Entry strategies under dominant standards.
Hybrid business models in the Open Source software industry

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Abstract

The paper analyses the entry strategies of software firms that adopt the Open Source production model. A new definition of business model is proposed. Empirical evidence, based on an exploratory survey taken on 146 Italian software firms*, shows that firms adapted to an environment dominated by incumbent standards by combining Open Source and proprietary software. The paper examines the determinants of business models and discusses the stability of hybrid models in the evolution of the industry.

Keywords: Open Source, software industry, business model, entry.

JEL Classification: L86, O33.

1. Introduction

The Open Source production model has a long history behind it. It was born in the computer science departments of the best U.S. Universities and in the research centres of large IT corporations where programmers used to share software and knowledge (Rosenberg, 2000). Initially it was a social movement (Stallman, 1984) that opposed the evolution towards a software industry dominated by incumbent firms that protected their code through strict intellectual property rights (Hall, 2003). On the basis of the good technical quality demonstrated by the cooperatively developed software (Raymond, 2001) the movement has progressively acquired economic importance. On one hand, large incumbent firms, such as IBM, Hewlett Packard, Compaq and Sun

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Microsystems, have strategically decided to release their source code to the community (Wichmann, 2002a; Hawkins, 2002). On the other hand, particularly after the wording of the Open Source Definition in 1998, a wave of new software firms has entered the industry trying to profit not from the traditional license fees but from other software-related services (Lerner and Tirole, 2002a, 2002b; Hecker, 2000).

This paper contributes to the literature by exploring the entry strategies of software firms in the Open Source field. We address three main issues. First, what business models do new entrants adopt? Given the novelty of the entry process, there is limited empirical evidence on the offering profiles, the source of revenues, the pricing and licensing policies and the relative weight of proprietary or Open Source solutions. Second, what are the determinants of the adoption of business models? Third, are the observed business models dynamically stable? Answering these questions is crucial for understanding the economic and financial sustainability of the Open Source paradigm within the software industry.

The paper is organised as follows.

Section II discusses the notion of Open Source business model in the existing literature and proposes a new definition.

Section III describes the methodology of a survey taken on Italian firms that supply Open Source based products and services to gather data on their structural characteristics and attitudes towards the Open Source and its community.

Section IV examines the evidence on business models. We find that *hybrid models* are largely dominants among the entrants while there is significant heterogeneity in the degree of hybridisation.

Section V explores the determinants of the firms' strategic choices with respect to the Open Source paradigm and their stability over time. We present a model that explains the stronger or weaker orientation of the business models towards the Open Source by making reference to motivational factors, level of investment in Open Source development activities and perceived obstacles to Open Source adoption due to network externality effects.

In section VI the model is tested using logit regressions that control for firm size and adoption timing.

Section VII summarises the main conclusions of the paper.

2. *The business models of the Open Source firms: in search of a definition*

How is it possible that a cooperatively produced collective good such as Open Source code (von Hippel and von Krogh, 2003) may be exploited by profit-oriented firms in order to generate sustainable revenue streams? The entry into the software industry of new firms that adopted the Open Source production mode has raised interest on this question.

Wichmann (2002b) has created a taxonomy of the business models of these new entrants that distinguishes between the product and the service side of the software market and explicitly refers to different positions in the software value chain. On the product side the author numbers *distributors* and *retailers*. *Distributors* aggregate, integrate and optimise the source code freely downloadable from the Internet that they convert in ready to install Open Source programs usually supplied together with documentation. *Linux distributors* carry on these activities for the Linux operating system while *niche and specialty Open Source distributors* work within a wide variety of Open Source projects. These companies typically target the mass market and the market for customized solutions for both individuals and firms, to which they also offer related services such as consulting, integration, support and training. This business model has been very successful. Linux distributor Red Hat has been leading its market since 2000 while, according to Zope Corporation, the Open Source application server Zope is now adopted by companies, newspapers, media, and the government…. . The main competitive advantage of these firms is the enormous saving in development costs. Wheeler (2003) estimates that without the contributes of the Open Source community the Red Hat 7.1 operating system would have required about 8,000 person-years of development time, and cost about one billion dollar.

Retailers sell Open Source distributions and other Open Source related materials, such as books or gadgets. This business model, called also *accessorizing business model* (Hecker, 2000), has been successfully set up by O'Really & Associates, which publishes a wide variety of user manuals for Open Source programs.

On the service side Wichmann refers to the provision of services such as *consulting, system implementation and integration, support, maintenance, remote administration, training and application management*[2] for Open Source products. Service provision is made effective not only by big distributors but, above all, it is the core business of small enterprises that target the private and SMEs market.

This kind of taxonomies are based on a value-chain representation, in which firms may locate themselves in terms of their contribution to the software development and service cycle. The empirical counterpart of these taxonomic efforts is mainly the small set of early entrants that succeeded in developing a high specialised business model or the large IT firms that have entered the field. This approach should be enriched in order to give a careful account of empirical evidence on the new wave of firms that recently entered the Open Source field. In fact, on one hand, it is possible that Open Source firms do not locate themselves in a small region of the value chain, but rather carry out several activities at the same time, perhaps as a transitory strategy before a clear division of labour emerges in the industry. On the other hand it must be recognised that firms may enter the Open Source business either coming from previous experiences with proprietary software or adopting Open Source since their birth. In both cases the question whether they offer *only* Open Source solutions must be kept open. Consequently it may be difficult to classify firms into a sharp taxonomy. Based on these elements more articulated definitions of business model should take into account: (a) the full profile of offering, (b) the relative importance of Open Source vs. proprietary software.

