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Divide et Impera! The Role of Firms in Large Open Source Software Consortia

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ABSTRACT

Previously literature on the role of firms in open source software (OSS) development is mainly based on qualitative data and case studies rather than on proper data sets. Research has shown that firms involved in OSS development generally face the challenge to balance the tension between the wish for external knowledge and the demand for control. As it is not entirely clear how firms deal with this tension the goal of the paper is to deepen the understanding of the use of external knowledge, especially in firm-driven OSS consortia. Based on a theoretical background a research design and resulting hypotheses were developed. The data set is based on an agglomeration of a specific firm-driven community and consists of 912 committers and 116 firms organized in 109 independent projects.

Keywords

Open Source Software, Open Innovation, External Knowledge, Governance Structures, Firm-Driven Communities

INTRODUCTION

A few years ago researchers had a common understanding of open source software development as an activity mainly driven by altruistic programmers who voluntarily contribute to software projects. Meanwhile it is more complex to provide a common understanding due to research activities in many areas like individual developer motivation, organization of communities, business models, and firm involvement (Krishnamurthy, 2005; Bonnaccorsi et al., 2006; Dahlander and Wallin, 2006; Wu et al., 2007; Fosfuri et al., 2008). Especially the advocacy of firms in open source software development projects arise new questions for both researchers and practitioners (Alexy and Henkel, 2007; Robles et al., 2007; Von Krogh and Spaeth, 2007; Fosfuri et al., 2008).

Due to the radical change in how to produce software compared to established models the first open source software projects like the Linux operating system attracted a lot of attention. Not only software developers were interested in this new phenomenon, also management science had a deep interest on how those self-organized development processes work (Lakhani and Von Hippel, 2003; Iannacci, 2005; Shah, 2006; Bitzer et al., 2007). Early research on OSS development focused on the question why people voluntarily contribute to software projects. Lakhani & Wolf (2005) found out that not all of the so-called voluntary committers are just intrinsically motivated. According to their study 40 % received direct or indirect financial compensation. It became obvious that firms play an important role in OSS development either as a hidden donator or as an active supporter (Dahlander and Wallin, 2006). The question why and how firms are participating in those software projects can be answered by looking at different business models and commercialization approaches (Krishnamurthy, 2005; Bonaccorssi, et al. 2006; West and Gallagher, 2006). However, most evidence in this area derives from qualitative research and case studies (see e.g. Dahlander and Magnusson, 2008). What is missing is evidence based on empirical sets of data.

Usually, software producing firms try to get their revenue by demanding monetary compensation for the use of their products – and therefore their intellectual property (IP) – through licensing agreements. In contrast, open source licences allow every licensee not only to use the software but also to look into the source code and to manipulate it. This enables every user to contribute to the ongoing development of the product either by reporting bugs or by adding new functionalities. Additionally, firms which open their product to a community of voluntary engaged people are hoping for innovation, increased flexibility, and cost reduction. From a resource-based point of view, the use of external knowledge is very important to ensure ongoing innovation (Miller et al., 2007). Especially small and medium sized enterprises which usually lack of resources, have an interest in acquiring external ideas by open their development processes. Thus, firm-driven open source development can be seen as one instance of open innovation (West and Lakhani, 2008).

RELATED LITERATURE

The success of the open source development model in commercial settings encourages firms to open their products which they formerly developed in a conventional way (Dahlander, 2007). Firms are releasing their in-house developed software code to the open source community for several reasons; some of them in order to reduce costs, some of them to increase their creative potential and others due to strategic and competitive reasons such as extending product lifetimes (Lerner and Tirole, 2002; Fitzgerald, 2006; Fosfuri et al., 2008). On the other hand, many projects which started as non-profit activities of small groups of software programmers were either supported or taken over by large software vendors. For example, IBM has contributed more than $ 1 billion to the development and promotion of Linux (Iansiti and Richards, 2007).

