Do firms take part in the projects of the OS community?

Some preliminary evidence and a research agenda

Preliminary draft

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Abstract

The Open Source (OS) software has progressively gained economic importance in recent years, and more and more commercial firms are getting involved, to various extents, in the OS movement. While a number of studies have investigated motivations and business models of OS-based software companies, very few works have examined whether and how firms actively participate to open projects.

This paper contributes to the literature by providing empirical evidence on the role and the activities of software houses in community developed projects. The research also proposes an original methodology of large-scale primary data collection from OS project repositories and linked Web sites. The findings show how different today's OS movement is from its origins and how important firm involvement has become, not only numerically but also for the deepness of its impact on community projects. Finally, further research developments are suggested.

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1. Introduction

It has been widely acknowledged that the projects of the OS community represent an impressive example of successful collective action processes (von Hippel and von Krogh, 2003). Indeed, thousand of developers, who do not receive any direct monetary compensation and work in a decentralised manner, have succeed in providing an enormous amount of code, often supplying high quality and complex programs (Benussi, 2006). Even more surprisingly, the movement has evolved considerably in recent years: Open Source has gained an increasing economic importance. Despite the dominance of proprietary standards, more and more users are now running OS programs on their systems (Ghosh, 2006), while new agents are taking part in the collective action by adopting open standards or using them in their productive processes. They are public bodies, Universities and research centres, and, even for profit firms, which witness how the idea, proposed by the Open Source Initiative[1] in 1998, of getting Open Source world closer to the commercial one, has been extremely farsighted. Several empirical analyses have shown as more and more software firms, including also several large market incumbents[2], are now involved, to various extents, in the movement (Bonaccorsi et al., 2006). In this framework, this paper focuses on the relationships between these companies and the Open Source community, namely, the issue of firms' involvement in the OS projects is addressed.

At present, there is plenty of evidence that open projects are much more than anarchical communities joined only by ideologically-oriented individuals writing code in their spare time on a voluntary basis[3]. Anyway, up to now, most studies on the relationships between commercial firms and the Open Source movement have mainly focused on the ways of doing business out of open

[1] http://www.opensource.org

[2] Think for instance of IBM that has been involved in Linux development since 1998.

[3] It is worth noting that the romantic idea of a thirteen years old smart programmer writing open code during the night is a myth of the Open Source that need to be put into perspective. Several authors have shown through empirical researches (see for instance Lakhani and Wolf, 2003; Hertel et al., 2003, Hars and Ou, 2002) the massive presence of people working in the IT sector OS among the developers communities. Dahlander and McKelvey (2005) confirm these results, acknowledging the presence of developers with a degree in Software Engineering.

standards (Kosky, 2005), or on the motivations of companies' entrance in the Open Source arena (Rossi and Bonaccorsi, 2006; Bitzer, 2004). The inkling that emerges from these researches is that, in general, firms exploit the code base provided by the OS community as a basis for preparing software solutions to be offered to their customers. Few works (see for instance Henkel, 2006) have investigated whether and how these companies directly feed, in their turn, such code basin by contributing their own developments back to the open projects.

Moreover, under a methodological viewpoint, it is worth noting that most of these analyses have been carried out through case studies or by gathering survey data.

Thus, the contribution of this paper to the literature is twofold. First, it investigates whether and how firms contribute to the projects of the OS community. Second, it proposes an innovative methodology, based on the analysis of the projects hosted on the largest OS repository, SourceForge[4].

We aim at providing original empirical evidence about three main research questions (i) Do for profit firms act not only as *takers* but also as *givers* by directly contributing to OS projects hosted on SourceForge? (ii) If yes, what do firms do within the projects? Do they only carry out ancillary works (bug fixing, mailing list assistance, and so on) or do they also provide code and undertake coordination activities? Moreover, (iii) Does the presence of firms shape the evolution of the projects? Namely, are there significant differences between projects participated by firms and the others? Finally, basing on the empirical findings, a research agenda for future developments is provided.

The paper is organised as follows: section 2 surveys the literature on firms involvement in the Open Source movement, section 3 describes data and methodology; section 4 summarises the results of the empirical investigation; section 5 concludes and discusses the research agenda.

[4] http://www.sourceforge.net.