Furthermore, whatever their business model, firms entering the Open Source field should not leave out of consideration the peculiar characteristics of the demand for software goods. Software is a network good, prone to network externality phenomena (Church and Gandal, 1992). The users of a software solution are the nodes of a *two way-virtual network* (Economides, 1996; Economides and White, 1994) that allows them to benefit from a flow of files, documentation and knowledge. As it happens in every network, agents' utility does not depend only on the *intrinsic value* of the good but also on its *synchronisation value*, which derives *from being able to*

[2] Some firms have endeavoured to offer services to the Open Source community in terms of marketplaces and organisation of conferences or meetings. Marketplaces aim at matching people who need a specific software product or service (buyers) with Open Source developers (sellers). Up to now this business model has turned out to be unsuccessful and *no company …has become profitable so far* (Wichmann, 2002b). The shortage of guarantees for the completion of the products typical to the Open Source production mode scares the buyers while the sellers do not want to pay for a service that the Internet network provides for free. For the same reason Open Source programmers are not willing to pay fees for information about conferences and meetings.

interact with other users (Liebowitz and Margolis, 1998). Therefore, the utility of a software program increases with current and expected size of the network of its users. Individuals that use a widely diffused program are able to exchange files and information with a lot of other users (*direct network externalities*, Katz and Shapiro, 1985) and have more chances of finding computers running that program. Moreover the larger the diffusion of a software the stronger the incentives for companies and individual programmers to develop compatible applications (*indirect externalities*, Farrell and Saloner, 1986, 1987; David and Greenstein, 1990) that, in turn, generate positive feedbacks on the users. In addition, the availability of support and assistance services depends on network size (Katz and Shapiro, 1985).

Network externalities deeply affect the diffusion path of software goods. Given that the incentive to choose a software increases with the size of the network of its users, the very early stages of the adoption process may be crucial in determining the long run equilibrium of the market. Every adoption decision taken, even *by chance* (Arthur, 1990), during these early stages shapes the expectations about the winner technology and increases the expected value to join the network. This process is fostered by *switching costs.* Learning to master a software program is a time and resource consuming activity. When customers decide to give up a software package they have to bear high switching costs that include training as well as lost productivity resulting from the adoption of a new system (Shy, 2001). There is no agreement on the final outcome of such process. A large part of the literature, building on the notion of increasing returns to adoption (Arthur, 1989, 1994), shows that an initial advantage of a technology will lead to its dominance in the long run. The limit equilibrium will be characterised by a single standard, so that the dynamics is of a winner-take-all type (Cook and Frank, 1995).

However, other contributions (Witt, 1997) point out the coexistence of competing technologies in equilibrium. In the case of Open Source, some authors (Bonaccorsi and Rossi, 2003; Dalle and Jullien, 2003) argue that this is the likely outcome. The disadvantages for new entrants created by incumbent standards may be compensated by various forms of collective action (von Krogh et al., 2003) driven by intrinsic motivations (Lakhani and Wolf, 2004). In particular, voluntary contributions to Open Source projects and advocacy activities may give cost and quality advantages to products that otherwise would be eliminated by the strength of the network externality effects. Under these conditions, voluntary collective action may reach the point where a critical mass of adopters

ensues the survival of the new technology (Huberman and Loch, 1999). In any case it is clear that new entrants facing an environment with an incumbent standard suffer from several disadvantages. Given this picture, there is an interesting dilemma for the prospective new entrants in the Open Source field. On one hand, given the widespread diffusion of proprietary products, Open Source firms might accept a compromise and include both Open Source and commercial products in their offering. This may be important to fill consumers' needs, taking into consideration their legacy, while possibly waiting for a complete line of Open Source products. On the other hand, in this way the firms run some risk of loosing the cooperation link with the Open Source community and the support from its Open Source customers. In fact, in order to compete with Open Source products, the firm depends on the contributions of the programmers' community. Maintaining close relationships with this community requires credibility and commitment (Kuster et al., 2002). According to Osterloh et al. (2002) firms which use Open Source code face considerable competitive disadvantages if they do not respect the rules of cooperation and trust of the community. Behaviours such as including pieces of Open Source code into proprietary programs or keeping close parts of the code of the programs released to the community are likely to reduce the incentives of individual programmers to contribute to Open Source projects in which firms are engaged. Moreover customers that have switched to Open Source due to strong social motivations regarding the fight for software freedom prefer to deal with suppliers that are themselves fully committed. As a result, striking the right balance turns out to be a challenging managerial decision.

Therefore, new entrants must decide whether to follow a *hybrid business model*, combining different types of licensing schemes and offering both Open Source and proprietary solutions, or a *pure model* completely based on Open Source software. Once they have adopted a hybrid model, an interesting question arises dealing with the relative importance of the two paradigms for the firm's business strategy.

3. Methodology and sample description

In order to gather empirical data on firms' strategic attitudes towards Open Source software, during 2003 we submitted a structured questionnaire to system administrators of Italian *Open Source firms*. We define as Open Source the firms that supply, in various ways, Open Source based products and services and release them under

Open Source licenses. It is worth to notice that a firm is defined as Open Source even if its offering include also proprietary solutions.

Sample selection was a critical task. Because of the novelty of the phenomenon, there is no complete directory of firms working with the Open Source Software and new firms are entering the field each year. Specialised journals are publishing lists of these firms but they are partial or restricted to specific business or geographical areas.

