Tight Prior Open Source Equilibrium

The Rise of Open Source as a Source of Economic Welfare

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August, 2005

Abstract

This paper develops the notion that open source has become a viable mode of production and resource allocation not only for intrinsicly motivated communities but for commercial firms, too. Following received economic wisdom this is due primarily to the fact that open source ultimately produces greater value on both the use and the production side. Open source thus acts as an institution that impacts on the structure of the software industry much more efficiently than politics and law. It also provides an economic perspective that may help refine the standard notion of the firm since it emphasises the link between firm and market, not the frontiers that separate the two.

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1 Introduction

Open source has come a long way since it first hit the radar screen of the academic community. The initial excitement soon gave way to empirical research and academic elaborations about the nature of open source. Scholars have by now put together a host of knowledge about the motivations behind open source development, the specifics of how open source projects organise and evolve, and the crucial institutions affecting open source.[1]

However, it has been a widespread belief if not assumption among most observers that the creation of open source software is effectively incompatible with the commercial objectives of software firms. In this vein open source is often being depicted as something that is invariably driven by communities of software developers motivated not primarily by pecuniary returns but intrinsic motivations (Osterloh et al. 2004). Some observers do acknowledge the relevance of rational economic objectives for individual programmers (Lerner and Tirole 2000; Ghosh et al. 2002; Lee et al. 2003), yet apart from summaries of the principal motives for firms to engage with open source from a business perspective (Koenig 2004) little academic attention has been paid to the specific role and importance of commercial software firms for open source in general.

Only very recently have scholars directed more attention to the specifics of commercial firms engaging in the development of open source (Dahlander 2004; Grand, von Krogh, Leonard, and Swap 2004). Indeed, it is starting to emerge that firms have been more than but passive beneficiaries of open source developments. A number of high profile software firms do contribute to open source projects very much in line with traditional open source ethics. Over the last years there has been a considerable upsurge of commercial contributions to and engagement with open source projects by commercial firms such as RedHat, IBM, JBoss, and MySQL.

In this treatise we try to explain some of the commercial activities surrounding and contributing to open source software, and put them into a due

[1] Weber (2004) has provided a good account of the current state of academic knowledge in the field.

economic perspective. In particular, we explain the economics of firms' open source activities on a more abstract level beyond mere descriptions of open source firms' business models.

2 The Value of Open Source

By its very definition open source has traditionally been at odds with the widely accepted notion of value stemming from the transactions of private properties. Current economics has largely been preoccupied with the question of how to allocate a given set of resources such that the resulting overall utility is maximised. The answer of virtually all economists has been an emphasis of private property entailing exclusion and tradability (Coase 1937; Coase 1960). In such a property rights framework economic value stems from transactions: people transact their labour for wages, and their money for things they consider more valuable to them than the price tag they carry. Thus, transactions will occur whenever the use value of a thing outweighs the costs of its creation. And, the creation of things depends on the prospect of their profitable transactions.

Open source, however, is fundamentally different. The social process of open source development creates value without any prospect of exclusive property and tradability (Weber 2004). It is based on common property by virtue of its specific licensing terms that in effect stipulate a complete waiver of private property rights to the software code. Software that is subject to such terms may be freely and repeatedly transacted without any consideration on the part of the receiver.[2] Hence, appropriation of profits based on the exclusion of others becomes impractical in most cases.

Still, open source has proven to create economic value despite its apparent incompatibility with the ubiquitous private property regime. The value of open source is twofold. On the one hand, value is being generated through

[2]For a closer description of open source licenses and a list of such see the website of the Open Source Initiative `http://www.opensource.org/`. You may also want to refer to Bruce Perens' definition of open source at `http://www.opensource.org/docs/definition.php`.

the usage of open source software. Given the absence of licensing fees for open source software and its non-discriminatory availability the surplus on the use side exceeds that of comparable proprietary software. And, not only does value stem from the mere usage of software, value also stems from the option of making modifications to the software. With proprietary software such modifications are typically neither permitted nor feasible given the absence of source code.