2. Firms' participation in the Open Source movement: a review of the literature

An increasing body of literature is investigating the changes that have taken place within the Open Source movement in recent years: from a social phenomenon with a strong ideological connotation (Raymond, 2000), it is now evolving in an economic reality that is deeply affecting industrial dynamics within the software industry (Gehring, 2006).

Particularly, commercial firms take part in the OS movement in different ways. Historically, the first form of involvement has been the gifting of code by large software companies to the Open Source community, as in the well known case of Netscape, which in 1998 released its Navigator under an OS license, giving rise to the Mozilla projects[5]. Other incumbents of the software market followed its example (Wichmann, 2002), and, nowadays, even Microsoft is opening to OS by turning over several of its programs to OS developers, playing a role in a process that the company has strongly criticized in the past.

However, it is not only a matter of the business strategy of large software houses. At present, the phenomenon of the engagement of software companies' in OS activities is becoming fairly widespread: more and more firms are entering the market by using open code downloaded from the Internet as an input for providing to their customers Open Source-based products and services. Bonaccorsi et al. (2006) have extensively described the phenomenon, calling these agents *Open Source firms*[6]. Using data from a large scale survey on 146 Italian Open Source firms, the authors have found a wide diffusion of *hybrid business models* that mix the offering of open solutions with the provision of proprietary software. In the same survey, almost half of the respondents claimed to participate (or to have participated) actively in the projects of the OS community (Bonaccorsi and

[5] Mozilla project is now developing the successful Web browser Mozilla Firefox, which is now experiencing an impressive diffusion, notwithstanding the dominance of Microsoft Internet Explorer. As in 2006, the average diffusion in Europe was around 14%, reaching a peak of 39% in Germany.

[6] On the contrary, proprietary firms are the ones that entirely base their activity on proprietary programs.

Rossi, 2003) and the results are confirmed by another survey carried out by the authors on a European basis[7].

The issue of firms' contributions to the OS community is fairly intriguing under an economic viewpoint, as it is a case of participation in collective action by for profit agents, for which it is hard to advocate the intrinsic motivations argument (Ryan and Deci, 2000) commonly used to explain individual involvement in the private provision of collective goods, in general (Elster, 1985, 1998), and in OS projects, in particular (Lerner and Tirole, 2002; Luthiger and Jungwirth, 2007). Up to now, firms' participation in collective action as has been poorly investigated by economic scholars[8]: firms' engagement in OS projects represent a valuable chance of addressing the problem. To the best of our knowledge, the studies that have explored how firms contribute to the code base provided by the OS community have focused on single project (Henkel, 2006; Dahlander and Wallin, 2006), or on a limited number of firms, often using case studies or other qualitative methodologies (Dahlander and Magnusson, 2005; Lin, 2006).

Even the survey data collected by Bonaccorsi and Rossi (2003) present several shortcomings. First, they do not provide any information on the projects to which respondents take part, not allowing for any characterisation of the collective action process in which the firms are involved. Second, although the authors have distinguished between coordination and simple participation, it would be interesting to know more about firms' activity within the projects and about their evolution over time. Finally, from phone follow up it emerged that sometimes the very concept of participation to Open Source is surrounded by confusion, making data prone to under and over-estimation problems.

[7] The survey was conducted in five countries (Finland, Germany, Italy, Portugal, and Spain) within the CIPR project of the PRIME Network of Excellence, ask the authors for further details.

[8] Several works have explored as firms lobby for gaining trade protection which benefits, not only those firms that lobby for protection and bore the costs, but also the free riders (Olson, 2004)

3. Data and methodology

The methodology proposed in this paper aims at addressing the issue of commercial firms' participation in the OS projects by collecting data from SourceForge, currently the largest Open Source repository[9] available on the Internet. The data gathering procedure allows to overcome some of the shortcomings highlighted in the previous section. Indeed, SourceForge provides plenty of information about the hosted projects, while the collection of information through the repository (and other related Web sites) eliminates the risk of subjective interpretation of the questions to which survey data are prone.

We sampled 300 projects out of 140,000 currently hosted on the repository that were selected on the basis of their level of activity. SourceForge provides detailed criteria for assessing the level of activity of a project. Such criteria are based on several metrics, such as the intensity of use of the instruments offered by the repository (e.g. forums, mailing lists); the bug reporting activity; the number of downloads or Web pages visits per day, and so on. On these bases, the repository provides a classification of the hosted projects: we selected the 300 projects ranking at the top positions (a fairly similar sampling procedure is in Klincewicz, 2005).

