Journal of the Association for Information Systems
JAIS

Research Article

Loyalty, Ideology, and Identification: An Empirical Study of the Attitudes and Behaviors of Passive Users of Open Source Software

Namjoo Choi
University of Kentucky
namjoo.choi@uky.edu

Indushobha Chengalur-Smith
University at Albany, SUNY
shobha@albany.edu

Saggi Nevo
University at Albany, SUNY
snevo@albany.edu

Abstract

Extant research on open source software (OSS) has primarily focused on software developers and active users but has paid limited attention to the less visible "passive" users who form the silent majority of OSS communities. Passive users play a critical role in the adoption and diffusion of OSS, and we need more research to understand their behaviors and motivations. We address this gap by drawing on the sociological theory of community markers. The three community markers in the context of OSS are loyalty, ideology, and identification. We also draw on marketing literature to propose four contributory behaviors of passive users of OSS that we theorize to be impacted by the community markers: user brand-extension, word-of-mouth, endorsement, and community involvement. We further classify passive users' contributory behaviors according to the difficulty of their enactment and examine the differential influence of the OSS community markers. Partial-least squares (PLS) analyses of data obtained through a survey of passive users of an OSS product provide support for the majority of the hypotheses.

Keywords: *Open Source Software, Passive Users, Online Community, Community Markers, Contributory Behaviors.*

* Choon-Ling Sia was the accepting senior editor. This article was submitted on 22nd April 2013 and went through two revisions.

Volume 16, Issue 8, pp. 674-706, August 2015

Loyalty, Ideology, and Identification: An Empirical Study of the Attitudes and Behaviors of Passive Users of Open Source Software

1. Introduction

In the early stages of the open source software (OSS) evolution, software products were made mostly by and for developers or individuals with strong technical skills (Levesque, 2005). Since then, the popularity of many successful end user OSS products such as Firefox and OpenOffice has expanded the user base and made it more heterogeneous by attracting an increasing number of non-technical users (Choi & Chengalur-Smith, 2009). This growth in the user base has entailed changes in the OSS landscape on the production side as well, with a greater focus on usability (Jin & Robertson, 2008). Creating a successful software product, whether proprietary or open source, entails both technical and non-technical activities. For example, apart from developing the software, key activities include artwork, documentation, marketing, and usability testing (Daffara, Barahona, & Carlos, 2008). Many OSS projects are often created via voluntary community-based efforts and, thus, lack financial resources for activities such as advertising and usability testing (Jin & Robertson, 2008). This scarcity suggests that nurturing non-technical end users and stimulating their contributions and efforts can play a vital role in the success of OSS products (Krishnamurthy, 2009)

Early research on OSS focused on software developers and their motivations to contribute code to OSS projects (e.g., Hars & Ou, 2002; Hertel, Niedner, & Herrmann, 2003; Lakhani & Wolf, 2005). More recent research has investigated other OSS project participants, such as active users who provide technical services such as helping other users install, configure, and customize the software (Bagozzi & Dholakia, 2006b; Zhang, Hahn, & De, 2013). While informative, this predominantly inward perspective cannot provide a well-rounded understanding of OSS projects' success, so we need more outward attention (Fitzgerald, 2006).

Our study is partly motivated by the above-mentioned need to focus more attention on external aspects of OSS projects. Accordingly, we focus on passive users of OSS, who are defined as those who "use" an OSS product(s) but do not contribute in ways that developers or active users do (e.g., committing code, reporting and/or fixing bugs, testing new releases) (Nakakoji, Yamamoto, Nishinaka, Kishida, & Ye, 2002).

The hierarchical model of a typical successful OSS project has an onion-like structure with the core developers at the center of the community (Raymond, 1998). The next layer comprises co-developers, followed by active users, and then passive users, with the number of participants in each layer being an order of magnitude greater than the previous layer (Crowston, Wei, & Howison, 2006). More commonly, a two-layer view groups core developers, co-developers, and active users to form the inner (internal) layer (Zhang et al., 2013) and passive users to form the outer (external) layer. Although the group of passive users is relatively amorphous and its size is not easily estimated (Crowston & Howison, 2005), Nakakoji et al. (2002) indicates that, for certain OSS projects, passive users may constitute 99 percent of the community. Given their substantial size and potential ability to support the growth and spread of OSS products, we need to investigate passive users' activities and motivations.

Prior researchers and practitioners have cast passive users in a background role of providing psychological motivation for the developers and active users (Nakakoji et al., 2002; Raymond, 2001). Yet, we argue that this group plays a more prominent role and should receive more attention. Specifically, passive users include enthusiasts who informally promote the OSS product and can serve as unofficial marketers by, for example, displaying the logo of the software product on their clothing or other belongings (see Appendix A). Although these passive users may not have the technical savvy to contribute to the code or its documentation, they can act as advocates for the software outside the OSS product's community. Such activities may not register in the archives of the community because passive users often do not use mailing lists or other standard communication channels and, thereby, fail to garner official recognition for their activities. However, such activities clearly contribute to the viability and success of many OSS communities as they help diffuse the OSS product. Accordingly, we examine the motivations that prompt passive users to engage in contributory behaviors.

Building on the importance of communities to OSS products' success, we draw on the sociological concept of a community to identify theoretically motivated antecedents for actions of passive users of OSS products. The core components or markers of a community are a sense of obligation, rituals and traditions, and consciousness of kind (Gusfield, 1978). We apply these markers to study passive users in OSS communities (specifically their attitudes). In the context of OSS, we propose potential inter-relationships among these three markers. Next, we draw on the consumer behavior literature to identify key behaviors of passive OSS users. Juxtaposing the sociology and consumer behavior literatures, we develop a model that links factors that motivate passive users of OSS products to engage in certain participatory and promotional activities as part of their daily life. We also classify the proposed passive user behaviors according to the behavioral difficulty of their enactment (Park, MacInnis, Priester, Eisingerich, & Iacobucci, 2010) and propose a differential influence of the OSS community markers on those behaviors. Thus, we contribute to knowledge about the motivations of passive OSS users and their engagement in behaviors that are beneficial for OSS products' success.

This paper makes three primary contributions to the literature. First, it sheds much needed light on passive users of OSS products who play a significant role in the sustainability and success of OSS communities but who have received little research attention. Second, it theorizes about the motivations of passive users for contributing to OSS communities and their products by drawing on the notion of community markers, and it empirically examines their impact on passive OSS users' contributory behaviors. Third, it classifies contributory behaviors based on their relative difficulty of enactment and establishes the differential influence of the motivations.

This paper proceeds as follows: In Section 2, we provide a theoretical foundation for our study and review the relevant literature to develop testable hypotheses. In Section 3, we describe the research methodology. In Section 4, we present our data analyses and results. Finally, in Section 5, we discuss the implications of our results for research and practice and the study's limitations and conclusions.

2. Theoretical Background and Hypotheses

OSS community members have been variously classified as developers or non-developers (von Krogh, Spaeth, & Lakhani, 2003); core, active, or peripheral participants (Fang & Neufeld, 2009); and modifiers or users (Zhang et al., 2013). Among those who do not contribute any code, non-developers have been described as subscribers to the OSS project mailing list (von Krogh et al., 2003), peripheral participants as those who contribute fewer than ten messages to the mailing list (Fang & Neufeld, 2009) and users as those who test new releases, submit bug reports, request features, and help others install, configure, and use the software (Zhang et al., 2013). In contrast to such active users, the passive users we study are not likely to subscribe to the OSS project's mailing list nor to generate bug reports or feature requests. Despite such limited visibility, we contend that their activities are critical to the sustainability of OSS communities and to the success of OSS products that are the focal point of communal activity.

2.1. OSS Communities and Community Markers

Online communities that have coalesced around an OSS product play an essential role in the product's development and post-development activities, and their characteristics can explain the behaviors and motivations of their members (Von Hippel, 2001). This study builds on the three core components, or markers, of a community: a sense of obligation, rituals and traditions, and consciousness of kind (Gusfield, 1978). These markers have been applied to conceptualize which characteristics constitute an online community in the contexts of both brand communities (Mathwick, Wiertz, & de Ruyter, 2008) and OSS communities (Bagozzi & Dholakia, 2006b); however, their direct impact on user participation behaviors has not been investigated. In the OSS context, we propose loyalty, ideology, and identification as the three community markers (a sense of obligation, rituals and traditions, and consciousness of kind, respectively) that motivate passive OSS users to engage in participatory behaviors that contribute to the success of OSS products.

2.1.1. Loyalty: A Sense of Obligation

One of the core markers of a community is a sense of duty or obligation. OSS communities are often organized around the idea of a gift economy where transactions are based on three fundamental obligations: the obligation to give, the obligation to receive, and the obligation to make a return for gifts received (Ljungberg, 2000). Thus, the recipients, or OSS users, have an unstated obligation to repay the gift of the OSS product at some future time. This obligation is manifested by the responsibility that members share to sustain the OSS community through retaining old members and integrating new ones. This community marker underlies activities that researchers have found to lead to increased group cohesion and collective action and commitment (Muniz & O'Guinn, 2001). For example, in the case of the Mozilla Firefox community, this marker is evidenced by the network of volunteers that created various websites (e.g., www.switch2firefox.com and www.affiliates.mozilla.org) to establish brand identity and increase the adoption and usage of the browser (Krishnamurthy, 2009). The user-funded two-page advertisement in *The New York Times* for the Mozilla Firefox Web browser that involved an average contribution of $30 by over 10,000 users (Krishnamurthy, 2009) is another example of an activity that arises from a sense of duty or obligation to a particular OSS community. Obligation to the community takes the form of behavior consistent with ensuring its survival through social consciousness and contracts (Muniz & O'Guinn, 2001; Schau, Muñiz, & Arnould, 2009). Downloading and using an OSS product is the beginning of a passive user's involvement in its associated community and building commitment to the product is key to maintaining or furthering the individual's involvement in the community. By committing resources, either financial or temporal, users are signaling their loyalty to the OSS product and community.

Loyalty is a key concept in consumer behavior research (e.g., Dick & Basu, 1994; Oliver, 1999). Early on, researchers mostly conceptualized loyalty around consumers' repeat purchasing behavior (e.g., Frank, Massy, & Lodahl, 1969), but they broadened the concept to include consumers' attitudes toward given products because they recognized that a consumer may be behaviorally but not attitudinally loyal (e.g., when there are no other options from which to choose) (e.g., Day, 1969). The distinction between behavioral loyalty and attitudinal loyalty becomes evident when new, competing product offerings become available in the market (Bhattacharya & Sen, 2003).

Recently, researchers began differentiating between loyalty and its outcome behaviors by arguing that the latter transcend favorable attitudes (e.g., De Matos & Rossi, 2008). For example, Dick and Basu (1994) argue that, to the extent that users are more loyal to a given product, they are more likely to engage in behaviors such as word-of-mouth and resistance to counter-persuasion. In line with this view, we propose that distinguishing between loyalty and its outcome behaviors would facilitate an analysis of the benefits that can be obtained from passive users of OSS products. Accordingly, in this paper, we define loyalty as the degree to which passive users hold a favorable attitude toward a given OSS product based on their overall cognitive and affective reflections on the product. Thus, consistent with extant research (e.g., Oliver, 1999), we conceptualize loyalty in this paper as an attitudinal construct rather than a behavioral construct. In Section 2.1.2, we examine the role of loyalty as a motivational antecedent for passive OSS users' behavior.

2.1.2. Contributory Behaviors

In Section 2.1.1, we note that a sense of obligation can induce various types of activities among a community's members. In particular, this community marker may lead to two types of community-oriented activities (Muniz & O'Guinn, 2001). The first type includes members' efforts to recruit and integrate new members by recommending the product to others and their efforts to retain existing members. The second type entails looking out for and helping other members of the community by offering tips for use of the software, solving problems or troubleshooting, or sharing information on product-related resources (Bagozzi & Dholakia, 2006a). These activities help to ensure the long-term survival of the community, which, in the case of OSS products, often means wider distribution and greater use of the software and improved versions in the future.