Estimates indicate that the commercial value of open source is indeed significant. Open source products have emerged as a competitive alternative to proprietary ones that are widely being deployed creating considerable surplus on the use side (Tiemann 2004). Adding to this, open source has been identified to be an important source of value for developing countries such as Brazil (Ghosh 2003).

On the other hand, part of the incentives behind the development of open source has been attributed to the utility stemming from the very process of participating in the development of open source (Osterloh et al. 2004; Ghosh et al. 2002; Fehr and Falk 2001). Hence, not only does open source create value through its usage but through its creation, too. This quality sets open source apart from received processes of value creation which assume the immediate prospect of rewards from transactions. It has also been making for much of the excitement about open source as a possibly novel mode of production based on entirely voluntary contributions to the production of economic goods.

However, while there is undoubtedly some value stemming directly from the participation in open source projects the role of intrinsic motivation must not be exaggerated, for it only provides part of the answer as to the motives behind open source. Indeed, commercial firms have started to become vital participants in the creation of open source, and rarely do firms base their business on intrinsic motivation.

3 Firms in the Open Source World

The role of firms in open source has started to show prominently in 1994 when Netscape, Inc. in the face of stiff competition by Microsoft decided to release its flagship browser Navigator under an open source licensing agreement. Today, its latest successor Firefox has won a host of favourable reviews and has taken back a 2-digit slice of Microsoft's share in the browser market.[3]

Although Netscape never actually managed to profit from their decision to release the code base of their browser, the creation of open source software has by now become the foundation of business models successfully pursued by a number of commercial firms. Revenue models of companies such as RedHat and JBoss are typically based on the in-depth expertise about the software and the ability to offer excludable and rivalrous services such as consultation, training, or customisation (Table 1).[4] Given the emerging empirical picture it is fair to say that commercial firms now form a vital part of the open source world.

Those companies are often critical driving forces behind the respective open source projects they build upon. Since their business model does not directly depend on generating licensing revenues from software products they have an incentive to cooperate with an external community of developers and users, and abide by the norms and rules of open source communities (Figure 1).

Firms bulding their business on open source differ in an important respect from the classic notion of a firm. They participate in producing a good with a wider community dispensing with standard commercial contracts and their ensuing transaction costs. This participation in turn generates knowledge that may be profitably used to contract commercial services and adjacent goods to third parties (Grand et al. 2004).

[3]See John Markoff, *Mozilla Plans Faster Growth For Its Browser*, New York Times, August 3, 2005.

[4]Returning to the case of Netscape: building on the success of the Firefox browser its successor Mozilla Foundation now plans to revert into a for-profit company (see *infra* note 3). The decision to release the Navigator code base may thus eventually start to pay off in pecuniary terms.

Firm	Open source activities	Revenue sources
RedHat, Inc.	Most successful Linux distributor, mainly aimed at the enterprise market	Subscriptions, support, services, certification
IBM Corp.	Strong financial and corporate commitment to Linux and other OSS projects; initial developer of Eclipse, an open source IDE now maintained by the Eclipse Foundation including IBM, CA, Oracle, RedHat, SAP	IT solutions
Novell, Inc.	Principal developer behind SuSE Linux following the acquisition of the German Linux distributor SuSE; Novell now builds most of their IT solutions upon Linux	IT solutions
Hewlett-Packard Corp.	Engages in development of open source projects related to their hardware products	Hardware sales
Sun Microsystems, Inc.	Primary contributor of code to OpenOffice.org	IT solutions
MySQL AB	Principal developer of the hugely popular open source database MySQL	Consulting, training, dual licensing
Trolltech AS	Principal developer of the open source QT application development framework	Dual licensing, training
JBoss, Inc.	Principal developer of the open source JBoss Application Server	Support, training, consulting

