MIS Quarterly

THEORY AND REVIEW

CARROTS AND RAINBOWS: MOTIVATION AND SOCIAL PRACTICE IN OPEN SOURCE SOFTWARE DEVELOPMENT

Georg von Krogh, Stefan Haefliger, Sebastian Spaeth, and Martin W. Wallin
ETH Zurich, SWITZERLAND {gvkrogh@ethz.ch} {shaefliger@ethz.ch} {sspaeth@ethz.ch} {mwallin@ethz.ch}

Appendix A

Review Sample

Article	Data/Method
Alexy and Leitner 2011	Scenario experiment with 229 European computer science students testing the effect of monetary rewards on intrinsic motivation of OSS developers.
Baldwin and Clark 2006	Models relationship between modular code bases and developers' incentives to join and remain involved in OSS development based on option value and game theory.
Benkler 2002	Theory paper trying to explain advantages of commons-based peer-production.
Berquist and Ljungberg 2001	Virtual ethnography using archival data from news groups and discussion lists trying to explain the power of gifts in OSS development.
Bitzer et al. 2007	Formal modeling aiming to explain the importance of intrinsic motivation in OSS development.
David and Shapiro 2008	Cluster analysis of data from David et al. (2003) to create motivation profiles.
David et al. 2003	Global online survey of 1,588 self-selected OSS developers.
Fershtman and Gandal 2007	Investigates the relationship between output and license restrictiveness using a sample of the 71 most active projects hosted on SourceForge.
Ghosh 2005	Survey with 2,700 respondents investigating e.g., demographics, motivations, and contributions.
Hars and Ou 2002	Online survey of 81 OSS developers aiming to explain participation.
Haruvy et al. 2003	Formal modeling aiming to explain how non-pecuniary benefits impact on OSS contribution.
Hemetsberger 2004	Content analysis of online survey responses of 1,139 OSS developers and users aiming to explain contribution.
Hertel et al. 2003	Online survey of 141 OSS developers of the Linux kernel.
Ke and Zhang 2008	Online survey of 204 OSS participants aiming to explain effort intensity.
Lakhani and von Hippel 2003	Online survey of 336 contributors to the Apache web server software.
Lakhani and Wolf 2005	Online survey of 684 SourceForge developers.
Lattemann and Stieglitz 2005	Reviews literature with the aim to identify factors that sustain motivation over the life cycle of an open source project.
Lee and Cole 2003	Uses archival data analyses, online research publications, and observations of how the Linux technology has evolved to create a community-based model of knowledge creation.

Article	Data/Method
Lerner and Tirole 2002	Uses four cases and descriptive statistics to highlight the extent to which economics can explain OSS participation ("career concerns").
Luthiger and Jungwirth 2007	Two surveys of 1,330 open source developers and 114 closed source developers to explore motivation from a "flow theory" perspective.
Markus 2007	Review and synthesis of OS governance literature.
Okoli and Oh 2007	Examines the impact of network closure and structural holes on social capital by using a sample of 465 Wikipedia participants.
O'Mahony and Ferraro 2007	Inductive ethnography exploring the evolution of governance structure and a logit regression model testing factors that increase the likelihood of becoming a leader.
Oreg and Nov 2008	Survey of 185 SourceForge users and 115 Wikipedia participants investigating individual motivation.
Osterloh and Rota 2007	Conceptual article exploring OSS characteristics that enable low-cost contributions and lower barriers to entry, and provide intrinsic motivation.
Riehle 2007	Examines firms' and employees' motivations to contribute to OSS development.
Roberts et al. 2006	Develops a model of motivation to participate in OSS development and tests it using data from an email survey of 288 Apache developers.
Rullani 2007	Uses SourceForge project data to model how various variables explain "contribution."
Schofield and Cooper 2006	Survey of 145 members of Linux user groups.
Shah 2006	Inductively develops a framework of changing motivation over time depending on governance structure using data from 88 qualitative interviews and archival data.
Spaeth et al. 2008	Case study examining private benefits of contributing to a public good.
Stewart et al. 2006	Investigates the effect of license restrictiveness and organizational sponsorship on developer activity by examining 138 OSS projects on www.freshmeat.net.
Stewart and Gosain 2006	Assesses a PLS model on effectiveness in OSS development based on OSS beliefs, values, and norms using survey data from 67 project administrators and SourceForge project data.
von Hippel and von Krogh 2003	Conceptual article proposing the private-collective innovation model.
von Krogh et al. 2003	Multi-source, grounded approach examining [un]successful joining and specialization process into www.freenetproject.org.
Wu et al. 2007	Develops a structural equation model to test the effect of motivations on satisfaction and intention for continued participation using a SourceForge web survey with 148 responses (12% response rate).
Xu et al. 2009	Develops a structural equation model to test the effect of motivation and community factors on voluntary involvement in OSS projects using a SourceForge web survey with 172 responses (17% response rate).
Ye and Kishida 2003	Investigates the importance of learning for motivation and provides descriptive statistics of the GIMP project's mailing list and code contribution behavior.
Yu et al. 2007	Propose eight motivations that drive volunteering individuals' motivation by creating hypotheses from a model.
Zeitlyn 2003	Conceptual article proposing the concept of "kinship amity" in understanding OSS development.

