Conference Paper: The Economics of Open-Source Networks

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Abstract

The open-source movement is becoming an overarching feature of knowledge-creating environments and this research investigates the mechanisms whereby such a model comes into existence. Far from being the result of gifts of anonymous benefactors, the open-source model is the outcome of a conveyance of informative, valuative and incitive signals that larger sets of potential contributors construe in a subjective fashion.

This study challenges the gift-economy metaphor and cautions the argument that open-source software is a reliable and generally applicable model for the forthcoming digital age.

Key words: Gift Economies, Networks, Knowledge-Like Goods, Market Signalling, Semiotics

1 Introduction: Overview and Research Objectives

The open-source movement is a growing phenomenon that pundits from different disciplines are studying by using different tacks ranging from software engineering to systems developments and information systems.

Although published a few years ago, Raymond's seminal work has been very influential in considering this emergent phenomenon as a gift economy where gift exchange represents the means whereby anonymous contributors start community building.

This study attempts to challenge this logic by (re-)exploring the mechanisms whereby the open-source model comes into existence. Its research objective is threefold: firstly, challenging the gift-economy metaphor; secondly, and perhaps more ambitiously, developing a new theoretical foundation underlying the open-source phenomenon whereby the open-source movement is considered as the outcome of a conveyance of informative, valuative and incitive signals; thirdly, stressing the relevance of the social over the technical and cautioning the argument that open-source software is a reliable and generally applicable model for the forthcoming digital age.

The remainder of this study unfolds as follows: section two reviews the literature in currency in a critical fashion. Section three introduces the theoretical foundations that underpin this research. Section four draws on the science of semiotics to review two polar case studies; finally, section five concludes by highlighting the lessons from this study as well as its limitations.

2 Literature Review

The open-source movement has been hailed as the overriding feature of knowledge-creating environments to the point that, within the information systems circles, some scholars have claimed that this model is the key to the understanding of future forms of organisations, knowledge work and business (Ljungberg 2000).

After the unexpected success of Linux, new projects have followed suit: Mozilla, the Netscape version of the Communicator browser, was announced to be open source in 1998 (Harmerly, Paquin et al. 1999); IBM has joined the Apache group by contributing its own code fixes and features to the open-source base (Fielding 1999) and Apple Computers has resorted to the same idea to build its new operating system (Sánchez 1999).

Even though the open-source model is being studied from a variety of academic disciplines that bring new theoretical conjectures into play, it seems that its understanding hinges upon the following tenets:

- The open-source model is a form of gift economy (Raymond 1999): the open-source movement is a form of gift culture based on altruistic motives whereby programmers are willing to make free contributions because of the unstated obligation to repay the gift at some future time. Raymond (1999) argues that such gift cultures are adaptations not to scarcity but to abundance deriving from no serious shortage of survival necessities like disk space, network bandwidth, computing power, etc.;

- Open-source software is an information good exhibiting network externalities stemming from standardisation (Shapiro and Varian 1999): the open-source software exhibits increasing marginal value deriving from a larger number of individuals using the standard. In other words, the larger the number of individuals using the standard, the more valuable the software;

- The open-source model heavily relies on hardware, software and infoware tools (O'Reilly 1999) instead of face-to-face communications: such a model makes use of Information and Communication Technologies (ICT) tools to support individual/group interactions because of information redundancies originating from sharing the same function. In other words, information redundancy implies that some knowledge must be possessed by the contributors even though they do not regularly need it because it permits to make sense of the knowledge of other contributors, thus allowing for the use of ICT tools instead of information-rich forms of communication based, for instance, on face-to-face meetings.

In sum, the existing literature regards the open-source movement as a gift economy exhibiting network externalities that, thanks to information redundancy, makes use of ICT tools instead of information-reach forms of communication.

As it stands, it seems that the literature in currency does ascribe the open-source sociability patterns to the gift-economy metaphor. In other words, gifts are considered as the basis to construct these peculiar types of voluntary social relationships.