Table 1: Important open source companies

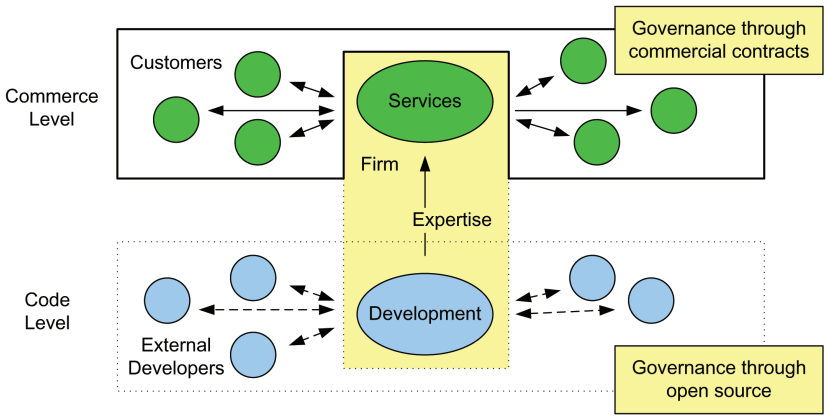

Figure 1: Layered structure and frontiers of an open source firm

The proliferation of firms engaging with open source is impacting on the organisation of the software industry (Demil and Lecocq 2003). A growing number of commercially motivated activities based on open source unfold on the production side, the use side, and in between, too. And, incumbent commercial software firms such as Microsoft begin to question their hitherto pursued business models and consider how they may adapt to the reality of open source (Seemayer and Matusow 2005).[5]

4 Innovation and Open Source

It has been a standard if hotly contested argument in economics that technological progress depends on the availability of state granted intellectual property rights to novel and non-obvious solutions to practical problems (Carlton and Perloff 2000). Notwithstanding its cursory appeal, there has thus far been little empirical backing for this assertion. A number of scholars have argued that the availability of intellectual property rights does not significantly affect technological progress and innovation. Boldrin and Levine (2002) argue that absent intellectual property rights protection there would still be sufficient commercial incentives for the creation of original works.

[5]See also Stephen Shankland, *A Microsoft-Red Hat warming trend?*, New York Times, May 10, 2005.

Benkler (2002) reasons similarly that open source indicates the irrelevance if not detrimental effect of intellectual property for innovation in the software industry. Bessen and Maskin (2005) argue that intellectual property rights have a particularly adverse effect on sequential innovations typical for the software industry.

Eric von Hippel (2005) makes another important point in favour of open source and against intellectual property rights: Open source allows for greater efficiency and advances on the production side as the dichotomy between producers and consumers begins to blur. The basic point in his argument is that the users' role in successful innovation cannot be assumed by a firm, thus rendering open source a superior mode of production in incorporating innovations on the user side into products. According to von Hippel the combined surplus of consumers and producers will be raised by open source. The above examples indicate that firms may still create viable business models around open source.

The impact of open source on innovation in the software industry as whole is subject to an ongoing debate. While incumbents have lamented that the competition of open source adversely affects the innovative potential of commercial firms (Kooths et al. 2003)[6] others have argued that innovations are, in fact, not necessarily tied to the research and development efforts of proprietary software producers (Wheeler 2005a). Given the available evidence it is probably fair to say that innovation in the software industry is not significantly related to either proprietary or open source software. Rather, major innovations are often made by smaller companies or individuals inside and outside academic institutions (Segelod and Jordan 2002b; Segelod and Jordan 2002a).

According to Watts (2003) the ultimate sources of innovations almost always trace back to individuals, whilst broader networks subsequently adopt

[6]Following standard economic theory Kooths et al. (2003) have argued that open source inevitably fails to bring about an efficient allocation of resources in the market. However, Pasche and von Engelhardt (2004) and Grand et al. (2004) have shown that such argument is tenuous given that software markets are far from a perfectly competitive market.