Appendix B

Intrinsic Motivation

Ideology	Ideology has been quoted as a major reason for starting the GNU project, one of the earliest coherent attempts to write software under an explicitly open license (Stallman 1999). The extent to which contributors adhere to ideology is usually captured by items such as "software should be free for all," "free to modify and redistribute," or that "open source code should replace proprietary software." *Key empirical findings:* • Support for ideological motives found in developer surveys (David and Shapiro 2008; David et al. 2003; Ghosh 2005; Lakhani and Wolf 2005). • Weak support by Hemetsberger (2004). • Hertel et al. (2003) found a positive, significant relationship between social and political motives, and accepted source code patches and lines of code contributions. • Stewart and Gosain (2006) found that open source developers' adherence to the community ideology (defined as "open source" norms, values, and beliefs) impacts on team effectiveness. • Yu et al. (2007) identified "moral obligation" and "advancement of virtual community motive" as individual motivations in a literature review.
Altruism	Altruism is the selfless concern for the welfare of others. A typical altruistic act consists of three characteristics: "a) it is an end in itself; it is not directed at gain, b) is emitted voluntarily, and c) does good" (Heider 1958 in Krebs 1970, p. 259). Due to the self-containment of an altruistic act, it fits well with the category of intrinsic motivation, and several authors have used the concept of altruism to explain code contribution of OSS developers. *Key empirical findings:* • Osterloh and Rota (2007) suggested that altruistic behavior caused by "pro-social motives" influences developers to contribute to OSS development. The "pro-social motive" is a type of intrinsic motivation (Lindenberg 2001, quoted in Osterloh and Rota 2007), which the authors link to open source contributions. • Haruvy et al. (2003) point out that companies need to manage contributors' motivations so as not to crowd out their altruistic motives. • Wu et al. (2007) investigated the intention of OSS developers to continue their involvement in future projects. Their structural equation model shows that altruism in the form of helping behavior influences developers' continuance only if mediated by their satisfaction. • Hemetsberger (2004) reported that 22% of developers ranked altruism as a motivational factor to contribute. Hemetsberger also attempted to differentiate between types of developer and found that the importance of altruism in explaining contributions is stronger for people who contribute a lot (30.7%), compared to medium (23.9%) and low contributors (6.5%). • Hars and Ou (2002) reported that altruism motivated developers to contribute: 16.5% of the survey participants rated high on altruism. Student and hobby programmers rated altruism the highest at 24.2%, followed by salaried and contract programmers at 11.1%, whereas only 7.7% of the programmers paid for open source development were driven by altruistic motivations. • Ghosh's (2005) survey finds selfish behavior to such a degree as to rule out altruistic behavior as an important characteristic of OSS development, although altruism is a driver for some individuals. • Bitzer et al. (2007) identify the "desire to give a present to the programmer community" as a crucial pattern in OSS literature and include it in a model.