Given that, we adopted a non-probability sampling procedure called *snowball sampling* in social science (Van Meter, 1990; Frank and Snijders, 1994; Thompson, 2002). We approached an initial short list of firms and asked their collaboration in referring to other firms active in the Open Source field. We stopped the procedure when no new referral was originated and succeeded in contacting 275 firms of which 146 accepted to participate (response rate: 53.1%). Clearly the sample is not statistically representative of the universe but, given the exploratory nature of the study, this was considered methodologically correct.

Given the sampling strategy, we have no information about non-respondents and cannot measure the related bias. During an intensive phone follow-up campaign, however, it was clear that firms strongly committed to Open Source were much more likely to devote time to our research. Under this perspective, among non-respondents there probably were firms that do not actually work with Open Source and were wrongly referred to by other firms, or Open Source firms with somewhat less commitment to the field. Consequently our respondents represent an acceptable cross-section of the Italian firms actively operating in the supply-side of the Open Source market. At the same time we are aware that survey data are influenced by the national origin. It is difficult to state how important is this limitation, given that to the best of our knowledge there are no published surveys on Open Source firms in other countries or on an international basis. In addition, this survey on Italian firms has been planned as a first exploratory step towards a multi-country study, which will be carried out in 2005 in five European countries. Table 1 reports descriptive statistics of firms' structural characteristics.

Variable	*Acronym*	*Unit of Measurement*	*Min.*	*Max.*	*Mean*	*St. Dev.*
Year of foundation	YF	Unit	1957	2003	1996	6.4
Year of Open Source adoption	YOSSA	Unit	1986	2003	1999	2.6
Staff	E	Unit	1	320	17.3	36.6
Graduate staff	DG	%	0	73	6.7	12.0
Average age of partners	AAP	Unit	22	58	36.1	7.5
Average age of employees	AAE	Unit	20	43	29.8	4.1
Average age of freelances	AAF	Unit	20	58	30.2	5.9
Open Source turnover in 1998	OSST98	%	0	100	35.7	36.5
Open Source turnover in 2001	OSST01	%	0	100	46.5	37.0
Change in turnover (in the last 3 years)	TC	%	-25	600	121.3	155.1
Change in Open Source turnover (in the last 3 years)	OSSTC	%	-10	700	91.4	138.5

Table 1: Descriptive statistics. Note: firms born after 2001 were asked for their Open Source turnover in the last year.

Most firms entered the market recently. The median year of foundation is 1996 while 1995 is the 25° percentile. About 40% of firms have been on the market since 2000 while 80 out of 146 were born since 1998, the year in which Open Source Initiative was set up to bring the business world near to the Open Source community.

Combining data on staff with turnover classes, it turns out that 99.3% of the sample consists of Small and Medium Sized Enterprises. The average number of individuals working for each firm is quite low, 81.9% of the firms have a total staff of less than 20 and 75% have been established by less than 5 founders. In about 70% of the cases firms' turnover is less than 516,000 euro while only five firms exceed 5 million euro. However, the growth of firms is remarkable. In the last three years, their turnover increased, on average, by 121.3%[3].

The median year of adoption of the Open Source technologies is 1999 while 2000 is the modal one, 62.3% of the firms adopted Open Source solutions since the very year of the foundation (early adopters). Most firms (78.0%) come from the software sector. The new paradigm has been diffusing in Italy for a short time and the firms not involved in the software sector probably suffer from lack of information. They are less likely to have access to the traditional information sources of the developers' community (websites, mailing lists, newsgroups) and are less aware of the business opportunities that ensue from the Open Source.

[3] Excluding the outlier value 666%. Part of the growth is due to newly created firms, whose turnover starts from zero at the initial period. It is worth to notice that Assinform (2004) estimates that, in Italy, the whole software product and service market experienced a negative growth rate of about -3.7% in 2003. In the United States, the global sale volume of software products and services was expected to growth annually by 17.8 by the end of 2001 (Iventosh et al., 2002).

130 firms (89.0%) number at least one technician among their founders. Nevertheless, less than 30% of the firms in the sample have a founding team composed only of technicians while most respondents number also individuals skilled in business and finance. Given the small size, the organisational division of labour is very fuzzy. It is difficult to measure the proportion of time devoted to programming activities. Based on an extensive phone follow up, we estimate that around 70% of the total staff have programming skills and are somewhat involved in this activity.

Only 6.2% of the founders come from Universities and research centres or were employed in public bodies or non-profit organisations. Few members of firms' staffs have a degree (6.7%) and 0.4% attended a Ph.D. program. While there is clearly the possibility that computer science undergraduate students are involved, this result is at odds with the surveys taken on Open Source developers (Ghosh et al., 2002). Our findings are in line with the results on individual developers as far as the age distribution of individuals is concerned. On average people are about 32 years old, founders form the oldest group while employees and freelances are in their early Thirties.

4. The business models adopted by new entrants in the Open Source field

According to our definition, business models are characterised by: (a) the full profile of offering, (b) the relative importance of Open Source vs. proprietary software. In order to capture the evidence on the offering profile, we use multiple-choice type of questions (table 2).

Service provided to the customers	*% of firms supplying the service*
Installation	80.1
Support	82.9
Maintenance	76.0
Development of ad hoc solutions	87.7
Distribution	63.0
Marketing of software produced by other companies	39.0
Consulting	84.9
Training	64.4
R&D	51.4

Table 2: Services offered by firms. Multiple choice-question.

