# The Impact of Open Innovation Communities on Firm Innovation Performance: Postprint

**Authors:** Wu Bing, Lu Yanjun

**Date:** 2023-10-08T00:00:00+00:00

## Abstract

[ Purpose / Significance ] This study aims to construct a model framework based on theories related to open innovation to evaluate the impact of open innovation platforms on corporate innovation performance, and to provide development recommendations for builders and users of open platform communities.
[ Method / Process ] Based on open innovation theory and knowledge management theory, we establish a model of the impact of open innovation communities on corporate innovation performance and propose research hypotheses; using Python programming to crawl relevant data from Xiaomi's open innovation community for empirical research to verify the research hypotheses.
[ Results / Conclusion ] The research results indicate: Community organizational mechanisms significantly positively influence community social network structure; Community technical mechanisms significantly positively influence community social network structure; Community social network structure significantly positively influences corporate knowledge acquisition; Community social network structure significantly positively influences corporate knowledge transformation; Community social networks significantly positively influence the activity level of community innovation sources; The activity level of community innovation sources significantly positively influences the scale of community innovation sources; The scale of community innovation sources significantly positively influences corporate knowledge transformation; Corporate knowledge transformation significantly positively influences corporate innovation performance; The activity level of community innovation sources significantly positively influences corporate innovation performance.

## Full Text

## Preamble

**ChinaXiv Cooperative Journal: Academic Exploration**
**The Impact of Open Innovation Community on Enterprise Innovation**

**Performance**

Wu Bing, Lu Yanjun
School of Economics and Management, Tongji University, Shanghai 200092

## Abstract

[**Purpose/Significance**] This study constructs a model framework based on open innovation theory to evaluate the impact of open innovation platforms on corporate innovation performance, providing development recommendations for both builders and users of open platform communities. [**Method/Process**] Grounded in open innovation theory and knowledge management theory, we establish a model of how open innovation communities influence corporate innovation performance and propose research hypotheses. We then conduct empirical research using Python-programmed web scraping of data from Xiaomi's open innovation community to validate these hypotheses. [**Result/Conclusion**] The findings indicate that: community organization mechanisms significantly and positively affect community social network structure; community technical mechanisms significantly and positively affect community social network structure; community social network structure significantly and positively affects corporate knowledge acquisition; community social network structure significantly and positively affects corporate knowledge transformation; community social network structure significantly and positively affects community innovation source activity; community innovation source activity significantly and positively affects community innovation source scale; community innovation source scale significantly and positively affects corporate knowledge transformation; corporate knowledge transformation significantly and positively affects corporate innovation performance; and community innovation source activity significantly and positively affects corporate innovation performance.

**Keywords:** open innovation community; enterprise innovation performance; knowledge management; community mechanism
**Classification Number:** F49
**Citation Format:** Wu B, Lu Y J. The impact of open innovation community on enterprise innovation performance [J/OL]. Knowledge Management Forum, 2019, 4(4): 205-217[date of citation]. http://www.kmf.ac.cn/p/180/.

## Introduction

Since the beginning of the 21st century, innovation models and development trends have undergone tremendous changes alongside globalization, informatization, and networking, with "open innovation" gradually becoming the dominant paradigm for corporate innovation. Since the concept of open innovation was first proposed [1], practical activities related to open innovation communities have flourished both domestically and internationally. Correspondingly, theoretical research on open innovation communities has continuously deepened, though current studies have primarily focused on the effectiveness of external

technologies in open innovation, open innovation business models, open innovation enterprises and intellectual property, research on open innovation environmental resources, and customer research under the open innovation model. However, research on the mechanism through which open innovation communities affect corporate innovation performance remains scarce [2].

Therefore, this study integrates open innovation community theory with knowledge management theory, adopts corporate innovation performance as the orientation, constructs a model of how open innovation communities influence corporate innovation performance, proposes research hypotheses, and applies web mining to open innovation community data for empirical validation. Theoretically, this research provides operable theoretical methods and analytical tools for qualitative analysis of open innovation communities; practically, it offers strategic guidance for effectively stimulating collective intelligence and maximizing the collaborative efficiency of open innovation communities.