Kinship amity	The concept of kinship amity (Fortes 1969) has been related to the concept of the gift economy (Zeitlyn 2003). However, kinship amity differs from the gift economy, since the former does not assume reciprocity in social relations. For example, there is no calculated economic relationship in families (kin). Kinship amity thus also differs from altruism as a motive to contribute, because it is restricted to the group to which one belongs, such as the OSS community. In our review, some equivalent constructs are subsumed under kinship amity, for example, the frequently cited motivation for OSS contributors, community identification (e.g., Hars and Ou 2002). Community identification instills a feeling of belonging to a certain group, and urges people to help others in that group. *Key empirical findings:* • Zeitlyn (2003) first suggested kinship amity as a motive in OSS and as an explanation for why people contribute to OSS. • Hemetsberger (2004), using concepts such as "group boundaries" and "group bonds," found a weak relationship between kinship amity and developers' level of contribution. • Lakhani and Wolf's (2005) survey identified kinship amity as an important motive for contributing, and showed it is an important determinant of the effort invested (hours per week). Other surveys (David and Shapiro 2008; Hars and Ou 2002) find similar results. Hars and Ou (2002) studied "community identification," finding a correlation between kinship amity and the number of hours per week spent on OSS contribution. • Hertel et al. (2003) tested the relationship between kinship amity and the number of accepted patches and lines of code, and found it to be positive and significant.
Enjoyment and fun	Enjoyment and fun have been said to motivate contributors to open source projects. One of the main drivers of the so called "hacker culture" emerging during the 1980s was for developers to enjoy the playfulness and experimentation with hardware and software (Levy 1984; Torvalds and Diamond 2002). *Key empirical findings:* • Benkler (2002) and Osterloh and Rota (2007) suggested that enjoyment plays an important role in OSS. • Lakhani and von Hippel (2003) showed in their survey that developers considered enjoyment and fun important when conducting technically challenging tasks, whereas mundane tasks, such as helping users to install software, required different motives. • Luthiger and Jungwirth (2007) conducted the most comprehensive study focusing exclusively on fun and enjoyment motivations. Their survey of 1,330 open source developers revealed that the fun factor had a significantly positive effect on both the number of hours spent on a project as well as on developers' intention to participate in the future. Fun accounted for 28% of the effort in terms of number of hours dedicated to projects. • Lakhani and Wolf (2005) found that developers deemed enjoyment-based motivation an important source of motivation. In their research, high levels of enjoyment also increased the hours per week that developers spent on a project. • Hertel et al. (2003), measuring the number of accepted patches and lines of code in the Linux project, also found a significant positive impact of fun and enjoyment. • Hemetsberger's (2004) survey identified modest positive impact of enjoyment on contributions to projects. • Shah (2006) showed that own-use value often formed the initial reason to join development, but over time fun and enjoyment increasingly form the sustaining motivation to long-term contribution. • Roberts et al. (2006) could not identify a significant link between intrinsic enjoyment and the number of accepted patches and lines of code.

Appendix C

Internalized Extrinsic Motivation

Reputation	Reputation can be classified as "peer reputation" and "outside reputation." Peer reputation is usually targeted at community insiders (peers, or kin) and potential employers who perceive peer reputation to signal talent. Very few studies have considered reputation directed outside the community and not targeted toward potential future employers. Outside reputation is concerned with anticipated reactions to the contributors by significant others, such as friends and relatives, and prestige awarded. *Key empirical findings:* • Raymond's (1998) essay "Homesteading the Noosphere" linked reputation to reciprocity in the gift economy and described it as the "major motivation" for developers. • Lerner and Tirole (2002) proposed peer reputation as a fundamental motivation. • Osterloh and Rota (2007) termed this motivation "ego gratification," which could easily be confused with intrinsically motivated self-determination, the happiness of having/being able to achieve something (see Deci and Ryan 1987). However, the authors classify it as an extrinsic signaling incentive, aimed at increasing one's own labor market value. • Lakhani and von Hippel (2003) differentiated peer reputation further. They proposed that peer reputation motivates "gratifying" technical tasks, while it fails to motivate the "necessary but mundane tasks" that are an inherent part of each software project. • Lattemann and Stieglitz (2005) proposed that contributors' roles are related to motivations. In their view, programmers (rather than bug fixers, or managers) were motivated through peer reputation. • Spaeth et al. (2008) argued that some motives are formed as by-products of contributions. In their empirical study of the Freenet project, the authors found that higher levels of contributions provided more peer reputation, such as positive mentioning in e-mail lists. • The surveys by Ghosh (2005), Hars and Ou (2002), Hemetsberger (2004), and Lakhani and Wolf (2005) reported peer reputation as a driver for participation. • Hars and Ou (2002) identified a weak but existing relationship between reputation and the number of hours invested. • Lakhani and Wolf (2005) found peer reputation to be the fourth biggest determinant of invested effort. • Roberts et al. (2006) measured the accepted lines of code. They identified a significant positive relationship between peer reputation motives and accepted code in the Apache project. • Hemetsberger (2004) found a weak relationship between outside reputation and participation. • Hertel et al. (2003) tested the impact of outside reputation on the number of accepted patches and lines of code. *Ceteris paribus* they found a significant positive impact of outside motivation on accepted code.
Gift economy/ Reciprocity	Originally a concept from anthropology (Mauss 1959), several authors discussed the logic of gift-giving in the context of OSS development (Bergquist and Ljungberg 2001; Raymond 1999; Zeitlyn 2003). Viewing OSS development as a gift economy asserts that developers give code to others expecting gifts in return. The corresponding internalized, extrinsic motivation can be termed "reciprocity." *Key empirical findings:* • Bergquist and Ljungberg (2001) suggested reciprocity as a motivation for contributions to OSS. • Hemetsberger (2004) and Lakhani and Wolf (2005) confirmed reciprocity in empirical studies that found moderate support, while David et al. (2003) found strong support. • In their survey, Lakhani and von Hippel (2003) found that reciprocity motivated developers to perform mundane tasks. It seems that people who have been helped by other contributors in the past are more inclined to reciprocate as they gain experience and knowledge.

