sustainable firm."

In that way the firm gets revenues from the specific license and can use the good part of OSS. Still, much of the revenues stems from other means of making business such as selling services and education around its product. Selling licenses stands for approximately 50% of our turnover. The rest originates from services related to customization of our product after the customers need as well as education around our database. Using multiple revenue sources is a strategy that has been used throughout the firm history. Another major shift has however taken place when the firm received a considerable amount of venture capital. The firm recruited a new external CEO and prioritized growth over profits. The parallel usage of two licenses is perceived as being a viable way of appropriate adequate returns for the firm in the long run.

Firm B

Firm B was one of the earliest OSS firms in Sweden and is therefore well-known within the software industry in Sweden. Firm B develops products and services based on OSS. Most effort is being made on a thin-client product, but the company also offers different kinds of courses related to OSS. The product is used to centralize applications through the use of server based computing and thin clients. The company also sells services to customize the product. The product is based on several different OSS modules from different OSS projects, which are bundled together in a closed proprietary framework. The modules are not closed, but the framework that makes them connect is proprietary. A person at the firm claims that this is the "*heart, brain and backbone of the system*". This framework is licensed to customers. The OSS modules have different licenses, which are described in the license agreement and are supported by Firm B as a part of the product. The firm therefore has to deal with the strategic issue of what is allowed according to the licenses in these modules. An additional security service that runs on the product for

accessing files over a network is also merchandised.

Firm B has tried a number of different ways of generating incomes throughout the years. One of the founders claimed that

> "When I come to think about it, we have tried a number of different things without finding out what the demand really is. We have developed solutions without conscious planning earlier, but today our focus is much more customer oriented. I suppose that is why we changed so much over time."

The company had sold a firewall black box, but that was spun out to a separate firm after a joint venture with another firm. Selling services has also been a major revenue source throughout the history. In the beginning of 2003, the firm made a major change and started to focus on selling a product based on OSS. The company was near bankrupt and was forced to do a major change in order to get access to new capital. Forced by this fact, the leading persons within the group sat down and had a discussion about the future and possible ways of creating a new way of appropriating returns and ensure the survival of the firm. Different ideas were tested and evaluate, but after a seminar about a thin client solution in the beginning of 2002, Firm B decided to focus on that.

> "We're currently building a framework that makes different OSS modules work together. In that way we don't have to pay expensive licenses and have to increase the price of the product. The code is usually very good and has a long history that ensures stability. In the end, the price/performance ratio is crucial for us".

The other ideas were put aside as they did not have enough of money to commercialize all ideas, and it took five months before the product was launched and the other means of getting revenues have continuously decreased since the new product was launched.

Firm C

Firm C set up one of the first company web pages ever in 1994. The company is famous for its web server, which is a full-featured open-source solution distributed under the GPL license. The web server has therefore a relatively long history, but has got fierce competition from other servers such as Apache, Microsoft and Netscape. The firm attempts to be unique towards it competitors by offering a web-based interface for configuration and administration that makes it simple to use. The web server however, does not generate revenues to the firm so they use a hybrid strategy in combining OSS with a more traditional way of making money. The rationale for giving away the product for free is the stiff competition from Apache that makes it hard to charge money for and extending the user base. The current focus is to make money on a Content Management System (CMS) that runs on the web server, which according to the company is easy to use and configure. Even though the web server is distributed under the GPL license, the CMS is proprietary software and sold with licenses. The company tries to appropriate returns by selling specialized services when installing the product. It also merchandise education in relation to their product.

Firm C has also tried several means of appropriation throughout the history. Up until 1999, the company was influenced by technological spirit, rather than making a sustainable business. The people at Firm C developed a programming language called

Pike, which a web server was built on. The people developed technological advances in product development which was the core of the focus of the company. During 1999, the company focused on establishing itself in the international market and supplying the technological developments they had been working with in the form of completed products. External expertise in the areas of product development and international establishment was brought in and the old internet pioneers within the company got a less central role. An initiated person claimed that

> "We have constantly moved away from the OSS concept towards a more traditional approach of selling proprietary software. We felt that something had to be done in order to survive. The original approach which was strongly influenced by ideas within the free and open source software movement was impossible to combine with profits in our case."