However, those activities are often intertwined (i.e., a member may solve problems or troubleshoot in the interests of retaining other members or may recommend the product to others by sharing information on product-related resources). In order to better discern the various activities that passive users of OSS products may undertake and to more clearly distinguish between passive users'

behaviors and their motivators, we propose four conceptually distinct contributory behaviors (user brand-extension, word-of-mouth, endorsement, and community involvement) that are important for the viability and success of OSS projects.

User brand-extension: software providers (OSS and proprietary) often expand their product offerings. For example, Google launched a variety of new services (e.g., Gmail, Google Maps) after the success of its search engine service. Likewise, the Mozilla Foundation launched an email client, Thunderbird, after the success of its Web browser, Firefox. These extensions can be directly incorporated into one's main products and offer added value (e.g., Google+). Clearly, for product extension efforts to achieve their goals, users must be willing to adopt the new offerings. In this paper, we define user brand-extension as the degree to which a user is willing to consider adopting other OSS products offered by the same community.

Despite its growing importance, the concept of brand extension has received little attention in information systems (IS) research. In marketing research, researchers have suggested loyalty as an antecedent for consumers' brand-extension intention or acceptance (Reast, 2005). Some studies indicate that greater loyalty toward a product is linked to higher levels of user brand-extension (e.g., Reichheld, 2003). In the IS context, the following example, of an anonymous user post, illustrates how loyalty can affect users' brand-extension intention:

> *I've been with Gmail since launch and I am so addicted to that feature that if it were taken away from me I might honestly quit email all-together……I am loyal to Google and will always sign up for their stuff.* (Google Operating System, 2007)

Thus, we expect a positive relationship between the community marker of loyalty and the user's brand-extension behavior. Therefore, in the context of OSS, we hypothesize that:

> **H1a**: *Greater loyalty toward an OSS product will have a positive impact on passive users' brand-extension.*

Word-of-mouth (WOM): WOM refers to a direct, explicit, and personal recommendation typically communicated via oral or written forms of communication (see Table 1). WOM is important for producers of goods and services, and customer referrals (or "buzz" marketing) are often the main thrust behind a product's success (Verlegh, Steenkamp, & Meulenberg, 2005). In the OSS context, WOM is particularly important considering that most OSS projects lack marketing resources for traditional marketing schemes such as advertising. This paper draws on marketing research (e.g., Chitturi, Raghunathan, & Mahajan, 2008; Reichheld, 2003) to define WOM as the degree to which a passive OSS user provides positive recommendations to another person, in online or offline settings, to persuade them to use the OSS product in question.

There are numerous ways for passive users to engage in WOM. For example, in the entertainment industry, fans of the reality TV show The Biggest Loser threw parties before the launch of the second season, which enlarged the show's audience (Godes & Mayzlin, 2005). Evidence from marketing research shows that loyal consumers are more likely to engage in positive recommendations about the product compared to less-loyal consumers (e.g., Reichheld, 2003; Srinivasan, Anderson, & Ponnavolu, 2002). When people are loyal to a product, they tend to support it, which makes WOM an important loyalty-based outcome (Kim & Son, 2009; Srinivasan et al., 2002). Evidence from recent OSS product offerings supports this positive relationship. For instance, following the official release of Firefox 1.0, volunteers publicized it in online forums such as Slashdot and USENET to increase the number of early adopters (Krishnamurthy, 2009). Furthermore, the user community established student representatives at college campuses in order to spread the word and increase adoption of Firefox (Krishnamurthy, 2009). Thus, we hypothesize that:

> **H1b:** *Greater loyalty toward an OSS product will have a positive impact on passive users' WOM.*

Endorsement: IS researchers have often used the terms endorsement and WOM interchangeably (e.g., Sia et al., 2009). However, we identifiy important dissimilarities between the two terms that merit treating them as distinct concepts in the context of OSS. As we note above, WOM refers to situations where users provide positive recommendations to a targeted audience. Users, however, can express their positive attitudes in other ways as well (e.g., by wearing a cap or a shirt with the logo of a product they feel loyal toward; see Appendix A). Some passive users may prefer the former (i.e., WOM), which is more direct and more private, whereas others may prefer the latter, which is less direct but more public. And some passive users may choose to express their loyalty by doing both.

We define endorsement as the degree to which passive users express their support or approval of the OSS product publicly to potentially unknown others on an ongoing basis. For example, users can endorse an OSS product toward which they feel loyal by placing its logo on their car (a bumper sticker), backpack (an applique), email signatures (e.g., linked images), or social networking websites to indicate their support for, or association with, it. In contrast to WOM, where the primary intent is to convert the audience into adopters or users, endorsement is relatively less action oriented and is likely to be derived from users' desire to associate with, or express their commitment to, the product. In addition, WOM is direct (i.e., targeted to a particular audience) and requires activation with each instance (e.g., individuals would be required to repeat the proselytizing message when they encounters potential converts). By contrast, endorsement is indirect and does not require reactivation (e.g., after users add a logo of an OSS product to their signature, they do not need to repeat the activity).

Given that endorsements are less-targeted expressions of product support, they are less explicit than WOM in terms of making specific recommendations. However, endorsements can signal the users' enthusiasm for the product on a more continuous basis rather than the one-time or intermittent involvement that is typical of WOM, and endorsements can also reach a wider audience. For instance, users can address a broad audience by blogging about a product without specifically calling for its adoption, "liking" it using Facebook, or writing positive product reviews. In the open source community, to support the launch of Firefox Version 1.5, enthusiastic users initiated a global video competition where users were invited to "tell the world in their own words why they love Firefox" (Krishnamurthy, 2009). Users blogged about the browser's superior capabilities, published testimonials, added links to their email signature files, banners, and buttons on their websites to create a viral marketing campaign (Krishnamurthy, 2009). This raised awareness of the product, led to increased traffic to the download site, and eventually to increased adoption (Krishnamurthy, 2009). Therefore, endorsements can deliver more public support and approval messages about the product.

Without loyalty, passive OSS users are less likely to engage in endorsement, which is an activity that requires time and effort. However, passive users often feel a moral obligation to exhibit solidarity with the OSS community by praising the software (Bergquist & Ljungberg, 2001), which suggests that a greater sense of moral obligation or loyalty would prompt passive users to engage in endorsement behaviors. Accordingly, we hypothesize that:

> **H1c:** *Greater loyalty toward an OSS product will have a positive impact on a passive users' endorsement of the product.*

To sum up, we can characterize the distinctions between WOM and endorsement by the dimensions in Table 1 below. WOM is typically communicated using the medium of words, either written or spoken, while endorsement can be nonliteral. With WOM, one attempts to persuade the recipient to switch to being a user, whereas endorsements are primarily designed to express satisfaction with or loyalty toward the product. For WOM, the user has to be actively engaged each time the message is communicated, but endorsers need only act once and the message can be broadcast indefinitely. Related to that, the audience for WOM is intentional or targeted (e.g., a particular colleague during a water-fountain encounter), whereas endorsement is unrestricted and can reach an unknown audience. Furthermore, as we argue later, the antecedents of users' engagement in WOM and in endorsement are different.

Table 1. Conceptual Distinctions Between WOM and Endorsement		
	Endorsement	Word-of-mouth
Primary media	Non-verbal	Verbal
Intent	Praise	Proselytize
Duration of effect	Continuous	One-time or intermittent
Audience	Unknown or open	Restricted or targeted

Community involvement: advances in communication technologies geared toward helping people connect and collaborate with like-minded individuals have led to the rapid development of various types of online brand communities (Muniz & O'Guinn, 2001). In such communities, users share information about the products or create content to promote and support the products toward which they feel loyal (Schau et al., 2009). For example, Jones Soda, a carbonated beverage firm, solicited customer co-creation from its community of loyal fans by inviting them to rate new flavors and submit photos and quotes for the labels that would fit on the packaging (Schau et al., 2009).

Some studies suggest that software providers can enjoy a range of benefits from user contributions (e.g., Bateman, Gray, & Butler, 2011). For example, given that most software products involve product-related knowhow, users' knowledge contributions through various online communities can reduce software providers' time and effort (and other scarce resources) in providing technical support (Jeppesen & Frederiksen, 2006). Also, since most software products require extensive feedback on issues such as usability and feature requests from their users (Sen, 2007), user participation in such activities can contribute to software providers' product quality improvement efforts (see Appendix B). In this paper, we define community involvement as the degree to which passive users are willing to participate in a community for their OSS product. Whereas WOM and endorsement touch on the same issues as the first community-related activity of obtaining new members for the community (Muniz & O'Guinn, 2001), community involvement is more closely associated with the second community-related activity of helping existing community members.

Given the potential significant benefits, we need to understand what leads passive users to become involved with OSS communities. Motivations may vary depending on the community's purpose (Lampe, Wash, Velasquez, & Ozkaya, 2010). For example, passive OSS users may see a competing product with an innovative feature. Instead of switching to the competing product, they might make a feature request to their incumbent OSS product's community to incorporate the feature because they feel loyal toward their OSS product and would like to see it improved. Alternatively, they may have discovered novel uses for the OSS product that they would like to share with other users. Other contributions, such as helping novice users or participating in community-led marketing, are also likely to be initiated due to participants' loyalty toward their software product. For example, in the case of the Web browser Firefox, users provided scripts that volunteers could put on their personal websites to direct visitors who used Internet Explorer to a splash page encouraging them to download Firefox instead (Krishnamurthy, 2009). We expect that passive users who feel loyal toward their OSS product would be more likely to participate in such community-oriented activities. Therefore, we hypothesize that:

H1d: *Greater loyalty toward an OSS product will have a positive impact on passive users' community involvement.*

As we hypothesize above, loyal passive users are more likely to engage in contributory behaviors (user brand-extension, WOM, endorsement, community involvement) toward their OSS product and its community. However, since loyalty by itself appears to adequately explain relatively simple behaviors but not more demanding behaviors (Park et al., 2010), we propose that we can see passive users' behaviors as conceptually located along a behavioral hierarchy or continuum that reflects their difficulty of enactment. Such a view can reflect a user's need to expend additional resources when engaging in the more demanding behaviors. Next, we examine which factors beyond loyalty can motivate passive users to engage in more demanding behaviors.

2.1.3. Behavioral Difficulty of Enactment

Drawing on Park et al. (2010), we propose that we can classify passive OSS user behaviors based on their difficulty of enactment to better understand what motivates users to engage in behaviors that are more demanding to enact. Accordingly, we conceptualize the behavioral difficulty of enactment as the extent to which passive users of OSS products expend social, psychological, and temporal resources[1] to enact various behaviors. In this section, we assess the level of difficulty associated with the enactment of the four contributory behaviors discussed in the previous section. Specifically, we identify the resources needed for each behavior and then classify the behaviors into the two categories; namely, simple and demanding.

Social resources refer to the quantity, diversity, and quality of relationships that an individual has (Dutton, Roberts, & Bednar, 2010). The allocation of such resources involves social interactions, support, and reputation (DeLongis, Folkman, & Lazarus, 1988). User brand-extension is a personal decision that does not typically involve social interactions; thus, we do not expect that social resources will be expended for such behaviors. Although WOM poses a risk to social interactions and reputations because it actively seeks to bring users into the adopters' fold, individuals can choose their audience and presumably reduce such risks. Endorsement entails greater risk to passive users' reputations relative to WOM because it publicly and continuously signals their support for or commitment to a given OSS product. We also expect community involvement to require high levels of social resources since it involves interactions with a potentially diverse and large number of community members.

Psychological resources refer to essential resources such as self-esteem and competency beliefs that motivate an individual to allocate other resources (Shaffer, Harrison, Gilley, & Luk, 2001). User brand-extension requires users to have sufficient competency beliefs to adopt related products. On the other hand, WOM requires a higher level of self-esteem or competency beliefs because users need to understand the product' capabilities in order to persuade someone else to use the product. Endorsement consumes greater psychological resources because publicly supporting and approving an OSS product presumably entails deeper knowledge about the product. Users' community involvement includes behaviors such as answering other users' questions or offering other non-code related contributions, which suggests that endorsement requires strong self-esteem and competency beliefs.

