Carrots and Rainbows: An Empirical Comparison of Motivations of Open Source Software Contributors

Completed Research

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Abstract

Open source software (OSS) communities have been witnessing growing commercial interests with increased corporate involvement in the recent years with acquisitions of major OSS platforms such as Red Hat and GitHub. Researchers have studied a wide variety of motivations behind individuals' participation in OSS communities. In this study, we build upon the framework, rooted in self-deterministic and social practice theories, proposed by von Krogh et al. (2012) and develop a model of OSS contribution likelihood. We empirically validate the model with a large dataset from 2017 GitHub Open Source Survey that includes over 5,500 randomly selected OSS developers. Results indicate that short-term and/or tangible motivations (carrots) and long-term, value-based factors (rainbows) influence OSS developers' contribution likelihood. However, carrots are relatively more important. Further, we find that as internal self-efficacy increases, effect of OSS hiring behind contribution to OSS decreases. Our research contributes to theory and practice.

Keywords

Open Source Software, Intrinsic Motivation, Extrinsic Motivation, IT workforce, Self-determination Theory, Social Practice

Introduction

The "open source" software (OSS) or "open source" code refers to a publicly accessible artifact that by design anybody can create, modify, and share (von Krogh and von Hippel, 2003). The concept of free and open-source software dates back to 1950s. However, the movement began 30 years later in the 1980s (Kulkarni, 2018). As of beginning of 2016, over 1300 OSS projects were active and the list continues to grow. Historically, primary contributors to the OSS projects were self-driven individuals with high levels of intrinsic and hedonic motivation. Corporate sponsorship of OSS projects existed even in the earlier days of OSS movement. However, as OSS became more popular in the 1990s, industry giants began to feel serious threat to their businesses and started to be involved more directly in the projects by funding them or by deploying their employees to these projects (Daniel et al., 2018; Fosfuri et al., 2008). Since then, corporations have been expanding their involvement in open source technologies and there has been a significant rise in the past decade. Black Duck and North Bridge, which assesses OSS trends on an annual basis, hosts Future of Open Source surveys annually. The 2016 survey, which received 1300 responses, revealed that 65% of companies are contributing to OSS projects (Black Duck, 2016). Some of the major contributors have been Microsoft, Google, and IBM. Microsoft alone deploys over 4500 employees to contribute to OSS projects. There has been a shift in the corporate involvement in OSS projects in the past few years with these sponsoring corporations buying out the OSS products completely. For example, Microsoft's acquisition of GitHub and IBM's purchase of Red Hat, the biggest in the history of OSS. Corporations still need to have access to technical talent, but they can increasingly be a hybrid of internal firm employees, and open source community contributors. As of 2017, there are over 2 million active developers on the GitHub who contribute to OSS projects (Asay, 2018). Traditionally, contribution to OSS has been voluntary with individuals primarily driven by intrinsic motives and intentions of social good. For instant, satisfaction, fulfillment arising from developing software, identification with the OSS community,

and hedonic motives (Hars and Ou, 2002; Hertel et al., 2003). However, extrinsic motivations such as being paid for contributing to OSS projects also played their role as well. The recent acquisitions of major OSS platforms like Red Hat and GitHub demonstrate that growing commercial interests in OSS. Given this shifting dynamic, we propose that some of the assumptions made in the literature regarding OSS contributor motivations may need to be revisited. One key question that arises, in the midst of changing landscape of open source projects with growing commercialization and acquisitions by large corporations is what actually drives the developers to contribute?

Evolution of OSS from relatively voluntary contributions driven by hedonic motivations to the one driven primarily by commercial motives shifts the dynamics of how OSS contributors involve in these projects. We propose that higher levels of firm participation changes the dynamics of open source participation, and new models for evaluating communities are required. Motivations behind open source contributions rooted in a variety of theoretical foundations and frameworks have been discussed in the literature. Most common among them by far has been self-determination theory (Deci and Ryan, 1985; Gagné and Deci, 2005) involving intrinsic and extrinsic motivations. While substantial research conducted demonstrated that both self-determination and social good predict open source contributions, little research has compared the relative influence of these motivations against each other. As commercial use of open source becomes more common, we posit that a relative understanding of self-deterministic and social good predictors will be critical to understanding the changing OSS phenomena.