## 1.1 Open Innovation Community

In open innovation theory, open innovation refers to enterprises' balanced coordination of internal and external resources for collaborative innovation. Through open innovation communities, users can directly or indirectly participate in innovation-related activities such as product ideation, research and development, and promotion [3]. Open innovation communities can typically be divided into open user innovation communities and open source communities.

Open user innovation communities organize end-users of products or services into distributed collaborative groups through online platforms, where community members can voluntarily and freely discuss various ideas, solve common problems, or improve solutions through knowledge sharing and creation [4-5]. Open source communities comprise individuals with shared interests who participate in developing and improving open source software [6-7], imposing no restrictions on computer program coding—anyone can utilize, modify, and disseminate the modified code without payment [8]. While user innovation communities emphasize user participation characteristics, the open source community model places greater emphasis on complete user participation and online collaborative software development.

This study focuses on open user innovation communities, as current research on such communities concentrates primarily on user participation motivations, lead user behaviors, interaction quality among users, definitions and management models of open innovation communities, how to create online communities, and user participation incentive mechanisms. Literature [9] and [10] propose that establishing open innovation communities should emphasize user behavior classification and participation rules, conducting classification research on community users' participation attitudes according to their participation tendencies, thereby proposing motivation models to explain user participation behavior. These studies examine the interactive role of lead users in new product devel-

opment processes and suggest rational community planning and strengthened user management. Literature [11] proposes a system dynamics model for open innovation communities to investigate key factors for successful community operation.

## 1.2 Knowledge Management Process

Knowledge management can be defined as a knowledge system within organizations where information and knowledge undergo processes of acquisition, creation, sharing, integration, recording, access, and updating to achieve the ultimate goal of continuous knowledge innovation, which then feeds back into the organizational knowledge system [12]. Knowledge has become the primary source of wealth in organizations, making knowledge management the most important organizational task for maintaining competitiveness. The main processes of knowledge management can be divided into knowledge acquisition, knowledge transformation, and knowledge application.

The knowledge acquisition process [13] marks the point when knowledge truly enters the organizational context. Knowledge is generated and exists not only within companies but also develops externally. Only when knowledge can be acquired and utilized by the organization does it become a valuable asset. The knowledge acquisition process includes searching, filtering, and integrating knowledge—capturing various useful knowledge from internal and external sources and storing it in organizational knowledge repositories according to classification frameworks or standards.

Knowledge transformation refers to changes in knowledge forms and self-renewal of knowledge objects, representing the mutual conversion process between tacit and explicit knowledge in organizational management activities [13]. Among numerous knowledge management activities, knowledge transformation constitutes the most important form. Through this transformation process, the quality of knowledge capital improves and core competencies are formed, making knowledge transformation an optimization process that unifies both the quantity and quality of knowledge capital.

The knowledge application process combines acquired knowledge with work to solve problems and improve efficiency. Knowledge application typically occurs in two situations: knowledge seekers consciously seek and apply knowledge after recognizing a problem; and managers recognize that certain knowledge could be widely applied across multiple departments or processes to substantially improve productivity, but relevant departments have not yet recognized or understood this, necessitating conscious knowledge promotion by management supplemented with direct guidance and regular training.

## 1.3 Community Network Management Mechanism

A community network is a space where netizens gather to communicate and interact, with the internet as its medium. Interactions among netizens typically center around specific themes. Community networks exist in various forms, primarily including social apps, discussion groups, friend circles, official forums, BBS, blogs, and other social network forms with sharing and communication attributes. A major advantage of community networks is that communication among users is timely and bidirectional, making the communication process more efficient. However, community networks also have certain disadvantages, such as uncertainty and potential risks, necessitating regulatory or management mechanisms to maintain healthy network development [16].

By establishing community management norms—such as member identity verification and posting regulations—a healthy and stable high-quality community can be constructed. As an online communication space for netizens, community networks fulfill functions including information dissemination, knowledge transfer, social network establishment, and transaction facilitation, enabling netizens to conduct theme-specific communication and interaction. Through this platform, all participants can achieve mutual benefits. Meanwhile, the quality of the community network environment is crucial for value realization. In a good, orderly community network environment, participants can clarify their needs, positioning, and value orientation, relationships among community members become harmonious, trust increases, cohesion strengthens, and more new members are attracted, naturally enhancing community network value. Conversely, in a relatively chaotic and disorganized community network environment, participant quality varies widely, making it difficult for participants to concentrate, resulting in poor community credibility, low community value, and failure to exert the positive effects community networks should have. Therefore, strengthening community network management capabilities becomes exceptionally important.

