**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 the same set of members creates and uses the contents. This co-creation of the OSS community facilitates the diffusion of the OSS platform, because it creates direct and indirect network effects. These direct and indirect network effects create visibility for the OSS platform and its complements (Lerner and Tirol 2002).

The OSS community contributes to the OSS platform diffusion by writing documents, addressing support requests, writing reviews, and using the OSS complements (Lerner and Tirol 2002). Some studies suggest that the pricing mechanism affects the success of the two-sided platforms (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 the OSS community is the social capital of an OSS platform, and this social capital drives the platform’s diffusion (Roberts et al. 2006). To signal its social capital, an OSS platform shows the OSS potential adopters the OSS complements’ rating distribution, and daily user counts. The rating valence and dispersion act as the community’s word of mouth signals, while the daily user counts act as the community’s observational learning signals. The evidences from meta-analysis of an OSS platform suggest that the following factors affect the OSS platform’s diffusion: the license types, the participation motives, the OSS community’s direct network effect, the OSS complements’ indirect network effect, and the market 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 OSS community direct and the OSS complements indirect network effects, the OSS legal settings, and the OSS community’s motivations for contributions.

To publish an OSS complement, the developer should submit its complement 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 the published OSS complements, the OSS community members can create their own versions as long as they adhere to the license restrictions (Rosen 2005). Managing an OSS community is not easy. Many studies on the OSS platforms emphasize the role of the loose governance and democracy. These studies address the need for the loose governance by nudging to transparency (Shah 2006, O’Mahony and Ferraro 2007, O’Mahoney 2007, Markus 2007), and the paradox of poetry versus pragmatism (Bahrami 2013, Rao et al. 2009, Krishnamurthy 2005). To maintain transparency, the OSS platform uses various forms of licenses, and various tools for motivation management (Subramanian 2009, Nair et al. 2004, Katz and Shapiro 1994, Banaccorsi and Rossi 2003). The licenses may range from very restrictive, such as General Public License (GPL), to less restrictive, such as Berkeley Software Distribution (BSD). The tools for the motivation management may range from asking for a monetary contribution, e.g. requesting a pecuniary contribution from the users, to advertising the developer’s profile. To maintain the balance between poetry and pragmatism, the OSS platform uses an 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 committee (Wang et al. 2012, Frey 2003).

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

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

OSS platform

OSS self-organized review committee

H3

OSS

Complement

OSS

Complement

…

H4

OSS platform

H5

New releases

H2

…. User community …

Rating, Usage

H1

The role of an OSS community can be characterized by three variables. First, the valence and the dispersion of ratings and the daily usage counts of an OSS complement capture its relevance to the OSS community. These user generated contents act as the signals of the social capital of an OSS complement, and they inform the potential OSS adopters of the OSS platform and its complements social capital levels (Moe and Trusov 2011, Chavalier and Mayzlin 2006, Bikhchandani and Hirshleifer 1998, Celen and Kariv 2004). Second, the number of the 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’s contribution level signals the tightness of the community governance. This tightness may in turn affect the community’s motivation to contribute to the OSS platform and its complements (Shah 2006, Caillaud and Tirol 1999).

We theorize that the signals of the positive valuation of the community increases the adoption of the OSS complements, while the fewer OSS complements and the fewer contribution of the OSS review committee diminish the OSS platform’s diffusion. Following the researches on the open platforms (Schultz and Urban 2012, Shah 2006, Mallapragada et al. 2012, Rochet and Tirole 2003), to explain the heterogeneity in the complements sensitivity, we incorporate the following variables: the license types of the OSS complements, the motivations of the OSS developers, and the competitions in the OSS market.

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

The OSS community generates four types of contents: the online word of mouth (WOM), the online observational learning signal, the codes’ reviews and the complementary codes. We call the first two shortly the User Generated Contents (UGC). By rating and reviewing, the OSS community generates the online word of mouth, and by using the OSS complements, the OSS community generates the online observational learning signals. By showing the valence and the distribution of the community ratings, an OSS platform broadcasts the online WOM, and by showing the number of daily users of the OSS complement, the OSS platform broadcasts the observational learning signals. To find the role of the community UGC, we use the valence and the dispersion of the community’s ratings, and the levels of the observational learning signals. These quality signals measure the direct network effects of the community’s opinions and actions on the OSS complements’ diffusions.

The ratings valences give the OSS adopters efficient accesses to the opinions of the OSS community (Henning-Thurau and Gwinner 2004), so the more positive the valence of the ratings, the more the community values the OSS complements. By signaling the high valuation of the OSS community, an OSS complement with a high rating valence enjoys the more adopters (Chevalier and Mayzlin 2006). Despite the rating valence point estimates of the community’s valuations, the variance of the rating distribution signals the community’s valuation uncertainty (Sun 2012). Despite deciding not to try a proprietary software with a high valuation uncertainty, a risk averse individual may decide to try an OSS complement. The customers may take the risk to adopt an OSS complement, because the expected benefit of the free launch outweighs the expected loss of a malicious Trojan (Golden 2005). As a free launch, an OSS complement may enjoy a higher dispersion of ratings, because the adopter can expects cognitive benefits from discovering a treasure under a rock (Water 2012), and we hypothesize the following:

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

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

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

**2.2 Release Strategy**

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

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

**2.3 OSS review committee governance**

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

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

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

**2.4 Network Externalities**

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

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

**2.5 Platform Competition**

A key distinction between the OSS platform and the proprietary platform is the absence of the pricing mechanisms in the former (e.g. Katz and Shapiro 1985, 1994, Shapiro and Varian 2013). The absence of the pricing mechanisms may suggest the consumers’ simultaneous use of the different OSS platforms. The simultaneous use is relevant as each platform has its own merits, and these OSS platforms’ merits do not have the monetary costs (Cai et al. 2008). However, the consumer search theory suggests that the consumers face cognitive costs of learning, in addition to the monetary cost of acquiring the products (Johnson et al. 2003). Therefore, the open platforms should exhibit the substitution rather than the complementary patterns, not only to the proprietary platforms, but also to the open platforms (Rochet and Tirol 2003). Therefore, we hypothesize:

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

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