Temporal resources indicate the time invested in these behaviors. Community involvement requires passive OSS users to invest more time compared to other contributory behaviors because it encompasses various activities such as content contributions and providing answers to other users' questions. We expect user brand-extension to require medium levels of temporal resources because it involves installing and trying the product's extensions. In relative terms, endorsement and WOM require relatively the least amount of time.

Table 2 shows the level of difficulty required to enact each behavior by resource type and summarizes the discussion above. Based on the overall level of resources needed for enacting each behavior, we classify brand extension and WOM as relatively simple behaviors and endorsement and community involvement as more demanding behaviors. This classification should not be interpreted as drawing within-category parallels (e.g., endorsement ≈ community involvement) but rather as drawing between-category distinctions. That is, the behaviors in one category are viewed as simpler, in relative terms, than the behaviors in the other category.

[1] Note that, given the non-physical and generally free nature of OSS products, we do not discuss physical and financial resources.

Table 2. Behavioral Difficulty of Enactment

Resources	Demanding		Simple	
	Endorsement	Community involvement	Use brand-extension	WOM
Social	High	High	N/A	Low
Psychological	High	High	Low	Medium
Temporal	Low	High	Medium	Low

Note: Difficulty level is categorized as low, medium, or high depending on the relative degree to which the behavior requires a user to expend the resource.

We further argue that, although passive users may be loyal toward their OSS product, they may choose to engage only in simple behaviors since the more demanding behaviors require them to invest greater levels of their limited resources. For example, a loyal user may engage in WOM but hesitate to wear a shirt with the logo of the product (i.e., endorsement) because such behavior demands expending a higher level of social and psychological resources. Similarly, a loyal user may be eager to try other products from the same provider but may not get involved in community activities because such activities require a higher level of social, psychological, and temporal resources. Because demanding behaviors require passive OSS users to invest more resources, we expect that other factors beyond loyalty are needed to prompt passive users into enacting those behaviors, we expect loyalty to play a less critical role in influencing the more demanding behaviors. Accordingly, we hypothesize that:

H2: *For passive users of OSS products, the impact of loyalty on the two simple behaviors (i.e., user brand-extension and WOM) is higher than on the two demanding behaviors (i.e., endorsement and community participation).*

Based on the discussion above, we posit that a sense of duty or obligation (i.e., loyalty toward an OSS product) will only take a community member so far and that additional motivators are needed to induce passive users to expend more resources and to engage in more demanding contributory behaviors. We now investigate the other characteristics of a community that could provide such a motivation and turn to the community markers of rituals and traditions and consciousness of kind.

2.1.4. Ideology: Rituals and Traditions

Rituals and traditions are shared processes or experiences through which the culture and meaning of the community is disseminated, validated, and perpetuated. In the context of OSS communities, this could take the form of a shared narrative or set of values (i.e., an ideology) (Bagozzi & Dholakia, 2006b). A stream of research in OSS has focused on identifying developers' motivations that voluntarily participate in and contribute to OSS communities (e.g., Hars & Ou, 2002), and found that the ideology of open source associated with OSS is one of the strongest motivations that drive OSS contributions (e.g., Lakhani & Wolf, 2005; Stewart & Gosain, 2006).

Open source ideology is generally referred to as a shared notion that the source code should be freely available to the public to ensure users' freedom to change, copy, distribute, improve, and study the code (Stallman, 2009). Ideology is conceptually distinct from loyalty since users may feel loyal toward a particular OSS product, but they may not feel ideologically bound to the open source philosophy. Also, loyalty focuses on a user's attitudes toward a particular product, which includes the user's cognitive evaluations of the product (Oliver, 1999), not toward the open source ideology at large. Nevertheless, users who subscribe to the open source ideology may believe that their ongoing commitment to an OSS product can help promote the key tenets of open source philosophy. This is similar to individuals who are ideological about renewable energy and environmental sustainability expressing deep commitment to a particular hybrid car, such as Toyota Prius (Kahn, 2007). Thus, we hypothesize that:

H3: *A passive user's open source ideology positively affects the user's loyalty toward an OSS product.*

Although researchers have found the ideology of OSS developers to serve as an important motivation for their contributions (Stewart & Gosain, 2006), the ideology of passive users and its possible impact on their behavior has not been investigated. Ideology is not a binary phenomenon, and members of an OSS community can exhibit varying levels of adherence. In general, proponents of an ideology actively seek to maintain and support the ideology (Hamilton, 1987). In the context of brand extension, extant research shows that, when people feel that the brand shares their core values, they tend to adopt other products from the brand (Carlson, Suter, & Brown, 2008; Schroeder, 2005). For example, consumers who support Body Shop's brand ideology of protecting the environment are more likely to adopt its other products to support the ideology (Verma, 2006). In the case of OSS, ideology spans a wide spectrum from a means to produce high-quality software to being an end in itself (i.e., a philosophy and way of life) (Ljungberg, 2000). Analogous to the behavior of environmental activists, some OSS community members may believe that using commercial software is akin to theft or hoarding and may prefer to use OSS products when possible. Thus, we hypothesize that:

H4a: *The greater the degree to which a passive user of an OSS product adheres to open source ideology, the more likely the user is to engage in user brand-extension behaviors.*

When passive users subscribe to the philosophy of the open source movement, they perceive behaviors aligned with open source ideology to be worthwhile and meaningful (Ke & Zhang, 2009). A principle at the core of the open source movement is making software (or, more specifically, source code) publicly available in order for more people to benefit from it (Stallman, 1985). One way of supporting this principle is acting as a diffusion agent to persuade others to adopt (Gwebu & Wang, 2011). Helping to spread the product to new users and, thereby, attracting more members to the community as potential contributors is consistent with the open source ideology of sharing and improving the software (Bergquist & Ljungberg, 2001; Stewart & Gosain, 2006). Accordingly, we expect that the more a passive user feels ideologically bound to the open source movement, the more likely the user is to engage in WOM that would contribute to increasing OSS adoption. Thus, we hypothesize that:

H4b: *The greater the degree to which a passive user of an OSS product adheres to open source ideology, the more likely the user is to engage in WOM behaviors.*

We foresee a similar positive relationship between subscribing to open source ideology and endorsing an OSS product. To illustrate, consider that we may observe individuals wearing caps or shirts with a particular logo that reflects their support or approval of a specific ideology. For example, some owners of Harley-Davidson motorcycles have reported wearing clothing or accessories with the company's logo to show their support of the espoused values of freedom or machismo that the brand carries (Park, MacInnis, & Priester, 2009). In a similar manner, we anticipate that, when a passive user feels strong adherence to open source ideology, the user is more likely to endorse an OSS product in some positive way. Therefore, we hypothesize that:

H4c: *The greater the degree to which a passive user of an OSS product adheres to open source ideology, the more likely the user is to engage in endorsement behaviors.*

Ideology is often integrated with a person's sense of self and can determine behavior (Ke & Zhang, 2009). For example, the use of "hacker slang" vernacular in OSS communities is seen as a way to promote and support open source ideology (Bagozzi & Dholakia, 2006b). Extant OSS literature shows that open source ideology positively influences developers' contributory behaviors such as team effectiveness (Stewart, Ammeter, & Maruping, 2006) and membership continuation (Bagozzi & Dholakia, 2006b). Research suggests that strong ideology often induces otherwise passive individuals to become more involved members of a community and participate in various activities such as rallies or assemblies to show support for the group that shares the same ideology (e.g., Hirsch, 1990). Thus, we expect that strong adherence to open source ideology would prompt passive users of OSS products to become involved in various community activities. Thus, we hypothesize that:

H4d: *The greater the degree to which a passive user of an OSS product adheres to open source, the more likely the user is to engage in OSS community involvement.*

As we discuss in Section 2.1.3, whereas we expect loyalty alone to motivate passive users to engage in simple behaviors, demanding behaviors that require users to expend more of their resources need stronger motivators (Park et al., 2010). Ideology can strengthen or "energize" individuals' effort toward supporting the community's goals and ideas, which suggests that stronger adherence would result in individuals' exhibiting higher commitment and showing willingness to invest greater levels of their resources (Ke & Zhang, 2009; Ryan & Deci, 2000). In other words, ideological zeal can provide a stronger motivation for demanding behaviors than loyalty. Therefore, we expect that passive users of OSS products who feel more strongly bound to open source ideology will be more likely to engage in demanding behaviors (i.e., endorsement and community involvement) compared with their less ideologically bound counterparts. Thus, we hypothesize that:

H5: *Open source ideology has a stronger impact on passive users' engagement in the two demanding behaviors (i.e., endorsement and community involvement) than loyalty.*

2.1.5. Identification: Consciousness of Kind

The third community marker is consciousness of kind. This is an intrinsic connection with other members of the community and a collective sense of separation from those outside the community (Muniz & O'Guinn, 2001). For instance, evidence of efforts to promote a sense of separation can be observed in Wikipedia's references to studies comparing it with Encyclopedia Britannica (http://en.wikipedia.org/wiki/Reliability_of_Wikipedia). A shared sense of belonging leads members to identify with the community and facilitates their integration into the community (Algesheimer, Dholakia, & Herrmann, 2005). In this paper, we define identification as the degree to which users perceives, feels, and values their belongingness with a given OSS product and, by extension, its community.

Being an owner and a user of an OSS product is key to associating with OSS communities. Thus, identifying with the OSS product itself can create a feeling of belongingness to the OSS community and erect a boundary between those who own and use it and those who do not. Researchers have found identification to lie at the core of all strong consumer brand relationships (Fournier, 1998), and, as software applications continue to permeate more of our everyday lives, users often identify with and, feel a sense of belonging with, their software products (Min, Yoo, & Lee, 2010).

Identification is about whether a user can identify with a product and, thus, feel oneness with it (Bhattacharya & Sen, 2003). Extant research suggests that consumers are likely to be loyal to the products that they identify with because people tend to like to be close to the object that they feel oneness with (Mittal, 2006). In other words, consumers who identify with the product are likely to feel commitment and be loyal to the product in order to sustain their relationship with it (Bhattacharya, Rao, & Glynn, 1995). In various dyadic relationship contexts, such as consumer-company, organization-employee, and friend-friend, researchers have established strong links between identification and identifier's commitment (Ahearne, Bhattacharya, & Gruen, 2005; Wan-Huggins, Riordan, & Griffeth, 1998). As such, we expect to find a similar link between passive users' sense of identification with an OSS product and their loyalty toward it. Thus, we hypothesize that:

H6: *OSS identification positively affects a passive user's loyalty toward an OSS product.*

Research on brand extension suggests that people who identify with a product are also likely to identify with other products offered by the same brand and, thus, likely to try and adopt them over other alternatives (e.g., Del Rio, Vazquez, & Iglesias, 2001; Hem & Iversen, 2003). This outcome is anticipated because the causes that triggered the original identification are also likely to be present in those other products (Nan & Heo, 2007; Lichtenstein, Drumwright, & Braig, 2004). Furthermore, users who are familiar with a product and understand its utility are more likely to identify shared qualities between the original product and its extension and, therefore, infer benefits from using extension

products (Volckner & Sattler, 2006). In the context of OSS, we expect that a passive user who identifies with an OSS product will tend to adopt other OSS products from the same community. Thus, we hypothesize that:

H7a: *The greater the degree to which a passive user identifies with an OSS product, the more likely the user is to engage in user brand-extension behaviors.*

People have a "vested" interest in the success of the product that they identify with, and they want to ensure that their connection with it is positively communicated to others due to their self-enhancement or distinctiveness desires (Bhattacharya & Sen, 2003). Such communication also provides social validation of such identification from others (Ashforth, 1998). In other words, a sense of identification can motivate individuals to seek ways to communicate and justify their product identification to others in their social network. Therefore, we expect that identification with an OSS product will lead passive users to engage in WOM. Thus, we hypothesize that:

H7b: *The greater the degree to which a passive user identifies with an OSS product, the more likely the user is to engage in WOM behaviors.*

Past research has shown that, when identification is strong, people tend to express their support for or approval of a given product using different venues such as visible or more lasting proxies (Schlenker, 1986) because identifiers wish to not only socially validate their identification with the product but also further internalize their identity claims by being close to the object of identification (Ashforth & Mael, 1989). Engaging in endorsement activities (i.e., wearing a cap or a shirt with a logo of a beloved product) can serve to place the identifier, at least mentally, close to the product. Thus, we expect that identification with an OSS product will positively influence its endorsement:

H7c: *The greater the degree to which a passive user identifies with an OSS product, the more likely the user is to engage in endorsement behaviors.*

Online communities are formed around their members' similar interests and needs (Jones, 1997). An individual who identifies with an object (e.g., a product) is likely to join a community that also identifies with it because people tend to desire to belong to a group (or community) of like-minded others with whom they can share their identification relationship (Ren et al., 2012). Furthermore, members of online communities who strongly identify with their product and community are likely to more actively engage in community activities to sustain and strengthen the identification relationship (Ma & Agarwal, 2007). In the context of OSS, we expect that passive users who identify with their OSS product will seek to share the identification relationship with other like-minded users by exchanging information about or collaboratively supporting the product. Thus, we hypothesize that:

H7d: *The greater the degree to which a passive user identifies with an OSS product, the more likely the user is to engage in OSS community involvement.*

Strong identification with a product can motivate behavior demanding a greater level of a user's resources because the user desires to sustain and enrich the relationship with the product (Aron et al., 2004; Lam, Hu, Ahearne, & Schillewaert, 2010). A recent study showed that people tend to invest more resources in brands with which they identify (Park et al., 2009). Identification makes behavior more congruent with personal goals and users feel greater volition to intensify their efforts accordingly (Ke & Zhang, 2009). Recall that loyalty is an attitudinal construct that is based on a user's overall cognitive and affective reflections on a given product. Thus, while identification implicates "hot" affect from linking a user's perceived-self to a product, strong loyalty involves an evaluative judgment and, thus, reflects "cold" affect (Cohen & Areni, 1991; Park et al., 2010). From this perspective, identification, unlike loyalty, has emotional and self-implications that can serve as powerful drivers of demanding behavior (Park et al., 2010). Therefore, we hypothesize that, compared with loyalty, a passive user's identification with an OSS product has a stronger effect on the user's willingness to engage in demanding contributory behaviors vis-à-vis the OSS product.

H8: *Identification with an OSS product has a stronger impact on the two demanding behaviors (i.e., endorsement and community involvement) than loyalty.*

Figure 1 below presents our research model. The bold lines indicate the stronger impacts that Hypotheses 2, 5, and 8 hypothesize

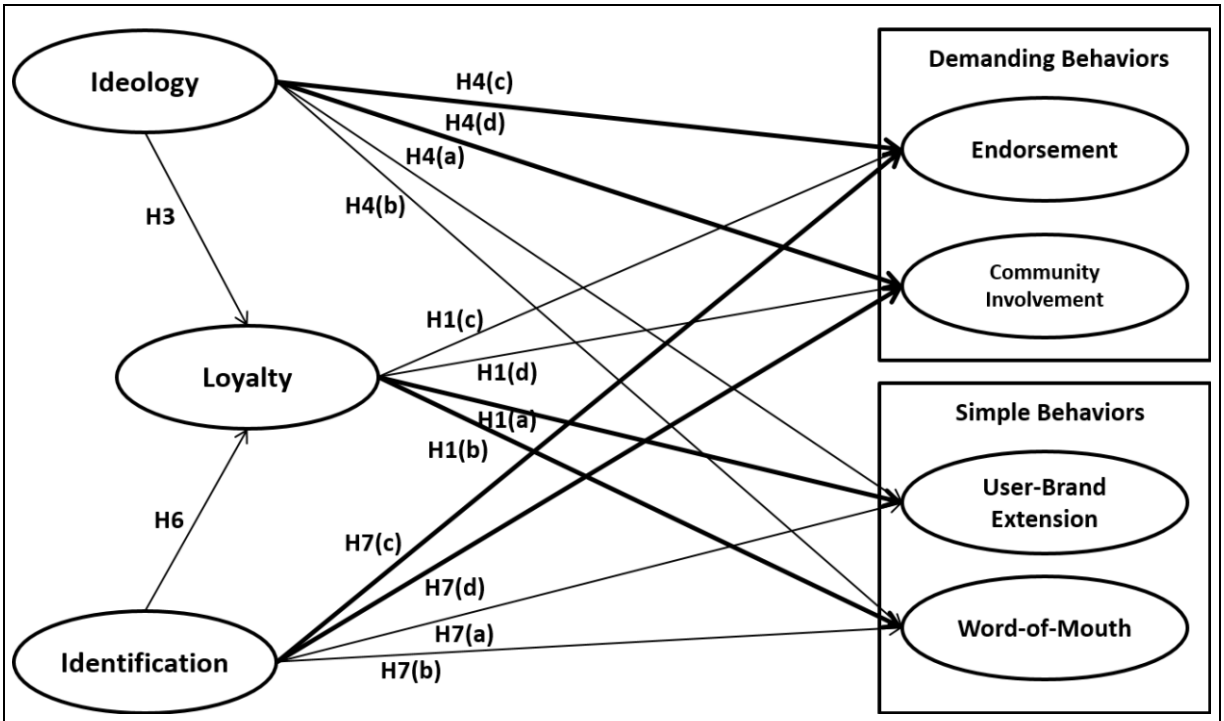

Figure 1. Research Model

3. Research Methodology

We empirically examined the proposed research model at the individual level using survey data, which we obtained via paper-based questionnaires. We chose a survey approach over other research methods such as laboratory experiments or case studies since our model includes perceptual variables (Dennis & Valacich, 2001). Surveys have been used successfully to study other aspects of software use at the individual level (e.g., Agarwal & Karahanna, 2000; Ye & Potter, 2011).

We chose the Mozilla Firefox Web browser as a specific OSS application for this study for several reasons. First, since virtually all Web browsers are free of charge, it permits us to focus on non-monetary issues that may sway users in favor of some OSS products (e.g., MySQL vs. SQL Server). Second, several alternative Web browsers exist, some of which are proprietary, that generate competition in the market (e.g., Microsoft IE, Google Chrome, Apple Safari, and Opera). Third, the various Web browsers provide similar features and user-interfaces, which lower the learning curve for users and, thus, make loyalty more critical. Finally, Firefox has a vibrant user community, which increases the likelihood that our sample will exhibit variation in terms of community participation. In the following sections, we describe the instrument development and data collection procedures we employed.

3.1. Instrument Development

We developed the initial version of the survey questionnaire by generating new scales or adapting existing scales that have been proven to be reliable and valid in previous studies. Most of the constructs employed from the extant literature (e.g., consumer loyalty) in this study are relatively new to IS research and, thus, needed additional items for the scales; we changed their wording to tailor them to the study's context (i.e., IS in general, OSS in particular). We scrutinized all scale items developed for the new construct (i.e., endorsement) for content validity using a two-step approach.

First, we performed two rounds of card sorting (Moore & Benbasat, 1991). Specifically, we wrote all items down on paper cards of equal size and shuffled to produce randomness of viewing. We first presented them to nine IS doctoral students. We asked each student separately to sort the cards into different piles based on similarities and differences among the items and then asked them to provide a label for each pile that they found to appropriately describe the pile. We reshuffled the cards after each student completed the task. We solicited concerns or suggestions about wording choices, ambiguity, or cross-loadings (i.e., when a single item appears to belong to two or more piles). Consequently, we made some wording changes and dropped items that fitted more than one construct. We conducted the second round of card-sorting with three faculty members from three different disciplines: public administration, mass communication, and economics (Conger, 1980). We separately provided each faculty member the remaining items from the first round and the construct definitions and asked them to sort them into appropriate piles that they believed represented the respective latent constructs. Once again, we solicited comments on wording choices, ambiguity, or cross-loadings and made further wording changes as necessary. We employed Light's Kappa, a version of Cohen's Kappa for multiple raters, by using the statistical software package R to assess the inter-rater agreement among the three scholars. The test statistic was 0.939, which is above the commonly accepted threshold of 0.75 (Fleiss, 1971). Thirty-three items remained after the two rounds of card-sorting. Next, to further ensure the content validity of the survey instrument, we pre-tested the questionnaire with 20 undergraduate students in an IS course, which led to minimal wording changes.

We pilot tested the final version of the survey questionnaire for its reliability with members of the sample frame. (Appendix C lists all the items for each construct along with their original sources.) Eighty-three students completed the survey in this pilot phase, and we conducted an exploratory factor analysis to assess the instrument's reliability. We separately conducted two rounds of principal component analyses (PCA) with a direct oblimin rotation using SPSS version 20.0 for the community marker variables and for the contributory behavior variables. Rather than an orthogonal rotation such as varimax, we chose direct oblimin because it is likely that the restrictive requirement of complete orthogonality among the variables may not hold for the community markers and for the contributory behaviors (Field, 2005). These findings regarding the psychometric properties of the instrument suggested that proceeding to the full-scale study was justified.

3.2. Data Collection

The population for this study was Firefox users who had been using the application on a voluntary basis either as a primary or secondary Web browser. The first author visited three large undergraduate IS classes (specifically, computer literacy, business information technology, and information literacy classes) and invited students to complete a paper-based version of the survey only if they met the above selection criteria. The author informed the respondents that there were no right or wrong answers and that the research team was interested primarily in their perceptions about their Web browser (Agarwal & Karahanna, 2000). We received a total of 369 questionnaires, representing 89 percent of the Firefox user students who were present in each class on the days we collected the data. We removed questionnaires with a large number of missing values. A final set of 346 usable surveys remained for data analyses. Table 3 shows the sample's demographic information.

Table 3. Sample Demographics

	Mean	Standard deviation
Age	20.34	2.72
Usage duration (years)	3.80	1.84
		Count of frequency
Gender	**Male** **Female**	223 123
Default	**Primary browser** **Secondary browser**	211 135

Notes: we coded gender as 1 for male and 0 for female; we coded default as 1 if Firefox was the primary browser and 0 if it was the secondary browser.

Since these classes were open to all majors and required in several of the university's colleges, they represented a cross-section of most majors in the university. Although university students may not be an ideal sampling frame when studying organizational phenomena, they are apt participants for this study because they are active and voluntary users of many software applications including Web browsers and have been often used successfully to study consumer technologies in the literature (e.g., Agarwal & Karahanna, 2000). Especially in the case of publicly available OSS, there appears to be no reason to consider students to be markedly distinct from the general population of working professionals about which we aim to learn. Moreover, Web browsers are a general-purpose application. Thus, they are distinct from some niche or trendy applications (e.g., social networking websites) that are known to appeal more to younger generations and may influence their affection toward them and, thereby, potentially influence their loyalty and identification formation process toward these applications (Mangold & Faulds, 2009; Nosko, Wood, & Molema, 2010).

4. Data Analysis and Results

We used partial least squares (PLS), a component-based structural equation modeling (SEM) technique, to analyze the data (Chin, 1998). We used PLS over a covariance-based SEM because the research was exploratory in nature rather than confirmatory (Chin, 1998), and because we conceptualized and treated the endorsement construct as formative (Chin, Marcolin, & Newsted, 2003). We also checked the adequacy of the sample size for a PLS analysis based on Chin and Newsted (1999) and the ten observations per item heuristic for a multiple regression analysis, which showed the sample size to be appropriate. The statistical package we used was SmartPLS 2.0 (Ringle, Wende, & Will, 2005).

