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Research-in-Progress

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Abstract

Blockchain technology has become increasingly popular in recent years. However, only 8% of blockchain open source projects are maintained actively on GitHub. Drawing on the online leadership literature, this study seeks to understand the correlation between leader characteristics and success of blockchain open source projects from the behavioral (knowledge contribution), structural (social capital) and cognitive (openness orientation) dimensions. Considering the unique decentralization nature of blockchain, this study further investigates the contingency effect of blockchain archetypes with empirical evidence from GitHub. Our findings provide novel insights for understanding the determinants of blockchain open source project success and leadership behaviors in the online community.
Keywords: Blockchain, open source project, online leadership, GitHub

Introduction

Blockchain is defined as a distributed ledger which is characterized with decentralization, peer-to-peer transmission, pseudonymity, and irreversibility (Iansiti and Lakhani 2017; Walsh et al. 2016; Ylihuumo et al. 2016). Blockchain is believed to have great potential in various fields including supply chain integration (Korpela et al. 2017), social business platform design (Fridgen et al. 2017), financial services (Tapscott and Tapscott 2016) and so on. Nevertheless, as an emerging technology, blockchain still faces great challenges with regard to security, privacy, latency, throughput and other technical issues (Glaser 2017; Swan 2015; Ylihuumo et al. 2016). In fact, open source software (OSS) community has become one of the dominant platforms for blockchain technology development. However, according to a report by Deloitte in 2017[1], only 8% of all blockchain OSS projects on GitHub are actively maintained, which means that the majority of blockchain OSS projects end up in failure. What are the key determinants of blokchain OSS project success or failure? This study sets out to answer the question.

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[1] *https://dupress.deloitte.com/dup-us-en/industry/financial-services/evolution-of-blockchain-github-platform.html*

Traditional research on OSS project success tends to focus more on factors like participation motivations, network structure of developers (Belenzon and Schankerman 2015; Singh et al. 2011; von Krogh and von Hippel 2006; von Krogh et al. 2012; Wang 2012). A small number of studies argue that social influence, especially the influence of leaders, is also fairly prominent for OSS project success (Dabbish et al. 2012; Li et al. 2012; Peng et al. 2013). As blockchain itself is crowded with technical challenges for the time being (Swan 2015; Ylihuumo et al. 2016), the role of project leaders is even more important in blockchain OSS projects. On one hand, the actions and characteristics of project leaders act as reliable signals of blockchain OSS project quality, thus stimulating the participation of more developers (Li et al. 2012; Oh et al. 2016). On the other hand, the coordination of project leaders is also a critical antecedent for OSS project success (Dahlander and O'Mahony 2011; Faraj et al. 2015).

Integrating several representative studies on online leadership (Bonaccorsi and Rossi 2003; Dahlander and O'Mahony 2011; Faraj et al. 2015; Johnson et al. 2015; Oh et al. 2016), in this study we mainly distinguish among three dimensions of blockchain OSS project leader characteristics, including behavioral dimension (i.e. knowledge contribution), structural dimension (i.e. social capital) and cognitive dimension (i.e. openness orientation). First, as knowledge contribution is always necessary for public recognition in online communities (Dahlander and O'Mahony 2011; Faraj et al. 2015; Fleming and Waguespack 2007), blockchain OSS project leaders with more contributions are assumed to better motivate the participation of other developers. Second, effective online leadership is also characterized with central network position (Johnson et al. 2015), so blockchain OSS project leaders with more social capital are also more influential (Wasko and Faraj 2005). Third, as OSS is a typical kind of open innovation, the openness orientation of leaders can also influence the participation of other developers; the license choice (e.g. GPL, BSD, MIT etc.) has often been used as the proxy of OSS project openness (Belenzon and Schankerman 2015; Shaikh and Vaast 2016). Besides, we further propose that the influence of blockchain OSS project leaders on project success is contingent on different blockchain archetypes. Based on the degree of decentralization and extensibility of blockchain technologies, Walsh et al. (2016) categorizes four archetypes of blockchain, including the decentralized/extensible type (e.g. bitcoin), the decentralized/inextensible type (e.g. counterparty), the centralized/extensible type (e.g. Ripple), and the centralized/inextensible type (e.g. R3), which provides the basis for blockchain OSS project archetypes involved in this study.

With empirical evidence from GitHub, this study intends to make theoretical contributions in following two aspects. On one hand, the determinants of blockchain OSS project success or failure will be discovered to some extent. We not only examine the influence of project leaders, but also investigate the contingency effect of blockchain archetypes, thus providing more comprehensive understanding in this respect. On the other hand, it extends the research stream of online leadership. Different from existing online and offline leadership research (Faraj et al. 2015; Li et al. 2012; Oh et al. 2016; Peng et al. 2013), we distinguish among the behavioral, structural and cognitive dimensions of leader characteristics. Besides, the research findings will also benefit blockchain developers and investors in practice.