The initial idea of giving away the web server and get it further developed by the community and then being able to make money was perceived as having more disadvantages than advantages. Therefore a major shift took place, where the web server remained free and publicly available, whereas the firm tried to sell licenses of its content management system for the web server.

Firm D

Firm D is a Finnish firm with offices in Estonia and Russia. It was founded in 1991 and is one of the most famous OSS firms in Finland. Firm D has experience working on projects of all sizes and of varying complexity. The company releases a Linux desktop, Linux server and office suit under the GPL-license, which can be downloaded from the community established by the firm. By giving away the product for free, Firm D attempts to build up recognition as a knowledgeable and trustworthy partner and hopefully sell services to customers. The firm helps customers integrate OSS after their needs and building different types of solutions. The company is an expert in the support and maintenance of GNU/Linux servers and desktop environments. The company also has the facilities to provide professional level training, technical support, remote services and to complete data solutions. The company is thus relying totally on selling services.

Firm D has done several things after it was founded. Selling OSS services and solutions became the only business in the mid 1990:ies. In the first quarter 2000 the firm an American venture capitalist made a major investment in the firm. At that time, Linux distributions were considered to be a desirable way to grow and Firm D changed to that after discussions with the venture capitalist. A person explained that

> "at that time the business models that venture capitalist was looking after publishing business. Printing carton boxes with Linux inside and selling them. We tried that in quite large scale and then discovered it's actually not a business. It would be a good business if you didn't have any R&D costs, but when you have R&D costs and you're doing a book publishing business then that is something that can't work. In general product development in open source base is something that is pretty hard to make it work. If you invest a lot and make some research and develop some nice new features – the day when you release the product everybody will have that also, freely in use. Then you can't compete and it's not sustainable."

Selling distribution was harder than they thought. For every box they sold, they made a considerable loss. A person claimed that

> "We were doing the same thing what RedHat is doing now 1,5 years ago. Giving up the commercial development of their Linux distribution in exactly the same steps. Eventually, you have no other options because making pure open source products is not sustainable. Absolutely, not sustainable. Then mixing it with some close source will eat up good things because of bad will from community if stop closing some part of the product".

So the firm changed the focus once again to selling services and solutions for customers primarily in Finland. After making considerable losses for years that they sold distributions, the firm is once again profitable. The Linux distribution remains within the company, but only as a marketing tool to spread the Firm D brand. It was also perceived as extremely hard to create a sustainable business model by producing a Linux distribution and therefore drastically changed. The more focused strategy with selling services has so far been more successful. He argued that

> "You can't create a sustainable competitive advantage by making new features or anything. The only advantage you can gain is by making services in a scalable way. The R&D must concentrate on developing processes, quality insurance, software engineering, methodology that fits to open source development models. In general you have to have a good process so that you can guarantee that the products will fit the need of customers. Perhaps know how to make it fast you have to have people who not what they're doing and are experts. That is basically what counts. Developing own open source products is simply crazy. That's why we have a community. The open source community is making the products, the suppliers and vendors, they take the products from the open source community and make them fit for the customers and also guarantee for support, maintenance and everything like that. I don't think that open source companies should deal with open source product development or R&D at all."

Today, therefore, they focus the strategy on selling services.

Firm E

Firm E is recently founded and combines hardware, software and services to deliver Linux based solutions for heavy calculations. It is based in Gothenburg, next to a technical university and has a close connection with academia and combines expertise in Linux with numerical calculations. The firm combines different OSS modules which are built together in a framework in order to build a Linux based solution for heavy calculations. The typical customer is demanding a high performing grid solution for technical and scientific computing. The system is built on open components and the firm develops a framework to make these components work together. Another kind of revenue source is selling hardware when they install Linux clusters. The managers at the company argue that even though the profit margin is low, it is valuable as a complement to other revenue streams from selling services.

These cases reveal the details of how firms appropriate returns in OSS. Appropriation take place by developing businesses on packaging, support, service, by using complementary proprietary software to varying degrees, embedding it into hardware products etc. It shows that a variety of approaches are used in the current situation and that most firms use more than one source of appropriation outlined in Table 7. Consultancy is most frequently used.