The selection of sample projects among the active ones depends on the moment in which data gathering has been undertaken. Indeed, the positions of the projects in the rank change every day, the fact that these projects have not been abandoned being the only constant thing.

The repository itself was an important source of information. Indeed, for each project, SourceForge provides detailed information on: the number of developers and administrators; the date of registration on the repository; the type of licence under which the code is released; the intended audience (e.g. advanced users vs. end users); the typology of products (e.g. Internet software vs. Management software); the compatibility with different operating systems; the use of mailing lists

[9] As of January 17th 2007, the repository hosted 139,286 projects and 1,485,883 registered users.

and forums; the bug reporting activities, and so on (e.g the programming languages or the availability of translations into foreign languages).

Nevertheless, it was not possible to detect firms involved by using only the repository, data on companies' participation has been collected mainly through projects' Web sites and other instruments outside SourceForge, in particular mailing lists and forums[10].

In short, the constructed database contains the following variables (table 1).

Table 1: The variables in the database.

Variable	*Unit of measure*	*Source*
Number of developers	Unit	SourceForge
Number of administrators	Unit	SourceForge
Type of licence	-	SourceForge
Bugs	Unit	SourceForge
Date of registration	Date	SourceForge
Number of mailing lists	Unit	SourceForge
Number of messages in public forums	Unit	SourceForge
Compatibility with Linux	Binary variable	SourceForge
Compatibility with Windows	Binary variable	SourceForge
Compatibility with other Open Source systems	Binary variable	SourceForge
Awards won	Unit	SourceForge
Programming languages	-	SourceForge
Typology of products	-	SourceForge
Intended audience	-	SourceForge
Number of donators	Unit	SourceForge
Type of database	-	SourceForge
Development phase	-	SourceForge
Translations into foreign languages	Unit	SourceForge
Support Requests	Unit	SourceForge
Patches	Unit	SourceForge
Feature Requests	Unit	SourceForge
Elements in Subversion	Unit	SourceForge
Downloads daily	Unit	SourceForge
Visited web pages inside SourceForge daily	Unit	SourceForge
Presence of firms	Binary variable	Outside SourceForge
Type of firms' involvement	-	Outside SourceForge

[10] Detailed information can be asked directly to the authors.

4. Main results

The most important characteristics of the 300 sampled projects, are summarised in the following.

Project dimensions. In line with the other empirical researches on the topic (see for instance Ghosh et al., 2002a, 2002b), in most cases, the developing team is fairly narrow: the median number of programmers is 7, while 15% of the projects have only one participant[11].

Licenses. As expected (Lerner and Tirole, 2005), the most widespread licence is GNU General Public Licence (GNU GPL, 57.91%), followed by its derivation (LGPL, with 12.84%), by BSD licence (7.76%), Mozilla Public Licence 1.1 (5.37%), and Apache Licence 2.0 (3.88%).

Technical aspects. The instruments that the repository puts at the disposal of developers have revealed to be very important for the software production process. They are widely used: almost every project has a forum; 66% of them have, at least, one mailing list and over 50% have a Web-site hosted on SourceForge. The most widespread programming language is Java (30.00%), even if the entire C family[12] is still predominant (57.00%). In 74 cases out of 300 (24.67%), a specific database is used in the developing process: MySQL has confirmed to be the most used one (47.30%), followed by PostgreSQL and JDBC. Notwithstanding that the majority of the projects are released under the flagship of the OS licenses, 55.67 % of the programs are compatible with the Windows operating systems and 16.67 % are developed exclusive for these ones. These results seem a further signal of the evolution of the OS movement from its strong ideological origins.

Intended audience and products. Projects target mainly developers (26.90 %) and end users (29.16 %). In general, it seems that the average user has high computer science skills: 30% of projects are clearly directed to firms, 10% target system administrators, and 4% are devoted to advanced end users. Solutions provided by the projects are fairly heterogeneous, many different classes of products (177) have been identified, the most frequent ones are development software (26 cases, 8.67%) and Internet related applications (20 cases, 6.67%).