In coming to grips with the open-source movement, it is worth questioning its alleged sociability patterns by using a philosophical method of inquiry. After all, Dahlbom (2000) argues that ancient and modern philosophy can be described as examples of vertical thinking whereby philosophers try to organise knowledge in several layers. 'The philosophical method is typically one of scepticism, of analysing knowledge

claims by questioning assumptions, weeding out what is uncertain, doubtful, or contingent in order to reach an unquestionable core' (Dahlbom 2000 pg. 223).

What is a gift economy? Is the open-source movement the exemplification of a gift economy thriving on resource abundance? And do anonymous contributors exchange gifts to improve the technology of social relations?

Cheal (1988) argues that the gift economy is a system of redundant transactions that is used to construct small social worlds. Gifts are redundant transaction if they meet the following criteria: firstly, they are not due to conformity to norms; secondly, they bring no advantage to their recipients; thirdly, and perhaps most importantly, the objects received from others in gift exchanges are things which the recipients could have provided for themselves, had they really wanted to (Cheal 1988).

Accordingly, in an affluent industrial society, redundancy in transactions refers to the rendering of goods and services that the recipient has both the ability and the entitlement to secure through his/her own immediate efforts. Had the open-source movement been an adaptation to affluence, as Raymond (1999) contends, each contributor would have clearly been able to secure the gift (i.e. the latest software release) through his/her own endeavour, which is obviously not the case.

In addition, Raymond's contentions are vulnerable to a more general problem. In his much celebrated work, 'The Cathedral and the Bazaar', Raymond compares markets, organisations and gift economies as alternative mechanisms to redistribute resources[1]. Whereas markets and organisations have long been considered as such, it is generally established that gift economies do not have as their principal purpose redistributive goals because of their very resource abundance. Subsequently, Raymond's argument is conceptually untenable because of his pointing to allocative mechanisms within alleged contingencies of no resource shortage. Moreover, Raymond's statement that the larger the number of open-source projects, the smaller the programmer pool does imply an overall problem of resource scarcity in terms of coding talent that contradicts his overall assumption of resource abundance.

Let us now turn to the thorny issue of community building. Are the acts of contributing to a certain project aimed at building social relations?

Perhaps they are, but it is more reasonable to assume that each contributor has his/her own private agenda: some individuals might contribute in the expectation of future

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[1] On this point see Raymond (1999).

reciprocation; other individuals might contribute to enhance their own reputation and, perhaps, sell it on the market at a future date; yet others might contribute because they want to build better software, customise it or, perhaps, because they are driven by more altruistic motives such as the attachment or commitment to certain values or ideals (Kollock 1999)[2]. Hence, assuming that the individuals are contributing to the open-source movement because of their urge to build better social relations is at best an extreme simplification of a much more complex picture.

Ultimately, the aforementioned remarks raise a penetrating question: if the open-source movement does not exemplify a system of redundant transactions aimed at improving the technology of social relations, what is its theoretical foundation?

The next section will attempt to address this question by looking at the open-source movement from yet another perspective that draws on Hayek's masterpiece (Hayek 1945).

3 The Symbolic Nature of Open-Source Networks

Raymond's work has been extremely significant in the open-source field but has already originated both derivative and counter-punctual analyses.

In his critical reaction to Raymond's work, Kuwabara (2000) offers an alternative perspective of open-source networks likening them to complex self-organising systems whose high levels of quality and performance depend upon local interactions that are tantamount to evolutionary processes featuring the absence of external intervention by a central authority. Even though compelling, Kuwabara's argument seems flawed in so far as the basis for determining optimal responses in interactions is related to the unavailability of global information to individual agents.

In other words, Kuwabara (2000) contends that the agents of a complex system, while adaptive, are not truly optimising and that no single agent has access to what all the other agents are doing. At most each agent gets information from a relatively small

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[2] Notice that Lerner and Tirole (2000) propose a possible link between these non-monetary incentives and extant economic language that makes such benefits non-exclusive. They further contend that the contributors' net benefit is equal to the immediate payoff (current benefit minus the associated opportunity cost of the time invested) plus the delayed payoff (career concern incentive plus ego gratification benefit).

subset of the set of agents and processes this 'local' information to come to a decision as to how he or she will act (Kuwabara 2000).