Learning	The motive to acquire new skills or to learn through OSS development appears in almost every contribution to the review sample. However, the definition of learning was often vague and referred to survey items such as "improve programming skills" (the opportunity to learn from the experience of writing software and the feedback provided by the peers who tested, integrated, and commented upon the software published). *Key empirical findings:* • von Hippel and von Krogh (2003) proposed that learning poses a private benefit derived from the contributions to OSS development (also proposed by Yu et al. 2007). Spaeth et al. (2008) confirmed in an empirical study that learning through feedback is a driver for participation. • Survey studies confirmed that "learning" motivated individuals to participate (Ghosh 2005; Hemetsberger 2004; Lakhani and Wolf 2005; Oreg and Nov 2008; Roberts et al. 2006), particularly in the surveys by David et al. (2003) and Hars and Ou (2002). • Roberts et al. (2006) additionally show that accepted patches and lines of code written were positively impacted by learning. • Wu et al. (2007) found that learning motives led to a higher intention to participate. • Ye and Kishida (2003) suggested the consideration of legitimate peripheral learning based on the work by Lave and Wenger (1991) to explain increasing levels of participation over time (see also Rullani 2007). • Xu et al. (2009) also find "skill development" to be a driver, although they refer to future work opportunities, rather than learning as a goal in itself. • Stewart and Gosain (2006) see "learning as a value in itself" as a dimension of the "OSS values" construct that impacts effort positively via "affective trust."
Own-use value	Own-use value refers to internalized extrinsic motives to create OSS for contributors' personal use. *Key empirical findings:* • Lakhani and von Hippel (2003), Osterloh and Rota (2007), and Raymond (1999) suggested developers of OSS "scratch their itch" by developing software they find useful, by fixing bugs, and by adding features they need. • Surveys by David et al. (2003), Ghosh (2005), Hars and Ou (2002), Lakhani and Wolf (2005), as well as Hemetsberger (2004) identified own-use value as a motive for participating in the development of OSS. • Wu et al. (2007) found own-use value was connected to the intention to participate. • Lakhani and von Hippel (2003) identified own-use value as a motive for taking on mundane tasks. • Hars and Ou (2002) reported that developers attributed a high score to own-use value as their motive regarding actual effort measured in hours spent per week. • Hertel et al. (2003) reported that own-use value had a significant effect on accepted patches and lines of code contributed. • Roberts et al. (2006) reported that own-use value exerted a significant negative impact on the level of participation in the Apache project, also measured in accepted patches and lines of code. One explanation offered is that developers motivated by own-use value worked "eclectically": they would fix bugs that annoyed them and then leave the development again, rather than remaining as long-term developers. This behavior would result in relatively low total contributions to one project. • Lattemann and Stieglitz (2005) proposed that own-use value might impact on OSS development via the roles individuals assume in communities. Contributors who mainly fix bugs may be particularly motivated by own-use value, whereas others such as managers (maintainers), might be more motivated by pay.