Firms therefore participate in open source software development to different degrees from financial support for infrastructure to paying committers, which leads to a high complexity. Dahlander (2007) tried to classify new emerged open source activities, or de novo entrants as he called it, by analyzing 67 selected open source projects. He identified four major approaches according to the degree of firm participation and whether or not a community was initiated by a firm.

	Firm initiated	Community initiated
High degree of firm participation	Approach I (23 firms)	Approach II (45 firms)
Low degree of firm participation	Approach III (12 firms)	Approach IV (14 firms)

Table 1: Typology of commercialization approaches (Dahlander, 2007, p.930)

The X axis shows whether firms established a community themselves while the Y shows how the firm was actively participating in the community. However, what is missing here is the factor of time. Dahlander assumes that firms do not change their level of participation. From a firm's point of view there are several different strategies to open source their intellectual property. However, these strategies can additionally change over time.

Following West & Gallagher (2006) we will distinguish between four types of open source software development, namely pooled R&D, spinouts, selling complements, and donated complements. Pooled R&D is a familiar model of open innovation. In this case, at least two firms are putting together their R&D effort to develop products according to their needs. What pooled OSS R&D differs from typical consortia is that spillovers are not controllable due to the openness of the organization structure.

If a technology a firm is offering does no longer contribute to the firm's value creation it usually has to be spun out. For example, Chesbrough (2003) analyzed many technological projects at Xerox and found out that some of them were spun out due to missing commercialization options under a Xerox leadership. However, some of these spin outs like Adobe had enormous success. Recently, software firms are also giving away their developments when they are no longer of use for them. For instance, Deutsche Post, a major German logistic company, has developed a service-oriented IT infrastructure over the last eight years. Service-oriented architectures (SOA) are a heavily discussed topic in IT settings due to the ability to create a flexible IT infrastructure. Recent developments made it necessary to offer the in-house solution, a SOA-framework, under the umbrella of the Eclipse Foundation as an openly available product.

Selling complements means that firms are giving away innovations for free to generate revenue from complementary goods (Boudreau, 2008; Economides and Katsamakas, 2006; Eisenmann et al., 2008). Closely related is the concept of donated complements. Although firms do not receive direct revenues neither through the core product nor by selling complementary goods, they can focus on customer loyalty by open their products for user adjustments.

In recent years, many firms opened several parts of their innovation processes for external participation. According to the different types of possible external sources (users, customers, universities, research centres, competitors, etc) it is very important to distinguish between them with regard to the degree of their involvement. Most activities in integrating users or customers in innovation processes can be observed in early and late phases of the innovation process – like making use of lead users or mass customizing products (Von Hippel, 1994; Piller and Walcher, 2006) – whereas integrating external partners in core development activities is open to a lesser extent. In the latter case, firms mainly make use of industrial R&D consortia and joint ventures which generally require formal agreements (de Rond and Bouchikhi, 2004; Sakakibara, 2002; Simonin, 2004) – without integrating users or customers. Furthermore, research in the area of open innovation is concentrated mostly on single users rather than on groups or communities as West and Lakhani (2008) are stating: "Non-firm actors such as communities are rarely to be found in the recent writings on open innovation". However, especially the role of

communities in creating, shaping and disseminating technological and social innovations outside the boundaries of the firm is a promising research area (Dahlander et al., 2008; West and Lakhani, 2008). Since heterogeneity is called to be a driver for creativity and communities are heterogeneous in nature they are therefore offering a hidden creative potential (Oldham and Cummings, 1996).

To sum up, OSS development is open innovation per se and firms generally have an interest in integrating external knowledge in their innovation processes. However, at the same time firms continue to demand leadership and authority in open settings. To our knowledge, little is known how to balance the tension between profiting from a community of voluntary committers and centralized control. Most evidence derives from qualitative interviews and case studies (Dahlander, 2007; Dahlander and Wallin, 2008; Lee and Cole, 2003; O'Mahony and Ferraro, 2007). One of the few exceptions is provided by Dahlander and Wallin (2006). In the following, we try to investigate how the use of external knowledge in firm-driven OSS projects, especially in pooled R&D, is governed.