The objective of this study is to investigate what motivates individuals to contribute in the midst of increasing corporate sponsorships and rising trends of OSS acquisitions. We investigate these motivations by using data collected directly from OSS participants regarding their motivations, professional outcomes and future OSS contribution likelihood. Particularly, our focus is to empirically investigate the theoretical framework developed by von Krogh and his team about individual motivations behind OSS contribution (von Krogh et al., 2012) rooted in Self-determination and Social practice view. Authors use metaphors carrots for tangible, short-term, and monetary rewards and rainbows for intangible, long-term, social good motivations influencing OSS contributions. Although rainbows play a key role in motivating individuals in their OSS contribution, we demonstrate that, in the fast-changing technology landscape, professional employment opportunity and high levels of individual's technical competence, measured as internal self-efficacy, enhances the influence of carrots over rainbows as key motivators for OSS contribution.

The rest of the paper is organized as follows. A brief literature review is presented in the next section, followed by a discussion on theoretical foundations and research model. Next, we present our research methodology and a brief outline of the data collected for this study. Discussion of results are presented next and finally, the paper is concluded with contributions, limitations, and suggestions for future research.

Literature Review

Software developers and other individuals with technical and managerial skills contribute to OSS projects by dedicating their time towards the goal of producing and distributing software that is free of cost to the community. OSS projects may take a long time with no clear visibility of an end goal. Under such situations, these individuals need to have high levels of motivation for continued contribution to such projects. In the early days of OSS development, contributors generally volunteered their time towards projects. However, with corporations getting directly involved by sponsoring projects, many individuals are now compensated for their time spent working on OSS. In this section, we present a brief review of the extant literature that focuses on individuals' motivations behind participating in OSS projects. By no means is our literature review exhaustive. We have framed our research within the "carrot" and "rainbow" taxonomy described by von Krogh et al. (2012). In this seminal paper, von Krogh et al. examined two different categories of OSS contribution motivation, summarized by the concept of "carrots" and "rainbows." While carrots include motivations of use-value, reward, or any short-term or tangible benefits, motivations of long-term, value-based, moral and ethical obligations, altruism, ideological views, and feelings of overall benefit to the society are considered as rainbows.

We performed a brief literature review of studies involving motivations behind why individuals contribute to OSS development projects. In the process, we searched articles using keywords such as "Open Source", "OSS", and "motivation". While our research in this paper considered how likely OSS developers and other participants are to contribute in future as the outcome variable, papers in our literature review studied

various kinds of outcomes such as Reputation, Intention to Accept Monetary Rewards, knowledge sharing, reputation-building, and self-development. Following the self-determination view and unity of life view (social practice) outlined by von Krogh et al. (2012), our review focused on motivations viewed as either carrot (short-term and/or tangible) or rainbow (long-term, value-based). According to self-determination theory (Deci and Ryan, 2012; Ryan and Deci, 2000), intrinsic motivations partially overlap with motivations identified from social practice view. While carrots and rainbows are viewed as short-term vs long-term respectively, we note that this categorization of motivations as carrots and rainbows are not mutually exclusive. In other words, when viewed as intrinsic vs extrinsic, social-practice motivations are mostly intrinsic and some of them (e.g., altruism, ideology, and social motives) could be classified under either category.

In a descriptive analysis of a survey data from 79 programmers in OSS projects, authors Hars and Ou (2002) observed that programmers have short-term and/or tangible (e.g., direct compensation, anticipated return, and building human capital) and long-term (e.g., altruism, identification with a community) motivations for participating in OSS projects. These findings echoed in other studies as well. In one study to understand drivers behind why people devote their time and expertise to open source projects, Baytiyeh and Pfaffman (2010) found that primary motivations behind their contribution was a sense of altruism and desire to create and learn. Surprising, being paid was not a significant motivator. In another study on Linux kernel community found that contributors have both long-term (e.g., identification as a Linux developer and user), and short-term and/or tangible (enjoyment of programming and networking with Linux community) motivations behind contributing to OSS (Hertel et al., 2003). In addition to contributing through software development, providing field support to the users of open source software is of paramount importance in OSS projects. Individuals providing free online technical support to the users of Apache open source software are motivated by direct learning benefits (carrot) accrued (Lakhani and Von Hippel, 2003).