## 1.4 Summary of Related Research

First, open innovation theory focuses on researching the acquisition and application of external knowledge resources, but effectively integrating external knowledge resources with internal ones requires combining enterprise knowledge management theory. However, current research integrating open innovation theory with enterprise knowledge management theory remains limited.

Second, most existing open innovation community research fails to effectively incorporate corporate innovation performance, despite the close relationship between open innovation community operation and corporate innovation performance. Therefore, research should explore the operational mechanisms of open innovation communities with corporate innovation performance as the orientation.

Finally, current empirical research on open innovation communities predominantly employs simulation and questionnaire surveys, which suffer from strong

subjectivity. However, open innovation communities have accumulated large amounts of objective data that can be mined through web scraping for empirical research.

## 2. Research Model

Drawing from open innovation theory and integrating knowledge management theory, we propose a model of how open innovation communities influence corporate innovation performance. As shown in Figure 1 [Figure 1: see original paper], we establish basic hypotheses that open innovation community mechanisms affect community social network structure, which in turn affects knowledge management processes and community innovation sources, and that both knowledge management processes and community innovation sources affect corporate innovation performance.

### 2.1 Hypotheses on Community Organization and Technical Mechanisms

Community organization mechanisms refer to how community managers employ organizational means to maintain normal community operation and activity levels [18], such as official community postings, resource sharing, and organized activities. When community networks are in a state of disorganization, high-quality participants struggle to invest sufficient energy and resources in community activities, leading to low community reputation and low-value information and knowledge dissemination, as well as low-level social circles. When clear governance entities exist within community organization, with clear community positioning and value orientation, community members trust each other, community cohesion strengthens, and community network value increases.

Community organization mechanisms can directly affect community social network formation, thereby influencing corporate performance [19]. We therefore propose:

**H1:** Community organization mechanisms positively affect community social network structure.

Community technical mechanisms refer to how community managers employ a series of technical means to maintain community network order and stability [20], such as: reviewing all posts before publication, prohibiting non-compliant language; deleting published posts that violate regulations in content or form; promptly punishing and publicizing users who publish unhealthy, uncivil, discriminatory, or aggressive content; and banning severely violating members' registered IDs. Technical intervention facilitates community network development, as community technical mechanisms can directly affect community social network formation and structural characteristics, thereby influencing corporate performance [21]. We therefore propose:

**H2:** Community technical mechanisms positively affect community social network structure.

## 2.2 Hypotheses on Community Social Network Structure

Community social network structure research takes relationships as the main thread, integrating individuals, micro-networks, and macro-structures. Through network information technology, it provides organizational guarantees for knowledge collaboration among community network members [22]. Open innovation communities rely on internet technology to integrate three elements—node users, node user relationships, and the overall community—forming community social networks with certain structural characteristics. The core is to fully leverage the advantages of community users' social network structures [23], such as network connectivity, network density, and network cohesive subgroups, to provide drivers for community collaborative development.

Social networks can create value by promoting actions among organizations or individuals and affect organizational knowledge management capabilities. Network relationship strength positively correlates with knowledge sharing [24]; therefore, establishing extensive relational networks with external parties can not only bring large amounts of heterogeneous information and knowledge to organizations but also provide more cooperation opportunities, thereby enhancing corporate competitiveness. We therefore propose:

**H3:** Community social network structure positively affects corporate knowledge acquisition.

Social network structure affects knowledge transformation in communities, particularly the transformation of tacit knowledge. Making tacit knowledge explicit is key to knowledge innovation, and tacit knowledge transformation occurs through knowledge interaction among community members. Members' status and reputation in the social network influence the development of knowledge interaction—the higher the position, the greater the influence and trust [25]. We therefore propose:

**H4:** Community social network structure positively affects corporate knowledge transformation.

When social network relationship breadth increases, organizational connection scope expands, marginal costs decrease, marginal benefits increase, and external innovation source characteristics change. The broader the organizational network relationships, the richer the resources, which more strongly affect community innovation source scale and activity [26]. We therefore propose:

**H5:** Social network structure positively affects community innovation source scale.

**H6:** Social network structure positively affects community innovation source activity.

## 2.3 Hypotheses on Knowledge Management Process

Corporate knowledge constitutes intangible resources and a key factor for maintaining competitive advantage. Knowledge gaps provide the premise for knowledge management—when organizations or individuals discover that their knowledge stock cannot meet demands, they seek knowledge according to target gaps, filling these gaps through knowledge acquisition and transformation, thereby initiating a new round of knowledge collaboration [27]. The knowledge management process is thus a dynamic cycle. Since the effects of knowledge application directly reflect in corporate innovation performance, we focus on knowledge acquisition and transformation, integrating knowledge application into corporate innovation performance.

Acquiring needed knowledge motivates community members' knowledge collaboration. Knowledge acquisition represents knowledge transfer among collaborative members, with external resources—most importantly knowledge—being crucial for corporate innovation processes [28]. Knowledge acquisition capability primarily manifests as high sensitivity and grasp of technology industry development trends [29], such as new feature suggestions, product bug feedback, and bug resolution. Utilizing external knowledge is an important link in enhancing innovation capability, thereby facilitating organizational technological innovation, with metrics such as patent application numbers and software releases measuring innovation performance [30]. We therefore propose:

**H7:** Corporate knowledge acquisition positively affects corporate innovation performance.

During open innovation processes, enterprises must continuously evaluate knowledge acquisition capabilities and formulate strategies to improve them based on evaluation results. Knowledge acquisition increases opportunities for mutual learning and cooperation among members. By assigning dedicated personnel or teams to study advanced technologies and methods involved in cooperative innovation [31], and encoding know-how and knowledge involved in organizational cooperative innovation for others' reference [32,33]—such as resolving product bugs, replying to bug reports, and developer communication—knowledge innovation capability is stimulated and organizational innovation performance enhanced. Tacit knowledge is more important for organizational innovation; the greater the degree of tacit knowledge transformation, the stronger organizational innovation capability and performance [34,35]. We therefore propose:

**H8:** Corporate knowledge acquisition positively affects corporate knowledge transformation.

**H9:** Corporate knowledge transformation positively affects corporate innovation performance.

## 2.4 Hypotheses on Community Innovation Source

In open innovation processes, enterprises collaborate with numerous innovation sources in open communities [36,37]. Community innovation source scale and activity constitute important characteristics of community innovation sources. Community innovation source scale refers to the number of behavioral actors directly associated with community innovation sources, such as posting users, replying users, and post views. Community innovation source activity refers to the participation enthusiasm of community innovation sources, such as user posting volume, replying volume, and high-quality post volume.

Both community innovation source scale and activity affect corporate innovation performance to varying degrees [38,39]. We therefore propose:

**H10:** Community innovation source scale positively affects corporate innovation performance.

**H11:** Community innovation source activity positively affects corporate innovation performance.

Collaboration with community innovation sources provides enterprises with effective access to heterogeneous knowledge resources from communities. The larger the community innovation source scale, the more heterogeneous knowledge resources enterprises need to transform [40], with innovation source scale determining the breadth of corporate knowledge transformation. Community innovation source scale affects the spiral ascent of knowledge transformation, thereby influencing corporate innovation performance [41,42]. We therefore propose:

**H12:** Community innovation source scale positively affects corporate knowledge transformation.

Open innovation communities are boundaryless dynamic collaborative communities where community innovation source activity reflects user participation enthusiasm. Active community innovation sources help reduce uncertainty in collaborative innovation, thereby affecting community innovation source scale [43]. We therefore propose:

**H13:** Community innovation source activity positively affects community innovation source scale.

# 3. Empirical Research

### 3.1 Empirical Object Selection

We selected Xiaomi's open innovation community as our empirical research object for the following reasons: Established in 2013, the platform has developed rapidly with stable growth in both user numbers and post volume. Compared with Haier's Hope community, also founded in 2013, Xiaomi's community demonstrates strong interactivity, with over 50 million registered users and more

than 10,000 daily active users. All required data—including Xiaomi community user data, post data, new product data, and patent data—can be obtained through Python programming.