Theoretical Background

Open Source Software (OSS) Development

The determinants of OSS project success have been widely studied from various perspectives. With regards to motivations, Belenzon and Schankerman (2015) insist that OSS project developers make contributions because of different motivations, including pure intrinsic motivations, reputation, labour market signaling and so on. Von Krogh et al. (2012) summarizes the intrinsic, internalized extrinsic and extrinsic motivations of OSS contributions, governance mechanisms and competitive dynamics of OSS projects in the form of literature review. Meanwhile, Spaeth et al. (2015) discovers that the credibility and openness of OSS community can motivate the participation of developers. From the perspective of network social capital, Singh et al. (2011) shows that internal cohesion positively influences OSS project success, while external cohesion has an inverse U-shaped relationship with OSS project success. Other studies have examined OSS project success in different ways. Participation structure and participation ratio can influence OSS project performance, and successful

OSS projects are usually developed by several core developers (Lee et al. 2017). Decentralized version control system (DVCS) increases the number of participants in OSS, but also reduces the average contribution (Islam et al. 2017). During the initial stage and the growth stage, the factors influencing OSS project success are different (Wang 2012). These literatures above have laid strong foundations for better understanding the determinants of OSS project success, while the role of OSS project leaders has received less attention, which leave much space to explore in the future.

Online Leadership

With the booming of open innovation and online community, the research stream of online leadership has grown rapidly (Bonaccorsi and Rossi 2003; Dahlander and O'Mahony 2011; Faraj et al. 2015; Johnson et al. 2015). Although online community is characterized with loosely coordination, self-organizing, voluntary, flattened hierarchies and informal structures (Dahlander and O'Mahony 2011; Faraj et al. 2015), leadership is still indispensable. In the field of OSS project development, Oh et al. (2016) distinguishes between uniform leader-member exchange (ULMX) and differential leader-member exchange (DLMX), and discovers these two kinds of leadership styles have different effects on user participation in online collaboration communities. Li et al. (2012) finds out OSS project leaders' transformational leadership is positively related to the intrinsic motivations of developers, and the active management style positively influences the extrinsic motivations of OSS developers, thus impacting the contribution behavior of developers. Peng et al. (2013) argues the ties between project leaders and followers can also be influential in OSS communities. The influence of online leadership functions through the mechanisms of social influence, herding and peer effects (Dabbish et al. 2012; Dewan et al. 2017; Oh and Jeon 2007). Existing research classifies participants in online communities into different groups, such as contributors or lurkers (Phang et al. 2015), core developers or peripheral developers (Setia et al., 2012). Among them, contributors or core developers emerge as leaders in online communities, other participants follow actions of these leaders to contribute in online communities like OSS platforms. Similarly, for blockchain OSS projects, online leadership will also play an important role in project success.

Blockchain and Blockchain Archetypes

As blockchain is an emerging technology, blockchain related research is relatively limited for the time being but tends to increase in the future. Most of existing studies focus on the technical issues of blockchain. For instance, Ylihuumo et al. (2016) summarizes various types of technical challenges of blockchain. Some researchers have also begun to explore the diffusion and business applications of blockchain (Abramova and Bohme 2016; Iansiti and Lakhani 2017; Zhao et al. 2016). With the development of blockchain technology, different blockchain archetypes have emerged, which poses great challenges for the understanding and application. Walsh et al. (2016) categorizes blockchain technologies into four different archetypes based on the degree of decentralization and extensibility. Among all these archetypes, the decentralized/extensible archetype (e.g. bitcoin) is the most common one. When investigating the influence of project leaders on blockchain OSS project success, the contingency effects of different blockchain archetypes will also be included in the research framework, so that blockchain OSS project will be understood more comprehensively.