Firms in the sample combine elements from all the categories mentioned in the literature. They distribute Open Source products (63.0%) but also develop customised solutions using Open Source software (87.7%) for which they presumably offer installation, support and maintenance (80.1%, 82.9% and 76.0%, respectively). At the same time, the majority of them are also active in the supply of complementary services such as consulting (84.9%), training (64.4%) and to a lesser extent, R&D (51.4%).

It terms of products (figure 1), the most frequent in the offering profile (77.2%) are Internet-based products (Web sites, portals, hosting). This confirms the success of the Open Source in the Internet segment. Anyway, around half of the firms also offer content management systems, management applications and e-commerce solutions.

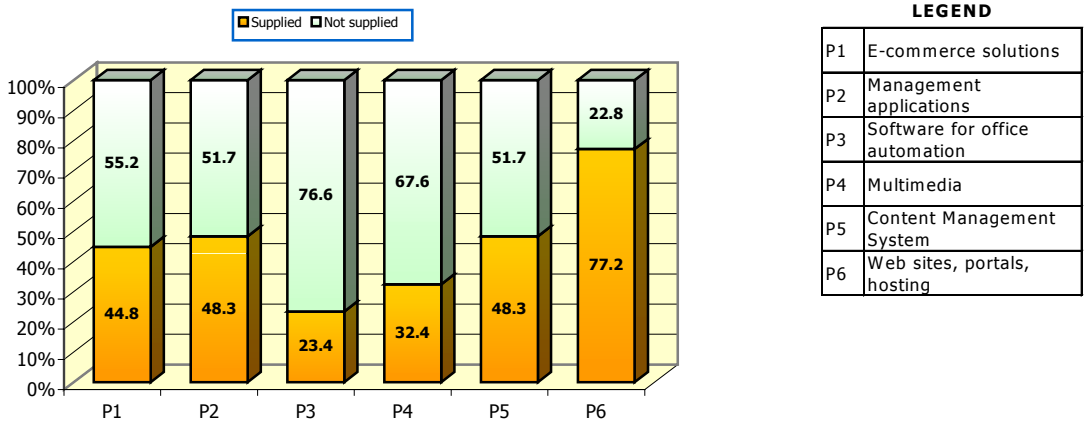

Figure 1: Products offered by firms. Multiple choice question.

In short, it seems clear that firms in the sample do not confine themselves to a narrow region in the value chain. On average they provide 6.4 different services and supply 7.6 different products. Given this evidence data are prone to multiple classifications. Since we do not know the proportion of firms' turnover for each of these activities, it is not useful to cluster firms.

In order to characterize firms' business models we combine the offering profile with the strategic dimension dealing with relative importance of Open Source vs. proprietary software. This is clearly a multidimensional construct. It refers to the proportion of products and services based on Open Source software, as measured by the

share of items on offer, of the license schemes adopted, and of total turnover. These objective elements (products and services, turnover, licenses) should be integrated with a subjective judgment about the *strategic importance* of Open Source in the long run market positioning.

For the purpose of the analysis, we single out firms adopting a *pure Open Source* business model and exclude them from the sample. In order to identify the *pure Open Source* firms we have combined three indicators: the share of turnover due to Open Source products and services (OSST01), the percentage of Open Source products on the total (%OSSP), and firms' statement about the typologies of solutions provided to the customers. A firm is purely Open Source if it holds that OSST01=100%, %OSSP= 100% and provides only Open Source solutions. We identify 8 firms (about 5.5% of the sample) adopting a pure Open Source business model. Although interesting under many respects, the analysis of the characteristics of this small group is out of the scope of this paper.

The rest of the respondents (138 out of 146) can be defined *hybrid firms*, in so far as they have a partial commitment to the Open Source paradigm. To go further ahead with the analysis we group hybrid firms through hierarchical cluster analysis using the Average Linking Method[4]. The following variables, which are indicative of the business model adopted, are considered in the analysis:

a. Percentage of Open Source turnover out of total turnover in year 2001 (OSST01)

b. Share of OSS products on the overall products supplied by the firm (%OSSP)

c. Typologies of solutions offered (SOL_C): only Open Source solutions (SOL_C=3), mainly Open Source solutions (SOL_C=2) and indifferently proprietary and Open Source solutions (SOL_C=1)

d. Strategic importance attached to Open Source Software (SI_OSS). This variable is measured on a five point Likert scale (from 1 = not at all important to 5 = very important)

[4] Franke and Von Hippel (2003) use this technique for exploring heterogeneity of the user needs in the field of the Apache security software. We chose hierarchical cluster analysis instead of partitioning because we preferred not to fix a priori the number of clusters. Moreover it is more appropriate when the number of observations is smaller than 200 (Everitt, 1993). Clustering procedures are based on different measures of distance between observations and groups that define the different methods. The choice of a given method depends on the expected number of clusters and on the expected quality or inequality of their size. Among hierarchical methods we choose the Average Linkage Method that computes the distance between two clusters as the average distance of all pair of observations. The application of other methods, in fact, such as the nearest neighbour method and furthest neighbour method would have produced a cluster including almost all the observations. This would have not allowed us to classify firms on the basis the characteristics of their Open Source business model.

e. Intensity of use of GNU General Public License (LICENSE). We mean both the licenses under which firms distribute their software and the licenses used to carry out the production process. This variable is coded 3 if the firm uses only the GPL, 2 if the firm uses it together with other Open Source licenses, and 1 if firm does not use GPL. The choice of the GNU GPL use as a proxy of the degree of Open Source involvement requires some further explanations. On one hand the GNU GPL is the flag of the Open Source movement. Its persistent nature assures that community developed code will not be hijacked and turned into proprietary (McGowan, 2001). Keeping the code open preserves developers' incentives to write valuable software because allows them to gain reputation among peers and signal their talent to software houses (Lerner and Tirole, 2001). Choosing to work with GPLed code, a firms shows its agreement with the knowledge sharing values of the Open Source community. On the other hand, a firm that inserts even one line of GPLed code in a program must release the whole software under this license scheme. Given that according to several empirical analyses GPL is the most diffused Open Source license[5], its use is indicative of the exploitation of Open Source code.