5.2. Different means of protection

In the theoretical framework, a frame was outlined for analyzing the means by which firms can protect their knowledge divided into categories and sub-categories and a brief explanation of how it could be used. This table was used to categorize the cases into Table 7.

Table 2: Frame for analyzing means of protection in OSS

Category	Sub-categories	Explanation of how it works in OSS
Intellectual property rights (IPR)	Patents, copyright	Institutional protection in terms of temporary monopoly granted to novel, useful and non-obvious innovations
		Institutional protection that grant creators exclusive right to reproduce, prepare derivative works, distribute, perform and display the work publicly
Secrecy		Keeping secrets within the firm, primarily by closing the code
First-mover advantages	Network externalities, first-mover advantages	Early entry to the market which can create advantages by acquire superior resources and capabilities
		Getting a large user base
Complementary assets		Using complementary assets such as distribution, marketing in conjunction with the innovation.

Firm A

Firm A attempts to build up a large user base of its database product. By doing so it hopes to benefit from network externalities in the way that new users chose the product due to the possibility of extensive feedback from other users and rapid bug-reporting. At the time when the company released it product, it rapidly attracted users, as the solution was novel and the products of competitors were many times more expensive. Firm A has also been active in establishing a community, which has been a valuable complementary asset in pacing the technological development. As the firm founded the project, they have copyright of the product, but the source code is open.

Firm B

Firm B bundles OSS modules in a framework that make them connect. By closing parts of the software, they use a secrecy strategy. Attracting users to the product is therefore not used, as it is hard when the software is closed. The product is also protected by copyright.

Firm C

Firm C combines a secrecy and network externality approach. By giving away their web server for free they have throughout the history hoped to attract users and developers that can contribute with code and bug-reports. That strategy was less effective for the firm, as the competition in the web server segment was stiff. So rather than relying on first mover advantages and the community as a complementary asset, the major strategy of the firm today is to rely on secrecy by closing the software. The product is also protected by copyright.

Firm D

Firm D solely relies on benefiting from network externalities. By giving away the product

for free, they attempt to get users and developers that can improve the product further. This in turn can build up their recognition among customers that are interested in buying services from them. The community also works as a complementary asset in giving rapid feedback of new products.

Firm E
Firm E bundles OSS modules in a framework and package that in hardware. The framework is closed, so in that way a secrecy strategy is used. The software is also protected by copyright.

The cases show that despite the weak institutional protection in OSS, there are other means of protection that the firms can rely on. The firms are not using patents and that is something that they are negative towards. Instead some of the firms rely on secrecy i.e. keeping valuable information and knowledge within the company to the degree possible or by closing parts of the software or keeping expertise within the boundary of the firm. Copyright is also frequently used among the firms that develop products, but it does not inhibit other users from screening the source code, modifying and redistribute. Also important for another type of firm is to create first-mover advantages and network externalities by attracting a large user base and move down the learning curve.

Table 5: Summary of the cases

	Firm A	Firm B	Firm C	Firm D	Firm E	
Current strategy to appropriate returns:						
	A dual licensing strategy. One free under the GPL-license and one commercial non-GPL license. It sells services and training.	Bundles OSS modules under different licenses and build a system that makes them connect.	Releases a free web server and sell a content management system that runs on the server.	Use a free Linux distribution with an Office suite to build reputation and thereafter sell services.	Bundles OSS modules under different licenses together with own code and sells installations as well as services.	
Change of strategy in appropriating returns:						
	Changed licensing strategy away from a firm specific to a dual licensing strategy.	Changed from mostly selling services related to OSS to create a product.	Moved away from the OSS concept to become more of a traditional software developer.	Tried selling Linux distributions, but changed as hard to appropriate returns.	New firm, so no major change.	
Means of appropriating returns:						Frequency:
Products						
Licensing	X	X	X			(3/5)
Black-box					X	(1/5)
Services						
Consultancy	X	X	X	X	X	(5/5)
Education	X	X				(2/5)
Support	X					(1/5)
	(4/5)	(3/5)	(2/5)	(1/5)	(2/5)	
Means of protection:						Frequency:
IPRs		X	X		X	(3/5)
Secrecy		X	X		X	(3/5)
First mover advantages	X			X		(2/5)
Complementary assets	X			X		(2/5)
	(2/4)	(2/4)	(4/4)	(2/4)	(2/4)	

6. Discussion

The objective of this paper was to explore how firms appropriate returns from innovations that are created outside the boundaries of firms and in the public domain using the case of OSS. This has been illustrated by using an explorative multiple case study of six firms.