Research Model and Hypothesis Development

Research Model

To explore how project leaders influence blockchain OSS project success, this study integrates theories of online leadership with research streams of OSS development and blockchain. Specifically, the behavioral (i.e. knowledge contribution), structural (i.e. social capital) and cognitive (i.e. openness orientation) dimensions of OSS project leaders are examined. Considering the different degree of decentralization for different blockchain archetypes (Walsh et al. 2016), we further integrate blockchain archetypes in the proposed research framework as a contingency factor. Thus, the final research framework is as Figure 1 below. Then six hypotheses are introduced as follows.
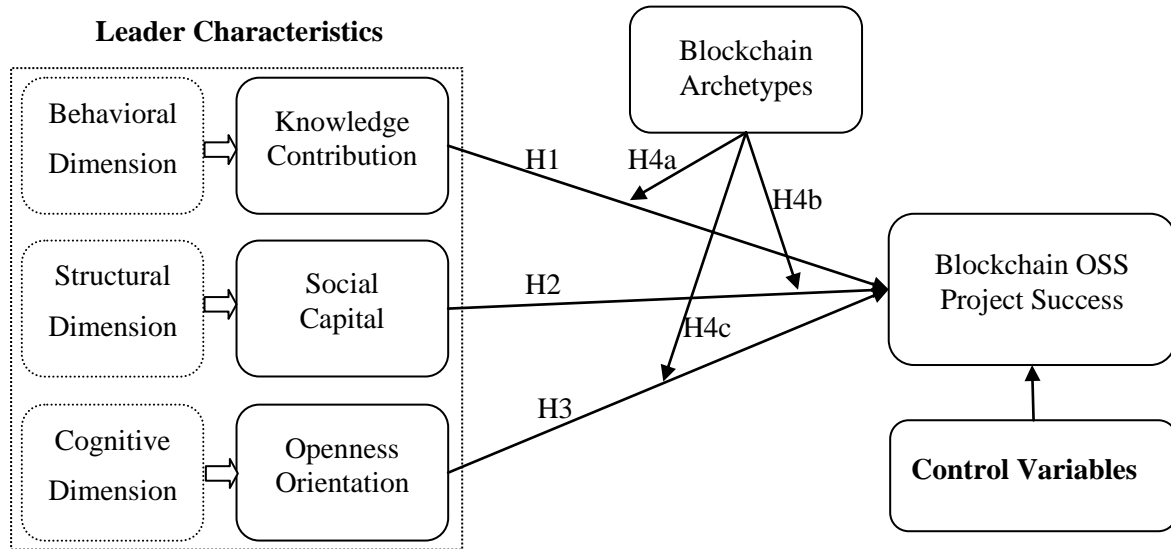
Figure 1. Research Framework

Online Leader Characteristics and Blockchain OSS Project Success

Behavioral dimension: leader knowledge contribution

In online communities, participants with much knowledge contribution are more likely to be recognized as leaders (Dahlander and O'Mahony 2011; Fleming and Waguespack 2007; Faraj et al. 2015). As social influence is prominent in online communities (Dabbish et al. 2012; Oh and Jeon 2007), blockchain OSS projects with leaders of much knowledge contribution can attract the participation of more followers. Meanwhile, OSS project leaders are also core developers in OSS projects (Dahlander and O'Mahony 2011; Oh et al. 2016). So, project leaders with much knowledge contribution are capable of leading the whole OSS project to success. In OSS communities such as GitHub, the profile and contribution history of project leaders are usually available for all developers. As blockchain OSS projects are characterized with much uncertainty, the knowledge contribution of project leaders act as positive signals to motivate more participation, finally resulting in blockchain OSS project success. Thus, the hypothesis is proposed as follows.

H1: The knowledge contribution of blockchain OSS project leaders is positively related to blockchain OSS project success.

Structural dimension: leader social capital

Social capital is defined as a kind of resource embedded in networks or relationships (Faraj et al. 2015; Nahapiet and Ghoshal 1998). Wasko and Faraj (2005) have distinguished three types of social capital which include structural social capital, cognitive social capital and relational social capital. Among them, structural social capital reflects the interactions among participants in the network, which is most obvious and turns out to be effective for online collaboration (Johnson et al. 2015; Singh et al. 2011). So in this study, we also mainly focus on the structural social capital of blockchain OSS project leaders. On blockchain OSS platforms like GitHub, project leaders have their own webpage with functions similar to social media (e.g. Facebook). So, developers can 'follow' or 'star' each other on the OSS platform. OSS project leaders with more followers are considered to have more structural social capital, and they are more influential to attract developers to participate in OSS projects. Thus,

H2: The social capital of blockchain OSS project leaders is positively related to blockchain OSS project success.

Cognitive dimension: leader openness orientation

Different OSS projects are characterized with different degree of openness, which can be reflected by the license choice of OSS projects (Belenzon et al. 2015; Islam 2017; Singh and Phelps 2013; Wang

2012). OSS licenses include both copyleft clauses which require the source code to be available in modified versions, and viral clauses which restrict the mingling of softwares with different licenses (Singh and Phelps 2013). Based on different types of copyleft clauses and viral clauses, OSS licenses are classfied into different categories. For instance, GPL (general purpose license) requires the source code and other subsequent source code built on it remain open source; MIT license allows open source code to be integrated into commercial software. Project leaders choose different license in their discretion, thus it can reflect the openness orientation of project leaders (Belenzon and Schankerman 2015; Shaikh and Vaast 2016). Because of the openness nature of OSS projects (von Krogh and von Hippel 2006; von Krogh et al. 2012), OSS projects with openness-oriented leaders are more likely to attract more participants. The hypothesis is put forward as follows.