4.1. Measurement Model

We assessed the psychometric properties of the scales in terms of construct reliability, discriminant validity, and convergent validity. The composite reliability scores of the six reflective constructs exceeded .70, indicating good internal consistency (Fornell & Larcker, 1981) (see Table 4). Cronbach's alpha scores, which are used to measure internal consistency, ranged from .930 for loyalty to .964 for ideology and user brand-extension, further indicating high consistency (see Table 4). We assessed discriminant validity with the square root of the average variance (AVE) extracted for each construct (the diagonal elements in Table 5). The square roots of the AVE were larger than the inter-construct correlations, suggesting satisfactory discriminant validity (Fornell & Larcker, 1981). We first assessed convergent validity by observing the loadings of the items. All items had loadings in excess of .70, indicating the instrument's convergent validity (Comrey, 1973) (see Table 4). We further assessed convergent validity by observing the square root of the AVE. All items met the criterion of a minimum level of .70 (the diagonal elements in Table 5), suggesting satisfactory convergent validity (Fornell & Larcker, 1981).

Table 4. Item Loadings, Cronbach's Alpha Scores, and Composite Reliability Scores

		1	2	3	4	5	6	Cronbach's alpha	Composite reliability
1. Loyalty	1	**0.943**	0.305	0.399	0.386	0.611	0.707	0.930	0.951
	2	**0.935**	0.307	0.443	0.365	0.612	0.742		
	3	**0.932**	0.366	0.340	0.408	0.592	0.667		
	4	**0.827**	0.263	0.335	0.319	0.529	0.597		
2. Identification	1	0.402	**0.824**	0.216	0.489	0.315	0.345	0.940	0.949
	2	0.338	**0.892**	0.253	0.518	0.319	0.317		
	3	0.270	**0.893**	0.316	0.539	0.335	0.341		
	4	0.269	**0.884**	0.362	0.535	0.354	0.359		
	5	0.278	**0.902**	0.275	0.565	0.311	0.323		
	6	0.235	**0.826**	0.294	0.571	0.311	0.310		
3. Ideology	1	0.375	0.355	**0.860**	0.485	0.494	0.486	0.964	0.971
	2	0.359	0.261	**0.902**	0.459	0.523	0.490		
	3	0.379	0.287	**0.944**	0.473	0.548	0.527		
	4	0.419	0.343	**0.956**	0.527	0.560	0.578		
	5	0.412	0.316	**0.956**	0.523	0.561	0.611		
	6	0.363	0.258	**0.910**	0.446	0.501	0.561		
4. Community Involvement	1	0.400	0.567	0.544	**0.945**	0.529	0.539	0.953	0.970
	2	0.392	0.598	0.476	**0.964**	0.479	0.485		
	3	0.376	0.603	0.493	**0.960**	0.474	0.470		
5. User brand-extension	1	0.601	0.334	0.561	0.449	**0.943**	0.685	0.964	0.974
	2	0.621	0.362	0.570	0.503	**0.961**	0.705		
	3	0.609	0.394	0.527	0.532	**0.949**	0.686		
	4	0.620	0.328	0.536	0.478	**0.949**	0.687		
6. Word-of-mouth	1	0.678	0.334	0.572	0.453	0.702	**0.938**	0.946	0.961
	2	0.709	0.335	0.551	0.453	0.660	**0.948**		
	3	0.724	0.329	0.548	0.454	0.690	**0.952**		
	4	0.660	0.426	0.516	0.578	0.645	**0.872**		

We modeled the construct, endorsement, as formative based on decision rules from Petter, Straub, and Rai (2007). More specifically, its six items are conceptually similar but represent six different ways of engaging in endorsement that could occur independently. Following Cenfetelli and Bassellier (2009) and MacKenzie, Podsakoff, and Podsakoff (2011), we then validated the construct by examining sign, significance, variance inflation factors (VIF), and item loadings. We found no evidence of multicollinearity (all VIFs were lower than the 3.33 threshold) (Cenfetelli & Bassellier, 2009). We did not find the path coefficient of item 2 to be significant. However, its loading was high (.83) with no multicollinearity issue (VIF=2.81), so we retained it (Cenfetelli & Bassellier, 2009). We found items 4 and 6 (see Appendix C) to be negatively associated with the construct, so we dropped them (Cenfetelli & Bassellier, 2009).

The mean scores of the two demanding behaviors (i.e., endorsement: 2.63 and community involvement: 2.90) were smaller than those of the two simple behaviors (i.e., user brand-extension: 4.58 and WOM: 4.82), which supports our classifying loyalty-induced behaviors according to their behavioral difficulty of enactment (see Table 5).

Because we collected the data we used in this study with a single source at one time, we performed a Harman's one-factor test to assess the common method variance among the latent variables (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Six factors that emerged with values greater one, accounting for 81.78 percent of the variance. The first factor accounted for 46.92% of the variance.

Therefore, no single factor accounted for a majority of the covariance, indicating that common methods bias is not an issue in this study (Podsakoff et al., 2003).

Table 5. Correlations Between Constructs

	Mean	Standard deviation	1	2	3	4	5	6	7
1. Loyalty	4.52	1.72	0.911						
2. Identification	2.16	1.32	0.418	0.871					
3. Ideology	4.23	1.71	0.342	0.330	0.922				
4. Endorsement	2.63	1.69	0.478	0.609	0.538	.			
5. Community Involvement	2.90	1.64	0.407	0.616	0.528	0.708	0.956		
6. User brand-extension	4.58	1.65	0.644	0.373	0.577	0.539	0.516	0.951	
7. Word-of-mouth	4.82	1.64	0.747	0.382	0.590	0.528	0.527	0.727	0.928

Notes: diagonal elements are the square roots of the AVE

4.2 The Structural Model

We included two control variables in the model. The first variable was the length of use of the Firefox browser (duration measured in years) and the second variable captured whether Firefox was the respondent's primary or secondary Web browser. We found neither control variables to be significant in the model. Figure 2 shows the results of the PLS analysis of the structural model.

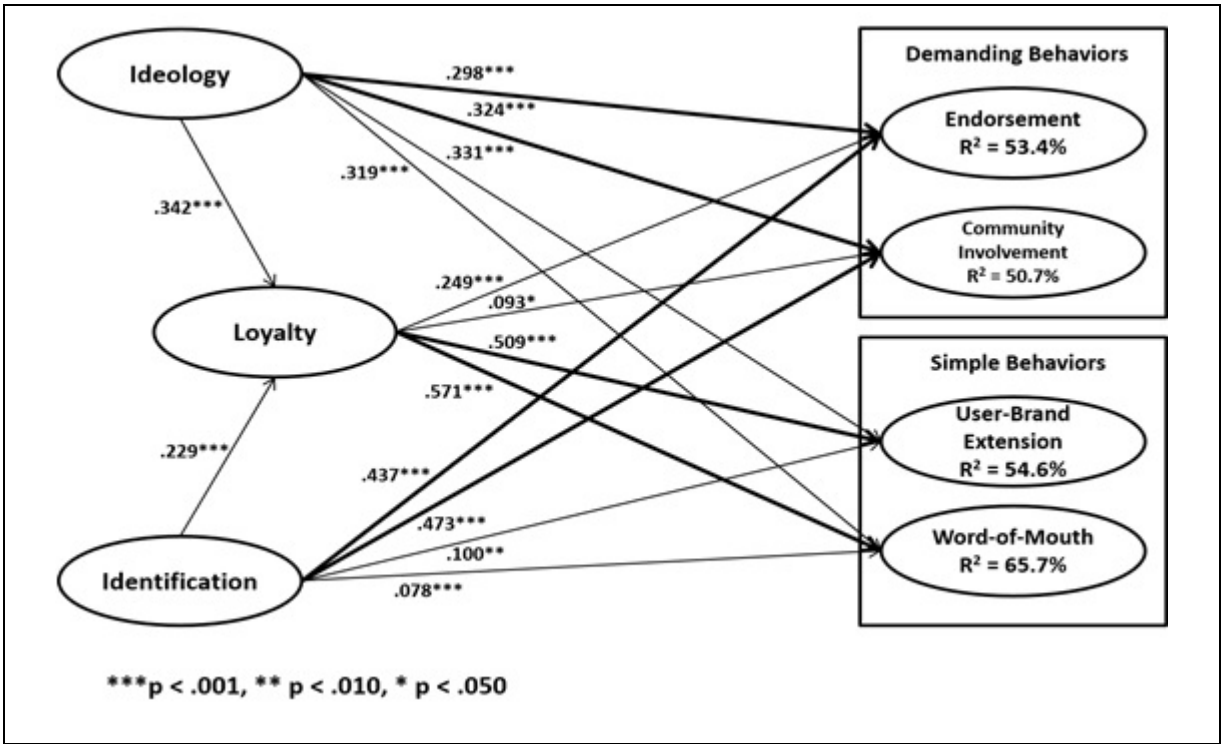

Figure 1. PLS Results

All path coefficients between loyalty and the four contributory behaviors were significant, supporting Hypotheses 1(a-d). Consistent with Hypothesis 2, the impact of loyalty on the two simple behaviors (i.e., user brand-extension and WOM) was higher than on the two demanding behaviors (i.e.,

endorsement and community involvement). Table 6 summarizes the results of the corresponding path coefficient difference z tests for Hypothesis 2 (simple vs. demanding) (Park et al., 2010).

Table 6. Results of the Path Coefficient Difference z Tests for Loyalty (Simple vs. Demanding)

Simple behaviors	Demanding behaviors	z-tests for path coefficient difference	
User brand-extension	Endorsement	z = 4.127	p < .001
	Community involvement	z = 6.603	p < .001
Word-of-mouth	Endorsement	z = 5.873	p < .001
	Community involvement	z = 8.709	p < .001

The path coefficients from ideology and identification to loyalty were significant, supporting Hypotheses 3 and 6. We also found significant support for Hypotheses 4(a-d) and 7(a-d), which predicted the positive impact of ideology and identification, respectively, on the four contributory behaviors. With regard to Hypothesis 5, we found the impact of ideology on community involvement to be significantly stronger than loyalty. However, its impact on endorsement was not significantly stronger than loyalty (p = .393). We discuss this lack of significance in the next section. Consistent with Hypothesis 8, we found identification to have a stronger impact on the two demanding behaviors. Table 7 summarizes the results of the corresponding path coefficient difference (relative to paths from loyalty) z tests (Park et al., 2010). Table 8 summarizes the results for the hypotheses tests.

Table 7. Results of the Path Coefficient Difference z Tests for Loyalty (Simple vs. Demanding)

Independent variables	Dependent variables	z-tests for path coefficient difference	
Ideology	Endorsement	z = 0.855	p = .393
	Community involvement	z = 4.182	p < .001
	User brand-extension	z = 3.236	p < .01
	Word-of-mouth	z = 5.578	p < .001
Identification	Endorsement	z = 2.984	p < .01
	Community involvement	z = 6.909	p < .001
	User brand-extension	z = 6.492	p < .001
	Word-of-mouth	z = 10.978	p < .001

Table 8. Summary of Hypothesis Tests	
Hypothesis	**Support**
H1(a-d): Greater loyalty toward an OSS product will have a positive impact on passive users' brand-extension (a), WOM (b), endorsement (c), and community involvement (d).	Yes
H2: For passive users of OSS products, the impact of loyalty on the two simple behaviors (i.e., user brand-extension and WOM) is higher than on the two demanding behaviors (i.e., endorsement and community involvement).	Yes
H3: A passive user's open source ideology positively affects his loyalty toward an OSS product.	Yes
H4(a-d): The greater the degree to which a passive user of an OSS product adheres to open source ideology, the more likely the user is to engage in user brand-extension (a), WOM (b), endorsement (c), and community involvement (d).	Yes
H5: Open source ideology has a stronger impact on passive users' engagement in the two demanding behaviors (i.e., endorsement and community involvement) than loyalty.	On endorsement: No On community involvement: Yes
H6: OSS identification positively affects a passive user's loyalty toward an OSS product.	Yes
H7(a-d): The greater the degree to which a passive user identifies with an OSS product, the more likely the user is to engage in user brand-extension (a), WOM (b), endorsement (c), and community involvement (d).	Yes
H8: Identification with an OSS product has a stronger impact on the two demanding behaviors (i.e., endorsement and community involvement) than loyalty.	Yes

5. Discussion

In this paper, we examine what motivates passive OSS users to engage in contributing behavior (and the contributions themselves). We performed this study primarily because of the notion that this silent majority in OSS communities performs important contributory activities that fly under the radar and that are not reflected in the archives and mailing lists of OSS communities and so overlooked. Yet, passive users' participation in communities is vital to the long-term success of OSS products (Nakakoji et al., 2002). To address this gap, we first propose four distinct types of contributory behaviors that passive users may engage in: brand extension, WOM, endorsement, and community involvement. We further identify two of these behaviors (namely, endorsement and community involvement) as requiring more resources from users and classified them accordingly as demanding behaviors. We subsequently verified this classification through empirical analysis.