OSS is often compared with the phenomenon of open science with its peer review, diffusion of ideas, critical examination and with recognition as an important source of motivation (Bezroukov 1999; Kogut and Meitu 2002). By focusing on this aspect of OSS, the discussion in the academia has paid less attention to the fact that firms are in fact trying to appropriate returns. The results are interesting in its own right, as the empirical data is novel, but the paper fills in a gap in the literature on OSS and raises fundamental questions about the exploitation of knowledge in the public domain.

OSS allows for customizations which can satisfy heterogeneity of demand (Franke and von Hippel 2003) which is a potential source of distinctive capabilities (Teece et al. 1997). Rather than buying a standard product which only can be modified to a certain extent, customers buy a solution that can be modified after their specific needs. By customizing after the special requirements a firm can extract greater value from their customers (Arora et al. 2001). Given that, the firms in OSS attempts to commercialize part of that value and appropriate adequate returns by finding new novel ways.

An interesting finding was that the cases outlined two main types of firms – 1) "FRIENDS" who are active in getting their product widely diffused through releasing code and establishing communities, and 2) "FOES" who only attempt to capitalize on the work on developers and users in the community. FRIENDS are more aligned with the community by giving away code and establishing projects, whereas FOES only appropriate the joint effort of the OSS community by acquiring knowledge in a given area and sell their expertise to their customers. FRIENDS can gain first-mover advantages versus its future competitors. In that respect, the firms can create a niche in which they believe that they can be able to appropriate returns in the future through getting adoption among user and developers. The rationale for FOES is to minimize R&D investments and time to market through using existing OSS modules. They develop processes and routines to capitalize on the effort of the common, but have to cope with the conditions under which different software can be used as they restrict commercial usage.

Knowledge is difficult to protect as expropriation and imitation is hard to detect. Even though patents are inefficient in some industries and under some circumstances, innovation is much larger than that which can be protected by patents (Mansfield 1986). In the software industry at large, patents has increased rapidly in both absolute as well as in relative numbers but it is questionable whether software patents increase research and development intensity (Bessen and Hunt 2003). Following López and Roberts (2002), firms use combinations of means of protection and thereby balance the relative inefficiency of one method by putting greater emphasis on alternative methods. In OSS as a private-collective innovation model, firms rely on other methods of appropriation than traditional institutional protection. Referring to the two types of firms above, FRIENDS primarily rely on creating first mover advantages and creating a community in relation to

their product. Communities also work as a complementary asset in pacing the software development. FOES, on the other hand, try to be more similar that traditional software through closing the code and relying on secrecy and copyright.

As O'Mahony (2003) recognizes, the commons attempts to avoid that this results in an exhaustion of their joint effort. From the perspective of firms, they have to balance the possibility of appropriating returns, while still maintain a good relation to the community and obey to their rules and codex. FRIENDS have more relations with user and developers within the OSS community as they release code and establish new projects. Conflicts between the FRIENDS and the community may arise as interests may collide. This is even more so among FOES, which are the archetype of actors that the OSS community aims to avoid as they appropriate the joint effort and deplete the commons.

The problems of appropriate returns have caused both FRIENDS and FOES to change over time in four out of five firms with a history. A common way of doing business does not exist within OSS today, so the firm seems to try different way by rapidly adapting when they realize that a strategy does not work. Far from all early entrants succeed, but have the advantage of gaining experiences and knowledge and possibly get the firm to be adaptive and change. The uncertainty of how to appropriate adequate returns in OSS causes firms to change appropriation strategy over time as they get new knowledge and experiences.

7. Conclusion

Many de novo entrants as well as incumbents have tried the possibility to appropriate returns with varying results. The firms try a variety of approaches to appropriate returns and forced by the appropriability issues and changing environment they change drastically over time. These firms face the challenge that important resources to provide competitive products and services are located outside the boundary of the firm and in the public domain. The commons are protected by legal and normative mechanisms, which make it even more complicated. It is therefore need for more research on how firms ensure access to projects in the community or communities.

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