**2.0 Conceptual Background**

In principle an open source software (OSS) platform is a type of distributed innovation system in which the platform owner opens its platform to third party contributors, who in turn develop complements to extend the OSS platform (Sawhney et al. 2000, Kogut and Metiu 2001, Boudreau 2010). A community of external developers (developer hub) and end-users drives innovation on an OSS platform. The OSS community members contribute either by developing complements on the platform (Boudreau 2010) or by using, testing, and submitting reviews on the OSS complements. The OSS community developers or users have two types of motives: intrinsic and extrinsic. The intrinsic motives include joy, altruism, and autonomy, and the extrinsic motives include money, skill, and reputation (Bitzer et al. 2007, Shah 2006, Franck and Jungwirth 2003).

To keep the OSS community participants active, the OSS governance should be democratic (Bahrami 2013, Rao et al. 2009, Krishnamurthy 2005). This democracy creates a chaos, a chaos that rise from numerous community feedbacks and requests. To manage this chaos, the OSS developers use an agile release management system (Sharma et al. 2002). This agile release management system differentiates OSS from proprietary software. An OSS developer also uses releases to satisfy consumers who request multiple changes. Bughin et al. (2008) calls such a community interaction “co-creation”, as same set of members create and use the content. This co-creation of OSS community facilitates the diffusion of an OSS platform, because it creates direct and indirect network effect. This direct and indirect network effects create visibility for OSS platform and complements (Lerner and Tirol 2002).

The OSS community contributes to OSS platform diffusion by writing documents, addressing support requests, writing reviews, and using an OSS complement (Lerner and Tirol 2002). Some studies on drivers of diffusion of platforms suggest that a platform’s success depends on pricing mechanism (Rochet and Tirol 2003, 2004,2006, Parker and Van Alstyne 2005, Economides and Katsamakas 2006), yet for an OSS platform, such a mechanism does not exist. Other studies suggest that OSS community is the social capital of an OSS platform, and this social capital drives platform’s diffusion (Roberts et al. 2006). To signal the level of its social capital, an OSS platform shows its OSS complement’s rating distribution, and daily user count. Rating valence and dispersion acts as word of mouth signals, while daily user counts act as observational learning signal. Evidence from meta-analytic of an OSS platform suggests that OSS platform’s diffusion is the result of: license type, participation motives, direct network effect of an OSS community, indirect network effect of OSS complements, and competition (Subramanian 2009, Nair et al. 2004, Katz and Shapiro 1994, Banaccorsi and Rossi 2003). Thus the diffusion of an OSS platform likely depends on the direct and indirect network effect of an OSS community, OSS legal settings, and OSS community’s contribution motivations.

To publish an OSS complement, the developer should submit it to the review committee (O'Mahony and Ferraro 2007). When the review committee reviewed the OSS complement, the OSS platform publishes the complement under the developer requested license. From a published OSS complement, other OSS community members can create their own version as long as they adhere to the license restrictions (Rosen 2005). Managing an OSS community is not easy. Many studies on OSS platforms emphasize the role of loose governance and democracy. These studies address the need for loose governance by nudging to transparency (Shah 2006, O’Mahony and Ferraro 2007, O’Mahoney 2007, Markus 2007), and the paradox of poetry and pragmatism (Bahrami 2013, Rao et al. 2009, Krishnamurthy 2005). To maintain transparency, OSS platform uses various forms of licenses, and various tools of motivation management (Subramanian 2009, Nair et al. 2004, Katz and Shapiro 1994, Banaccorsi and Rossi 2003). Licenses may range from very restrictive, such as general public license (GPL), to less restrictive, such as Berkeley Software distribution (BSD). Tools for motivation management may range from, asking for monetary contribution, e.g. requesting pecuniary contribution from user, to advertising developer’s profile. To maintain the balance between poetry and pragmatism, OSS platform uses OSS review committee. When a new OSS complement developed, the developer nominates it to the review committee, a committee like an academic journal’s review commitee (Wang et al. 2012, Frey 2003).