### 3.2 Data Collection and Preprocessing

We used Python programming to capture relevant data from Xiaomi's open innovation community. Due to platform settings that only retain forum data from the past year, we obtained raw data spanning 543 days from March 2017 to August 2018. The data were cleaned and preprocessed through the following steps: removing garbled, erroneous, or duplicate posts; and removing users with fewer than 5 posts within one year. After processing, we obtained 352,147 user data points and 4,881,764 post records. To further measure Xiaomi's corporate innovation performance indicators, we obtained software release numbers from Xiaomi's official account. Considering the lag in patent applications, we retrieved 3,954 patents filed by Xiaomi from July 2017 to December 2018 from the National Intellectual Property Administration website. All obtained indicator data were aggregated by day.

### 3.3 Measurement Indicators

Based on our research hypotheses, variables, and the characteristics of Xiaomi's open innovation community, and combining available data from the community, we propose the measurement indicators shown in Table 1 (columns 1-3). Descriptive statistics for these measurement indicators appear in columns 4-5 of Table 1.

## 4.1 Data Reliability and Validity Analysis

Since we used objective data with large differences in indicator magnitude, we first standardized the data before analysis. We measured reliability using Cronbach's alpha coefficient and validity using exploratory factor analysis. To avoid issues with Cronbach's alpha, such as reliability inflation and assumptions of equal importance among measured variables, we strengthened our assessment through composite reliability (CR $> 0.6$) and average variance extracted (AVE $> 0.5$) [44].

We analyzed each indicator variable's Cronbach's alpha (reliability analysis), composite reliability (CR), average variance extracted (AVE), and factor loadings using SPSS (see Table 2 ). All eight variables showed Cronbach's alpha coefficients above the critical value of 0.70, CR coefficients above 0.6, AVE coefficients above 0.5, and factor loadings above 0.5, indicating suitability for path analysis [44].

## 4.2 Hypothesis Testing

We used the maximum likelihood method in structural equation modeling (SEM) to validate the 13 proposed hypotheses. The model's path analysis is shown in Figure 2 [Figure 2: see original paper], where path coefficients reflect the direction and magnitude of influence between latent variables. Values in parentheses below variables indicate the degree to which latent variables can be explained, reflecting the model's predictive power. The combined effect of community organization and technical mechanisms explains 97.3% of community social network structure variance. Community social network structure explains 46.7% of corporate knowledge acquisition variance and 99.5% of community innovation source activity variance, showing stronger explanatory power for innovation source activity. The combined effect of community social network structure and innovation source scale explains 97.5% of corporate knowledge transformation variance. Innovation source activity explains 99.4% of innovation source scale variance. The combined effect of innovation source activity and corporate knowledge transformation explains 56.8% of corporate innovation performance variance.

### 4.2.1 Community Organization and Technical Mechanisms

Consistent with our hypotheses, both community organization and technical mechanisms significantly and positively affect community social network structure, with technical mechanisms (path coefficient 0.660) showing greater impact than organization mechanisms (path coefficient 0.325). This indicates that community organization mechanisms (such as official postings, resource sharing, and club activities) and technical mechanisms (such as handling problem posts and punishing problematic users) positively promote the formation, stability, and development of open innovation community social networks, with technical mechanisms serving as particularly important safeguards for stable community development.

### 4.2.2 Community Social Network Structure, Knowledge Management, and Innovation Sources

Consistent with our hypotheses, community social network structure significantly and positively affects both corporate knowledge acquisition and transformation, with stronger influence on knowledge acquisition (path coefficient 0.683) than on knowledge transformation (path coefficient 0.351). This demonstrates that the effectiveness of corporate knowledge acquisition and transformation largely depends on community social network structural characteristics such as network centrality, density, and cohesive subgroups.

Consistent with our hypotheses, community social network structure strongly positively affects community innovation source activity (path coefficient 0.997), and innovation source activity significantly positively affects innovation source scale (path coefficient 0.184). Contrary to our hypotheses, community social net-

work structure shows no significant positive effect on innovation source scale. This suggests that while social network structural characteristics help enhance innovation source activity, their impact on innovation source scale occurs indirectly through innovation source activity.

#### 4.2.3 Knowledge Management, Community Innovation Sources, and Corporate Innovation Performance

Consistent with our hypotheses, corporate knowledge transformation strongly positively affects corporate innovation performance (path coefficient 0.953). Contrary to our hypotheses, corporate knowledge acquisition shows no significant positive effect on either corporate knowledge transformation or corporate innovation performance. This indicates that although corporate knowledge acquisition—such as new feature suggestions, product bug feedback, and bug resolution—directly increases corporate knowledge assets, the effective pathway to improving corporate innovation performance is corporate knowledge transformation, such as resolving product bugs, replying to bug reports, and developer communication.