HYPOTHESES

Relationships between firms and communities have often been analyzed (Von Hippel, 1994; Piller and Walcher, 2006). Especially those between firms using OSS commercialization approaches and a community of committers are of high interest (Dahlander and Magnusson, 2005; West and Lakhani, 2008; West and O'Mahony, 2008). Individuals sponsored or paid by firms should have a deeper knowledge than those joining a firm-driven community from outside (Dahlander and Wallin, 2006). Thus, it can be expected that programmers who receive financial compensation for their work are more active. On the other hand, it can be assumed that if firms are sponsoring communities they are doing so in order to take part in decisions. To be able to affect decisions is very crucial to effectively use the OSS development model. As leadership implies control and authority we try to analyze governance structures in firm-driven OSS development in the following way.

Hypothesis 1a: The more firm-paid committers are involved in a project the more likely the project leaders are firm-paid.

Hypothesis 1b: The more voluntary committers are involved in a project the more likely the leader is a voluntary committer.

Many OSS projects are supported by more than one firm. Intense firm participation in a project points to what West and Gallager (2006) call pooled R&D. Instead of establishing joint ventures to collaborate in R&D – with all the advantages of shared resources and reduced costs – firms make use of the OSS development model. Open standards and the possibility to look into the source code enables knowledge transfer between firms and allows external participants to become part of a project quite easily. Generally it could be assumed that if many firms have an interest in a certain development they are giving the leadership to voluntary committers in the community to avoid losses through ambiguity in competences. However, we try to show that even if more firms are engaged in a project they still have an interest in controlling development activities. Furthermore, as every firm should have an interest in directing a development according to its needs, the number of firm-paid project leaders should increase with the total number of committers.

Hypothesis 2a: The more firms are involved in a project, the more likely the project leaders are firm-paid.

Hypothesis 2b: The more firms are involved in a project, the more firm-paid project leaders exist.

Using OSS development models is closely related to underlying business models. According to the type of OSS license very different business models are possible (Krishnamurthy, 2005; Bonaccorsi et al., 2006). Depending on the business model a firm chooses one of the major tasks is to find or to create a community of voluntary committers (Dahlander, 2005). However, previous investigations didn't consider the change of business models over time. For example, Innotek, a producer of software to virtualize servers, first started as a traditional software vendor, then switched to a dual licensing strategy and is now part of Sun Microsystems, Inc. Every transformation affected the business model as well. Therefore, we have to include the concept of time in our studies.

In addition, thinking in an open innovation paradigm, mature projects should consist of many voluntary committers who provide their external knowledge. On the other hand, one of the motivations for voluntary programmers to join a project is to take part in decisions according the software's evolution. As firms still have an interest in leading a project, not every committer who is willing to contribute is welcomed by firm-driven communities. Therefore we want to show that projects started by firms – Dahlander's (2007) approach I – do not significantly change their structure over time. If a project is increasing its growth is mainly caused by new paid committers.

Hypothesis 3: The older a project is, the lower the ratio of voluntary committers to firm-paid committers is.

RESEARCH DESIGN

In 2008 we conducted three interviews with informants representing three for-profit organizations active in open source software development. The interviews lasted approximately 60 minutes and were tape recorded for later consultation. Although they were designed for a different purpose they evolved as a basis for this research. The informants reported that they are generally interested in integrating external knowledge – both in form of IP owned by other companies as well as owned by free programmers – but that they still want to have the exclusive power to decide. As we couldn't find appropriate evidence in the literature according to our specific needs, we started to search for large firm-driven open source software communities. As we needed projects close to R&D consortia we concentrated on OSS development governed by foundations. It pointed out that there are only few large OSS foundations which fit the requirements, namely Mozilla, Apache, Linux and Eclipse. All of them are acting like consortia with strictly defined governance structures. We chose Eclipse due to several reasons. First of all, Eclipse started as a project within IBM and is therefore firm-driven. Secondly, the foundation is one of the most successful ones with more than 100 members, which provides us with data for significant results. Thirdly, the governance rules ignore the size of a firm. Every strategic board member has only one vote even if they donate much more than the others.

