Electronic Commerce Research and Applications 30 (2018) 51–61

Contents lists available at ScienceDirect

Electronic Commerce Research and Applications

journal homepage: www.elsevier.com/locate/elerap

How founders' social capital affects the success of open-source projects: A resource-based view of project teams

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ARTICLE INFO

Keywords:
Innovation
Open source
Product development
Resource-based view
Social capital

ABSTRACT

Volunteers under the open-source paradigm organize themselves and coordinate their efforts through the Internet to develop new products and services. Researchers have recognized open-source project founders' social capital as an important factor to determine the performance of innovations in the open-source software (OSS) context. This study extends previous research by considering the founders' social capital as a means to create strategic resources of project teams. We use data collected from an OSS development community to identify the role of founders' social capital in team resource acquisition and utilization. We also clarify its inconsistent effects on innovation performance. From a resource-based view, we find that team size, as a manifestation of human resources, and team brokerage, as a manifestation of organizational resources, are determined by the social capital of project founders, and, in turn, have effects on innovation performance. However, team size and team brokerage contribute differently to innovation performance. The findings enrich our understanding of the impact of founders' social capital in OSS communities and provide OSS project leaders and firm managers with guidelines on boosting their chances for successful projects.

1. Introduction

Open-source software (OSS) has transformed business markets (Belenzon and Schankerman, 2015; Howison and Crowston, 2014; Lin, 2008). Software companies highlight the importance of OSS in their commercialization strategies and increase their involvement in OSS projects. Nearly 59% of software firms participate in open-source projects to gain a competitive edge, and 67% of these firms actively encourage their developers to engage in and contribute to open-source projects (BlackDuck, 2016). Unlike proprietary software development, which relies solely on internal resources, the success of OSS development depends on external resources (Chesbrough, 2003). Source code contributors are not formally employed by the organization or by the OSS project with which they are affiliated. This feature of OSS development makes it less costly (Boulanger, 2005), but ease of worker mobility and absence of direct monitoring pose challenges to OSS development. Thus, this situation raises the question of how project leaders in the OSS community and managers of firms such as IBM, which actively participate in open-source projects, can create successful strategies in an extremely fluid labor market and knowledge-intensive activities.

Strategy research explores how heterogeneity in resources can lead to differential performance. With this view, strategic networks are among the most important types of rent-generating resources (Gulati et al., 2000) due to their access to information, resources, markets, and technologies, especially in a world where firms are embedded in exchange relationships with other actors (Galaskiewicz and Zaheer, 1999; Gulati, 1998; Granovetter, 1985). Building on social network theory, strategy research suggests network strategies to increase innovation performance (Ahuja, 2000; Baum et al., 2000; Nerkar and Paruchuri, 2005; Soh, 2010).

In the OSS domain, developers and projects form a complex network of relationships. Founders' social capital or the pattern of collaborative relationships (ties) among volunteers has been proposed to have a direct impact on OSS performance through their access to resources, information, and feedback (Mallapragada et al., 2012). However, findings on the specific effect of founders' social capital on performance have been inconclusive; sometimes the effect is positive, and sometimes it is negative (Grewal et al., 2006). A potential reason for the inconsistency of findings is the treatment of strategic team resources as a black box. Previous works have not addressed how founders' social capital may help acquire valuable team resources, which are critical to driving

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https://doi.org/10.1016/j.elerap.2018.05.003

competitive advantage under the OSS paradigm.

The open-source model is a decentralized development model that encourages open collaboration (Levine and Prietula, 2013) and peer production (Benkler, 2002). Building successful collective projects requires drawing together the work of a group of self-selected volunteers (Belenzon and Schankerman, 2015; Howison and Crowston, 2014; Tapscott and Williams, 2006). Project founders and their social capital are important, but they cannot succeed solely by themselves.

The primary purpose of this study is to examine how founders' social capital influences innovation performance through team resource acquisition and utilization. We recognize important team resources in the OSS context and argue that the inconsistent effect of founders' social capital can be addressed by examining the under-studied tradeoff between these team resources on performance.

We contribute to the existing literature in several ways. First, we adopt a project team-level view rather than an individual-level one to study the link between founders' social capital and innovation performance. The general assumption of most previous research is that founders' social capital "somehow" develops the strategic resources of project teams. We view that founders' social capital can be regarded as a means to create the strategic resources of project teams. We introduce resource-based view (RBV) into this specific context and identify two important team resources that may determine the innovation performance of OSS. These team resources are a manifestation of the human resources of the RBV if a sufficient number of volunteers can be attracted to participate in the project, and a manifestation of organizational resources of the RBV if the team can occupy a high brokering position in the network.