In a longitudinal study of Apache projects, Roberts et al. (2006) demonstrated that OSS contributors' motivations are intricately connected. Tangible benefits (carrots) such as payment for contribution and gaining status and opportunities, lead to above average contribution levels. However, the research found no significant impact on contribution due to intrinsic motivations. The "carrot" incentives of OSS contributors may go beyond learning and directly include professional outcomes. In a field survey of OSS participants, researchers Wu et al. (2007) found that OSS developers' helping behavior (rainbow) and economic incentives (carrots) such as career advancement, satisfying personal needs, and enhancing human capital influence their continued intention to contribute to OSS development.

Similarly, In a comparative study involving open source software and open source content (documentation), researchers found that software contributors are motivated more by tangible benefits such as reputation building and self-development (carrots) than content contributors, who are driven by altruism and benevolence (rainbows) (Oreg and Nov, 2008). Researchers Xu et al. (2009) found that voluntary developers in OSS projects are driven by tangible motivations such as personal software needs, gaining skills, and enjoyment (carrots) and long-term, broader motivations of community ideology and developing interpersonal relationships (Rainbows).

In summary, researchers examined long-term, value-based of altruism, obligation, ideologies, and a few community motivations such as identification with the community, desire to help others, and perception of fairness to share content mutually in a virtual community. However, there are aspects of motivation that are evidenced by the affordances of the individual OSS communities. These aspects include, for example, having a welcoming community, particular code of conduct within the community, and maintenance of code responsively. These important factors have been ignored in the literature. Similarly, extant studies have studied short-term, tangible motives such as remuneration as a driver for involving in OSS projects. However, previous research has not directly considered OSS participation as a contributor for employment outcomes. This paper addresses these research gaps by analyzing the relationship between employment outcomes and OSS participation.

Theoretical Foundations and Research Model

We developed our research model (Figure. 1) based on theoretical foundations primarily rooted in Deci and Ryan's self-deterministic view (1985) and MacIntyre's social practice view as expounded by von Krogh et al. (2012). Although researchers have studied various kinds of extrinsic motives behind individuals'

contribution to OSS projects, in the age of increasing commercialization and corporate involvement, there will be a shift in the motives behind these contributions. While there is overlap between the self-deterministic view and the social practice view as described by von Krogh et al. (2012), our research model attempts to isolate particular variables that have been associated with these respective views that are more closely aligned with one perspective over another. Our research model therefore focuses on community based OSS involvement, characterized by the community-based priorities espoused by the OSS contributor, and financial based involvement, characterized by direct financial remuneration associated with OSS participation. We align community-based involvement with the altruistic and community based motivations described by the social practice view. In contrast, the financial motivations associated with direct remuneration for OSS contributions are associated with the self-deterministic view. This approach in the research model enables both analysis of, and comparison across these two common theoretical models used to describe OSS contributions.

Figure 1: Model of OSS Participant's Contribution Likelihood
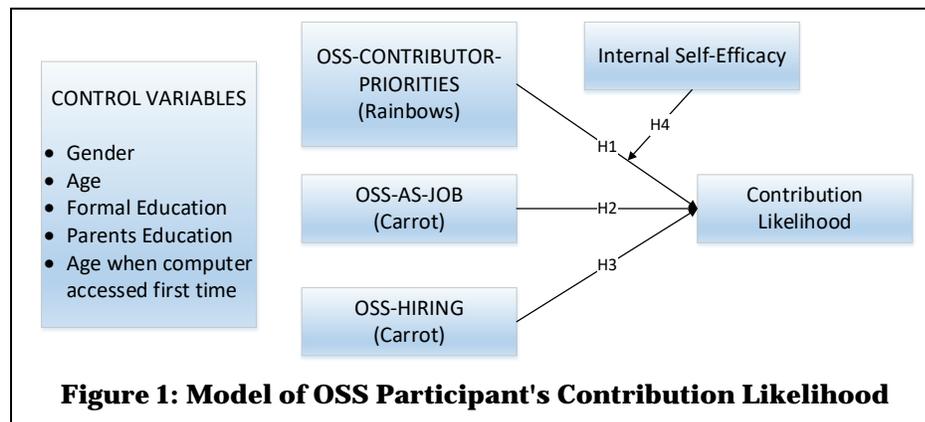
We believe that OSS developers' expectations of getting hired by the sponsoring corporation or getting a job by contributing to OSS community play a vital role in OSS developers' likelihood of contributing to the project. We propose social practice motivators from the perspective of contributors' belief of social aspects of OSS such as having an open source license, widespread use, a welcoming community, and a code of conduct can have a positive influence on their likelihood of contribution to OSS development.