This committee’s performance is critical to maintain democracy. An OSS review committee determines the time to release of an OSS complement. Before an OSS platform publishes an OSS complement, and OSS review committee should commit or accept it (Mockus et al 2002). To maintain democracy, some OSS platforms ask the review committee explicitly not to judge the relevance of an OSS complement, to leave the judgment to community members. The community members reveal their opinion about relevance of an OSS complement by rating and use (Lakhani and Von Hippel 2003). To generate rapid feedback and engagement from the OSS community, an OSS developer may release early an OSS complement version that performs only core functionalities, but lacks secondary features or final aesthetic. Raymond (1999) calls this central tenet of OSS model “release early, release often”. This rapid evolution and frequent incremental release is possible by rapid and frequent community feedbacks and requests, which flow over “World Wide Web” (Feller and Fitzgerald 2000). These rapid and frequent feedbacks and requests of OSS community create a chaos. a chaos that OSS developers can manage by agile release management system (Sharma et al. 2002).

As in Figure 1, the drivers of diffusion of an OSS platform and complements, thus should include: (1) products rating and daily users count of the community (2) releases of OSS platform and complements (3) review process performance (4) network externality of OSS complements (5) OSS platform competitors.

OSS platform

OSS self-organized review committee

H3

OSS

Complement

OSS

Complement

…

H4

OSS platform

H5

New release

H2

…. User community …

Rating, Usage

H1

The role of an OSS community can be characterized by three variables. First, the valence and dispersion of rating and daily usage count of an OSS complement captures its relevance to the OSS community. These user generated contents act as signals of social capital of an OSS complement, and they inform potential OSS adopters of it (Moe and Trusov 2011, Chavalier and Mayzlin 2006, Bikhchandani and Hirshleifer 1998, Celen and Kariv 2004). Second, the number of new OSS complements, not only contains information about the extendibility of the OSS platform, but also it signals the community engagement level. Third, the OSS review committee contribution level signals the tightness of the community governance. This tightness may in turn affect community’s motivation to contribute (Shah 2006, Caillaud and Tirol 1999).

We theorize that signals of positive valuation of user community influences the adoption of an OSS complements positively, while fewer OSS complements and fewer contribution of OSS review committee can diminish OSS platform’s diffusion. Following research on open platforms (Schultz and Urban 2012, Shah 2006, Mallapragada et al. 2012, Rochet and Tirole 2003), to explain heterogeneity in complements response, we incorporate the following variables: the license type of an OSS complement, the motivation of OSS developers, and competition.

**2.1 Effects of End-User’s Generated Content**

OSS community generates four types of contents: online word of mouth (WOM), online observational learning signal, review and codes. We call the first two shortly user generated content (UGC). By rating and reviewing, OSS community generates online word of mouth, and by using an OSS complement, it generates online observational learning signal. By showing the valence and the distribution of community ratings, an OSS platform presents online WOM, and by showing the number of daily users of the OSS complement, it generates observational learning signal. To find the role of community UGC, we use rating valence and dispersion, and observational learning signal. These quality signals measure direct network effect of community on OSS complements’ diffusion.

Rating valence gives OSS adopter an efficient access to the opinion of the OSS community (Henning-Thurau and Gwinner 2004), so greater valence of rating signals community high valuation for an OSS complement. By signaling high valuation of OSS community, an OSS complement with high rating valence enjoys more adopters (Chevalier and Mayzlin 2006). Despite rating valence point estimate of community’s valuation, the rating distribution variance signals community’s valuation uncertainty (Sun 2012). Deciding not to try proprietary software with high valuation uncertainty, a risk averse individual may try an OSS complement. Individuals may take the risk and adopt an OSS complement, because the expected benefit of the free launch outweighed the expected loss of a malicious Trojan (Golden 2005). Consequently, as a free launch, an OSS complement may enjoy higher dispersion of rating, because the potential adopter can take cognitive benefit from discovering the treasure under the rock (Water 2012), and we hypothesize the following:

*Hypothesis 1a (H1a): As OSS complements’ rating valence and dispersion increases, the size of OSS community users of an OSS complement increases.*

Large number of daily users of an OSS complement may signal relevance to a potential adopter. In addition a potential adopter may put different weights on rating and daily usage counts. Different studies separate observational learning from online WOM, because the first one induces herding behavior and it is harder to forge (Chen et al. 2011). In addition, more daily users of an OSS complement may signal lower cognitive cost of usage, user friendliness. In other word, from daily user counts consumers form expectation about the latent community’s cost of adoption. As a result, an OSS potential adopter may adopt an OSS complement with more daily users, and we hypothesize:

*Hypothesis 1b (H1b): As the numbers of daily users of an OSS complement increases, the sizes of OSS community users of an OSS complement increases.*

