**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 extend and build over it (Sawhney et al. 2000, Kogut and Metiu 2001, Boudreau 2010). Innovation in an OSS platform is driven by communities of external developers and end-users who contribute their expertise not only to develop the platform, but also to develop its potential complements, which in turn, could spur platform diffusion (Boudreau 2010). To extend the platform through complements, the developer should submit its complement to the developer hub to have it reviewed by the review committee (O'Mahony and Ferraro 2007). After the review committee finished reviewing the OSS complement, the good is presented to mass users under a license. Other OSS community members can then test and use the OSS complement and submit feedback, or observe the code and create their own version as long as they adhere to the license restrictions (Rosen 2005). The term “cocreation” describes such collaboration within the community because the content is created and used by the same set of members (Bughin et al. 2008). The community contributes by writing documentation, addressing support request, writing reviews, and using the OSS complement and platform, generating product visibility (Lerner and Tirol 2002). The community members’ contribution either as a developer or user is driven by two types of motives: intrinsic and extrinsic. Intrinsic movies include joy, altruism, and autonomy, and extrinsic movies include money, skill development and reputation (Bitzer et al. 2007, Shah 2006, Franck and Jungwirth 2003).

Raymond (1999) call to “release early, release often” is a central tenet of the OSS model. A product version that performs only core functionalities, but lacks secondary features or final aesthetic can be released to generate rapid feedback and engagement from the OSS community. OSS is characterized by the rapid development and rapid evolution of software, by frequent, incremental release, and by interaction over “Internet” (Feller and Fitzgerald 2000). These frequent and incremental releases are used as a mean for chaos management (Sharma et al. 2002), a chaos rising from flood of feedback and change requests of engaging community.

Evidence from meta-analytic studies regarding drivers of diffusion of a platform suggest that success depends on pricing mechanism (Rochet and Tirol 2003, 2004,2006, Parker and Van Alstyne 2005, Economides and Katsamakas 2006), yet in the context of an open source platform, such a mechanism may not be relevant. Similar OSS research suggest that in OSS platform, type of license, community movies to participate, direct network effect of community, indirect network effect of OSS complements, and competition can affect the diffusion of the platform (Subramanian 2009, Nair et al. 2004, Katz and Shapiro 1994, Banaccorsi and Rossi 2003). Thus the success of an OSS platform likely depends on the direct and indirect network effect of OSS community. In particular, the community network drives the social capital of the OSS platform and complements, as reflected by user rating, usage signal and review process deep feedback (Roberts et al. 2006).

As in Figure 1, the drivers of diffusion of an OSS platform and complements, thus should include: (1) products rating and usage signal 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

Many studies on open source platform emphasize the role of loos governance and democracy in managing an open platform, allowing for transparency (Shah 2006, O’Mahony and Ferraro 2007, O’Mahoney 2007, Markus 2007), while exerting some level of force, by referring to the paradox of poetry versus pragmatism (Bahrami 2013, Rao et al. 2009, Krishnamurthy 2005). When a new OSS complement developed, the developer nominates it to the review committee, a committee like review committee of an academic journal (Wang et al. 2012, Frey 2003). This committee’s performance is a critical determinant of time to release of the OSS complementary goods, as the review committee should commit or accept the complement before allowing it to be published (Mockus et al 2002). In OSS context, the user community generated content, therefore, should be the primary source of decreasing the workload of the review committee, parallel with community role to support (Lakhani and Von Hippel 2003).

The interplay within the OSS community can be characterized by four variables. First, the valence and dispersion of rating captures the level of relevance of an OSS complement to the OSS platform user community and indicates the evaluation of user community, framing a feedback signal to inform other users within the community (Moe and Trusov 2011, Chavalier and Mayzlin 2006). Second, number of daily users of the complements, if presented to the potential adopters, may inform them of the usefulness of an OSS complement (Bikhchandani and Hirshleifer 1998, Celen and Kariv 2004). Third, the number of new OSS complements, developed by the OSS community, not only contains information about the extendibility of the platform, but also it indicates the level of community engagement. Fourth, the performance of review committee may act as a latent measure of the tightness of the governance of an open platform, affecting motives of community contributors (Shah 2006, Caillaud and Tirol 1999).

We theorize that positive evaluation of user community, framed in positive rating and higher usage, influences the adoption of an OSS complements, and fewer contribution of reviewed committee and dearth of OSS complements can diminish OSS platform’s diffusion. Finally, following research on open platforms (Schultz and Urban 2012, Shah 2006, Mallapragada et al. 2012, Rochet and Tirole 2003), we incorporate the following characteristics of an OSS complement to explain heterogeneity in response of complements to above variables: the type of license of an OSS complement, the motives of developer of an OSS complement, competition and churn.