[11] On average, each project counts 14 developers and 3 coordinators.
[12] For instance C, C++, visual C++, and so on.

About firms' participation, ninety seven projects out of the 300 (32.33%) count the involvement of one or more firms. This result is fairly intriguing and it is in line with the recent developments of the economic literature that has emphasized the increasing importance of firms in the open source scenario. A deeper investigation of the phenomenon is, then, crucial in order to understand the evolution of the OS movement and its impact on the industrial dynamics of the software industry.

Companies' participation takes on various forms, three main kinds of involvement can be singled out: (i) *project coordination*, this is the most frequent way companies' participation, with 60 cases; (ii) *collaboration* to code development, in different phases and at different extents (bug fixing, testing or offering services, 37 cases); (iii) *provision of code* or protocols[13] (7 cases).

It is worth noting that the sum is 104 instead of 97, as in 7 cases there is more than one firm involved in different ways in the same project (in 6 of these cases, there is a firm coordinating the project and one or more firms collaborating to it).

The numerous cases of companies appointed as project coordinators witness the good relationships between firms and the Open source community. Indeed, OS projects have a decentralised structure and the leadership emerges from the bottom up (O'Mahony, 2003), being the consequence of the very foundation of the project, the provision of valuable code or of bright solutions to critical technical problems (Bonaccorsi et al., 2006). The ways in which firms succeeded in achieving the leadership have been investigated (see table 2). In most cases, the firm itself founded the project, but there is also evidence of companies that entered an existing project and replaced the coordinator. Seven coordinating firms were settled up by the members of the initial project coordinating group.

Table 2: Ways in which coordination is achieved by firms.

Ways in which coordination is achieved	N	%
Setting up the project	36	60.00
Entrance in the project and replacement of the previous coordinators	17	28.33
The project coordination team sets up a firm	7	11.67
TOTAL	60	100.00

[13] For example, communication protocols used to share informations among different devices.

After having provided evidence on the role played by firms within the OS community, we have explored whether and how their presence shapes the evolution of the projects. Several disparities have been singled out between projects participated by firms (group A) and the others (group B). Table 3 summarises the results of the inferential procedures carried on to detect statistically significant differences.

Table 3: Comparison between projects participated by firms and the others. Note: Hartley's Test (a), t Test (b), Mann-Whitney U Test (c), Chi-Square Test (d) and Pearson Correlation Coefficient (e)

Characteristics of the projects	*Projects participated by firms*	*Projects not participated by firms*	*Test*	*P value*
PARTICIPATION				
Average number of developers	19	5	a, b, c, e	0.01
Average number of project coordinators	11	1	a, b, c, e	0.01
TECHNICAL ASPECTS				
Average number of mailing lists	2.61	1.69	a, b, c, e	0.01
Bug reporting activity	744	358	a, b, c, e	0.01
Future requests	222	144	a, b, c, e	0.01
Elements in SVN	605	391	a, b, c, e	0.01
Patches	189	60	a, b, c, e	0.01
Programming language: C family	40.21%	65.02%	d, e	0.05
Programming language: Java	47.42%	21.67%	d, e	0.05
Number of translations into different languages	9	5	a, b, c, e	0.01
LICENSE				
Usage of the GNU General Public	45.36%	73.89%	d, e	0.05
USERS AND PRODUCTS				
Intended audience	(1) Developers, (2) End Users	(1) End users, (2) Developers	d, e	0.05
Companies as targeted users	39.92%	12.42%	d, e	0.05

In general, projects participated by firms are larger: they are joined by more developers and have more coordinators than the others. Moreover, data seem to highlight that they show a higher level of activity, as it is witnessed, for instance, by the more intense bug reporting activity and by the wider use of mailing lists.

As expected, firms' presence has an impact on the management of IPRs. The use of the General Public License is less common in projects joined by firms: the percentage of GPLed solutions decreases from 73.89 % in group B to 45.36% in group A. It is worth noting that LGPL remains, in both cases, the most appreciated alternative.

Commercial companies seem to shape also the typology of software provided: products targeted to companies are more diffused in group A and, in general, there is evidence that the average user of

the software produced within a project participated by a firm has higher computer science skills. Other technical differences deal with the use of different programming languages, with a wider presence of the Java language.