Consistent with our hypotheses, innovation source activity significantly positively affects corporate innovation performance (path coefficient 0.811), and innovation source scale significantly positively affects corporate knowledge transformation (path coefficient 0.727). Contrary to our hypotheses, innovation source scale shows no significant direct effect on corporate innovation performance. This demonstrates that innovation source activity—such as user posting volume, replying volume, and high-quality post volume—helps improve corporate innovation performance, while the knowledge aggregation effect generated through innovation source scale—such as numbers of posting users, replying users, and post viewers—must indirectly affect corporate innovation performance through corporate knowledge transformation.

## 5.1 Implications for Open Innovation Community Construction and Development

Based on the above analysis, the direct factors affecting corporate innovation performance are corporate knowledge transformation and innovation source activity, with corporate knowledge transformation having a greater impact than innovation source activity. Since community organization and technical mechanisms jointly affect community social network structure, which directly affects corporate knowledge transformation while indirectly affecting it through innovation source activity and scale, these mechanisms play a positive role in promoting community development and corporate performance. Conversely, neither corporate knowledge acquisition alone nor expanded innovation source scale independent of knowledge transformation significantly affects corporate innovation performance.

From a macro perspective, enterprises should planfully develop and utilize open

innovation communities according to their development goals and characteristics. The impact of open innovation communities on corporate innovation performance is multidimensional, with different indicators affecting innovation performance across different dimensions and with varying strength. Therefore, enterprises should analyze their own advantages and current development objectives to selectively cultivate and utilize influential indicators in open innovation communities, achieving corporate innovation performance-oriented community development.

From a micro perspective, a series of open innovation community organization and technical mechanisms can indirectly affect corporate innovation performance through community social network structure. Therefore, it is necessary to formulate and improve community organization and technical mechanisms to promote stable community development, enhance community innovation source activity, thereby achieving knowledge aggregation effects from expanded innovation source scale and improving corporate innovation performance.

## 5.2 Discussion on Community Organization and Technical Mechanisms

Currently, few studies integrate open innovation theory with knowledge management theory to explore how open innovation communities affect corporate innovation performance. Our research examines community organization and technical mechanisms from four aspects:

First, we treat open innovation community organization mechanisms (including official postings, resource sharing, and organized activities) and technical mechanisms (including complaint punishment announcements, complaint handling postings, and complaint handling replies) as independent variables affecting community social network structure. Results show that these mechanisms indirectly affect corporate innovation performance through community social network structure. Therefore, open innovation community builders should effectively plan and enhance the effectiveness of community organization and technical mechanisms.

Second, we propose that community social network structure (including centrality, density, and cohesive subgroups) affects corporate knowledge management processes and community innovation sources. Findings indicate that social network structure directly influences corporate knowledge acquisition, transformation, and innovation source activity; indirectly affects innovation source scale through innovation source activity; and indirectly affects corporate knowledge transformation through innovation source scale. Therefore, open innovation communities should focus on enhancing innovation source activity.

Finally, we emphasize the importance of affecting corporate innovation performance through corporate knowledge management processes and community innovation sources. Results show that knowledge transformation and innovation

source activity directly affect corporate innovation performance, while innovation source scale indirectly affects corporate innovation performance through corporate knowledge transformation. Therefore, strengthening corporate knowledge transformation is an important pathway to improving corporate innovation performance.

## 6. Research Limitations and Future Directions

First, while we constructed model measurement indicators, obtained variable measurement data through data mining, and applied structural equation modeling to test hypotheses about how open innovation communities affect corporate innovation performance, the reasonableness and validity of our measurement indicators require further improvement despite their objectivity and weights.

Second, we adopted a cross-sectional research design, yet open innovation community characteristics and user social behaviors are dynamic. Longitudinal research could provide deeper understanding of the dynamic development of community network structures. Therefore, longitudinal research design represents a future research direction that could enhance understanding of the interrelationships or causal relationships among variables in our model.