Eclipse itself is not just a project; it is also a foundation which hosts several other projects. Eclipse as both, software product and foundation has a fascinating history. Eclipse was a development environment originated inside the boundaries of IBM. The major competitors to the Eclipse development environment were Microsoft's Visual Studio and Sun's NetBeans. To gain momentum IBM open sourced its development although they were sharing a $40 million dollar investment with its competitors (O'Mahony, 2005). However, other vendors were now able to build their products on top of Eclipse rather than using proprietary software from competitors. Meanwhile there are many projects hosted by the Eclipse Foundation. Although in general, every individual is welcome, possible future committers have to run through a process where they have to prove their programming qualification. Furthermore they have to agree to certain process rules.[1]

The Eclipse website – which is donated by firms like AMD, HP, IBM, Intel, Magma and Novell – provides a lot of information concerning their projects like name of committers, their affiliation, the status of a project, the commitments to a project and many more. We developed a data base model concerning individuals, which we call actors, participating firms and projects using MySQL Database and PHP Scripts. The scripts automatically collected necessary information but some facts had to be included manually using a standardized form. We identified 912 committers from 116 firms in 109 projects. It's worth noting that two of our three informants spoke about 180 members, although not every member is listed on the website. With our database it is possible to formulate different SQL statements to serve different research goals. The output is a simple Microsoft Excel sheet which is the basis for an analysis with SPSS version 17. Obviously there are some limitations. It is not possible to take the provided data for granted as it is unclear how frequently Eclipse is updating its information.

Data and variables

Some researchers have focused on E-mail and mailing lists to measure governance structures and communication procedures (Von Krogh et al., 2003; Dahlander and Wallin, 2006). Relying on Email for example has certain disadvantages as individuals often have more than one Email address and especially those captured inside firm boundaries are writing oftentimes anonymously – without permission. We chose a different approach. The basis of the present study is the relationship between developers and firms measured by connections in projects. From a theoretical point of view one could argue, that committers are building ties across projects which could be visualized in social network analysis (SNA) (Dahlander and Wallin, 2006; Valverde and Solé, 2006; Gao and Madey, 2007). Although it is possible to use SNA in this context the aim of this paper is to support the provided hypotheses by using regression analysis.

Dependent variable

We use three dependent variables depending on the type of hypotheses we want to test: (1) the number of firm-paid project leaders in a project (NUMFLEAD), (2) the number of voluntary project leaders in a project (NUMVLEAD), (3) the ratio of firm-paid committers to the total number of committers (RATIOP).

Many scholars are differentiating between voluntary and sponsored committers and are avoiding the term firm-paid due to the possibility that individuals could receive direct or indirect financial compensation (Lakhani and Wolf, 2005; West and O'Mahony, 2008). In the case of Eclipse firm affiliated committers have an Email address with a firm's postfix and the name of the supporting firms are accessible. This points to direct financial compensation only and legitimates the term "firm-paid". As mentioned above, firms are paying contributors to have control in the development process. The extent to which firms

[1] For further details see: http://wiki.eclipse.org/Development_Resources

have control over all committers participating in OSS projects is measured by whether or not the project leaders are firm-paid. A committer is firm-paid if he has an indicated affiliation. Projects typically have more than one project leader. Therefore, the dependent variable is the number of project leaders a project has. Hypothesis 2b requires a dependent variable concerning the number of voluntary project leaders. In theory, the number of voluntary project leaders a project has is the total number of leaders minus the number of firm-paid leaders. To be sure, we also check if their affiliation entry is empty.