Appendix D

Extrinsic Motivation

Career	Lerner and Tirole (2002) first suggested studying the signaling behavior of OSS developers. Their proposition, derived from economic literature, stated that individual developers would be motivated by career concerns when developing OSS. By publishing software that was free for all to inspect, they could signal their talent to potential employers and thus increase their value in the labor market. *Key empirical findings:* • Has been proposed by Lerner and Tirole (2002), Riehle (2007), Yu et al. (2007) as motivation. • Some surveys including Lakhani and Wolf (2005), Hemetsberger (2004) found weak support for career concerns as motivation. • Hars and Ou (2002) and Ghosh (2005) found more substantial support for career concerns as motivation. • Wu et al. (2007) found career concerns related to intended participation. • Hars and Ou (2002) found strong support of the motivation for efforts measured in hours per week spent on OSS development. They also report that career concerns played a more important role for paid participation in OSS development than for unpaid participation. • Roberts et al. (2006) and Hertel et al. (2003) documented a positive and significant relationship between career concerns, accepted code patches and lines of code. • Xu et al. (2009) use a single construct—"Reputation and Skill Gaining"—which they state "may help the developer's future work opportunities" (2009, p. 153), driving involvement.
Pay	A significant minority (approximately 40%) of contributors is paid to participate in OSS projects (Lakhani and Wolf 2005). An examination of contributions to the Linux kernel found only 9% of the developers involved worked in their own time (Kroah-Hartman et al. 2009). *Key empirical findings:* • Lakhani and Wolf (2005) examined the degree of participation and its link to financial motives. They concluded that the financial subsidy of these projects was substantial. For example, paid contributors dedicated 17.7 hours per week on all FOSS projects they participated in, while volunteers contributed 11.7 hours per week. As programmers often participate in several projects simultaneously, Lakhani and Wolf reported the results for the focal project of the programmers as well. These results showed a similar pattern: 10.3 hour per week for the paid contributor and 5.7 hours per week for the volunteer. The differences between the groups were found to be significant. • Surveys by Hars and Ou (2002), Hertel et al. (2003), and Luthiger and Jungwirth (2007) reported findings consistent with Lakhani and Wolf (2005).

References

Alexy, O., and Leitner, M. 2011. "A Fistful of Dollars: Are Financial Rewards a Suitable Management Practice for Distributed Models of Innovation?," *European Management Review* (8:3), pp. 165-185.

Baldwin, C. Y., and Clark, K. B. 2006. "The Architecture of Participation: Does Code Architecture Mitigate Free Riding in the Open Source Development Model?," *Management Science* (52:7), pp. 1116-1127.

Benkler, Y. 2002. "Coase's Penguin, or Linux and the Nature of the Firm," *Yale Law Journal* (112:3), pp. 369-447.

Bergquist, M., and Ljungberg, J. 2001. "The Power of Gifts: Organizing Social Relationships in Open Source Communities," *Information Systems Journal* (11:4), pp. 305-320.

Bitzer, J., Schrettl, W., and Schröder, P. J. 2007. "Intrinsic Motivation in Open Source Software Development," *Journal of Comparative Economics* (35:1), pp. 160-169.

David, P. A., and Shapiro, J. S. 2008. "Community-Based Production of Open-Source Ssoftware: What Do We Know About the Developers Who Participate?," *Information Economics and Policy* (20:4), pp. 364-398.

David, P. A., Waterman, A., and Arora, S. 2003. *FLOSS-US: The Free/Libre/Open Source Software Survey for 2003*, Stanford Institute for Economic Policy Research, Stanford University, Stanford, CA (http://www.stanford.edu/group/floss-us/report/ FLOSS-US-Report.pdf).

Deci, E. L., and Ryan, R. M. 1987. "The Support of Autonomy and the Control of Behavior," *Journal of Personality and Social Psychology* (53:6), pp. 1024-1037.

Fershtman, C., and Gandal, N. 2007. "Open Source Software: Motivation and Restrictive Licensing," *International Economics and Economic Policy* (4:2), pp. 209-225.

Fortes, M. 1969. *Kinship and the Social Order: The Legacy of Lewis Henry Morgan*, Chicago: Aldine.