Previous research has examined the role of technical self-efficacy in open source participation (Endres et al., 2007). We further conceptualize that an individual's confidence in technology, measured as internal self-efficacy moderates the relationship between OSS developer's expectations of being hired and their likelihood of contribution to the project. Figure 1 presents our research model.

The extant literature has proposed that individuals participate in open source projects for a variety of reasons. Some of these reasons relate to the individuals' journey and engagement with a shared community of developers (von Krogh et al., 2012). Previous literature has found that robust communities are associated with an OSS contributors opportunities to develop their personal reputation through community involvement (Oreg and Nov, 2008). The experience that developers have in participating in an open source community has been associated participation outcomes and intentions (Chang and Chuang, 2011). Differing OSS communities have been found to provide varying levels of engagement and developer support (Cai and Zhu, 2016). Strong communities may provide developers with intrinsic motivations or "rainbows" to participate in OSS tasks. We propose that, consistent with the extant literature, greater levels of community engagement will be positively associated with OSS participation likelihood.

Hypothesis 1: Greater levels of perceived OSS community engagement will predict greater levels OSS contribution likelihood

Extrinsic financial rewards have been found to predict greater levels of OSS participation (Krishnamurthy et al., 2014). As companies increasingly take on leadership roles in OSS communities, some individual contributors do so as part of their job responsibilities. In such cases, OSS participation may be directly linked to the individuals' current remuneration. We propose that individuals whose current job responsibilities include assignments to contribute to OSS communities or will be positively associated with OSS participation likelihood.

Hypothesis 2: Greater levels of job responsibility to contribute to OSS will predict greater levels of OSS participation likelihood

Extrinsic motivations for OSS participation go beyond the potential for current remuneration. OSS participation has also been associated with contributors' perceived ability to find future employment (von Krogh et al., 2012). In addition to future employment, some OSS participants perceive that their OSS contributions are directly related to their being hired in their current position. We propose that individuals who perceive that OSS participation has a greater direct relationship to their current employment will be more likely to intend to provide future contributions to OSS.

Hypothesis 3: Greater levels of perceived influence of OSS skills to an individuals' ability to be hired in their current position will predict greater levels of OSS participation likelihood

Open source communities involve high tech-savvy individuals who possess strong technical competencies or at least confidence of learning new skills if required to contribute for the software development. We believe that an individual's confidence in their skills is very important for their continued contribution to OSS communities. General self-efficacy refers to a person's degree of confidence in his or ability to perform a particular behavior in the face of challenges and obstacles (Bandura, 1997). Individuals contributing to open source development need to have the ability to persist longer in the face of challenges they face. Specifically, their competence in the technology being used in the development of the particular software becomes a key factor. Thus, technology self-efficacy among OSS contributors plays an important part in applying their technology related knowledge and skills for achieving their objective.

An individual's perception that their OSS related skills were associated with their current employment may be considered an external validation of that individual's technical skills. While external validations of skills can be valuable, internal valuations by these individuals are also valuable. The extent to which an individual perceives that they are capable of contributing to task or work is termed self-efficacy (Tims et al., 2014). Self-efficacy regarding technical work has been associated with OSS participation (Endres et al., 2007). We propose that greater levels of internal self-efficacy in completing OSS related tasks would be positively moderate the relationship between the perceptions of perceived OSS skills and future OSS contribution likelihood.

Hypothesis 4: Greater levels of internal OSS self-efficacy will positively moderate the relationship between the perceived influence of OSS contributions to an individuals' ability to be hired in their current position and greater levels of OSS participation likelihood

Researchers of OSS have long identified both intrinsic and extrinsic motivations for OSS participation. While there is support in the extant literature for participation using both intrinsic and extrinsic factors, relatively little research has examined the intrinsic and extrinsic factors simultaneously. Theorists have proposed that greater levels of extrinsic motivation will "crowd out" intrinsic motivational factors (von Krogh et al., 2012). We propose that when extrinsic, financial factors of OSS participation such as OSS as a job responsibility or perceived OSS contributions to an individual's ability to be hired in their current position, those intrinsic, community-based factors will be relatively less important.