**2.2 Release Strategy**

OSS platform and its complements issue releases more frequently than proprietary software (Bonaccorsi and Rossi 2003, Feller and Fitzgerald). Making frequent releases possible, frequent change requests of community members can create chaos (Fogel 2005, Dalle 2003, Godfrey and Tu 2000). To survive in this chaos, an OSS developer uses frequent release strategy (Von Krogh and Von Hippel 2006). Each release comes with a new enhancement. This enhancement increases the adoption of an OSS complement (Fogel 2005). Thus, we hypothesize the following:

*Hypothesis 2(H2): As the developers or an OSS platform releases a new version, the size of OSS community users of the OSS complement increases.*

**2.3 Third-party self-governance (AMO)**

To use the full potential of an active community, an OSS platform adopts democratic governance. Several studies mention OSS governance as a key success factor for an OSS platform (Shah 2006, O’Mahony and Ferraro 2007, O’Mahony 2007, Markus 2007). For example, Shah argues that governance structures affect the evolution of OSS community motives. The CEO of Mozilla describes the governance system of Mozilla intermingle of poetry and pragmatism[[1]](#footnote-1), poetry by democratic and loose governance, and pragmatism by processes to manage the chaos. An OSS platform addresses this paradox in its OSS review process, a process that resembles review process in academia (Hojat et al. 2003).

Facilitating quicker release of a quality OSS complement, OSS review process’s efficiency benefits an OSS platform’s diffusion. The OSS review process can have direct and indirect effects. As opinion leaders in OSS community, the developers are likely to generate more positive word of mouth, when contribution of the review committee increases. In addition, quicker high quality release makes the community of users satisfied (Dedrick and West 2004). Satisfied community directly, and satisfied developer indirectly affect OSS platform’s diffusion. As a result, we predict that more review committee contribution can increase the adoption of OSS platform.

*Hypothesis 3 (H3): As the contribution of the OSS review committee increases, the size of an OSS community increases.*

**2.4 Network Externality**

Opening the platform to third party developers to develop complementary goods is the primary basis for an OSS platform (Sawhney et al. 2000, Kogut and Metiu 2001, Boudreau 2010). We characterize the effect of this strategy using accumulative number of OSS complements that community develops. As OSS developers’ become more active they develop more OSS complements. More OSS complements creates more benefits for the OSS community (Boudreau 2010). Garnering OSS complements benefit, the OSS community’s size increases. Larger community is parallel with larger social capital. Larger social capital enables the OSS platform to learn more from heterogeneous community needs. Learning more from community needs allows an OSS community to develop more relevant OSS complements in a shorter time frame (Grewal et al. 2006, Mallapragada et al. 2012). Therefore,

*H4: As the number of OSS complements increases, the size of the OSS community increases.*

**2.5 Platform Competition**

A key distinction between OSS platform and proprietary platform is the absence of pricing mechanism in the former (e.g. Katz and Shapiro 1985, 1994, Shapiro and Varian 2013). The absence of pricing mechanism may suggest consumers’ simultaneous use of different open platforms. Simultaneous use is relevant as each platform has its own merits, and these merits come without monetary costs (Cai et al. 2008). However, consumer search theory suggests that consumers face a cognitive cost of learning, in addition to monetary cost of acquiring the product (Johnson et al. 2003). Therefore, open platforms should exhibit substitution rather than complementary pattern, not only to proprietary platforms, but also to other open platforms (Rochet and Tirol 2003). Therefore, we hypothesize:

*Hypothesis 5 (H5): As the size of community of an OSS platform increases, the size of community of its peers decreases.*

**References**

*O'Mahony, Siobhán, and Fabrizio Ferraro. "The emergence of governance in an open source community." Academy of Management Journal 50, no. 5 (2007): 1079-1106.*

*Rosen, Lawrence. Open source licensing. Prentice Hall, 2005.*

*Bughin, Jacques, Michael Chui, and Brad Johnson. "The next step in open innovation." The McKinsey Quarterly 4, no. 6 (2008): 1-8.34.*

*Lerner, Josh, and Jean Tirole. "Some simple economics of open source." The journal of industrial economics 50, no. 2 (2002): 197-234*

*Bitzer, Jürgen, Wolfram Schrettl, and Philipp JH Schröder. "Intrinsic motivation in open source software development." Journal of Comparative Economics 35, no. 1 (2007): 160-169.*

*Raymond, Eric. "The cathedral and the bazaar." Knowledge, Technology & Policy 12, no. 3 (1999): 23-49*

*Feller, Joseph, and Brian Fitzgerald. "A framework analysis of the open source software development paradigm." In Proceedings of the*