Whereas the absence of a central authority is unquestionable, it seems that the strength of open-source projects revolves around ideas coming from the bottom in the form of local knowledge. Raymond himself recognises this peculiar feature within the Linux project when he argues that the person who understands and fixes the problem is not necessarily the person who first spots it. In other words, it seems that an efficient allocative mechanism is at work whereby larger social worlds can immediately find out bugs spotted in particular circumstances of place and time as well as location-specific information and needs. We might well ask then what is this efficient signalling mechanism?

Perhaps, the answer to this issue lies in the signalling function of the physical instantiation of posting or updating on-line source codes, the source code being an exact language as well as objective knowledge that enhances communication and coordination among contributors (Kaisla 2001).

In a market economy plagued by scarce resources, prices are symbols (Hayek 1945; Ciborra 1993) that convey specific messages telling, for instance, that, at a particular time in a given location, there is an overabundance of commodity X or a shortage of service Y. Tens of thousands of individuals who are totally unaware of the reasons why prices have changed, subsequently, buy or sell such goods or services, thus moving in the right direction. On the contrary, in a networked, e-lance economy, afflicted by an alarming dearth of coding talent (Weber 2000), the price mechanism cannot operate efficiently because the contributions that new individuals bring in the economy are not measurable in monetary terms, hence the need to find a substitute for the price system.

I shall argue that, within knowledge-creating environments akin to the open-source movement, the physical instantiation of posting or updating on-line source codes replaces the price system because it functions as an informative, valuative and incitive signal that larger sets of anonymous contributors construe in a subjective fashion.

Hence, the open-source model is the outcome of a conveyance of signals, the open-source software being a side effect of a signalling mechanism that individual agents establish to augment their own good. Metaphorically speaking, thence, hackers, programmers and contributors are far from being benevolent benefactors operating in a gift economy whose only purpose is to share their own knowledge; they are

individualistic agents whose actions produce public goods that are a side-effect of their private behaviour.

The end result of this signalling process is an extreme form of a networked, distributed joined effort resembling the concept of market economy. Networks like markets are ways of coordinating economic activities, the former being characterised by the fact that all participants make a contribution, the latter featuring a sharp distinction between contributors (i.e. suppliers) and users (i.e. buyers) (Wegberg and Berends 2000).

Apart from this peculiarity, the open-source model exhibits the typical traits of a market economy afflicted by a dearth of coding talent, its initiator(s) being tantamount to auctioneer(s). More in detail, the open-source network features:

- No entry barriers on the supply side: businesses and programmers alike find it moderately inexpensive to go open source and start their own project;
- Identical knowledge-like products: open-source products such as operating systems, Web servers, Web browsers, programming languages, etc. display identical features because their physical properties resemble those of knowledge (Quah 1999);
- Perfect information of the signalling mechanism: businesses and programmers alike are perfectly informed about the signalling mechanisms being used to convey local information, invoke cooperation as well as aid in the preferential selection of projects;
- Presumed knowledge of the production function: programmers are presumed to accurately know the open-source production function (i.e. programming).

In addition, to the extent that programmers are using their spare time to make contributions, the open-source network may be considered as being characterised by an exchange of spare time for non-monetary benefits where the contributors' spare time may be regarded as a substitute for money. In other words, whereas in a market economy the purchasing medium available in many hands and displaying a constant marginal utility is money (Marshall 1916), in a networked, e-lance economy such a medium is represented by the contributors' spare time and its associated opportunity costs. Hence, the contributors' spare time is the equivalent of what economists call numeraire that is a good having unit price that the contributors themselves are willing to exchange up to the point where the (expected) non-monetary marginal benefit equates the associated opportunity cost.

Considering the open-source network as a market-like mechanism raises a new conceptual problem: are market-like mechanisms efficient in the context of knowledge-like goods (i.e. public goods)?