To understand what motivates passive users of OSS products to engage in these contributory behaviors, we draw on the sociological theory of community markers and adapt its main building blocks to OSS communities. Specifically, we map loyalty, ideology, and identification onto the markers: a sense of obligation, rituals and traditions, and consciousness of kind (respectively) after uncovering conceptual similarities. We then examine the capacity of the markers to serve as motivators of contributory behavior for passive users. Although community markers have been recognized as appropriate for OSS communities (e.g. Bagozzi & Dholakia, 2006b), to the best of our knowledge, this is the first study to explore their role as antecedents of passive users' contributory behaviors and compare their differential impacts. The first community marker, loyalty, has been extensively studied in marketing as an antecedent of contributory behaviors. We extend our understanding of this key factor by theorizing that, in the OSS context, the impact of loyalty is more nuanced and has less influence on the more demanding contributory behaviors. Moreover, we

propose that the other two OSS community markers, ideology and identification, have a stronger impact on the demanding behaviors relative to loyalty.

The results support most of our hypotheses and offer insights for OSS communities that seek to generate more contributions from their passive user base. Our data show that adherence to OSS ideology and identification with OSS products lead passive users to develop loyalty towards OSS and motivate them to contribute to OSS communities by engaging in WOM, endorsement, user-brand-extension, and community involvement. We discuss implications for research and practice derived from this study and the study's limitations in the following sections.

5.1. Implications for Research

OSS researchers have investigated the impact of adherence to open source ideology on developers and active users, but, to the best of our knowledge, ours is the first study to consider the influence of ideology on passive users. While marketing researchers have studied loyalty extensively, it has received only scant attention in the context of OSS products, and our study shows that, in this context, loyalty's role is more nuanced than in traditional commerce settings. By taking a sociological view, our study investigates the relative impact of three community markers (loyalty, ideology, and identification) on passive users' contributory behaviors. We further distinguish between these three markers by proposing and confirming inter-relationships between them and, in doing so, establish ideology and identification as antecedents to loyalty. Finally, we find empirical evidence that loyalty, ideology, and identification have positive and varying impacts on all four contributory behaviors (i.e., user brand-extension, WOM, endorsement, and community involvement).

Building on Park et al. (2010), we classify the four contributory behaviors into two different categories based on their relative difficulty of enactment. We found that the impact of loyalty on the two simple behaviors (i.e., user brand-extension and WOM) was higher than on the two demanding behaviors (i.e., endorsement and community involvement). We proposed two new factors, ideology and identification, which can better explain what motivates users to engage in the demanding behaviors. In this regard, we make two significant contributions. First, we add to the literature by suggesting that contributory behaviors need to be conceptualized along a behavioral hierarchy or continuum that reflects the level of difficulty associated with the enactment of contributory behaviors. By doing so, one can better identify the varying effects of motivators on behaviors with different levels of enactment difficulty. Although we dichotomize behavioral difficulty, the types of contributory behaviors can likely be more finely distinguished in future research. Furthermore, the existence of other behaviors and their potential drivers is also worth investigating. Second, prior research has not examined the role of ideology and identification in motivating passive OSS users to engage in contributory, especially more demanding, behaviors. Thus, we contribute to the OSS literature by demonstrating that these two factors are important even at the outer layers of OSS communities and should be considered when studying passive OSS users.

We also define and conceptualize the construct of endorsement, distinguish it from WOM, and develope a valid and reliable scale for measuring this important contributory behavior. The concept of endorsement identifies user activities that are increasingly important to the IS industry but are beyond the scope of the concept of WOM. The results support the notion that endorsement is a more demanding behavior than WOM and that identification has a higher predictive power for this behavior than loyalty. Future research could re-visit models in which WOM was found to play a role and extend them to incorporate the endorsement construct. We also recommend that future operationalization of endorsement include items that capture context-specific behaviors such as the "like" function in Facebook or placing a logo of a brand on social networking websites or blogs (see Appendix C).

Future research could build on this study to explore other behaviors. For example, behaviors such as defending an OSS product to others or derogating alternatives as a means of maintaining loyalty toward the OSS product (Johnson & Rusbult, 1989) are also evident among OSS users (e.g., antipathy toward Microsoft) (Bisson & Branscombe, 2010). Such behaviors may be examined in laboratory settings where some users are exposed to negative and disparaging comments about the focal OSS product whereas others are exposed to positive and approving comments. Then, those users' intention to engage in contributory behaviors may be assessed. In fact, some of the

contributory behaviors may also be examined in laboratory settings. For example, to assess engagement in WOM, a passive user may be asked to write a text message to a friend regarding the product in question and the content of that text could be scrutinized for positiveness or negativeness vis-à-vis the product. Likewise, endorsement could be assessed by offering participants a cap, a shirt, or a sticker with the product's logo and then examining how the various treatment groups responded.

As we previously mention, relatively little attention has been devoted to brand extension in IS research in general and in OSS research in particular despite the growing evidence that many successful leading software providers expand their product or service categories through brand extension (e.g., Google's Gmail or Mozilla's Thunderbird). We finds that passive users of OSS products engage in this important behavior and that it is primarily influenced by loyalty and ideology. We need more research to better understand this construct and its role in IS research. Beyond the context of OSS, brand extension could play a role in the broader IS research. This phenomenon of software providers extending their offerings under the brand's umbrella appears to be growing (either organically or, more often, via mergers and acquisitions). In recent years, companies such as Amazon, Google, and Oracle, which were previously been associated with a single product or service, have expanded their product offerings considerably. It might be worthwhile to examine how loyalty to the brand (say Amazon) plays a role in decisions to obtain additional products (e.g., rent cloud storage services).

The study shows that identification is a stronger predictor of the two demanding behaviors than loyalty, which highlights the significance of the construct in both IS research in general and OSS research in particular. Unlike consumer products that more greatly emphasize the significant role of consumer-product or brand identification, software products have been mostly theorized about using rational technology-task fit models. As it becomes more evident that users can identify with their software products (Darlin, 2010), examining strategies that can increase user identification could be considered for future research.

A plethora of studies in OSS research have been devoted to understanding the motivations of developers that voluntarily contribute to OSS projects (e.g., Hars & Ou, 2002; Hertel et al., 2003; Lakhani & Wolf, 2005). However, little attention has been paid to the factors that motivate passive users to contribute back to OSS communities. The findings from this study show that adherence to open source ideology has a positive and direct impact on all the four behaviors and that its influence on community involvement is stronger than that of loyalty. Note that, although the impact of ideology on endorsement (.298) was higher than loyalty (.249) in terms of their path coefficients, we did not find the difference to be statistically significant. One potential explanation is that, while ideology is about the open source movement in general, endorsement is about a particular OSS product (i.e., Firefox) (Ke & Zhang, 2009). Thus, it is possible that a passive user who strongly adheres to open source ideology may not want to expend much effort in endorsement for a particular OSS product and vice versa. Investigating the difference using multiple OSS products could help to control for this potential effect. Nonetheless, these results overall indicate that passive users' adherence to open source ideology positively affects their intention to engage in contributory behaviors that are critical for the viability and success of OSS projects.

5.2. Implications for Practice

We also provide several important implications for practitioners. As Table 5 shows, the mean scores of the two demanding behaviors (endorsement: 2.63 and community involvement: 2.90) were significantly lower compared to the simple behaviors ($p < .001$). Apparently, users shrink from participating in the former activities, relative to their involvement in WOM and brand extension, which supports the propositions that endorsement and community involvement are more resource intensive. However, these demanding behaviors can be more beneficial to OSS communities than simpler behaviors. For example, publicly displaying the logo of an OSS product or complimenting it on a personal blog (i.e., endorsement) can reach a wider audience than that that is reached via WOM, which suggests endorsement's amplified marketing impact. Similarly, participating in content creation for an OSS community-led marketing (i.e., community involvement) beyond trying and using other products from the community (i.e., user brand-extension) can benefit the community's collective effort

of growing its user base. Thus, OSS communities need to investigate strategies that could encourage passive users to engage in endorsement and community involvement.

To the extent that OSS communities understand the factors that influence passive users' willingness to engage in certain behaviors, they can focus their limited resources on the factors that better motivate their users to engage in those behaviors. This study shows that identification is a strong predictor for the two demanding contributory behaviors (i.e., endorsement and community involvement). Not only does this indicate that passive OSS users can identify with and feel a sense of belonging with their OSS products, but it also signals to OSS community administrators that developing strategies to build identification is likely necessary to garner those demanding contributory behaviors.

Application developers and designers are already beginning to consider how to build brand identity based on an assumption that application users can develop a bond if they can identify with branded software applications (Darlin, 2010). For example, the Mozilla foundation has a team of volunteers whose goal is to create visual identity (e.g., logos, themes, banners) for its OSS products (e.g., Firefox, Thunderbird) (Krishnamurthy, 2009). Considering that users co-develop and further refine this marketing-related content, their marketing impact would be more effective than the traditional top-down approach commonly employed in corporations (Muniz & Schau, 2007).

Further, this study shows that, beyond being a strong motivation for OSS developers, passive users' adherence to open source ideology also influences their motivations to engage in contributing behaviors. Despite the increased awareness among the general public, many casual or general users of OSS products are assumed not to possess a strong adherence to open source ideology (Stallman, 2009). Our results suggest that OSS communities should develop strategies aimed at increasing passive users' level of adherence to open source ideology given its positive impact on contributory behaviors. For example, information about the philosophy behind OSS, along with a clear indication that the product is an OSS application, and the associated implications can be placed on the community homepage, download page, or download windows for OSS products.

5.3. Limitations

Readers should interpret the implications derived from the results of this study with caution. Although we performed a series of refinement and validation processes, the survey instrument could benefit from future assessments of its reliability and validity because most of the items employed from the extant literatures were contextualized to the OSS context and because it also contained items developed for a new construct (i.e., endorsement). Future studies focusing on different OSS products and possibly non-OSS products could help to assess the instrument's external validity. Additionally, we measured contributory behaviors with respondents' intention to perform the behaviors rather than their actual behaviors. Although behavioral intention is an important causal predictor of behavior (Ajzen & Fishbein, 1980), researchers have found that it does not always translate into behavior due to, for example, a lack of financial resources (Boden, 1973), raising concerns over internal validity. While lack of financial resources is not likely a serious concern in the context of OSS, future research could help to assess the study's internal validity using actual behaviors. Also, the research setting for this study was an educational institution and the respondents were students. Although several mitigating factors suggest that the findings could be generalized to other passive OSS users, future research targeting a broader population could assess the study's external validity. Finally, findings could have wider impact if other OSS products, and possibly non-OSS products, are examined.

5.4. Conclusions

Our study highlights passive users' contributions—users who do not commit code, test new releases, or fix or even report bugs but still play a significant role in the sustainability and success of OSS communities. In this paper, we establish the motivations of passive users for contributing to OSS communities and also examine their specific contributions. We conclude that, similar to developers and active users of OSS, ideology plays an important role in prompting passive users to contribute their efforts to help the OSS community. In addition, identification with an OSS product is another vital driver of contributory behaviors. We distinguish between simple and demanding contributory

behaviors and determine that the more demanding behaviors require more than just loyal feelings toward the OSS product or community. Specifically, we find that both ideology and identification are required for passive users to exert themselves to exhibit more demanding behaviors such as endorsement and community involvement.