Since, as expected, the five variables are correlated (see Appendix), we run a principal component analysis (PCA1) to derive the factors to be included in the cluster analysis. Two components are extracted from the data, meaning that the heterogeneity in the sub-sample of *hybrid* firms has *two* different dimensions (see table 2A of the Appendix). It seems that the use of the GPL is not related in any way with firms' Open Source orientation, given that LICENSE is the only variable significantly correlated with the second factor extracted. The first component is, indeed, positively and significantly correlated with all the variables but LICENSE. This leads to the conclusion that the most reliable indicator of firms' attitudes towards Open Source technologies is the first factor extracted by PCA, whereas GPL use is likely to be independent of the firms' strategic choices. Different explanations of this result are possible. First, the use of GPL might answer the purpose of signalling to the Open Source community that the firm agrees with its value. Such behaviour aims at obtaining feedbacks and contributions from developers, independently of the real firms' market behaviour. Further, the persistent nature of GPL reduces firms' power to freely choose their license policy and force them to use this license independently of any other consideration.

[5] On 27th August 2004, the SourceFourge repository (http://sourceforge.net) numbered 86,474 registered projects. Almost 80% of them

Cluster analysis reveals two distinct and well-characterised sub-groups.

Variable	*Acronym*	*More Open Source Oriented firms (MOSS)* N=74		*Less Open Source Oriented firms (LOSS)* N=64		*Mann- Whitney Test P-value*
		Mean	*St. dev.*	*Mean*	*St. dev.*	
Percentage of Open Source turnover on the total in year 2001	OSST01	60.93	31.67	13.59	14.51	0.000
Share of OSS products on the overall products supplied by the firm	%OSSP	0.90	0.177	0.67	0.28	0.000
Typologies of solutions supplied by the firms	SOL_C	4.64	0.56	3.09	0.95	0.000
Strategic importance attached to Open Source Software	IS_OSS	2.01	0.56	1.13	0.34	0.000
First factor extracted by the principal component	PCA1	0.79	0.49	-0.92	0.55	0.000

Table 3: Descriptive statistics of MOSS and LOSS firms.

It stands to reason that the firms in the former cluster (MOSS) are more Open Source-oriented than the firms in the latter one (LOSS).

Software products and services identified in the offering profile have been measured only on a binary basis (present/not present). In addition, a large majority of firms actually carried on almost all activities and does not fall into any sharp categorisation. We come to the conclusion that the best way to characterise business models is to focus on the orientation towards Open Source, as captured by the proposed clusterisation into MOSS and LOSS firms.

5. Explaining hybrid business models

The previous discussion has highlighted that software firms adopt a hybrid business model that may accommodate largely different strategic orientations towards Open Source. This results leaves us with two puzzling questions. First of all, what are the determinants of the orientation towards Open Source in the choice of the business model? Why do some firms use mainly Open Source code and deliver to customers ad hoc solutions under Open Source licenses while others seem to be more reluctant to abandon, or seem keener to adopt, proprietary software? Second, is the hybrid model a transient phase in the strategic evolution of firms, or is it a permanent feature of this industry? In other words, are we observing a mere artefact of an (unobserved) underlying transition from a pure proprietary model towards a pure Open Source model and vice versa, or rather a steady state organisational equilibrium?

are released under the GPL.

5.1. A model of determinants of business models

The first question requires the development of an explanatory model. We propose a model in which three factors explain the orientation towards Open Source: motivational factors, level of investment into software development within the Open Source community, and perceived obstacles to Open Source adoption due to network externality effects (table 4).

Variable class	*Variable*	*Acronym*	*MOSS*			*LOSS*			*SAMPLE*			*Mann- Whitney test p-value*
			N	*Mean*	*Std. Dev*	*N*	*Mean*	*Std. Dev*	*N*	*Mean*	*Std. Dev*	
A	Because we want to be independent of the price and licence policies of the large software companies	M1	73	4.0	1.2	59	3.5	1.2	132	3.8	1.2	0.010
	Because we wish to place our skills at the disposal of the Open Source community and hope that others will do the same	M5	74	3.5	1.2	59	3.2	1.2	133	3.4	1.3	0.073
	Because we agree with the values of the Open Source movement	M6	73	3.9	1.2	59	3.5	1.4	132	3.7	1.3	0.079
	Because contributions and feedback from the Open Source community are very useful to fix bugs and improve our software	M8	74	4.1	1.1	59	3.6	1.3	133	3.8	1.2	0.031
	Because of the reliability and quality of the Open Source programs	M10	74	4.1	1.1	59	3.5	1.2	133	3.8	1.2	0.004
B	No. of projects the firms joined since the very start of their Open Source activity	ALL_A_PM	44	7.3	10.2	11	4.5	6.9	55	6.7	9.6	0.100
	No. of projects the firms joined during 2002	C_PM	68	2.0	3.0	47	0.5	1.3	115	1.4	2.5	0.000
	No. of projects the firms coordinated since the very start of their Open Source activity	ALL_A_CP	65	1.2	3.8	45	0.6	3.0	110	1.0	3.5	0.006
	No. of projects the firms coordinated during 2002	C_CP	66	0.4	1.0	47	0.3	1.2	113	0.4	1.1	0.062
	% of Line of Codes (LOCs) the firms contributed to each project on average	%_LOCs	55	10.5	22.4	42	4.1	14.5	97	7.7	19.6	0.001
	Contributions by the firms incorporated in the official versions of the projects	N_C_OV	50	1.4	2.6	42	0.1	0.3	92	0.8	2.0	0.000
C	Importance attached by firms' customers to direct network externalities	DIRECT	73	2.5	1.2	56	3.4	1.3	129	2.9	1.3	0.000
	Importance attached by firms' customers to direct network externalities	INDIRECT	73	2.2	0.9	54	2.9	1.6	127	2.5	1.3	0.009