Type of software	Relevant standard	Commercial variant	Open source variant
Operating system	Hardware specification, API for software applications	Windows, MacOS	Linux, FreeBSD
Desktop environment	User interface, API for software applications	Typically part of OS	KDE, Gnome
Word processor	User interface, document format	Microsoft Word	OpenOffice Writer
Spreadsheet	User interface, document format	Microsoft Excel	OpenOffice Calc
Presentation software	User interface, document format	Microsoft PowerPoint	OpenOffice Impress
Drawing software	User interface, document format	Microsoft Visio	Kivio, OpenOffice Draw
IDE (integrated development environment)	User interface, programming language specifications	JetBrains IntelliJ, Microsoft Visual Studio	Eclipse
Web server	HTTP	Microsoft IIS	Apache, Roxen
Web browser	HTTP, HTML	Microsoft IE	Firefox
Content management system	ODBC, SQL, HTML	Vignette Content Management	Plone, Typo3
J2EE application server	J2EE specification, ODBC, SQL, HTML	IBM Websphere	JBoss
Database	SQL, ODBC	Oracle	MySQL
E-mail server	SMTP, POP, IMAP	Microsoft Exchange	sendmail
E-mail client	SMTP, POP, IMAP	Microsoft Outlook	Thunderbird
DNS server	DNS	Microsoft DNS server	bind

Table 2: Most high profile open source alternatives

such an invention if they consider them useful, thus rendering the invention an innovation. An advantage of open source communities over firms in creating innovations lies in their potentially superior capability of incorporating and developing inventions due to their typically loosely coupled network structure (Benkler 2002). On the other hand, one might argue that conventional firms excel in reducing the transaction costs accompanying the organisation of resources.

Whether or not open source is the more innovative mode of production, open source clearly excels in making software robust and affordable. Arguably, the most well-known and successful open source software products are those that resemble or establish functionalities whose demand is well specified: Linux is a POSIX conform operating system, Apache is a web server implementing widely accepted RFC standards, and Firefox is a web browser that equally implements HTTP and HTML standards (Table 2). The same holds for e-mail clients such as Thunderbird, desktop environments such KDE, and file servers such as SAMBA.

5 Economic Viability of Open Source

The increasing impact of open source is the software market and its industry raises the question whether open source ultimately is an economicly viable mode of production. At first glance open source exhibits a number of features that make it rather unattractive as a mode of production for commercially motivated producers. It makes the commercial licensing of digital copies of a creation practically unfeasible since open source licensing stipulates that no restrictions on further dissemination may be asked of any recipient. Yet, the conventional business model of most commercial software producers is vitally based on such restrictions.

Particularly, one might ask why a firm would forego profits from licensing its software to users. When we adopt a dynamic Schumpeterian perspective on economic development, however, open source becomes a very natural development. According to Schumpeter (1942) economics may be understood as a dynamic process that always creates new disequilibria stemming from

innovations that but with a time lag propagate to competitors. Such innovations create temporary monopolies serving as sources of above average profit for the innovator. Competition will erode these profits after a period of time. When we apply this idea to software it follows inevitably that a competitive market in software may only be realised through open source. The competitive equilibrium in software not only drives profits to zero but prices, too. This being the case, open source as a mode of licensing becomes the natural result stemming from competitive forces in a market since it leaves but a small portion of surplus in the hands of producers and puts the bulk of surplus in the hands of consumers. The firms mentioned above build their business model precisely on the premise that a sustainable competitive equilibrium in code inevitably drives a software towards open source.

Of course, the achieval of such a competitive equilibrium hinges upon the possibility for competitors to imitate software. Software, in this respect, differs from other goods such as cars. A new technology will typically propagate to competitors after a certain time lag (Carlton and Perloff 2000). Either an innovation will be plain copied or - if it is subject to intellectual property rights - its functionalities will be resembled. In the field of software functionalities may be concealed such that sufficient reverse-engineering efforts become infeasible (Samuelson and Scotchmer 2002). Thus an incumbent producer may very successfully fend of competition efforts by exerting his intellectual property rights (see e. g. Auletta 2001). However, even if intellectual property rights and the specific nature of software unduly increase the time lag for competition to emerge in the software industry a number of economic factors serve to offset this effect.

