The Knowledge Spillover Risks Management Framework for Collaborative Innovation

Xun Xi¹, Tianyu Hu¹2,#, Yueyue Zhang¹, Xiaoping Wang¹, Dengfeng Huang¹, Feng Hu¹, Haiyan Zhou³,*
¹Global Value Chain Research Center, Zhejiang Gongshang University, Hangzhou, Zhejiang 310018, China
²School of Software, Henan University of Animal Husbandry and Economy, Zhengzhou, Henan 450046, China
³International Business Research Center, Zhejiang University of Finance and Economics, Hangzhou, Zhejiang 310018, China

*Corresponding author e-mail:yanjiulilun8@126.com,
#And Tianyu Hu is the co-first author

Abstract. Knowledge spillover is a manifestation of knowledge externality, its negative impact on collaborative innovation cannot be ignored. Designing independent variables based on defining the key impact factors of knowledge spillover risks, propose hypothesis of the relationship between independent variables and dependent variables, and then verify hypothesis, analysis the minimum value and stability of knowledge spillover risks. Finally, based on the analysis results, constructing management framework of knowledge spillover risks for collaborative innovation.

1. Introduction

Compare with positive effects of knowledge spillover, the negative effects of knowledge spillover cannot be ignored. Some scholars defined it as the knowledge which organization is not willing to share, nevertheless it is misappropriated by collaborator. As a result, organization’s competitive advantage is damaged. For innovation alliances such as Industry-University-Research Institute, knowledge spillover can lead to product assimilation, especially for medium and small-scale clusters with insufficient input of elements and limited available resources. In addition, knowledge spillover may also increase the rapid accumulation of local companies, result in a “congestion effect” in which the number of competitors and input costs continue to grow.

Risk as the uncertainty between production purpose and final product, it is a by-product of some inputs, so there is an implicit relationship between input and risk. Argote et al. believes that knowledge spillover risks have already been generated in the process of gathering cooperative intelligence and is affected by many factors. Based on this, knowledge spillover risks is regarded as outcome of core member's knowledge innovation ability(L) and spillover knowledge quality within alliance(S). Based on the Cobb-Douglas knowledge production function, designing model for knowledge spillover risks of collaborative innovation is:
\[ R \cong \theta L^\alpha S^\gamma \quad (\theta > 0, \alpha < 0, \gamma < 0) \] (1)

In (1), \( R \) indicates knowledge spillover risks; \( \theta \) denotes the correction coefficient, which is a constant in the formula; \( \alpha \) denotes the elastic index of core member's knowledge innovation ability\((L)\) for knowledge spillover risks; \( \gamma \) denotes the elastic index of spillover knowledge quality within alliance\((S)\) for knowledge spillover risks. There is an inverse relationship between knowledge spillover risks and core member's knowledge innovation ability\((L)\) and spillover knowledge quality within alliance\((S)\), so both \( \alpha \) and \( \gamma \) are negative value.

On the basis of not changing correlation and tropism of variables, Take the natural logarithms of the two sides of (1) separately:

\[ \ln R \cong \ln \theta + \alpha \ln L + \gamma \ln S \] (2)

At this point, knowledge spillover risks\((R)\) are transformed into sum of polynomials with the independent variables \( L \) and \( S \). Where \( \ln \theta \) represents a constant term; \( \alpha \ln L \) represents impact of core member's knowledge innovation ability and the elasticity index \( \alpha \) on knowledge spillover risks. In the process of collaborative innovation, the most closely related elements of such influencing factors include rationality of organizational structure and organize employees' learning ability. Similarly, \( \gamma \ln S \) represents impact of spillover knowledge quality within alliance and the elasticity index \( \gamma \) on knowledge spillover risks. Elements of this factor include informal communication density among alliance members and input-output ratio of R&D within alliance. Integration of variables relationships, available Figure 1.