Public goods are goods characterised by non-excludability and non-rivalry in their consumption. Non-excludability refers to the fact that if the public good is supplied, no user can be excluded from consuming it except, possibly, at an infinite cost. Non-rivalry, otherwise, refers to the fact that consumption of the public good by one user does not reduce the quantity available for consumption by any other (Myles 1995).

The implication of non-excludability is that consumption cannot be controlled efficiently by a price system since no user can be prevented from consuming the public good if it is provided. Hence, any good satisfying this condition does not fit into the framework of the pure market economy and needs an alternative allocative mechanism whereby the marginal rate of transformation between the public good and each private good is equated to the sum, over all users, of the marginal rates of substitution. In other words, since an extra unit of public good increases the utility of all users, the efficient allocation requires that the sum of the marginal benefit of all individual users be equated to its marginal cost (Myles 1995).

In the open-source network, however, this problem can easily be bypassed because: a) the signalling mechanism is not based on the price system; b) the agents of the open-source model are vying for private non-monetary benefits (reputation, peer esteem, less boredom, future reciprocation, etc.) not pure public goods; c) the (expected) aggregate marginal benefit of all individual users equates, by definition, the (expected) aggregate marginal cost since users and producers are perfectly identical[3]. Hence, not only is the open-source network an example of a market-like mechanism whose externality is represented by the provision of a public good[4]; it is also exempt from free riding because free riders would not get any private non-monetary benefits from their actions.

After all, why does this new metaphor matter? To the extent that open-source networks may be considered as market-like mechanisms, their sociability pattern no longer depends upon the gift economy metaphor but, on the contrary, on the

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[3] Note that I am arguing for an efficient use of the contributors' spare time not for an efficient provision of the public good. On the latter, see Johnson (2000).

[4] van Wegberg and Berends (2000) claim, at this purpose, that the Linux operating system may have been, with hindsight, a side-effect of another project. Likewise, Linus Torvald maintained that 'Linux emerged by coincidence'. See Kaisla (2001).

behaviour of their users/contributors. Ultimately, a thorough understanding of the nature of these market-like mechanisms should revolve around the analysis of the way signs are being interpreted by the users/contributors themselves.

4 Semiotic Insights and Case Studies

Semiotics is the science of signs, whether animal or human, language or non-language, true or false, adequate or inadequate, healthy or pathological (Morris 1946). Previous sections of this work have already emphasised, in the open-source context, the use of signs as informative means that convey local information concerning the circumstances of place and time. But what are signs? Do they have pre-specified modes of usage and dimensions?

This research loosely uses the words signs, signals and symbols as synonyms without falling into any technicalities. Any physical instantiation can be a sign (or symbol/signal) as long as it can be perceived and interpreted: gestures, words, numbers (or prices), pictures, behaviours, institutions, and so on, are all signs (Liebenau and Backhouse 1990).

Any organism for which something is a sign may be called an interpreter. The disposition in an interpreter to respond, because of the sign, by a certain type of response-sequences is called the interpretant. Anything which would permit the completion of the response-sequences is called a denotatum of the sign. Finally, the conditions fulfilling the denotatum are called the signification of the sign (Morris 1946). In the open-source model, for instance, the gesture of posting or updating on-line source codes is the sign; the pool of potential contributors is the interpreter of the sign; their disposition to cooperate is the interpretant; the specific open-source project is the signification of the sign whereas the non-monetary benefit (peer esteem, reputation, less boredom, future reciprocation, etc.) for contributing to the project is the denotatum.

Signs may be used to convey information (informative function), to aid in the preferential selection of objects (valuative function) or incite a specific set of response-sequences (incitive function). In the open-source model, posting or updating on-line (source) code, for instance, fulfils these three functions because it conveys

local information, spurs the preferential selection of certain projects rather than others and invokes cooperative behaviours.

Signs have four dimensions to whom we can apply different analytical tools: pragmatics, semantics, syntactics and empirics (Liebenau and Backhouse 1990).