Hypothesis 5: When considered together, self-deterministic factors of job responsibilities of contributing to OSS and OSS contributions to an individual's ability to be hired in their current position will predict future OSS contribution likelihood more effectively than social good motivations of OSS community engagement

Research Methodology

Data

In conducting our analysis we use secondary data collected by the 2017 GitHub Open Source Survey (Geiger, 2017). This data survey includes approximately 5,500 randomly selected participants from 3,800 open source repositories that are included in GitHub. We converted Likert scale survey response data to numerical format for conducting our analysis. The data includes a variety of variables related to the motivations, technical priorities and career outcomes associated with open source participation.

Methodology

We performed the analysis by breaking the hypotheses into six models using multiple regression. Each model will be presented independently with the control variables, while the final model will include all variables included in the analysis. Model A presents our controls variables compared against the dependent variable of OSS contribution likelihood. Model B tests hypothesis 1, Model C tests hypothesis 2, Model D tests hypotheses 3, Model E tests hypothesis 4, and Model F tests our final hypothesis, which will include all variables considered in the analysis. By building the hypotheses in sequence the relative importance of the variables considered may be analyzed. The use of multiple regression provides an overview of the results of the data, and given the relatively large survey sample size can provide overall insights regarding the relationships observable in the data. While this methodological approach does include limitations that will be discuss later in the paper, it does provide preliminary insights regarding the data collected which may be used for the further development of a research agenda regarding OSS contributions.

Model Variables

Independent Variables

OSS contributor priorities: Respondents to the survey were asked the relative importance of nine OSS community characteristics, with responses provided on a five-point scale. The community characters included in the survey include: an open source license, a code of conduct, a contributing guide, a contributor's license agreement (CLA), active development, responsive maintainers, a welcoming community and widespread use. Responses to the survey questions were averaged to one variable used in the analysis.

OSS as a job. Respondents to the survey who indicated that they were employed were asked if they were "paid for any of your time spent on open source contributions". Employment was considered to be any type of work for pay, and included freelance workers working on a contract basis. Reponses were provided on a three-point scale ranging from the respondents' receipt of direct payment to no payment.

OSS in hiring. Respondents to the survey who indicated that they were employed were asked the extent to which "your involvement in open source was to getting your current job". Reponses were provided on a five-point scale ranging from very important to not at all important.

Moderating Variables

Internal OSS Self-efficacy. Respondents to the survey were asked the extent to which the felt that "I have the skills and understanding necessary to make meaningful contributions to open source projects.". Reponses were provided on a five-point scale ranging from strongly agree to strongly disagree.

Dependent Variables

Future OSS contribution likelihood. Respondents to the survey were asked "How likely are you to contribute to open source projects in the future?" Reponses were provided on a four-point scale ranging from very likely to very unlikely.

Control Variables

Gender. Respondents to the survey were asked, "What is your gender?" Reponses were provided on a three-point scale ranging including man (coded 1) non-binary (coded 0) and woman (coded -1).

Age. Respondents to the survey were asked, "What is your age?" and provided with eight different categories for responses ranging from "17 or younger" to "75 or older." Categorical responses we sequenced according to age and numbered 1-8.

Formal Education. Respondents to the survey were asked the "highest level of formal education that you have completed?" and provided with seven different categories for responses ranging from "Less than secondary (high) school" to "Doctorate (Ph.D.) or other advanced degree (e.g. M.D., J.D.)." Categorical responses we sequenced according to degree attained and numbered 1-7.

Parents Education. Respondents to the survey were asked the "highest level of formal education you're your parents achieved?" and provided with seven different categories for responses ranging from "Less than secondary (high) school" to "Doctorate (Ph.D.) or other advanced degree (e.g. M.D., J.D.)." Categorical responses we sequenced according to degree attained and numbered 1-7.

Age of first computer with internet access. Respondents to the survey were asked the "How old were you when you first had regular access to a computer with an internet connection?" and provided with five different categories for responses ranging from "Younger than 13 years old" to "Older than 45 years." Categorical responses we sequenced according to age and numbered 1-5.