2. knowledge spillover risks stability for collaborative innovation

2.1. Minimal value analysis for knowledge spillover risks

The ultimate goal of collaborative innovation is to pursue the maximization of profits, which requires knowledge spillover risks to be minimized as much as possible. According to formula (2), construct 3D view between core member's knowledge innovation ability\((L)\), spillover knowledge quality within alliance\((S)\) and knowledge spillover risks\((R)\), see Figure 2, mesh line shown in Figure 2 intersects with LOS coordinate plane on curve \( a \), see Figure 3.
As shown in Figure 2, the direction indicated by axis arrow is positive. On the \( L \) and \( S \) axes, there is a certain negative correlation between knowledge core member's knowledge innovation ability, spillover knowledge quality within alliance and knowledge spillover risks, that is, \( L \) and \( S \) as dependent variables, under a certain value of elasticity index \( \gamma \) and \( \alpha \), knowledge spillover risks presents a law of diminishing accompany with its increasing. Combining equation (2), we can see that under original elasticity coefficient, alliance could strengthen core member's knowledge innovation ability or increasing spillover knowledge quality within alliance to reduce knowledge spillover risks. At the same time, since elasticity index \( \alpha \) and \( \gamma \) satisfy condition \( L\ln \theta - \alpha \ln R - \ln \gamma \ln S = 0 \) or \( S\ln \alpha - \alpha \ln R - \ln \gamma \ln L = 0 \), acquirability, increase in one of independent variable will cause elastic index of another independent variable to upgrade, further reducing knowledge spillover risks, thus exerting a collateral effect.

Any \( L \) or \( S \) curve in Fig. 2 intersects with the other variable curve cluster, for an independent variable, when the other independent variable is completely fixed, it gradually moves away from \( \ln R \) axis as increase in \( \theta \) value. Take any two points \( C(S_C, L_C) \) and \( D(S_D, L_D) \) on curve \( a \) that are based on same knowledge spillover level but different values of \( \theta \), easy to see \( S_C + L_C > S_D + L_D \), in other words, \( SL \) combination at point \( C \) is greater than \( SL \) combination at point \( D \) at the same level of knowledge spillover risks. Above shows, as alliance researches desire level of knowledge spillover risks, policy, technology, and cultural environment that be faced with may change, and mode of cooperation adopted will also change due to vary in collaboration phase. At this time, knowledge spillover risks faced by alliance may rebound owning to changes in internal and external environment, and the more severe the change, the more unstable the knowledge spillover risks, and the greater the value of \( \theta \). The most effective response for alliance is to enhance member’s knowledge innovation ability, especially core subject, and increasing spillover knowledge quality.

2.2. Stability analysis for knowledge spillover risks

2.2.1. Change of \( \theta \) and knowledge spillover risks stability. As shown in Figure 4, with increase of \( \theta \) value, curve \( a \) change direction is indicated by vector \( u \), that is, curve \( a \) gradually moves away from origin which in the \( LOS \) coordinate axis as increase in \( \theta \) value. Take any two points \( C(S_C, L_C) \) and \( D(S_D, L_D) \) on curve \( a \) that are based on same knowledge spillover level but different values of \( \theta \), easy to see \( S_C + L_C > S_D + L_D \), in other words, \( SL \) combination at point \( C \) is greater than \( SL \) combination at point \( D \) at the same level of knowledge spillover risks. Above shows, as alliance researches desire level of knowledge spillover risks, policy, technology, and cultural environment that be faced with may change, and mode of cooperation adopted will also change due to vary in collaboration phase. At this time, knowledge spillover risks faced by alliance may rebound owning to changes in internal and external environment, and the more severe the change, the more unstable the knowledge spillover risks, and the greater the value of \( \theta \). The most effective response for alliance is to enhance member’s knowledge innovation ability, especially core subject, and increasing spillover knowledge quality.
within alliance.