*twenty first international conference on Information systems, pp. 58-69. Association for Information Systems, 2000.*

*Sharma, Srinarayan, Vijayan Sugumaran, and Balaji Rajagopalan. "A framework for creating hybrid-open source software communities." Information Systems Journal 12, no. 1 (2002): 7-25.*

*Sawhney, Mohanbir, and Emanuela Prandelli. "Managing distributed innovation in turbulent markets." California management review 42, no. 4 (2000): 24-54.*

*Rochet, Jean-Charles, and Jean Tirole. "Platform competition in two-sided markets." Journal of the European Economic Association 1, no. 4 (2003): 990-1029.*

*Rochet, Jean-Charles, and Jean Tirole. "Two-sided markets: A progress report." The RAND Journal of Economics 37, no. 3 (2006): 645-667.*

*Parker, Geoffrey G., and Marshall W. Van Alstyne. "Two-sided network effects: A theory of information product design." Management Science 51, no. 10 (2005): 1494-1504.*

*Rochet, Jean-Charles, and Jean Tirole. Two-sided markets: an overview. Vol. 258. IDEI working paper, 2004.*

*Economides, Nicholas, and Evangelos Katsamakas. "Two-sided competition of proprietary vs. open source technology platforms and the implications for the software industry." Management Science 52, no. 7 (2006): 1057-1071.*

*Subramaniam, Chandrasekar, Ravi Sen, and Matthew L. Nelson. "Determinants of open source software project success: A longitudinal study." Decision Support Systems 46, no. 2 (2009): 576-585.*

*Nair, Harikesh, Pradeep Chintagunta, and Jean-Pierre Dubé. "Empirical analysis of indirect network effects in the market for personal*

*digital assistants." Quantitative Marketing and Economics 2, no. 1 (2004): 23-58.*

*Katz, Michael L., and Carl Shapiro. "Systems competition and network effects." The Journal of Economic Perspectives (1994): 93-115.*

*Bonaccorsi, Andrea, and Cristina Rossi. "Why open source software can succeed." Research policy 32, no. 7 (2003): 1243-1258.*

*Shah, Sonali K. "Motivation, governance, and the viability of hybrid forms in open source software development." Management Science 52, no. 7 (2006): 1000-1014.*

*Roberts, Jeffrey A., Il-Horn Hann, and Sandra A. Slaughter. "Understanding the motivations, participation, and performance of open source software developers: A longitudinal study of the Apache projects." Management science 52, no. 7 (2006): 984-999.*

*O’Mahony, Siobhán. "The governance of open source initiatives: what does it mean to be community managed?." Journal of Management & Governance 11, no. 2 (2007): 139-150.*

*Markus, M. Lynne. "The governance of free/open source software projects: monolithic, multidimensional, or configurational?." Journal*

*of Management & Governance 11, no. 2 (2007): 151-163.*

*Franck, Egon, and Carola Jungwirth. "Reconciling rent-seekers and donators–The governance structure of open source." Journal of Management and Governance 7, no. 4 (2003): 401-421.*

*Kogut, Bruce, and Anca Metiu. "Open‐source software development and distributed innovation." Oxford Review of Economic Policy 17, no. 2 (2001): 248-264.*

*Bahrami, Homa. "People operations at mozilla corporation:: scaling a peer-to-peer global community." California management review 56, no. 1 (2013): 67-88.*

*Hayagreeva Rao, Robert I. Sutton, David W. Hoyt. "Mozilla: Scaling Through a Community of Volunteers" Stanford Graduate School of Business. (2009): 1-30.*

*Krishnamurthy, Sandeep. "The Launching of Mozilla Firefox-A Case Study in Community-Led Marketing." Online verfügbar unter: http://citeseerx. ist. psu. edu/viewdoc/download (2005).*

*Wang, Lei, Ji Xiang, Jiwu Jing, and Lingchen Zhang. "Towards fine-grained access control on browser extensions." In Information*

*Security Practice and Experience, pp. 158-169. Springer Berlin Heidelberg, 2012.*

*Frey, Bruno S. "Publishing as prostitution?–Choosing between one's own ideas and academic success." Public Choice 116, no. 1-2 (2003): 205-223.*

*Mockus, Audris, Roy T. Fielding, and James D. Herbsleb. "Two case studies of open source software development: Apache and Mozilla."*

*ACM Transactions on Software Engineering and Methodology (TOSEM) 11, no. 3 (2002): 309-346.*