Analysis of Results

A multiple linear regression model was used to examine the hypothesized effects. Models A-E are analyzed using robust regression. Robust regression is an alternative to least squares to control for potential outliers or unusually influential observations (Rousseeuw and Leroy, 2005). The data are normally distributed. Variance inflation factors did not exceed 1.15, well below a 2.5 threshold indicating potential multicollinearity concerns. Due to the normal distribution of the data, and low VIF, no transformations were completed on the data prior to regression analysis. Using this approach, the variables that have a significant relationship with the dependent variable are identified. Given the size of the data set, listwise deletion was used for records that did not include all relevant data for a model.

DV: Future OSS Contribution Likelihood					
	MODELS				
Controls	**A**	**B**	**C**	**D**	**E**
Gender	.088** (.035)	.0606 (.036)	.099** (.037)	.092* (.038)	.066 (.038)
Age	-.0589*** (.015)	-.027 (.014)	-.066*** (.018)	-.049** (.017)	-.067*** (.017)
Formal Education	.016* (.008)	.003 (.008)	.007 (.009)	.013 (.009)	.006 (.009)
Parents Formal Education	.002 (.007)	.001 (.007)	-.011 (.008)	-.005 (.008)	-.009 (.007)
Age at first internet	-.025 (.017)	-.005 (016)	.005 (.018)	-.004 (.018)	.005 (.017)
Independent Variables					
Community priorities		.113*** (.023)			
OSS as Job			.174*** (.017)		
OSS as Hiring				.093*** (.009)	.189** (.072)
Internal Self-efficacy					.291*** (.057)
Internal Self-efficacy * OSS in Hiring					-.026 (.015)
R^2	0.013***	0.016***	0.061***	0.063***	0.129***
N	3,365	2,407	1,856	1,854	1,852

p<.05* p<.01** p<.001***

Table 1: Multiple linear regression model output

Hypothesis 1 proposed that contributor community priorities will be positively associated with future contribution likelihood is supported at p<.01. This indicates that while including our control variables, OSS contributors are more likely to plan future contributions if they value intrinsic characteristics of the OSS community. Hypothesis 2 proposed that OSS contributors who are compensated for their contributions through their employment are more likely to plan future OSS contributions. This hypothesis is supported at p<.001. Hypothesis 3 proposed that OSS contributors who feel that their OSS participation directly resulted in their current position will have greater likelihood of future OSS contribution was supported at p<.001. Hypothesis 4, which proposed that greater levels of self-efficacy of OSS developers would positively moderate OSS contribution likelihood of individuals who felt that OSS contributions had directly contributed to their current position, was not supported. While we could not find support for hypotheses 4, a positive and significant direct relationship was observed between internal self-efficacy and future OSS

contribution likelihood.   Table 2 summarizes the variable coefficients, standard error and significance for hypotheses 1-4.

When analyzing hypothesis 5 all variables in the analysis will be considered together. Hypothesis 5 examines the relative extent to which the variables under consideration relate to the dependent variable. In order to conduct analysis regarding the relative importance of the variables standardized beta weights are used to compare variables (Jann, 2007). While the unstandardized beta weights reported in Table 2 generally indicate larger weightings on extrinsic motivators such as OSS as a Job than intrinsic motivators such as OSS community priorities, the standard deviations of the variables differ substantially, making the unstandardized beta weights an inappropriate measure by which to make comparisons of the relative predictive power of the variable. Table 3 presents the standardized beta weights.

DV: Future OSS Contribution Likelihood	
Controls	Model F
Gender	.052*
Age	-.110***
Formal Education	0.004
Parents Formal Education	-0.033
Age at first internet	0.011
Independent Variables	
Community priorities	.092***
OSS as Job	.143***
OSS as Hiring	0.479**
Internal Self-efficacy	.352***
Internal Self-efficacy * OSS in Hiring	-.394*
R^2	0.153***
Incremental R^2	0.024
N	1,792

p<.05 p<.01** p<.001***

Table 2: Standardized beta weights

By examining standardized beta coefficients we see can see the relative effect of each variable. The beta coefficient indicates the degree of change in the dependent variable that is predicted to be observed in a one unit change of the independent variable. By using this method, we see that a one unit change in a respondents OSS hiring variable is associated with nearly five times the effect on future OSS contribution likelihood than a one unit change in perceived intrinsic value of the OSS community priorities. This indicates that hypothesis 5 is supported. When considering the self-deterministic and social good benefits of future OSS participation at the same time, self-deterministic benefits will have greater predictive power on future contribution likelihood.