When talking about open innovation and integrating external knowledge it can be assumed that over time the proportion of voluntary committers increases due to openness which implies invitation for externals to participate. Mature firm-initiated projects should generally consist of many voluntary participants. As in our case the entry barriers for external programmers are really high we try to show that the percentage of voluntary committers (and therefore the participation structure) is not significantly changing. We measure the ratio of firm-paid committers to the total number of committers simply by dividing the number of firm-paid committers by the total number of committers.

Independent variable

The independent variables are whether or not individuals have affiliations with firms sponsoring the project an individual is working in (NUMPCOM, NUMVCOM). In contrast to the dependent variable we are concentrating on the total number of individuals rather than the number of project leaders. The independent variable for hypothesis 2 is the number of firms participating in an open source project hosted by Eclipse Foundation (NUMFIRM). As all firms are listed on the website in conjunction with the projects they are supporting it was relatively easy to include the information in the database. The independent variable for hypothesis 3 is the maturity of a project. Eclipse projects do have different status varying from "incubating", "non-incubating" to "mature". The age of a project is measured by drawing on the project release date. Project size, measured by the overall number of participants is used as a control variable.

DESCRIPTIVE RESULTS

On a descriptive level we found out that the majority of developers are affiliated with IBM (approximately 35.87%). This is not astonishing considering the history of the Eclipse project. To our surprise the second largest group is the one affiliated with no firm. On the other hand it is worth noting that 51 out of the 109 projects do not have voluntary committers at all.

We tried to prove our hypotheses by using linear regression analysis. To our surprise, none of our hypotheses could be supported significantly. We tested them in different ways by concentrating on project status, participation type, and project type. Table 2 and 3 show the distribution of a) firm-paid leaders and b) firms in projects. Dealing with Hypothesis 2b shows, even if not significant, that obviously the number of firms is not mirrored in the leadership structure. This raises new questions regarding the role of leadership in R&D consortia.

Leaders in Project	1	2	3	4	5	6	7
Number	38	15	2	2	1	0	1
Percentage	64,4 %	25,4 %	3,4%	3,4 %	1,7 %	0 %	1,7 %

Table 2: Distribution of firm-paid leaders in projects

Firms in Project	1	2	3	4	5	6	7
Number	9	8	16	8	7	3	2
Percentage	15,3 %	13,6 %	27,1 %	13,6 %	11,9 %	5,1 %	3,4 %
	8	9	10	11	12	13	14
	1	0	1	1	1	1	1
	1,7 %	0 %	1,7 %	1,7 %	1,7 %	1,7 %	1,7 %

Table 3: Distribution of firms in projects

	1	2	3	4	5
1 DURATION	1				
2 NUMVCOM	-0,016	1			
3 NUMPCOM	0,034	0,212*	1		
4 NUMCALL	0,028	0,4	0,979**	1	
5 RATIOP	0,055	-0,761**	0,235*	0,061	1

*,** Significant at 0,05; 0,01

Table 4: Correlation matrix

Table 5 shows the correlation matrix. The variables according to numbers of committers are correlating significantly due to their design. It is not possible to include the other variables in the table because of scale incompatibly.

DISCUSSION

In this research we tried to identify and to structure participation of both, firms and individual programmers in firm-driven open source software projects. The object of interest is the Eclipse Foundation and its affiliated projects. Participation is mainly measured by whether or not an individual is listed on a project's website. Furthermore, it is of high importance to develop additional hypotheses according to the change of an underlying business model to fill one of the identified research gaps. To summarize, based on a theoretical background the goal of this research was to contribute with empirical findings to balance the tension between motivating external individuals to participate and the desire for control from a firms' point of view. If further research is able to show, that firms have heavily taken over the open source idea to commercialize their products, we have to ask again why voluntary individuals should contribute anymore. Therefore, firms entering the OSS market should be aware of the fact that many identified drivers to participate e.g. the desire to satisfy own needs (Bitzer et al., 2007; Lakhani and Wolf, 2005) won't work in OSS consortia.