## References

[1] Qin M, Qiao H, Chen L H. Research on user contribution behavior in enterprise open innovation communities: examples from well-known domestic enterprise communities [J]. Management Review, 2015, 27(1): 126-137.
[2] Yan J J, Liao D, Tan Y S. Research status and prospects of enterprise open innovation resource allocation [J]. World Sci-Tech R&D, 2016(5): 1113-1122.
[3] Bengtsson M, Raza-Ullah T, Vanyushyn V. The coopetition paradox and tension: the moderating role of coopetition capability [J]. Industrial Marketing Management, 2016, 53(3): 19-30.
[4] Ruan P N, Zhao Y Q. Research on user requirement identification based on open innovation communities: a case study of Xiaomi Community [J]. Soft Science, 2017, 31(12): 98-102.
[5] Von Briel F, Recker J. Lessons from a failed implementation of an online open innovation community in an innovative organization [J]. MIS Quarterly Executive, 2017, 16(1): 35-46.
[6] Laffey J M, Schmidt M, Amelung C. Open for social: how open source software for e-learning can take a turn to the social [J]. International Journal of Open Source Software & Processes, 2017, 2(1): 49-64.
[7] Xiao Y, Yang Z L, Hao J. Research on knowledge sharing organization models inspired by open source communities [J]. Library Science Research, 2016(1): 76-84.
[8] Linaker J, Munir H, Wnuk K, et al. Motivating the contributions: an Open Innovation perspective on what to share as open source software [J]. Journal of Systems and Software, 2018, 135(1): 17-36.

[9] Wang T T, Qi G J, Zhang Y L, et al. Research on users' continuous knowledge sharing behavior in open innovation communities [J]. Information Science, 2018, 36(2): 78-85.
[10] Hienerthe C, Lettl C, Keinz P. Synergies among producer firms, lead users, and user communities: the case of the LEGO producer–user ecosystem [J]. Journal of Product Innovation Management, 2014, 31(4): 848-866.
[11] Li Y Y, Qi G J. System dynamics research on enterprise open innovation community management from the perspective of innovation value chain [J]. Business Economics and Administration, 2017(6): 117-129.
[12] McAdam R. Knowledge management as a catalyst for innovation within organizations: a qualitative study [J]. Knowledge & Process Management, 2015, 7(4): 233-241.
[13] Nonaka I, Krogh G V. Perspective—tacit knowledge and knowledge conversion: controversy and advancement in organizational knowledge creation theory [J]. Organization Science, 2009, 20(3): 635-652.
[14] Martinez-Torres R, Olmedilla M. Identification of innovation solvers in open innovation communities using swarm intelligence [J]. Technological Forecasting and Social Change, 2016, 109(8): 15-24.
[15] Guo A F, Chen J F, Guo J, et al. The impact of user-related characteristics on idea adoption in virtual innovation communities: a case study of Dell's "IdeaStorm" community [J]. China Science and Technology Forum, 2018(8): 140-146.
[16] Cheng Q L, Yin L G, Sun Y C, et al. Construction of enterprise-led innovation communities: an open innovation perspective [J]. Science Research Management, 2017, 39(S1): 56-63.
[17] Chen L, Fong P S W. Evaluation of knowledge management performance: an organic approach [J]. Information & Management, 2015, 52(4): 431-453.
[18] Ji H Y. Research on the influence mechanism of open innovation on enterprise performance from the perspective of network capability [D]. Beijing: Beijing University of Posts and Telecommunications, 2017.
[19] Dong Z L. External knowledge search, knowledge integration mechanisms, and corporate innovation performance: the moderating role of external environmental characteristics [D]. Changchun: Jilin University, 2017.
[20] Ruan P N, Zhao Y Q. Research on influencing factors of enterprise open innovation community management performance [J]. Science and Technology Management Research, 2017(17): 145-150.
[21] Xie X M, Li C. Social relationship networks and new product innovation performance: a moderating effect model based on knowledge-technology collaboration [J]. Science of Science and Management of S.&T., 2014(6): 58-66.
[22] Ruan P N, Zhao Y Q. Research on influencing factors of enterprise open innovation community management performance [J]. Science and Technology Management Research, 2017(17): 145-150.
[23] Xia E J, Deng Q, Zhang M. Fuzzy comprehensive evaluation of open innovation community networks [J]. Technology Economics, 2014(10): 8-14.
[24] Kim K, Lee W R, Altmann J. SNA-based innovation trend analysis in software service networks [J]. Electronic Markets, 2015, 25(1): 61-72.