Conclusions and further developments

The empirical results reported in this work reveal as, at present, the OS movement differs considerably from its origins. In line with the most recent literature, the increasing role of for profit firms is acknowledged: in almost one third of the 300 sampled projects there is some form of firms' participation. Different types of links exist between these companies and the OS community. Namely, firms may coordinate a project (the most frequent case), offer code or protocols, or provide other kinds of contributions in different phases of the software production process.

As expected, firms have an impact on the evolution of the projects in which they take part. Our preliminary investigations have highlighted several statistically significant differences between the projects participated by firms and the others. It has emerged that the former are larger and more active, make less use of the GPL licenses, show several technical peculiarities, and, in general, produce software solutions targeted mainly on companies and high skill-users.

Summing up, notwithstanding that our findings do not allow to come to definite conclusions, they call for the definition of a clear research agenda.

First, a wider survey of literature on firms' participation in collective action is needed to disentangle the main aspects of the topic, which it would be of interest to investigate with reference to firms' engagement in Open Source activities. Particularly, we are confident that an interdisciplinary approach should be of help, as sociology and psychology scholars have extensively contributed to the understanding of the processes of private provision of collective goods (see von Holzinger, 2003 for a survey of this literature).

Second, clear research hypotheses should drive the empirical analyses. Basing on the current results, the following research questions turn out to be challenging

(i) Are projects in which firms involved are more successful than the others? Hence, do companies contribute crucially to the achievement of the Open Source Software, as the founders of the Open Source Initiative[14] hoped? This is a fairly intriguing issue that poses methodological problems, as the very concept of project success is hard to define (Raja and Tretter M. J., 2006) and requires the integration of several metrics of project activity. Moreover, some endogeneity concerns are likely to emerge. Namely, is it firms' involvement to determine the success of a project or, on the contrary, do successful projects tend to attract companies? Clearly, inferential procedures that we used up to now, are not suitable to address these issues, the definition of empirical models and the application of appropriate econometric techniques are required.

(ii) What are the characteristics of the firms involved in OS projects? Up to now, we have explored the topic through case studies, which have been focused on the relationships between the companies and the projects. However, data should be gathered on structural characteristics of these firms (e.g. size, age, competences, product/service portfolio, etc.) in order to inquire whether and how they differ from those following a traditional software production process and how these difference are related to project participation.

(iii) Moreover, a wide literature (Chesbrough et al., 2006) is now exploring the so called *open innovation model*, according to which firms can achieve a greater return on their innovative activities by using a broad range of sources (Chesbrough, 2003). Open Source is a clear example of open innovation approach (West and Gallangher, 2006) as, on the one side, the OS community is a large knowledge basin from which firms can get information, one the other side, OS licenses are designed to foster instead of forbidden the access to the information. In this framework, it is then of interest to explore how

[14] *"We in the open source community have learned that this rapid evolutionary [software production] process produces better software than the traditional closed …Open Source Initiative exists to make this case to the commercial world"*, from the Web site of the Open Source Initiative, http://www.opensource.org/.

project participation shapes the innovation activity of the involved firms. In short, are these firms more innovative than the others?

(iv) Finally, it has been widely acknowledged that Open Source movement was born in Universities and research centres (Bonaccorsi and Rossi, 2003), while the motivations of OS developers have been compared to those of academics doing scientific research (Bezroukov, 1999). Our data have shown that, besides firms and individuals developers, also several Universities and research centres are involved in OS projects. This deserves attention. Particularly, it is important not only to provide evidence on the impact of public research on the OS movement, but also to explore whether and how participating in OS projects affects the scientific activities of University researchers. The OS community is undoubtedly an enormous source of knowledge, does the access to it have a positive impact on academic performances (e.g. publications)?

These are only part of the questions raised by the fast evolution of the Open Source software. In order to provide rigorous answers, we are actually working on enlarging our sample from 300 to 1,000 SourceForge projects. Moreover, up to now data on firms' participation have been gathered through different sources as mailing lists or project websites. This methodology may run the risk of underestimating the phenomenon: e.g. a firm that has made a only a contribution to the code might not appear on the project Website. In order to overcome this problem, we are exploring the possibility to collect information on participation directly from the code posted on SourceForge, using software scanning applications (as for instance CODD) as it has been done for individual developers (Ghosh and Prakash, 2000, Rullani and David, 2006).

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