Second, instead of studying the effect of prior collaboration ties on team size formation (Hahn et al., 2008), we include different network topologies of collaboration ties to measure founders' social capital and examine how it contributes to team size formation. Team brokerage formation has been considered simultaneously. While most studies predominantly maintained a single level of perspectives (Zaheer and Soda, 2009), we examine the origins of brokerage from a multilevel network perspective.

Third, while most studies examine the effect of these two resources separately (Ahuja, 2000; Haleblian and Finkelstein, 1993; Mao et al., 2016; Nerkar and Paruchuri, 2005), we examine the effect of team size and brokerage on performance, and emphasize that the tradeoffs between these resources are central to addressing the inconsistent effects of founders' capital on OSS performance.

Our hypotheses are empirically tested using primary data collected from 791 projects on SourceForge.net, a collaborative OSS development platform. The results show that team resources play an important role in the relationship between founders' social capital and innovation performance. Specifically, founders' social capital can encourage a large number of volunteers to join, thereby creating brokerage opportunities at the project team level. However, the two kinds of team resources contribute differently to innovation performance. Team size has an inverted U-shaped effect on efficiency, whereas team brokerage has a U-shaped effect on efficiency. Team size has a U-shaped effect on effectiveness, whereas team brokerage has an inverted U-shaped effect on effectiveness. Therefore, founders' social capital increases team size and brokerage, but the effects of the former and the latter on performance are contrary. The ultimate effect of founders' social capital on innovation performance is positive or negative, which depends on whether the benefits of increased team size (team brokerage) outweigh the costs of increased team brokerage (team size).

2. Theoretical background and hypothesis development

2.1. Open-Source community

The importance of OSS increases along with advances in e-commerce, which relies heavily on OSS, such as web servers (e.g., Apache), operating systems (e.g., Linux), and programming languages (e.g., Python and Java) (Madey et al., 2002). The key difference between OSS and traditional proprietary software (PS) is the availability of the source code. In the traditional PS development model, the code is considered a valuable intellectual property and is closely guarded. Strict separation exists between the producer and the user (Krishnamurthy, 2003). Interested users may provide suggestions for change, but the innovation of PS is limited to the producer and relies on internal resources. The producer must employ many full-time software developers at considerable cost to innovate. Producers or top managers can strategically select team members based on expertise and personality. They naturally have legitimacy and control over resource acquisition and utilization. OSS products provide public access to the source code and empower developers to aid in product development through online communities (e.g., SourceForge and RubyForge). Anyone can create customized solutions for their needs, add features, and resolve bugs under an open-source license. Unlike traditional projects that rely solely on internal resources, OSS projects open the boundary of the innovation process using external resources (Chesbrough, 2003). OSS development depends on the interactions of volunteers in the community (Krishnamurthy, 2003), which enables OSS projects to have the potential to provide high-quality products at free acquisition cost (Boulanger, 2005).

Early empirical studies have focused on interpreting the open-source phenomenon, which is distinct from the traditional software development model. These studies attempt to understand why developers contribute their software development efforts for free. They find that volunteer contributors are motivated by user value (Lakhani and von Hippel, 2003), enjoyment of programming (Hertel et al., 2003), reputation and status (Zeitlyn, 2003), career advancement (Lerner and Tirole, 2001), and networking within the community (Hertel et al., 2003). Another stream of studies aims to understand the nature of the OSS model (Osterloh and Rota, 2007) and recognize it as a community-based innovation model (Lee and Cole, 2003). These studies posit that the success of an OSS project is a function of the extent to which a project receives resource input from the community (Krishnamurthy, 2003; Stewart et al., 2006). However, community resources are finite because volunteers, their time and effort, are limited (Lee et al., 2017). OSS projects can be hindered by their inability to acquire resources, such as volunteer developers who are willing to join and complement their source code (Belenzon and Schankerman, 2015; Subramaniam et al., 2009). These limitations make attracting contributions from the community to gain competitive advantage a concern for project leaders and firms.

Emerging studies have examined the specific choices of volunteers on which project to join. Stewart et al. (2006) find that project license, which grants different degrees of control over the source code, is influential. Hahn et al. (2008) conclude that volunteers are likely to join a project when they have prior collaborative ties with its members. Belenzon and Schankerman (2015) focus on the labor market implications of selecting varying degrees of project licenses. Studies in this direction provide an improved understanding of how to increase the probability of attracting potential developers. Our study extends the literature by examining factors that influence the decisions of volunteers on which projects to join and how these decisions shape team structure in the network. Other studies examine the determinants of OSS performance, which include project features (Subramaniam et al., 2009; Stewart et al., 2006), contributor behavior (David and Rullani, 2008), and knowledge sharing (Kuk, 2006). Given that developers and projects form a complex network of relationships in the OSS domain, a stream of works focuses on how social network structures influence innovation performance (Grewal et al., 2006; Mallapragada et al., 2012).

Research on organizational settings regards strategic network as one of the most important types of rent-generating resources because firms become highly embedded in their networks of social relationships with