Broadly speaking, these dimensions represent a range from the most social to the most technical aspects. Pragmatics takes into account the assumptions, expectations and beliefs of the agents (i.e. contributors) involved as well as the social environment or context in which signs are used. Semantics looks at the meaning that signs acquire according to the agents. Syntactics, otherwise, provides us with the tools for the construction of formal rules whereby the agents themselves interact. Finally, empirics describes the codes and physical characteristics of the medium of communication. Obviously, in the open-source setting, the aforementioned dimensions materialise in the following levels: a) the economic, cultural, structural, technical, political and ethical environment endemic to open-source networks (i.e. pragmatics); b) the project indicated by the sign coupled with the agents' disposition to react in a certain way (i.e. semantics); c) the copy-left rules aimed at keeping software free (i.e. syntactics); d) the ICT tools being used to allow for on-line interactions (i.e. empirics).

Every sign involves an interpretation process, for a sign must have a meaning which is both its signification and its interpretant (Morris 1964). Subsequently, to properly explore the meaning of signs, this research makes use of an interpretive methodology. More in detail, this research attempts to bring a new perspective on the area of open-source software. It tries to find differences within seemingly similar cases in order to draw inductive conclusions based on the analysis of polar case studies (Pettigrew 1990) and, subsequently, break simplistic frames (Eisenhardt 1989) that resort to the gift-economy metaphor to explain the paramount pattern of sociability within the open-source movement. This manner of interpretation proceeds by investigating the meaning that such symbolic forms as posting on-line (source) codes, joining open-source networks or deserting (forking) them, acquire with respect to one another, as well as to the whole that they comprise.

4.1 Polar Case Studies: Linux vs. Mozilla

'The case study is a research strategy which focuses on understanding the dynamics present within single settings' (Eisenhardt 1989). Case studies can involve either single or multiple cases as well as combine several levels of analysis. The cases can be chosen to replicate previous studies or extend emergent theory or even provide examples of polar types to fill theoretical vacuums. Even though the cases may be chosen randomly, random selection is neither necessary nor preferable. Given the limited number of cases that can thoroughly be studied, it makes sense to focus on extreme situations in which the process of interest is 'transparently observable' (Pettigrew 1990). Whereas the goal of random sampling is to obtain accurate statistical evidence of the distribution of variables within the population being analysed, the interpretive perspective aims at carefully choosing cases to fill existing theoretical vacuums. Linux and Netscape, therefore, are both to be analysed as paradigms of polar case studies representing stories of success and semi-failure of open-source networks.

In his much acclaimed trilogy of papers, 'The Cathedral and the Bazaar', 'Homesteading the Noosphere' and 'The Magic Cauldron', Raymond (1999) suggests that open-source models have a high payoff when:

a) Reliability, scalability and stability are critical;
b) Correctness of design and implementation is not readily verified by means other than independent peer review;
c) Software is a business-critical capital good;
d) Software establishes or enables a common computing and communication infrastructure;
e) Key methods (or functional equivalents) are part of common engineering knowledge.

Even though the aforementioned requirements seem to hold within the Linux and the Netscape project, it is worth inquiring why the Linux project was much more successful than the Netscape one.

Previous sections of this work have highlighted the dimensions this research attempts to use. Whereas Linux and Mozilla are almost alike in so far as their technical aspects

are concerned (i.e. similar copy-left rules and use of on-line newsgroups)[5], it seems that profound differences appear when investigating their social characteristics.

Bezroukov (1999a) argues that open source is a social phenomenon where the status of any member is influenced both by contributions to one or more projects and by non-productive, social activities of status enhancement. Political behaviour and political manoeuvring are usually concealed in programming groups involved in open-source projects. Those who have political power usually deny it; those who want it pretend they do not; those who are skilled in political manoeuvring conceal their abilities (Bezroukov 1999a). Considering the political environment of Linux and Mozilla produces some eye-opening insights concerning, for instance, the reasons why Netscape purposefully created an ad-hoc '.org' Web site to garner its pool of programmers whereas Linus Torvald used a pre-existing on-line newsgroup (USNET).