References

Aaker, D. A., & Keller, K. L. (1990). Consumer evaluations of brand-extensions. *Journal of Marketing*, *54*(1), 27-41.

Agarwal, R., & Karahanna, E. (2000). Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage. *MIS Quarterly*, *24*(4), 665-694.

Ahearne, M., Bhattacharya, C. B., & Gruen, T. (2005). Antecedents and consequences of customer-company identification: Expanding the role of relationship marketing. *The Journal of Applied Psychology*, *90*(3), 574-585.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ: Prentice-Hall.

Algesheimer, R., Dholakia, U. M., & Herrmann, A. (2005). The social influence of brand community: Evidence from European car clubs. *Journal of Marketing*, *69*(3), 19-34.

Aron, A., McLaughlin-Volpe, T., Mashek, D., Lewandowski, G., Wright, S., & Aron, E. (2004). Including others in the self. *European Review of Social Psychology*, *15*(4), 101-132.

Ashforth, B. E. (1998). Becoming: How does the process of identification unfold. In D. A. Whetten & P. C. Godfre (Eds.), *Identity in organizations: Building theory through conversations* (pp. 213-222). Thousand Oaks, CA Sage Publicatio.

Ashforth, B. E., & Mael, F. (1989). Social identity theory and the organization. *Academy of Management Review*, *14*(1), 20-39.

Bagozzi, R. P., & Dholakia, U. M. (2006a). Antecedents and purchase consequences of customer participation in small group brand communities. *International Journal of Research in Marketing*, *23*, 45-61.

Bagozzi, R. P., & Dholakia, U. M. (2006b). Open source software user communities: a study of participation in Linux user groups. *Management Science*, *52*(7), 1099-1115.

Bateman, P. J., Gray, P. H., & Butler, B. S. (2011). The impact of community commitment on participation in online communities. *Information Systems Research*, *22*(4), 841 -854.

Bergquist, M., & Ljungberg, J. (2001). The power of gifts: Organizing social relationships in open source communities. *Information Systems Journal*, *11*(4), 305-320.

Bhattacharya, C. B., Rao, H., & Glynn, M. A. (1995). Understanding the bond of identification: An investigation of its correlates among art museum members. *Journal of Marketing*, 59(4), 46-57.

Bhattacharya, C. B., & Sen, S. (2003). Consumer-company identification: A framework for understanding consumers' relationships with companies. *Journal of Marketing*, 67(2), 76-88.

Bisson, S., & Branscombe, M. (2010). Why do we (love to) hate Microsoft? *Zdnet.* Retrieved from http://www.zdnet.co.uk/blogs/500-words-into-the-future-10014052/why-do-we-love-to-hate-microsoft-10017855/

Boden, M. A. (1973). The structure of intentions. *Journal for the Theory of Social Behaviour*, 3(1), 23-46.

Carlson, B. D., Suter, T. A., & Brown, T. J. (2008). Social versus psychological brand community: The role of psychological sense of brand community. *Journal of Business Research*, 61(4), 284-291.

Cenfetelli, R. T., & Bassellier, G. (2009). Interpretation of formative measurement in information systems research. *MIS Quarterly*, *33*(4), 689-707.

Chin, W. W. (Ed.). (1998). *The partial least squares approach for structural equation modeling*. Hillsdale, NJ: Mahwah, NJ: Lawrence Erlbaum.

Chin, W. W., Marcolin, B. L., & Newsted, P. R. (2003). A partial least squares latent variable modeling approach for measuring interaction effects: Results from a Monte Carlo simulation study and an electronic-mail emotion/adoption study. *Information Systems Research*, *14*, 189-217.

Chin, W. W., & Newsted, P. R. (1999). Structural equation modeling analysis with small samples using partial least squares. In R. Hoyle (Ed.), *Statistical strategies for small sample research*. Thousand Oaks, CA: Sage.

Chitturi, R., Raghunathan, R., & Mahajan, V. (2008). Delight by design: The role of hedonic versus utilitarian benefits. *Journal of Marketing*, *72*(4), 48.

Choi, N., & Chengalur-Smith, I. (2009). An exploratory study on the two new trends in open source software: End-users and service. In *Proceedings of the 42nd Annual Hawaii International Conference on Systems Sciences.*

Cohen, J. B., & Areni, C. S. (1991). Affect and consumer behavior. In h. S. Robertson & H. H. Kassarjian (Eds.), *Handbook of consumer behavior* (pp. 188–240). Englewood Cliffs, NJ: Prentice Hall.

Comrey, A. L. (1973). *A first course in factor analysis*. New York: Academic Press.
Conger, A. J. (1980). Integration and generalization of kappas for multiple raters. *Psychological Bulletin Psychological Bulletin*, *88*(2), 322-328.
Crowston, K., & Howison, J. (2005). The social structure of free and open source software development. *First Monday*, *10*(2).
Crowston, K., Wei, K. L. Q., & Howison, J. (2006). *Core and periphery in Free/Libre and Open Source software team communications.* Paper presented at the Proceedings of the Hawaii International Conference on System Sciences.
Daffara, C., Barahona, J. G., & Carlos, J. (2008). Guide for SMEs. *Free/Libre and Open Source Software Metrics.*
Darlin, D. (2010). Digital devices can become objects of affection. *The New York Times*. Retrieved from http://www.nytimes.com/indexes/2010/12/02/technology/personaltechspecial/index.html?hp
Day, G. S. (1969). A two-dimensional concept of brand loyalty. *Journal of Advertising Research*, *9*(3), 29-35.
De Matos, C., & Rossi, C. (2008). Word-of-mouth communications in marketing: a meta-analytic review of the antecedents and moderators. *Journal of the Academy of Marketing Science*, *36*(4), 578-596.
Del Rio, A. B., Vazquez, R., & Iglesias, V. (2001). The effects of brand associations on consumer response. *Journal of Consumer Marketing*, *18*(5), 410-425.
DeLongis, A., Folkman, S., & Lazarus, R. S. (1988). The impact of daily stress on health and mood: psychological and social resources as mediators. *Journal of Personality and Social Psychology*, *54*(3), 486-495.
Dennis, A., & Valacich, J. (2001). Conducting research in information systems. *Communications of the AIS*, *7*(5), 1-41.
Dick, A. S., & Basu, K. (1994). Customer loyalty: Toward an integrated conceptual framework. *Journal of the Academy of Marketing Science*, *22*(2), 99-113.
Dutton, J. E., Roberts, L. M., & Bednar, J. (2010). Pathways for positive identity construction at work: Four types of positive identity and the building of social resources. *Academy of Management Review*, *35*(2), 265-293.
Fang, Y., & Neufeld, D. (2009). Understanding sustained participation in open source software projects. *Journal of Management Information Systems*, *25*(4), 9-50.
Field, A. (2005). *Discovering statistics using SPSS*. London: Sage.
Fitzgerald, B. (2006). The transformation of open source software. *MIS Quarterly*, 30(3), 587-598.
Fleiss, J. L. (1971). Measuring nominal scale agreement among many raters. *Psychological Bulletin*, *76*(5), 378-382.
Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39-50.
Fournier, S. (1998). Consumers and their brands: Developing relationship theory in consumer research. *Journal of Consumer Research*, *24*, 343–373.
Frank, R. D., Massy, W. F., & Lodahl, T. M. (1969). Purchasing behavior and personal attributes. *Journal of Advertising Research*, *9*, 15-24.
Godes, D., & Mayzlin, D. (2005). How companies turn buzz into sales. *MIT Sloan Management Review*, *46*(2), 5-6.
googlesystem.blogspot.com. (2007). *What's Gmail's selling point?* Retrieved October 12, 2012, from http://googlesystem.blogspot.com/2007/02/whats-gmails-selling-point.html
Gusfield, J. (1978). *Community: A critical response*. New York: Harper and Row.
Gwebu, K. L., & Wang, J. (2011). Adoption of open source software: The role of social identification. *Decision Support Systems*, *51*(1), 220-229.
Hamilton, M. B. (1987). The elements of the concept of ideology. *Political Studies*, *35*(1), 18-38.
Hars, A., & Ou, S. (2002). Working for free? Motivations for participating in open-source projects. *International Journal of Electronic Commerce*, *6*(3), 25-39.
Hem, L. E., & Iversen, N. M. (2003). Transfer of brand equity in brand extensions: The importance of brand loyalty. *Advances in Consumer Research*, *30*, 72-79.
Hertel, G., Niedner, S., & 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), 1159.
Hirsch, E. L. (1990). Sacrifice for the cause: Group processes, recruitment, and commitment in a student social movement. *American Sociological Review*, *55*(2), 243-254.

Jeppesen, L. B., & Frederiksen, L. (2006). Why do users contribute to firm-hosted user communities? The case of computer-controlled music instruments. *Organization Science*, *17*(1), 45-63.

Jin, L., & Robertson, B. (2008). Lessons learned from the development and marketing of Mozilla Firefox browser. In *Proceedings of the 14th Americas Conference on Information Systems*.

Johnson, D. J., & Rusbult, C. E. (1989). Resisting temptation: Devaluation of alternative partners as a means of maintaining commitment in close relationships. *Journal of Personality and Social Psychology*, *57*(6), 967-980.

Johnson, M. D., Herrmann, A., & Huber, F. (2006). The evolution of loyalty intentions. *Journal of Marketing*, *70*(2), 122.

Jones, Q. (1997). Virtual-communities, virtual settlements & cyber-archaeology: A theoretical outline. *Journal of Computer-Mediated Communication*, *3*(3).

Kahn, M. (2007). Do greens drive Hummers or hybrids? Environmental ideology as a determinant of consumer choice. *Journal of Environmental Economics and Management*, *54*(2), 129-145.

Ke, W., & Zhang, P. (2009). Motivations in open source software communities: The mediating role of effort intensity and goal commitment. *International Journal of Electronic Commerce*, *13*(4), 39-66.

Kim, S. S., & Son, J. Y. (2009). Out of dedication or constraint? A dual model of post-adoption phenomena and its empirical test in the context of online services. *MIS Quarterly*, *33*(1), 49-70.

Krishnamurthy, S. (2009). Case: Mozilla vs. Godzilla—the launch of the Mozilla Firefox browser. *Journal of Interactive Marketing*, *23*(3), 259-271.

Lakhani, K. R., & Wolf, R. G. (2005). Why hackers do what they do: Understanding motivation and effort in free/open source software projects. In J. Feller, B. Fitzgerald, S. A. Hissam & K. R. Lakhani (Eds.), *Perspectives on free and open source software* (pp. 3-22). Cambridge, MA: Massachusetts Institute of Technology.

Lam, S. K., Hu, Y., Ahearne, M., & Schillewaert, N. (2010). Resistance to brand switching when a radically new brand is introduced: A social identity theory perspective. *Journal of Marketing*, *74*(6), 128-146.

Lampe, C., Wash, R., Velasquez, A., & Ozkaya, E. (2010). Motivations to participate in online communities. In *Proceedings of the 28th International Conference on Human Factors in Computing Systems.*

Levesque, M. (2005). Fundamental issues with open source software development. *First Monday*, *9*(4).

Lichtenstein, D. R., Drumwright, M. E., & Braig, B. M. (2004). The effect of corporate social responsibility on customer donations to corporate-supported nonprofits. *Journal of Marketing*, 68(4), 16-32.

Ljungberg, J. (2000). Open source movements as a model for organising. *European Journal of Information Systems*, *9*(4), 208-216.

Ma, M., & Agarwal, R. (2007). Through a glass darkly: Information technology design, identity verification, and knowledge contribution in online communities. *Information Systems Research*, *18*(1), 42-67.

MacKenzie, S. B., Podsakoff, P. M., & Podsakoff, N. P. (2011). Construct measurement and validation procedures in MIS and behavioral research: Integrating new and existing techniques. *MIS Quarterly*, *35*(2), 293-334.