One important factor that makes for a structural competitive advantage of open source over proprietary software is its unique value proposition that cannot be matched by producers pursuing proprietary business models. Apart from its competitive price open source delivers greater value to customers, for they can utilise the software in any way including unforeseen ones. To put it differently, the unfettered modifiability of open source as part of its use value may be seen as a distinct feature that adds significant value on the

use side.[7]

Along these lines Frischmann (2004) provides another argument in support of open source: an economic good that exhibits infrastructure properties will create the greatest benefit on the use side when its access is not restricted. That is true not only for infrastructures such as lakes and the internet but for software in general. For the highest conceivable level of accessibility for software to obtain open source will be the natural conclusion. While it is true that there is an economic incentive for producers not to give up control over intellectual property the higher use value of open source creates an economic pressure from the consumer side to the opposite, particularly in the presence of existing open source alternatives.

The conflict between keeping control and delivering greater value through flexible software certainly proves a challenge for existing business models based on exclusive licensing of proprietary software in binary form.[8] It might be argued that this conflict could be resolved by proprietary producers drafting contracts over their software in ways such as to give their customers wide ranging control over the software that is being transacted. This would also allow the exclusion of third parties from a usage of the software and, thus, possibly increase the competitive position of the two parties to the transaction. However, such exclusion might eventually lower the value of the software for the buyer should he decide to use the software in ways that conflict with the contract. Also, the transaction costs of agreeing upon and enforcing such contracts on both parts of the transaction are likely to be much higher than simply agreeing on an open source development contract.

[7]There is an ongoing debate over the *true* costs of open source. One concept that has been introduced by Bill Kirwin of Gartner Research in this vein is that of *total cost of ownership* (TCO). Some studies claim that the cost of proprietary software is ultimately lower than that of open source software. However, Wheeler (2005b) has shown that most of these studies are seriously flawed.

[8]See Seemayer and Matusow (2005) who decribe how Microsoft, one of the biggest proprietary software producers, have tried to find a middle way by letting crucial customers accessing portions of their source codes. Microsoft have understood very well that access to source code constitutes a product characteristic that adds value on the use side. However, their Shared Source Program does not amount to the non-discriminatory access granted by open source licenses.

In sum, aside from competitive pressure that drives software towards open source economic rationality on part of the consumers put further pressure upon producers to move towards open source. Thus, open source is an attractive and viable economic mode for both customers and producers as the successful commercial ventures detailed above have shown.

6 Social Welfare through Open Source

Social welfare through open source comprises more than the economic value stemming from its creation and usage. The increased competition put upon proprietary producers also shifts economic power to the user, thus increasing his welfare. Adam Smith, often quoted as the founding father of modern economics, has already noted that power needs to be diffused on both sides of a transaction for the market mechanism to produce desirable results and that institutions have to be in place to balance the power distributed in a society.

It has been a widely held view that the state has to create the due legal conditions in order to foster open source (Lessig 1999). In particular, the intellectual property rights regimes disseminated throughout the world by the according WIPO treaties have repeatedly been blamed to disadvantage open source over proprietary companies with the means to engage in costly legal activities (Weber 2004; Bessen and Maskin 2005). This view, however, might have been rendered futile by the corporate backing that open source has come to enjoy. This backing creates an institutional framework that allows for open source to prosper even in the face of proprietary opposition and offsets some of the adverse legal institutions.

Adding to the open source development activities by commercial entities different commercial actors have started to assume some of the business risks stemming from market uncertainties and legal uncertainties in the field of open source. Venture capitalists have entered the open source arena, thus taking over financial risks (Chitnis 2004). Also, indemnification programs assuming some the legal risk of infringing upon others' intellectual property rights by using open source have been set up by commercial players like IBM

and HP, and distributors such as Novell, as well as third parties.[9]

The significance of open source as a means of restoring competition and driving the markets towards sustainable equilibria must not be underestimated since it renders state intervention largely unnecessary. It has often been duly remarked that state intervention carries the risk of creating wrong incentives and should thus be avoided if possible (Coase 1960). In the context of open source Comino and Manenti (2003) remark that government intervention in favour of open source should not go beyond the provision of information. However, in a free market economy even such a stance requires a non-trivial level of political justification.[10]

In short, the role of law in establishing favourable institutions for open source as a mode of production and consumption may have been exaggerated. It appears as though open source has changed the whole value equation in the industry such that it emerges as a superior mode of production.[11] Ultimately then, it is not ideology or government intervention that brings about the institutional change, but economic rationality on part of consumers and producers.