Table 4: Explanatory variables of the adoption model: Mann-Whitney tests.

A. Motivational factors

The literature has explored in great detail the motivations of individual programmers in Open Source (Lerner and Tirole, 2002a; Hertel et. al., 2003; Feller and Fitzgerald, 2002; Ghosh et al., 2002; Hars and Ou, 2002). It is much less clear whether these motivations carry on to private, profit-oriented firms (Bonaccorsi and Rossi, 2004). Why should business firms have an interest in social, intrinsic, non-profit, value-rich motivations often found for individuals?

An important reason might be that many firms are entrepreneurial ventures created by individual programmers, often with a long history in the field and strong personal beliefs and values. These entrepreneurs may want to *shape* their firm around the values of the Open Source community.

The questionnaire collected data on eleven different motivation variables of firms' involvement in Open Source activities[6]. Descriptively, the intensity of agreement with several social motivations, plus a few economic and technological ones (5 items out of 11), is indeed higher for MOSS than for LOSS firms (see table 4). We want to test whether this is also an explanatory factor in a logit regression model, with a predicted positive sign. Since motivational variables are highly correlated, we perform a principal component analysis (PCA2). As expected, a unique factor is extracted (MOTIV), explaining almost half of the variance of the data (see table 5A of the Appendix).

B. Level of investment in Open Source development activities

In order to adopt an Open Source business model firms must distribute their code under a license scheme that satisfies the OSD requirements. They download freely available code from the Internet and adapt, integrate, customise it to their customers' needs. In principle, they are not requested to deliver their intermediate or final products to the community but only to make the source code fully accessible to the customers and to those that ask for it. They are not obliged to take part in any of the multitude of projects aimed at developing Open Source software. At the same time, we observe that firms do participate in projects[7], although with a moderate effort: 53.8% took part to at least one project from the very start of their Open Source activity, while only 7.7% have participated to more than 10 projects. At the same time 46.2% never participated.

Taking part in a project is a time and resource consuming activity. The returns from participating as a company are in terms of commercial visibility and technological learning. Active participation in the community allows collecting information about products, services, customers and eventual openings of market niches. A strategy of active involvement is likely to be an important asset for firms. However, firms must balance these effects against

[6] The taxonomy of motivations is as follows (Feller and Fitzgerald, 2002).
Economic motivations: because Open Source software allows small enterprises to afford innovation; because we want to be independent from the price and licensing policies of large software companies; because in the field of Open Source good IT specialists are easy to find; because opening our source code allows us to gain a reputation among our customers and competitors. *Social motivations*: because we agree with the values of the Open Source movement; because we want to place our source code and skills at the disposal of the Open Source community and hope that others will do the same; because we think that software should not to be a proprietary commodity. *Technological motivations*: because contributions and feedback from the Open Source community are very useful to fix bugs and improve our software; because of the reliability and quality of the Open Source software; because we want to study the code written by other programmers and use it for developing new programs and product; to obtain products not available on the proprietary software market.

the possibility of inadvertently providing advantages to their direct competitors by making the source code available. In addition, there is still the option to free ride on others' effort without contributing. Therefore firms that actively participate to projects must have a strategic plan for the exploitation and appropriation of the benefits from their development activity, mainly in terms of customisation and complementary services. In turn, this means that there must be several customers ready to adopt Open Source solutions and pay for it and for related services, and this is possible only if the firm has a clear commitment and enjoys large credibility as an Open Source supplier. As a result, we posit a positive relationship between the level of involvement in Open Source projects and the orientation of the business model towards Open Source (i.e. a MOSS business model).

Although MOSS firms are likely to use more the code developed within project, the active participation is not a necessary condition, so that the variables should not be affected by endogeneity.

We use six metrics of firms' project participations (see Appendix, table 3A). As in the case of the variables measuring motivations, we check for linear correlations and run a Principal Component Analysis (PCA3) to overcome correlation problems (see table 6A of the Appendix). Two components are extracted, dealing respectively with projects participation, that is, number of projects joined or coordinated (INV) and firms' contributions effort (CONTRIB) as measured by the percentage of Line of Codes contributed by the firm on the total.