REFERENCES

1. Alexy, O. and Henkel, J. (2007): Promoting the Penguin: Who is Advocating Open Source Software in Commercial Settings? *Working Paper, Munich Business School*.
2. Bitzer, J., Schrettl, W. and Schröder, P.J.H. (2007): Intrinsic Motivation in Open Source Software Development. *Journal of Comparative Economics*, 35, 160-169.
3. Bonaccorsi, A., Giannangeli, S. and Rossi, C. (2006): Entry Strategies Under Competing Standards: Hybrid Business Models in the Open Source Software Industry. *Management Science*, 52, 7, 1085-1098.
4. Boudreau, K. (2008): Opening the platform vs. opening the complementary good? The effect on product innovation in handheld computing. *HEC working paper series, available on SSRN; abstract 1251167*.
5. Chesbrough, H. (2003): The Logic of Open innovation: Managing Intellectual Property. California Management Review, 45, 3, 33-58.
6. Dahlander, L. (2005): Appropriation and appropriability in open source software. *International Journal of Innovation Management*, 9, 3, 259-285.
7. Dahlander, L. (2007): Penguin in a new suit: A tale of how de novo entrants emerged to harness free and open source software communities. *Industrial and Corporate Change*, 16, 5, 913-943.
8. Dahlander, L. and Magnusson, M.G. (2005): Relationships between open source software companies and communities: Observations from Nordic firms. *Research Policy*, 34, 4, 481-493.
9. Dahlander, L. and Magnusson, M.G. (2008): How do make Firms Make Use of Open Source Communities? *Long Range Planning*, 41, 629-649.
10. Dahlander, L. and Wallin, M. W. (2006): A man on the inside: Unlocking communities as complementary assets. *Research Policy*, 35, 1243-1259.