Ghosh, R. A. 2005. "Understanding Free Software Developers: Findings from the FLOSS Study," in *Perspectives on Free and Open Source Software*, J. Feller, B. Fitzgerald, S. A. Hissam, and K. R. Lakhani (eds.), Cambridge, MA: MIT Press, pp. 23-46.

Hars, A., and Ou, S. 2002. "Working for Free? Motivations for Participating in Open-Source Projects," *International Journal of Electronic Commerce* (6), pp. 25-39.

Haruvy, E., Prasad, A., and Sethi, S. 2003. "Harvesting Altruism in Open-Source Software Development," *Journal of Optimization Theory and Applications* (118:2), pp. 381-416.

Heider, F. 1958. *The Psychology of Interpersonal Relations*, New York: Wiley.

Hemetsberger, A. 2004. "Fostering Cooperation on the Internet: Social Exchange Processes in Innovative Virtual Consumer Communities," extended abstract published in *Advances in Consumer Research* (Vol. 29), S. M. Broniarczyk and K. Nakamoto (eds.), Valdosta, GA: Association for Consumer Research, pp. 354-356.

Hertel, G., Niedner, S., and Herrmann, S. 2003. "Motivation of Software Developers in Open Source Projects: An Internet-Based Survey of Contributors to the Linux Kernel," *Research Policy* (32:7), pp. 1159-1177.

Ke, W., and Zhang, P. 2008. "Motivations for Participating in Open Source Software Communities: Roles of Psychological Needs and Altruism," in *Proceedings of the 12th Pacific Asia Conference on Information Systems*, Suzhou, China, pp. 136-148.

Krebs, D. L. 1970. "Altruism - Examination of Concept and a Review of Literature," *Psychological Bulletin* (73:4), pp. 258-302.

Kroah-Hartman, G., Corbet, J., and McPherson, A. 2009. *Linux Kernel Development: How Fast It Is Going, Who Is Doing It, What They Are Doing, and Who Is Sponsoring It: An August 2009 Update*, The Linux Foundation (http://www.linuxfoundation.org/).

Lakhani, K. R., and von Hippel, E. 2003. "How Open Source Software Works: 'Free' User-to-User Assistance," *Research Policy* (32:6), pp. 923-943.

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 *Perspectives on Free and Open Source Software*, J. Feller, B. Fitzgerald, S. Hissam, and K. R. Lakhani (eds.), Cambridge, MA: MIT Press, pp. 3-22.

Lattemann, C., and Stieglitz, S. 2005. "Framework for Governance in Open Source Communities," in *Proceedings of the 38th Annual Hawaii International Conference on System Sciences*, Los Alamitos, CA: IEEE Computer Society Press, pp. 192b.

Lave, J., and Wenger, E. 1991. *Situated Learning: Legitimate Peripheral Participation*, Cambridge, UK: Cambridge University Press.

Lee, G. K., and Cole, R. E. 2003. "From a Firm-Based to a Community-Based Model of Knowledge Creation: The Case of the Linux Kernel Development," *Organization Science* (14:6), pp. 633-649.

Lerner, J., and Tirole, J. 2002. "Some Simple Economics of Open Source," *Journal of Industrial Economics* (50:2), pp. 197-234.

Levy, S. 1984. *Hackers: Heroes of the Computer Revolution*, New York: Anchor Press/Doubleday.

Lindenberg, S. M. 2001. "Intrinsic Motivation in a New Light," *Kyklos* (54:2/3), pp. 317-342.

Luthiger, B., and Jungwirth, C. 2007. "Pervasive Fun," *First Monday* (12:1), January (available at http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/1422).

Markus, M. L. 2007. "The Governance of Free/Open Source Software Projects: Monolithic, Multidimensional, or Configurational?," *Journal of Management and Governance* (11:2), pp. 151-163.

Mauss, M. 1959. *The Gift: The Form and the Reason for Exchange in Archaic Societies*, London: Routledge.

Okoli, C., and Oh, W. 2007. "Investigating Recognition-Based Performance in an Open Content Community: A Social Capital Perspective," *Information & Management* (44:3), pp. 240-252.

O'Mahony, S. C., and Ferraro, F. 2007. "The Emergence of Governance in an Open Source Community," *Academy of Management Journal* (50:5), pp. 1079-1106.

Oreg, S., and Nov, O. 2008. "Exploring Motivations for Contributing to Open Source Initiatives: The Roles of Contribution Context and Personal Values," *Computers in Human Behavior* (24:5), pp. 2055-2073.