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

Feedback of end user community on OSS complement occurs either through rating as a form of word of mouth (Sun 2012), or through usage level data, which may in turn induce herding behavior (Chen et al. 2011). In either case, community members’ feedbacks signal individual perception of the quality of OSS complement (Sun 2012, Chen et al 2011). These signals may not always only include point estimate for the community’s perception of quality, and they may contain information about the level of uncertainty of population about the value of an OSS complement (Sun 2012). The signal of uncertainty may impede risk adverse individuals’ adoption of proprietary good, yet on an OSS context the response may be different. In open source context, individuals may take the risk and adopt the product, when the expected benefit of the free launch outweighed the expected loss of malicious Trojan (Golden 2005). To capture both forms of quality signals, we characterize both rating valence and dispersion, and observational learning signal (daily usage) to measure direct network effect of community on OSS complements diffusion. For example, positive rating valence of OSS complement may vary directly with the valence of word of mouth of community users, while variance of distribution of rating may uncover the uncertainty in community’s perception about the quality of the OSS complement. A potential adopter may find large number of daily users of an OSS complement a positive signal of its relevance to her life, and she make take the risk to download a complement, although its ratings has high dispersion.

**2.1.1. Effects of Product Rating**

Product rating provides an efficient access of potential adopters to the opinion of the community (Henning-Thurau and Gwinner 2004), so greater the valence of product rating signals community high valuation of an OSS complement. By signaling high valuation of OSS community, an OSS complement with high rating valence enjoys higher level of adoption (Chevalier and Mayzlin 2006). As a free launch, OSS complement may even enjoy from higher dispersion of rating, due to the potential adopter’s cognitive benefits of discovering the treasure under the rock (Water 2012). As a result both valence and dispersion of the community rating may contain relevant information for the adoption decision of potential adopters, and we hypothesize the following:

*Hypothesis 1a (H1a): As OSS complements’ rating valence and dispersion increases, the number of its adopters increases.*

**2.1.1. Effects of Community Usage**

In our research context, community daily usage level of an OSS complements is presented to potential adopters. The number of daily users of an OSS complement, if shown to consumers, may provide an efficient truthful signal of community actual attitude, in contrast to community’s chatter which may not be truthful (Chen et al. 2011). The cost of using an OSS complement is more cognitive, rather than pecuniary. Therefore, forming an expectation about community’s cognitive cost to use an OSS complement, suggests that an increase in observational learning signal should increases the adoption of the complementary good, and we hypothesize:

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

**2.2 Release Strategy**

OSS platform and its complements issue releases more frequently than proprietary software (Bonaccorsi and Rossi 2003, Feller and Fitzgerald). This more frequent releases are direct impact of community contributions (Dalle 2003, Godfrey and Tu 2000), yet community contributions in turn draw chaos through multiple change suggestions and requests (Fogel 2005. An OSS developer uses version control system to manage this chaos (Von Krogh and Von Hippel 2006). Each release comes with a new amelioration of an old complement in response to community’s suggestions and requests (Fogel 2005). For OSS such improvements should result in higher adoption rate (Fogel 2005). Thus, we hypothesize the following:

*Hypothesis 2(H2): As the developers or an OSS platform release a new version, the numbers of new adopters of OSS complement increases.*

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

Several studies emphasize the role of OSS community and OSS governance in the success of the 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 motives in OSS community. The CEO of Mozilla refers to the governance system of Mozilla as a mingle of poetry and pragmatism[[1]](#footnote-1). Poetry is referred to allowing for democracy and loose governance, while pragmatism emphasizes the role of governance to manage the chaos. For our study context, this tradeoff refers to the role of the review process. It parallels the role of review process in academia (Hojat et al. 2003).

Because contribution of the review committee facilitates the release of the quality OSS complement, within a shorter timeframe, the adoption process of an open platform should benefit from the efficiency of this process. When contribution of the review committee increases, the developers as opinion leaders in OSS community also should generate more positive word of mouth. In addition, quicker release with higher quality can keep the community of users more satisfied, helping the adoption process to gain momentum (Dedrick and West 2004). We predict that higher contribution of the review committee can increase the adoption of OSS platform.

*Hypothesis 3 (H3): As the contribution of the review committee increases, the magnitude of adoption of an OSS platform increases.*

**2.4 Network Externality**

Opening the platform to third party developers to develop complementary goods is the primary basis for an open innovation system (Sawhney et al. 2000, Kogut and Metiu 2001, Boudreau 2010). We characterize the effect of this strategy using accumulative number of OSS complements developed on the platform. As community of developers engagement increases (i.e. more complements are developed), the benefits that the OSS community receives from an open platform increases (Boudreau 2010). Open platforms that garner many OSS complements benefit from larger community engagement, which in turn increases the size of the community of adopters, creating more social capital. More social capital enables the OSS platform and its complements to understand and take advantage of community engagement, development and feedback to speed up innovation process (Grewal et al. 2006, Mallapragada et al. 2012). Therefore,

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

**2.5 Platform Competition**

The absence of pricing mechanism is critical in the open source context, as most of the studies on network effect focus on the role of pricing mechanism (e.g. Katz and Shapiro 1985, 1994, Shapiro and Varian 2013). The consumer may decide to use different open platforms simultaneously as she does not face monetary constraint anymore, and as each open platform has its own merit (Cai et al. 2008). However, consumer search theory suggests that consumers still face a cognitive cost of learning (Johnson et al. 2003). Therefore, open platforms should exhibit substitution rather than complementary pattern. In other word, an open platform may compete not only with proprietary platforms, but also other open platforms (Rochet and Tirol 2003). That is, the open platform should be substitute to its peers.

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

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