Hamerly, Paquin et al. (1999) maintain at this purpose:

> 'Giving away the source code meant Netscape was collaborating with the Net. And there was a crucial concept that had to be accepted: the Netscape Client Product Development Group and Mozilla.org were not the same organization. Mozilla.org's goal is to act as the coordinator for all of the people worldwide working on the software. Product Development's purpose is to ship products--Netscape products based on the Mozilla code. Since both groups are working on the same product, interests can overlap. But the group behind Mozilla.org knew that it would be disastrous for the Net to look at the organization and say, "These people only have Netscape's interests in mind and they're only about shipping Netscape products." This would mean that Mozilla.org had failed in its goal to be a good maintainer. The separation had to be real and the Net had to know it' (Harmerly, Paquin et al. 1999).

Hence, to be successful, the initiators' objectives are to be not polluted by ego-driven, commercial or political biases. The pragmatics of open-source movements goes well beyond the political environment though. Netscape's technical environment, for instance, is characterised by a higher degree of complexity due to the late opening of the Mozilla project that arguably led to a smaller pool of programmers. Hence, the Netscape experience suggests an interesting hypothesis according to which the longer a business awaits to go open source, the smaller the pool of programmers being drawn to the project because of the higher degree of intellectual and conceptual effort required by the project itself.

In addition, there is room to believe that Mozilla and Linux translate into a different ethical and economic environment, the former being the incarnation of a business

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[5] The reader should notice that I am referring to the Mozilla Public Licence (MPL).

strategy aimed at competing with Microsoft IE browser, the latter being the expression of pure commitment to pristine ethical values based upon cooperation as well as mutual interests. By the same token, even the structural environment seems to be different, Linux being characterised by a benevolent dictatorship, Mozilla being dominated by a commercial leadership that reserves the right to make code management decisions on the basis of Netscape's business interests, thus refraining programmers from joining.

What about the meaning of such gestures as posting on-line source codes, joining or deserting an existing project?

It is stated above that the word meaning incorporates both the interpreter's disposition to respond in a certain way (i.e. interpretant) and the object being signified by the sign (i.e. signification). Whereas the signification of posting or updating on-line source codes assumes a different connotation according to the political, structural, technical, ethical and economic project environment, the disposition to react depends on the individuals' set of environmental and motivational circumstances (Morris 1946). Contributors, for instance, may join an existing project because they believe they are a part of a movement, perhaps a higher calling one. Whether their interpretant is fighting Evil Microsoft, striving to create insanely great software, boredom, or future reciprocation (Eunice 1998) depends on their special motivational and environmental circumstances which, in turn, partly hinge on the context itself. Moreover, reputational benefits play a significant role in determining whether to join or desert an existing project. Lerner and Tirole (2000) contend that such incentives are stronger the more visible the performance to the relevant audience, the more informative the performance about talent and, finally, the higher the impact of effort on performance (Lerner and Tirole 2000)[6].

Ultimately, not only does the comparison of these polar case studies stress the preponderance of the social over the technical; it also produces interesting insights that caution the argument that open-source software is a reliable and generally applicable model for the forthcoming digital age.

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[6] My study does not fully analyse the patterns of behaviour that programmers establish being mostly focussed on the signalling function of posting or updating on-line source codes which, by reflection, incorporates such patterns of behaviour. On this topic see Lerner and Tirole (2000).

5 Conclusions

The open-source movement is a network resembling a market economy featuring identical users and contributors whose private behaviour produces, as a side-effect, open-source software. Such a network exhibits the characteristic traits of no entry barriers on the supply side, identical knowledge-like products, perfect information of the signalling mechanism and presumed knowledge of the production function (i.e. programming) typical of any market economy, its scarcity problem being its limited resources in terms of coding talent.

Even though this study overlooks the future of open-source networks, their learning practices, their competency traps and situations dissimilar to e-lance economies, this work cautions the argument that open-source software is always reliable and forewarns against the scarcity problems that the growing commercial reality of open-source projects is to face in the foreseeable future.

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