C. Network externality effects

A model of strategic orientation of firms should include elements that describe the competitive environment. In case of Open Source, the most important factor is the competition between two de facto standards: the dominant standard based on Microsoft operating systems and compatible applications, and the new emerging standard based on Linux. As it is well known, the competitive battle has had so far largely different outcomes in two sub markets: Microsoft Windows is undoubtedly the leader in the client side and virtually all largely diffused applications are Microsoft compatible; in the server side, on the contrary, the dominant solution is the Web server Apache developed on an Open Source basis. Although recently many Open Source solutions have been

[7] By participation we meant in the survey: (a) a formal decision to take part in a project on behalf of the company, (b) authorisation to employees to participate to projects and work on it during working hours. Thus we do not include the commonly reported behaviour of programmers working on Open Source projects during working hours *without* declaring it to their employers.

made compatible with Microsoft systems, compatibility is still an important obstacle to the Open Source diffusion. Most users, in fact, perceive the two systems as incompatible and think that Open Source programs are more difficult to use than proprietary ones. This means that significant switching costs are always at work. The relative importance of switching costs vis-à-vis perceived benefits of Open Source, on the other hand, may differ across the markets. As a proxy of network externalities we use two variables measured on a 5-point Likert scale. Firms were asked to give a mark from 1 (*not important at all)* to 5 (*very important*) to the importance attached by their customers to the availability of largely diffused software packages (DIRECT, *direct network externalities*) and of a large number of compatible applications (INDIRECT, *indirect network externalities*) as obstacles to the adoption of Open Source. Once again mean differences show the expected sign in the MOSS and LOSS groups.

5.2. Are hybrid business models transient of permanent?

A subtler question is whether the hybrid model is a permanent or transient feature. The orientation towards Open Source may be interpreted as an intra-firm technology diffusion process, in which firms that adopted a different process technology – namely, conventional proprietary software - progressively switch to the Open Source technology. At the same time, it cannot be excluded that an opposite process is taking place. In any case we do not know the length of this transition dynamics and cannot control for it by observing the state of the diffusion at two different dates. However, we can control for the date at which the firm *has started* to adopt Open Source. The variable YADOPT measures the length of the interval since the initial adoption in terms of number of years. If the hybrid model were a transient equilibrium, then the probability to be a MOSS firm would be positively influenced by YADOPT. On the contrary, if we would find a non-significant coefficient, we might conclude that there is no compelling evidence for an underlying transition dynamics that makes hybrid models an unstable equilibrium.

Another control we put in the model is for size. A large literature posits a positive relationship between firm size and technology adoption (Karshenas and Stoneman, 1993; 1995). It has been claimed that smaller organizations are less likely to adopt than larger ones (Åstebro, 2004) and, even after adopting, they are less likely to utilize extensively the new technology (e.g., Fichman and Kemerer, 1997). According to this view, we should expect to

find more MOSS business models among large firms. We check this hypothesis by estimating the size effect on the probability for a firm to choose a MOSS business model. Firm size is measured by staff in year 2002 (SIZE). We also controlled for a different specification of size (classes of turnover) and found similar results.

6. Empirical results

In order to test the model, we include explanatory and control variables in a logit estimation, coding the dependent variable as 1 if the firm chooses a more Open Source-oriented business model (MOSS) and 0 otherwise (LOSS).

Final specifications of the model have been controlled for possible collinearity problems (see table 7A in the Appendix). Since variables DIRECT and INDIRECT are found to be very collinear (linear correlation coefficient = 0.55), they have been alternatively included in the tested specifications. Diagnostic checks are carried on in order to evaluate the robustness of the estimations and influential cases are excluded from the sample (Bollen and Jackman, 1990). Table 5 reports the coefficient estimates.

Dependent Variable: Business model orientation (coded 1 if MOSS, 0 if LOSS)		
Independent Variable	*MODEL I*	*MODEL II*
MOTIV	0.4371* (1.81)	0.4740** (2.00)
INV	1.4257*** (3.35)	1.2791*** (3.21)
CONTRIB	0,9929** (2.02)	1.2376*** (2.63)
DIRECT	-0.5295*** (-2.83)	- -
INDIRECT	- -	-0.4789** (-2.49)
YADOPT	0.0923 (1.07)	0.1521* (1.73)
SIZE	-0.0786*** (-3.04)	-0.0862*** (-3.30)
Constant	2.7785*** (3.80)	2.3162*** (2.67)
Number of observations	135	135
LR statistic	60.45***	58.54***
Pseudo R2	0.324	0.314

Table 5: Logit estimates of business model adoption. t-statistics in parentheses. ***, **, * indicate significant at the 1%, 5% and 10% level of significance. Three observations have been dropped because they were classified as influential cases.

All variables have the expected sign and the R square is reasonably good for a cross-section study.

Motivational factors positively influence the probability to be a MOSS firm, although the effect is slightly significant in Model I.

Variables describing the involvement in Open Source projects enter positively in both specifications with highly significant coefficients.

As expected, the higher the perceived importance of direct and indirect externalities, the lower the probability of adoption of a business model that strongly relies on the entrant standard, rather than the incumbent one. This result confirms the importance of increasing returns in market demand in explaining the industrial dynamics of the new entrants and seems a major contribution to the literature.

Our control variables also suggest interesting results. The year of adoption is not significant in Model I and weakly significant in Model II. Therefore we cannot exclude that the extent of adoption is subject to an in intra-firm process that requires some time to be implemented. At the same time, there is no strong evidence for the argument that hybrid models cannot be sustained in the long run. We believe we have identified a distinctive and relatively permanent feature of a young industry subject to strong competition between competing network standards. Further research is needed on this topics. We are planning to replicate the survey on the Italian sample in order to build panel data. Furthermore, in the extension of the survey to five European countries planned for 2005, we will ask for the intensity of adoption at different dates. These evidences will allow a more articulated answer to the stability problem.

An interesting result is found with respect to the size control. We find that smaller firms are significantly more likely to be more Open Source oriented. If Open Source can be interpreted as a new process technology, then this result is at odds with most of the literature. Our data confirm the notion that Open Source is a production paradigm that does not support company growth, but rather makes it possible for small firms to be innovative and find sustainable revenue streams.