Discussion

Our results demonstrate valuable insights regarding the role of self-deterministic and social practice factors as key drivers of individuals' contribution to OSS. Consistent with the literature, self-deterministic factors are positively associated with contribution likelihood. Independently, both factors are significantly associated with developers' OSS contribution likelihood. However, when considered together, self-deterministic factors are more important. Findings of our statistical analysis further demonstrate that individual's confidence in their technical skills measured as internal self-efficacy is positively related to greater contribution likelihood.

Interestingly, while the direct effect of internal self-efficacy is positively associated with future contribution likelihood, the interaction of effect of self-efficacy with OSS hiring is negative. This finding has theoretical implications for motivations behind OSS contributions. The result means that as the confidence in developers' technical abilities increase their primary motivation of OSS hiring behind contributing to OSS decreases. This could be that as external validations of self-efficacy are provided through hiring, the relative value of job hiring on participation likelihood is crowded out. Future research examining the interrelationship between self-efficacy, the technical competencies of individuals, and external validation of effectiveness (through hiring or payment) could deepen our understanding of contributor motivations

Through this study, we make two theoretical contributions to the OSS literature. First, we studied the influence of some of the under-examined social factors such as having an open source license, code of conduct, and responsive maintainers on OSS contribution. Second, we validated that in the increasing commercialization of OSS, self-deterministic factors become more important than social practice factors. Further, we highlight OSS contributor motivations from the perspective on contributors, using a large

integrated dataset. The public dataset included in this analysis provides researchers the opportunity to validate many of our existing assumptions regarding the motivations of OSS contributors in light of changing OSS community structures.

Limitations and Future Research

This study uses a robust dataset through which to conduct analysis, however all data were collected from contributors on the OSS source code hosting site GitHub. There may be differences in OSS contributor communities that leverage other source code management tools. The data included in this analysis are also from a single time period. With the recent growth of large IT company investments in OSS, as evidenced by recent Microsoft and IBM acquisitions, longitudinal analysis of the trend impacting OSS motivations would provide a meaningful contribution to the literature. Our data also represents self-reported motivations and contribution intentions. Other measurement techniques could be utilized to externally validate self-reported measures.

The survey instrument includes many potential variables that could be used to describe OSS contributions, however the supervised modeling approach required for the development of multiple regression provides only a limited view of the complexity and nuance of the data available. Future research may use alternative methods, such as structural equation modelling or other survey-based techniques, to further analyze the relationships captured within the dataset. The limitations of the regression-based approach do not allow the research model to fully unpack the complicated relationship between self-deterministic activities and the social practice view, and merely highlights the relative influence that the three variables of interest in our model have on intentions for future OSS contributions. As the dynamics of corporate involvement in OSS communities continue to expand, large secondary datasets such as those used in this study may provide a valuable mechanism by which shift in contributor priorities may be identified.

Conclusion

Open source software development has come a long way since the foundation of open source movement in the mid 80's with its core objective of use the software for any purpose, modify it as you deem necessary, and re-distribute its copies as you wish (Free Software Foundation, 1996). Although corporate sponsorship of open source projects existed even in the early days, there was ongoing battle between proprietary and open source software. As the popularity of open source products grew, industry technology giants began to view open source alternatives as threats to their dominion in the market. With this, corporate involvement in open source projects also increased through direct funding or deploying people to work on OS projects. The commercialization grew such an extent that the corporations even started acquiring open source projects.

In this ever-growing commercialization of open source initiatives, this study demonstrates key drivers of individuals' possibility of contribution to open source software projects. Following von Krogh et al. (2012) conceptualization of self-deterministic view and social practice view, we demonstrate a model of contribution likelihood and investigated key factors that influence OSS developers' future contribution intentions to OSS development. Carrots and rainbows are both examples of motivations for OSS contributors, however our analysis demonstrates that when considering both motivations—carrots are more meaningful.

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