H3: The openness orientation of blockchain OSS project leaders is positively related to blockchain OSS project success.

Moderation Effects of Blockchain Archetypes

The influence of online leadership may not always be constant, it also depends on contingency factors. For instance, the effects of leadership style on online community participation are contingent on factors such as environment uncertainty, community size, community structure and so on (Ho and Rai 2017; Oh et al. 2016). In the case of blockchain OSS projects, there are different archetypes with various degree of decentralization (Walsh et al. 2016). Decentralization means less permission restriction and more public access (Walsh et al, 2016), which is the consistent with the open nature of OSS projects. So, it's reasonable to infer that for blockchain OSS projects with higher degree of decentralization, the social influence of online leadership will be strengthened. Based on three basic hypotheses above, another three hypotheses of moderation effects are introduced as follows.

H4a: The decentralization of blockchain archetypes positively moderates the relationship between knowledge contribution of project leaders and blockchain OSS project success.

H4b: The decentralization of blockchain archetypes positively moderates the relationship between social capital of project leaders and blockchain OSS project success.

H4c: The decentralization of blockchain archetypes positively moderates the relationship between openness orientation of project leaders and blockchain OSS project success.

Research Methods

Data and Measures

The datasets for this study will be collected through the GH Torrent project and the GitHub API as existing research does (Gousios 2013; Lee et al. 2017; Mergel 2015). GH Torrent is a research project initiated by Georgios Gousios from Delft University of Technology, monitors and records activities of all OSS projects on GitHub (Gousios 2013). With the help of GH Torrent and GitHub API, we will pick out projects related to 'bitcoin', 'counterparty', 'Ripple', and 'R3', which are the four typical blockchain archetypes mentioned in Walsh et al. (2016) and closely related to this study.

Following prior research, the measurements of the core constructs including *Project Success*, *Knowledge Contribution*, *Social Capital*, *Openness Orientation* and *Blockchain Archetypes* are summarized as Table 1 below.

Table 1. Measurements of the Core Constructs

Constructs (Symbol)	Measurement	References
Project Success (SUCCESS)	The logarithm value of the number of commits/contributors during the time window of this study.	Daniel and Stewart 2016; Islam et al. 2017; Nan and Kumar 2013; Peng et al. 2013; Singh et al. 2011
Knowledge Contribution (CONTRIBUTE)	The number of repositories that blockchain OSS project leaders have participated in.	Dabbish et al. 2012; Dahlander and O'Mahony 2011; Faraj et al. 2015
Social Capital (SOCIALCAP)	The number of followers for OSS project leaders on GitHub.	Dabbish et al. 2012; Wasko and Faraj 2005
Openness Orientation (OPENNESS)	License of OSS projects on GitHub by categorically coding.	Belenzon and Schankerman 2015; Singh and Phelps 2013; Wang 2012
Blockchain Archetypes (ARCHETYPE)	Dummy variable based on the degree of decentralization; With bitcoin and counterparty OSS projects coded as 1, Ripple and R3 projects coded as 0.	Walsh et al. 2016

Model and Estimation Method

As the dependent variable *Project Success* is measured by continuous datasets, ordinary least square (OLS) regression will be conducted. Besides those five core constructs listed in Table 1 above, several developer-level and project-level control variables will also be included in the econometric models. Developer-level control variables include leader property (institution vs. individual), leader tenure (the duration of project leaders on GitHub), leader location. Project-level control variables include project age, project quality (rating/staring), programming language, project location. Series of regression analysis will be conducted to test all those hypotheses mentioned above. Here, the regression function for H4a, one of the most complicated hypotheses in this study, is listed below as an example.

$$SUCCESS = \alpha + \beta1 * CONTRIBUTE + \beta2 * SOCIALCAP + \beta3 * OPENNESS + \beta4 * ARCHETYPE + \beta5 * CONTRIBUTE * ARCHETYPE + \sum_{k=1}^{n} \lambda_i * CONTROL_i + \varepsilon$$

Notes: i = 1, 2, 3, 4, 5, 6, 7

Potential Implications

This research investigates how the knowledge contribution, social capital and openness orientation of online project leaders influence blockchain OSS project performance. Meanwhile, how different blockchain archetypes influence the relationship above will also be clarified. In this way, we will contribute to the research streams of blockchain, open source software (OSS) development, as well as online leadership. Besides, this study can also provide some practical implications for technical experts and investors who are interested in blockchain.

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