[25] Martinez-Torres M R. Analysis of open innovation communities from the perspective of social network analysis [J]. Technology Analysis & Strategic Management, 2014, 26(4): 435-451.
[26] Pirkkalainen H, Pawlowski J M, Bick M, et al. Engaging in knowledge exchange: the instrumental psychological ownership in open innovation communities [J]. International Journal of Information Management, 2018, 38(1): 277-287.
[27] Foote A, Halawi L A. Knowledge management models within information technology projects [J]. Journal of Computer Information Systems, 2018, 58(1): 89-97.
[28] Wu B, Zhang C Y. The impact of knowledge inventory on E-Learning knowledge acquisition in SNS corporate knowledge communities [J]. Systems Engineering—Theory & Practice, 2013, 33(3): 726-732.
[29] Martinez-Torres M R. Content analysis of open innovation communities using latent semantic indexing [J]. Technology Analysis & Strategic Management, 2015, 27(7): 859-875.
[30] Dewangan V, Godse M. Towards a holistic enterprise innovation performance measurement system [J]. Technovation, 2014, 34(9): 54-58.
[31] Wang C H, Chang C H, Shen G C. The effect of inbound open innovation on firm performance: evidence from high-tech industry [J]. Technological Forecasting and Social Change, 2015, 99: 222-230.
[32] Burcharth A, Knudsen M P, Sondergaard H A. The role of employee autonomy for open innovation performance [J]. Business Process Management Journal, 2017, 23(6): 1245-1269.
[33] Randhawa K, Josserand E, Schweitzer J, et al. Knowledge collaboration between organizations and online communities: the role of open innovation intermediaries [J]. Journal of Knowledge Management, 2017, 21(6): 1293-1318.
[34] Ritala P, Huizingh E, Almpanopoulou A, et al. Tensions in R&D networks: implications for knowledge search and integration [J]. Technological Forecasting & Social Change, 2017, 120(7): 311-322.
[35] Ahn J M, Ju Y H, Moon T H, et al. Beyond absorptive capacity in open innovation process: the relationships between openness, capacities and firm performance [J]. Technology Analysis & Strategic Management, 2016, 28(9): 1009-1028.
[36] Lin Q, Guo D Q. Research on influencing factors of knowledge cloud dissemination capability in open innovation communities [J]. Information Studies: Theory & Application, 2017, 40(2): 92-96.
[37] Martinez-Torres M D, Rodriguez-Pinero F, Toral S L. Customer preferences versus managerial decision-making in open innovation communities: the case of Starbucks [J]. Technology Analysis & Strategic Management, 2015, 27(10): 1226-1238.
[38] Lichtenthaler U. A note on outbound open innovation and firm performance [J]. R&D Management, 2015, 45(5): 606-608.
[39] Gomez J, Salazar I, Vargas P. Does information technology improve open innovation performance? an examination of manufacturers in Spain [J]. Information Systems Research, 2017, 28(3): 661-675.

[40] Huang S F, Chen J, Wang Y D, et al. External heterogeneity and its impact on open innovation performance [J]. Technology Analysis & Strategic Management, 2015, 27(2): 182-197.
[41] Greco M, Grimaldi M, Cricelli L. An analysis of the open innovation effect on firm performance [J]. European Management Journal, 2016, 34(5): 501-516.
[42] Caputo M, Lamberti E, Cammarano A, et al. Exploring the impact of open innovation on firm performances [J]. Management Decision, 2016, 54(7): 1788-1806.
[43] Du S L, Yalcinkaya G, Bstieler L. Sustainability, social media driven open innovation, and new product development performance [J]. Journal of Product Innovation Management, 2016, 33(S1): 55-71.
[44] Wu B, Chen X H. Continuance intention to use MOOCs: integrating the technology acceptance model (TAM) and task technology fit (TTF) model [J]. Computers in Human Behavior, 2017, 67(2): 221-232.

## Author Contributions

Wu Bing: Research design and manuscript writing;
Lu Yanjun: Data collection and analysis.

*Note: Figure translations are in progress. See original paper for figures.*