If this is true, then the prediction of the economics of standards and of the industrial organisation of network industries that the software industry is structurally subject to concentration should be reconsidered.

7. Conclusions

Since its beginning, the rise of the Open Source movement has attracted the interest of the economists and organisational scientists mainly because it is a challenge to well received theories of individual motivation and task coordination.

This paper attracts the attention on a new aspect of the phenomenon, namely the entry of software firms and the rise and consolidation of a new industry. We investigate the configuration of these firms and find that they follow what we call "*hybrid business models"*. The orientation towards Open Source is found to be positively associated to the intensity of (mainly non-economical) motivations that are typical of individual programmers, to the extent of the involvement into the cooperative production of collective software goods, and negatively to the perceived weight of the network externalities as obstacles to adoption. Quite surprisingly, size does not favour the adoption of Open Source. The paper proposes a new way of defining business models, finds original evidence, and identifies robust explanatory variables. It is therefore a contribution to the emerging theory of industrial organisation and industrial dynamics of the Open Source industry.

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Appendix

Correlation matrices

Variable	%OSSP	LICENSE	SOL_C	SI_OSS	OSST
%OSSP	1.000	0.157	0.273**	0.364**	0.188
LICENSE	0.157	1.000	-0.008	0.187*	0.116
SOL_C	0.273	-0.008	1.000	0.488**	0.325**
SI_OSS	0.364	0.187*	0.488**	1.000	0.540**
OSST	0.188	0.116	0.325**	0.540**	1.000

Table 1A: Correlation matrix of the variables used in the cluster analysis. Notes: ** p value <0.01, * p value< 0.05.

Variables	M1	M5	M6	M8	M10
M1	1.000	0.259**	0.232**	0.364**	0.110
M5	0.259**	1.000	0.588**	0.400**	0.219*
M6	0.232**	0.588**	1.000	0.297**	0.368**
M8	0.364**	0.400**	0.297**	1.000	0.322**
M10	0.110	0.219*	0.368**	0.322**	1.00

Table 2A: Correlation matrix of the motivation variables. Notes: ** p value <0.01, * p value< 0.05.

Variable	*Acronym*	ALL_A_PM	C_PM	ALL_A_CP	C_CP	%_LOCs	N_C_OV
No. of projects the firms joined since the very start of their OS activity	ALL_A_PM	1.000	0.493	0.436	0.292	-0.072	0.157
No. of projects the firms joined during	C_PM	0.493	1.000	0.310	0.454	0.331	0.426
No. of projects the firms coordinated since the very start of their OS activity	ALL_A_CP	0.436	0.310	1.000	0.695	0.257	0.423
No. of projects the firms coordinated during 2002	C_CP	0.292	0.454	0.695	1.000	0.271	0.167
% of Line of Codes (LOCs) the firms contributed to each project on average	%_LOCs	-0.072	0.331	0.257	0.271	1.000	0.442
Contributions by the firms incorporated in the official versions of the projects	N_C_OV	0.157	0.426	0.423	0.167	0.442	1.000

Table 3A: Correlation matrix of the variables dealing with involvement in Open Source projects. Notes: ** p value <0.01, * p value< 0.05.

Factor loadings of Principal Component Analyses

Variable	*Acronym*	*Principal Components*	
		1	2
Percentage of Open Source turnover on the total in year 2001	FSL01	0.609	-0.71
Share of OSS products on the overall products supplied by the firm	%POSS	0.585	0.222
Typologies of solutions supplied by the firms	SOL_C	0.706	-0.366
Strategic importance attached to Open Source Software	SI_OSS	0.826	-2.089e-02
Intensity the use of GPL	LICENSE	0.279	0.896

Table 4A: Factor loadings of PCA1.

Variable	*Acronym*	*Principal Components*
		1
Because we want to be independent of the price and licence policies of the large software companies	M1	0.537
Because we wish to place our skills at the disposal of the Open Source community and hope that others will do the same	M5	0.771
Because we agree with the values of the Open Source movement	M6	0.767
Because contributions and feedback from the OS community are very useful to fix bugs and improve our software	M8	0.707
Because of the reliability and quality of Open Source Software	M10	0.565

Table 5A: Factor loadings of PCA2.

Variable	*Acronym*	*Principal Components*	
		1	*2*
No. of projects the firms joined since the very start of their OS activity	ALL_A_PM	0.580	-0.407
No. of projects the firms joined during	C_PM	0.711	4.77e-02
No. of projects the firms coordinated since the very start of their OS activity	ALL_A_CP	0.781	-0.293
No. of projects the firms coordinated during 2002	C_CP	0.808	-0.186
% of Line of Codes (LOCs) the firms contributed to each project on average	%_LOCs	0.446	0.732
Contributions by the firms incorporated in the official versions of the projects	N_C_OV	0.355	0.715

Table 6A: Factor loadings of PCA3.

	MOTIV	INV	CONTRIB	DIRECT	INDIRECT	YADOPT	SIZE
MOTIV	1.0000						
INV	-0.0090	1.0000					
CONTRIB	0.0633	0.0000	1.0000				
DIRECT	-0.1188	-0.0766	-0.0609	1.0000			
INDIRECT	-0.0393	-0.1355	-0.0112	0.5500	1.0000		
YADOPT	-0.0180	-0.0100	-0.1559	-0.0647	0.0782	1.0000	
SIZE	-0.2314	-0.0106	0.0555	0.1261	0.1159	0.0936	1.0000

Table 7A: Correlation matrix among explanatory variables in the logit regressions.