11. Dahlander, L., Frederiksen, L. and Rullani, F. (2008): Online Communities and Open Innovation: Governance and Symbolic Value Creation. *Industry and Innovation*, 15, 2, 115-123.
12. de Rond, M. and Bouchikhi, H. (2004): On the Dialectics of Strategic Alliances. *Organization Science*, 15, 1, 56-69.
13. Economides, N. and Katsamakas, E. (2006): Two sided competition of proprietary vs. Open source technology platforms and implications for software industry. *Management Science*, 52, 7, 1057-1071.
14. Eisenmann, T.R., Parker, G. and Van Alstyne, M. (2008): Opening platforms: How, when and why? *Harvard Business School Working Paper Series No. 09-030, Cambridge, Mass*.
15. Fitzgerald, B. (2006): The Transformation of Open Source Software. *MIS Quarterly*, 30, 3, 587-598.
16. Fosfuri, A., Giarratana, M. and Luzzi, A. (2008): The Peguin Has Entered the Building: The Commercialization of Open Source Software Products. *Organization Science*, 19, 2, 292-305.
17. Gao, Y. and Madey, G. (2007): Network Analysis of the Sourceforge.net Community, in Feller, J.; Fitzgerald, B.; Scacchi, W. and Sillitti, A. (eds.): *Open Source Development, Adoption and Innovation*, Springer, Boston, p.187-200.
18. Iannacci, F. (2005): Coordination processes in open source software development: The Linux case study. *Emergence: Complexity and Organization*, 7, 2, 20-30.
19. Iansiti, M. and Richards, G. (2007): The Business of Free Software: Enterprise Incentives, Investment and Motivation in the Open Source Community. *Harvard Business School Working Paper Series 07-028, Cambridge, Mass.*
20. Krishnamurthy, S. (2005): An Analysis of Open Source Business Models. in Feller, J., Fitzgerald, B., Hissam S.A. and Lakhani, K.R. (eds.): *Perspectives on Free and Open Source Software*. MIT Press, Cambridge, Mass., p.279-296.
21. Lakhani, K.R. and Von Hippel, E. (2003): How Open Source software works: „Free“ User-to-User Assistance. *Research Policy*, 32, 923-943.
22. Lakhani, K.R. and Wolf, R.G. (2005): Why Hackers Do What They Do: Understanding Motivation and Effort in Free/Open Source Software Projects. in: Feller, J., Fitzgerald, B., Hissam S.A. and Lakhani, K.R. (eds.): *Perspectives on Free and Open Source Software*. MIT Press, Cambridge, Mass., p.279-296.
23. Laursen, K. and Salter, A. (2006): Open for Innovation: The role of Openness in Explaining Innovation Performance among U.K. Manufacturing Firms. *Strategic Management Journal*, 27, 131-150.
24. Lerner, J. and Tirole, J. (2002): Some simple economics of open source. *Journal of Industrial Economics*, 50, 2, 197-234.
25. Miller, D.J., Fern, M.J. and Cardinal, L.B. (2007): The Use of Knowledge for Technological Innovation within Diversified Firms. *Academy of Management Journal*, 50, 2, 308-326.
26. O'Mahony, S., Cala Diaz, F. and Mamas, E. (2005): IBM and Eclipse. Harvard Business School Working Paper 9-906-007.
27. Oldham, G.R. and Cummings, A. (1996): Employee creativity: Personal and Contextual Factors at Work. *The Academy of Management Journal*, 39, 3, 607-634.
28. Piller, F.T. and Walcher, D. (2006): Toolkits for idea competitions: a novel method to integrate users in new product development. *R&D Management*, 36, 3, 307-318.
29. Robles, G., Duenas, S. and Gonzalez-Barahona, J.M. (2007): Corporate involvement of Libre Software: Study of presence in debian code over time. in Feller J., Fitzgerald B., Scacchi W. and Sillitti A. (Hrsg.): *Open Source Development, Adoption and Innovation*, IFIP Volume 234, Springer, Boston.
30. Sakakibara, M. (2002): Formation of R&D Consortia: Industry and Company Effects. *Strategic Management Journal*, 23, 11, 1033-1050.
31. Shah, S. (2006): Motivation, Governance, and the Viability of Hybrid Forms in Open Source Development. *Management Science*, 52, 7, 1000-1014.
32. Simonin, B. (2004): An Empirical Investigation of the Process of Knowledge Transfer in International Strategic Alliances. *Journal of International Business Studies*, 35, 5, 407-427.
33. Von Krogh, G., Spaeth, S. and Lakhani, K.R. (2003): Community, joining, and specialization in open source software innovation: A case study. *Research Policy*, 32, 1217-1241.

34. Valverde, S. and Solé, R. (2006): Self-organization and Hierarchy in Open Source Social Networks. *Santa Fe Institute Working Paper*. URL: (last access: 02/02/2009) http://www.santafe.edu/research/publications/workingpapers/06-12-053.pdf
35. Von Krogh, G. und Spaeth, S. (2007): The open source software phenomenon: Characteristics that promote research. *Journal of Strategic Information Systems*, Vol.16, p.236-253.
36. Von Hippel, E. (1994): Sticky Information and the Locus of Problem Solving. *Management Science*, 40, 429-439.
37. West, J. and Gallagher, S. (2006): Challenges of open innovation: The paradox of firm investment in open source software. *R&D Management*, 36, 3, 319-331.
38. West, J. and Lakhani, K. (2008): Getting Clear About Communities in Open Innovation. *Industry and Innovation*, 15, 2, 223-231.
39. West, J. and O'Mahony, S. (2008): The Role of Participation Architecture in Growing Sponsored Open Source Communities. In: *Industry and Innovation*, 15, 2, 145-168.
40. Wu, C.-G., Gerlach, J.H. and Young, C.E. (2007): An Empirical Analysis of Open Source Software Developers' Motivations and Continuance Intentions. *Information & Management*, 44, 253-262.