Mangold, W. G., & Faulds, D. J. (2009). Social media: The new hybrid element of the promotion mix. *Business Horizons*, *52*(4), 357-365.

Mathwick, C., Wiertz, C., & de Ruyter, K. (2008). Social capital production in a virtual P3 community. *Journal of Consumer Research*, 34(6), 832-849.

Min, J., Yoo, Y., & Lee, H. (2010). *Yes, it is me: Emotional attachment to self-presenting information technology* (Working paper).

Mittal, B. (2006). I, me, and mine: How products become consumers' extended selves. *Journal of Consumer Behaviour*, *5*(6), 550-562.

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research*, *2*(3), 192-222.

Muniz, A. M., & Schau, H. J. (2007). Vigilante marketing and consumer-created communications. *Journal of Advertising*, *36*(3), 35-50.

Muniz, A. M. J., & O'Guinn, T. C. (2001). Brand community. *Journal of Consumer Research*, *27*(4), 412-432.

Nakakoji, K., Yamamoto, Y., Nishinaka, Y., Kishida, K., & Ye, Y. (2002). Evolution patterns of open-source software systems and communities. In *Proceedings of the Workshop on Principles of Software Evolution, International Conference on Software Engineering*.

Nan, X., & Heo, K. (2007). Consumer responses to corporate social responsibility (CSR) initiatives: Examining the role of brand-cause fit in cause-related marketing. *Journal of Advertising*, *36*(2), 63-74.

Nosko, A., Wood, E., & Molema, S. (2010). All about me: Disclosure in online social networking profiles: The case of Facebook. *Computers in Human Behavior*, *26*(3), 406-418.

Oliver, R. L. (1999). Whence consumer loyalty? *The Journal of Marketing*, *63*, 33-44.

Park, C. W., MacInnis, D. J., & Priester, J. (2009). Brand attachment and a strategic brand exemplar. In B. Schmitt & D. Rogers (Eds.), *Handbook of brand and experience management* (pp. 3-17). Northampton, MA: Edward Elgar Publishing.

Park, C. W., MacInnis, D. J., Priester, J., Eisingerich, A. B., & Iacobucci, D. (2010). Brand attachment and brand attitude strength: Conceptual and empirical differentiation of two critical brand equity drivers. *Journal of Marketing*, *74*(6), 1-17.

Petter, S., Straub, D., & Rai, A. (2007). Specifying formative constructs in information systems research. *MIS Quarterly*, *31*(4), 623-656.

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879.

Raymond, E. S. (1998). The cathedral and the bazaar. *First Monday*, *3*(3).

Raymond, E. S. (2001). *The cathedral and the bazaar: Musings on Linux and open source by an accidental revolutionary*. Sebastopol, CA: O'Reilly.

Reast, J. D. (2005). Brand trust and brand-extension acceptance: the relationship. *Journal of Product and Brand Management*, *14*(1), 4-13.

Reichheld, F. F. (2003). The one number you need to grow. *Harvard Business Review*, *81*(12), 46-54.

Ren, Y., Harper, F., Drenner, S., Terveen, L., Kiesler, S., Riedl, J., & Kraut, R. (2012). Building member attachment in online communities: Applying theories of group identity and interpersonal bonds. *MIS Quarterly*, *36*(3), 841-864.

Ringle, C. M., Wende, S., & Will, S. (2005). *SmartPLS 2.0 (M3) beta*. Retrieved from http://www.smartpls.de.

Roy, S. K., Butaney, G., & Bhutany, B. (2009*). Examining the effects of the customer loyalty states on the word of mouth.* Paper presented at the Pacific Asia Conference on Information Systems, Hyderabad, India.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *The American Psychologist*, *55*(1), 68-78.

Schau, H. J., Muñiz, A. M., & Arnould, E. J. (2009). How brand community practices create value. *Journal of Marketing*, *73*(5), 30-51.

Schlenker, B. R. (1986). Self-identification: Toward an integration of the private and public self. In R. Baumeister (Ed.)., *Public self and private self* (pp. 21-26). New York: Springer-Verlag.

Schroeder, J. E. (2005). The artist and the brand. *European Journal of Marketing*, *39*(11/12), 1291-1305.

Sen, R. (2007). Waiting for usable open source software? Don't hold your breath! *Communications of the Association for Information Systems*, *20*, 382-392.

Shaffer, M. A., Harrison, D. A., Gilley, K. M., & Luk, D. M. (2001). Struggling for balance amid turbulence on international assignments: Work-family conflict, support and commitment. *Journal of Management*, *27*(1), 99-121.

Sia, C. L., Lim, K. H., Leung, K., Lee, M. K. O., Huang, W. W., & Benbasat, I. (2009). Web strategies to promote internet shopping: is cultural-customization needed? *MIS Quarterly*, *33*(3), 491-512.

Srinivasan, S. S., Anderson, R., & Ponnavolu, K. (2002). Customer loyalty in e-commerce: An exploration of its antecedents and consequences. *Journal of Retailing*, *78*(1), 41-50.

Stallman, R. (1985). *The GNU manifesto*. Retrieved from http://www.gnu.org/gnu/manifesto.html

Stallman, R. (2009). Viewpoint: Why “open source” misses the point of free software. *Communications of the ACM*, *52*(6), 31-33.

Stewart, K., Ammeter, A., & Maruping, L. (2006). Impact of license choice and organizational sponsorship on success in open source software development projects. *Information System Research*, *17*, 126-144.

Stewart, K. J., & Gosain, S. (2006). The impact of ideology on effectiveness in open source software development teams. *MIS Quarterly*, *30*(2), 291-314.

Szajna, B. (1996). Empirical evaluation of the revised technology acceptance model. *Management Science*, *42*(1), 85-92.

Verlegh, P. W. J., Steenkamp, J.-B. E. M., & Meulenberg, M. (2005). Country-of-origin effects in consumer processing of advertising claims. *International Journal of Research in Marketing*, *22*, 127–139.

Verma, H. V. (2006). *Brand management: Text and cases*. New Delhi: Excel Books India.

Völckner, F., & Sattler, H. (2006). Drivers of brand extension success. *Journal of Marketing*, *70*(2), 18-34.

Von Hippel, E. (2001). Innovation by user communities: Learning from open-source software. *MIT Sloan Management Review*, *42*(4), 82-86.

von Krogh, G., Spaeth, S., & Lakhani, K. R. (2003). Community, joining, and specialization in open source software innovation: A case study. *Research Policy*, *32*(7), 1217-1241.

Wan-Huggins, V. N., Riordan, C. M., & Griffeth, R. W. (1998). The development and longitudinal test of a model of organizational identification. *Journal of Applied Social Psychology*, *28*(8), 724-749.

Ye, C., & Potter, R. (2011). The role of habit in post-adoption switching of personal information technologies: An empirical investigation. *Communications of the Association for Information Systems*, *28*, 585-610.

Zhang, C., Hahn, J., & De, P. (2013). Continued participation in online innovation communities: Does community response matter equally for everyone? *Information Systems Research*, *24*(4), 1112-1130.

Appendix

Appendix A: T-shirts with a Software Product Logo

Table A-1. T-shirts with a Software Product Logo

Product	Examples
Firefox	
Chrome	
Android	
Apple	

Appendix B: Examples of Contributory Behaviors

Table B-1. Some Examples of Contributory Behaviors

Appendix C: Research Constructs and Measures

Table C-1. Research Constructs and Measures

Construct	Measures		Sources
Loyalty	Item 1	I consider myself to be highly loyal to Firefox.	Kim & Son (2009)
	Item 2	I have a strong preference for Firefox.	
	Item 3	I feel I am committed to Firefox.	
	Item 4	I do not foresee my loyalty for Firefox would willingly change.	
Identification	Item 1	I feel Firefox is part of me.	Park et al. (2010), Johnson, Herrmann, & Huber (2006)
	Item 2	I feel emotionally connected to Firefox.	
	Item 3	I believe using Firefox says a lot about who I am.	
	Item 4	I believe Firefox can reflect my personal lifestyle.	
	Item 5	My own sense of who I am (i.e., my personal identity) overlaps with my sense of what Firefox represents (i.e., the Firefox's identity).	
	Item 6	When someone praises Firefox, it feels like a personal compliment.	
Ideology	Item 1	I consider myself an enthusiastic advocate for the Open Source Software (OSS) movement.	Ke & Zhang (2009)
	Item 2	I believe source code should be freely shared.	
	Item 3	I believe in the value of the OSS movement.	
	Item 4	I believe the OSS movement greatly enhances our society.	
	Item 5	I agree with the general philosophy of the OSS movement.	
	Item 6	I believe OSS benefits those who cannot afford software they need.	
User brand-extension	Item 1	If the Mozilla foundation introduces other products, I would be likely to try them.	Aaker & Keller (1990)
	Item 2	I would consider adopting other products from the Mozilla foundation.	
	Item 3	I intend to try other products from the Mozilla foundation.	
	Item 4	I think it is worth trying other products from the Mozilla foundation.	
Word of mouth	Item 1	I would say positive things about Firefox to other people.	Kim & Son (2009), Roy, Butaney, & Bhutany (2009)
	Item 2	I would recommend Firefox to anyone who seeks my advice.	
	Item 3	I would refer my acquaintances to Firefox.	
	Item 4	I would talk to others about the benefits of switching to Firefox.	

Table C-1. Research Constructs and Measures (Cont.)

Construct	Measures		Sources
Endorsement	Item 1	I would consider putting the Firefox logo on my social networking site.	New
	Item 2	I would like to wear a T-shirt/cap with the Firefox logo.	
	Item3	I would consider putting the Firefox logo on my blog.	
	Item 4	*I would consider putting the Firefox logo on my email signature (dropped).*	
	Item 5	I would consider putting a badge with the Firefox logo on my backpack.	
	Item 6	*I would consider putting the Firefox logo on my car (dropped).*	
Community involvement	Item 1	I would consider participating in Firefox's online user communities.	Algesheimer, Dholakia, & Herrmann (2005)
	Item 2	I intend to take part in Firefox's online user community activities.	
	Item 3	I would consider contributing to the Firefox's online user community activities.	
Age	Years		N/A
Gender	1	Male	N/A
	2	Female	
Usage duration	How long have you been using Firefox? (years)		Szajna (1996)
Default	1	Primary Browser	N/A
	2	Secondary Browser	

Note: we used a 7-point Likert scale with anchors at strongly disagree and strongly agree unless otherwise noted.

About the Authors

Namjoo CHOI is an Assistant Professor at the School of Information Science, University of Kentucky. He received his PhD in Informatics from the University at Albany, State University of New York. His research interests include open source software, online communities, and technology adoption and post-adoption. His research work has been published in academic journals such as *IEEE Software*, *Journal of the American Society for Information Science and Technology*, *Library & Information Science Research, Library Hi Tech*, and *Journal of Computer Information Systems*.

InduShobha CHENGALUR-SMITH is a faculty member in the Information Technology Management department at the School of Business in the University at Albany, SUNY. She received her PhD from Virginia Tech and prior to joining academia she worked in both the private and the public sectors. Her research interests are in the areas of Virtual Communities, Technology Adoption and Implementation, and Information Quality and Security. She has worked on federally sponsored grants as well as industry-sponsored projects, ranging from best practices in computational thinking to technology implementation. She serves on the Editorial Boards of *Information & Management* and the *ACM Journal of Data and Information Quality* and her research has been published in academic journals such as *Information Systems Research*, *European Journal of Information Systems*, *Journal of the AIS, Journal of Strategic Information Systems, Communications of the ACM*, and multiple *IEEE Transactions*.

Saggi NEVO is an associate professor of information technology management at the School of Business at the University at Albany. He received his PhD from York University in 2007. His research focuses on post-implementation, the business value of IT, and open source software. His research has appeared in *MISQ, JAIS, EJIS, JSIS, JIT*, and *SMR*. His 2011 *JSIS* paper won the journal's best paper award and the AIS's top-five papers award.