Contrary to what has been widely believed, it might well turn out that liberal market economics is well capable of incorporating open source. The growing involvement of firms in open source indicates that as a mode of consumptions as well as production it is compatible with tight prior equilibrium theory (TP) which holds that "decision makers so allocate the resources un-

[9]Practically all firms that offer open source products to their customers indemnify them from legal problems due to possible copyright and patent infringements. See also the website of Open Source Risk Management, Inc. `http://www.osriskmanagement.com/` who offer insurances specifically for open source users and developers.

[10]Imagine the state would grossly interfere with the market by advertising what he considers to be disadvantaged products. Coase (1960) is probably right in this respect, arguing that the cost of acquiring information needed to arrive at informed conclusions as to corrections of market imperfections generally exceeds the possible benefit of such remedies.

[11]Paul Romer has been quoted in Ludwig Siegele, *Lieber Ruhm im Netz als Rubel im Sack*, Die Zeit, 12/2002 (`http://hermes.zeit.de/pdf/archiv/archiv/2000/12/200012.open_content_.xml.pdf`) saying that open source represents a novel mode of production that questions some of the prevalent assumptions about the ubiquity of the market.

der their control that there is no alternative allocation such that any one decision maker could have his utility increased without a reduction occurring in the expected utility of at least one other decision maker" (Reder 1982, p. 33). Not only does open source realize this assertion for the consumption of software but, importantly, for its production, too. It thereby resolves the often assumed dilemma between the production and the consumption of an intangible good, at least in the instance of software products.[12]

7 Conclusion

Open source emerges as a major force of economic wealth that also helps tilting the balance of power from the producer back to the user side. It appears to serve as a due means of driving software markets towards competitive equilibrium states. And, it does so without major assistance of government by means of interference with the market. The success of open source is very much independent from antitrust and competition policies aimed at curtailing adverse influences of existing monopolies.

Most scholars have thus far argued that in the face of strong incumbent monopolies and intellectual rights regimes favouring bigger competitors open source would well deserve some respect if not assistance by policy makers (Lutterbeck, Gehring, and Horns 2000; Weber 2004; Lessig 1999). Yet, it seems as though open source does not even require such support. The rationality of people on all sides turns out to effectively "promote an end which was no part of [their] intention" (Smith 1910).

We have mentioned above the premise of TP that people always act rationally in increasing their utility towards a Pareto-efficiency situation. We have shown that not only is the consumption of open source compatible with this notion but production, too. The most important realisation is that people do derive utility from dispensing with the exertion of maximum legal and factual control over assets and rather choosing to cooperate rather than

[12]See Watt (2000) for an economic elaboration of the conflict between economic theory and intellectual property law.

compete with one another. Richard Stallman, one of the most important pioneers of open source, once remarked: "[K]nowledge should be shared with other people who can benefit from it, and that important resources should be utilized rather than wasted". It has turned out that this approach not only makes for a moral imperative but for viable business models, too.

There is a wider implication of the growing importance of open source in the software industry and beyond (Benkler 2004). The success of open source as a mode of production puts into question the frontiers of the firms and with it the entire received notion of the firm. While Coase (1937) was right in his assertion that firms capitalise on transaction costs in the market the question that has remained open ever since is how the link between a firm and its customers may be shaped best. The emergence of open source indicates that a good part of the value stemming from transactions at this intersection may only be realised when a significant portion of control and power comes to rest with the customer. While most marketing text books have come to appreciate the role of the customers in the shaping of a firm's products and communications, an economic theory that properly deals with the firm in its relation to its customers remains to be put forward.

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