Osterloh, M., and Rota, S. G. 2007. "Open Source Software Development—Just Another Case of Collective Invention?," *Research Policy* (36:2), pp. 157-171.

Raymond, E. S. 1998. "Homesteading the Noosphere," *FirstMonday* (3:10), November 10 http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/1474/1389).

Raymond, E. S. 1999. "The Cathedral & the Bazaar," in *The Cathedral & the Bazaar,* Sebastapol, CA: O'Reilly & Associates, Inc., pp. 19-64.

Riehle, D. 2007. "The Economic Motivation of Open Source Software: Stakeholder Perspectives," *Computer* (40:4), pp. 25-32.

Roberts, J. A., Hann, I., and Slaughter, S. A. 2006. "Understanding the Motivations, Participation, and Performance of Open Source Software Developers: A Longitudinal Study of the Apache Projects," *Management Science* (52:7), pp. 984-999.

Rullani, F. 2007. "Dragging Developers Towards the Core: How the Free/Libre/Open Source Software Community Enhances Developers' Contribution," IFIP Working Group 2.13 (http://ifipwg213.org/system/files/rullani_socenv.pdf).

Schofield, A. and Cooper, G. S. 2006. "Participation in Free and Open Source Communities: An Empirical Study of Community Members' Perceptions." in *Open Source Systems* (IFIP Working Group 2.13), Berlin: Springer, pp. 221-231.

Shah, S. K. 2006. "Motivation, Governance, and the Viability of Hybrid Forms in Open Source Software Development," *Management Science* (52:7), pp. 1000-1014.

Spaeth, S., Haefliger, S., von Krogh, G., and Renzl, B. 2008. "Communal Resources in Open Source Software Development," *Information Research* (13:1) (http://informationr.net/ir/13-1/ paper332.html).

Stallman, R. 1999. "The GNU Operating System and the Free Software Movement," in *Open Sources: Voices from the Open Source Revolution*, C. DiBona, S. Ockman, and M. Stone (eds.), Sebastopol, CA: O'Reilly & Associates, Inc., pp. 53-70.

Stewart, K. J., Ammeter, A. P., and Maruping, L. M. 2006. "Impacts of License Choice and Organizational Sponsorship on User Interest and Development Activity in Open Source Software Projects," *Information Systems Research* (17:2), pp. 126-144.

Stewart, K. J., and Gosain, S. 2006. "The Impact of Ideology on Effectiveness in Open Source Software Development Teams," *MIS Quarterly* (30:2), pp. 291-314.

Torvalds, L., and Diamond, D. 2002. *Just for Fun: The Story of an Accidental Revolutionary*, New York: HarperCollins

von Hippel, E., and von Krogh, G. 2003. "Open Source Software and the 'Private–Collective' Innovation Model: Issues for Organization Science," *Organization Science* (14:2), pp. 209-223.

von Krogh, G., Spaeth, S., and Lakhani, K. 2003. "Community, Joining, and Specialization in Open Source Software Innovation: A Case Study," *Research Policy* (32:7), pp. 1217-1241.

Wu, C., Gerlach, J. H., and Young, C. E. 2007. "An Empirical Analysis of Open Source Software Developers' Motivations and Continuance Intentions," *Information & Management* (44:3), pp. 253-262.

Xu, B., Jones, D. R., and Shao, B. 2009. "Volunteers' Involvement in Online Community Bbased Software Development," *Information & Management* (46:3), pp. 151-158.

Ye, Y., and Kishida, K. 2003. "Toward an Understanding of the Motivation of Open Source Software Developers," in *Proceedings of 2003 International Conference on Software Engineering*, Portland, OR, May 3-10, pp. 419-429.

Yu, J., Jiang, Z., and Chan, H. C. 2007. "Knowledge Contribution in Problem Solving Virtual Communities: The Mediating Role of Individual Motivations," in *Proceedings of the 2007 ACM SIGMIS CPR Conference on Computer Personnel Doctoral Consortium and Research Conference*, St. Louis, MO, April 19-21, pp. 144-152.

Zeitlyn, D. 2003. "Gift Economies in the Development of Open Source Software: Anthropological Reflections," *Research Policy* (32:7), pp. 1287-1291.