*Lakhani, Karim R., and Eric Von Hippel. "How open source software works:“free” user-to-user assistance." Research policy 32, no. 6 (2003): 923-943.*

*Moe, Wendy W., and Michael Trusov. "The value of social dynamics in online product ratings forums." Journal of Marketing Research 48, no. 3 (2011): 444-456.*

*Chevalier, Judith A., and Dina Mayzlin. "The effect of word of mouth on sales: Online book reviews." Journal of marketing research 43, no. 3 (2006): 345-354.*

*Çelen, Boğaçhan, and Shachar Kariv. "Observational learning under imperfect information." Games and Economic Behavior 47, no. 1 (2004): 72-86.*

*Bikhchandani, Sushil, David Hirshleifer, and Ivo Welch. "Learning from the behavior of others: Conformity, fads, and informational cascades." The Journal of Economic Perspectives (1998): 151-170.*

*Caillaud, Bernard, and Jean Tirole. "Party governance and ideological bias." European Economic Review 43, no. 4 (1999): 779-789.*

*Schultz, Jason, and Jennifer Urban. "Protecting open innovation: The defensive patent license as a new approach to patent threats,*

*transaction costs, and tactical disarmament." Harvard Journal of Law and Technology 26 (2012).*

*Mallapragada, Girish, Rajdeep Grewal, and Gary Lilien. "User-generated open source products: Founder's social capital and time to product release." Marketing Science 31, no. 3 (2012): 474-492.*

*Rochet, Jean Charles, and Jean Tirole. "Platform competition in two‐sided markets." Journal of the European Economic Association 1, no. 4 (2003): 990-1029.*

*Sun, Monic. "How does the variance of product ratings matter?." Management Science 58, no. 4 (2012): 696-707.*

*Chen, Yubo, Qi Wang, and Jinhong Xie. "Online social interactions: A natural experiment on word of mouth versus observational*

*learning." Journal of Marketing Research 48, no. 2 (2011): 238-254.*

*Golden, Bernard. Succeeding with open source. Addison-Wesley Professional, 2005.*

*Hennig Thurau, Thorsten, Kevin P. Gwinner, Gianfranco Walsh, and Dwayne D. Gremler. "Electronic word of mouth via consumer opinion*

*platforms: What motivates consumers to articulate themselves on the Internet?." Journal of interactive marketing 18, no. 1 (2004): 38-52.*

*Waters, Sonia. "Getting More than You Paid For: The Parable of the Treasure and the Pearl as the Experience of Transformation." Pastoral Psychology 61, no. 4 (2012): 423-434.*

*Dalle, Jean-Michel, and Nicolas Jullien. "‘Libre’software: turning fads into institutions?." Research policy 32, no. 1 (2003): 1-11.*

*Godfrey, Michael W., and Qiang Tu. "Evolution in open source software: A case study." In Software Maintenance, 2000. Proceedings. International Conference on, pp. 131-142. IEEE, 2000.*

*Fogel, Karl. Producing open source software: How to run a successful free software project. " O'Reilly Media, Inc.", 2005.*

*Von Krogh, Georg, and Eric Von Hippel. "The promise of research on open source software." Management science 52, no. 7 (2006): 975-983.*

*Hojat, Mohammadreza, Joseph S. Gonnella, and Addeane S. Caelleigh. "Impartial judgment by the “gatekeepers” of science: fallibility*

*and accountability in the peer review process." Advances in Health Sciences Education 8, no. 1 (2003): 75-96.*

*Dedrick, Jason, and Joel West. "An exploratory study into open source platform adoption." In System Sciences, 2004. Proceedings of the 37th Annual Hawaii International Conference on, pp. 10-pp. IEEE, 2004.*

*Grewal, Rajdeep, Gary L. Lilien, and Girish Mallapragada. "Location, location, location: How network embeddedness affects project*

*success in open source systems." Management Science 52, no. 7 (2006): 1043-1056.*

*Shapiro, Carl, and Hal R. Varian. Information rules: a strategic guide to the network economy. Harvard Business Press, 2013.*

*Cai, Y. L., A. Y. C. Nee, and W. F. Lu. "Platform differentiation plan for platform leverage across market niches." CIRP Annals-Manufacturing Technology 57, no. 1 (2008): 141-144.*

*Johnson, Eric J., Steven Bellman, and Gerald L. Lohse. "Cognitive lock-in and the power law of practice." Journal of Marketing 67, no. 2 (2003): 62-75.*

1. https://clarity.fm/questions/270/answers/354/share [↑](#footnote-ref-1)