2.2.2. Change of $\alpha$ and knowledge spillover risks stability. As shown in Figure 5, point $Q$ is rotation center point of curve $a$, and it is also zero elastic point. With $|\alpha|$ increasing, curve $a$ rotates clockwise around $Q$. In the lower part of point $Q$, make any straight line parallel to $S$ axis and intersect with curve $a$ under different $|\alpha|$ at point $G(S_G, L_G)$ and point $F(S_F, L_F)$. Similarly, on the left side of the point $Q$, make any straight line parallel to $L$ axis and intersect with curve $a$ under different $|\alpha|$ at point $P(S_P, L_P)$ and point $K(S_K, L_K)$. It can clearly be seen that $S_G < S_F$ and $L_G < L_K$, manifest under condition of the same core member’s knowledge innovation ability, spillover knowledge quality within alliance gradually decreases with increase of $|\alpha|$. Conversely, condition of the same spillover knowledge quality within alliance, core member’s knowledge innovation ability gradually promote with increase of $|\alpha|$. This is because the greater the absolute value of the elasticity index $\alpha$ of core member’s knowledge innovation ability, the more reasonable the organizational structure and the stronger the learning ability.

Under the same quality level of spillover knowledge, the larger the $|\alpha|$, the stronger the core member’s knowledge spillover ability, and when knowledge spillover risks of collaborative innovation reaches expected value, rebound probability will decrease, so knowledge spillover risks will become more stable. Adversely, with adjustment of organizational structure and strengthening staff’s innovation ability, if core member achieve the same knowledge innovation ability, the requirements for spillover knowledge quality will be relatively reduced, so less likely it is to create knowledge spillover
risks, and risks will become more stability. Due to layout restrictions, the next part of “Change of \( \gamma \) and knowledge spillover risks stability” is not displayed, if the reader is interested in it, you can ask the author.

3. Knowledge Spillover Risks Management Framework for alliance collaborative innovation

The empirical results shows: the minimum value of knowledge spillover risks exists within controllable range in alliance collaborative innovation, and it has negative connection with core member's knowledge innovation ability and spillover knowledge quality within alliance; under premise that knowledge spillover risks reaches a minimum value, the possibility of risks rebound has a positive correlation with severity of environmental changes, but there has a negative correlation with rationality of organizational structure, organize employees' learning ability, informal communication density among alliance members and input-output ratio of R&D within alliance. Based on above results, design a management framework as Figure 6. Under controllable conditions, approaching the minimum value of knowledge spillover risks and maintaining knowledge spillover risks in a stable state, the following measures can be taken:

Build a learning alliance and establish an spillover knowledge review agency. First of all, as a learning organization, collaboration innovation members gradually create a positive learning atmosphere and cooperation attitude in process of information transmission and technology sharing. R&D process is a learning process, members creates a good learning atmosphere that can enhance their knowledge innovation ability, which in turn improvement of R&D quality and efficiency. Secondly, the main task for alliance knowledge review agency is focusing on alliance R&D goals, providing effective information resources for all alliance members and eliminate unnecessary transaction costs. As Figure 6 shows, alliance knowledge review agency generates new knowledge by filtering out spillover knowledge, and then provides required knowledge for members a, b, c respectively. Jointly establishing a specialized spillover knowledge review agency will reduce pressure and burden for alliance members on absorbing knowledge, and the expected benefits it brings will far outweigh the costs.

Alliance members should establish a sense of staged collaboration, and consciously broaden informal channels of communication between them. On the one hand, during the transitional period of cooperation, members a, b, and c should gradually breaks R&D knowledge confidentiality status to allow cooperation more substantive, the purpose is to better adapt to changes in the environment within the alliance and to stabilize knowledge spillover risks. On the other hand, the formal exchanges between majority of members are similar, and the informal exchanges are not in the same way, especially in a country like China that is full of informal institutions, it often depends on informal communication to establish trust between alliance members. This requires increasing controllable informal communication channels in collaborative innovation process, increasing "table-style"
exchanges between peers and "walk-style" communication between superiors and subordinates, reducing the existence of "back-to-back" phenomenon within alliance.

Develop contractual learning incentives and optimize organizational structure. Combine organizational culture and incentive mechanism can foster employee whose be provided with contractual spirit. To formulate a contractual incentive mechanism for learning, it is necessary to have a rigid-charter that suits organization, and also to pay attention to a flexible mechanism that varies from person to person and from department to department, for instance, personal career development system, linking pay and learning performance institution, job elimination system institution, etc. Provide institutional protection for establishment of learning and inspire status to alliance members. Corresponding to institutional protection is rationalization structure of organizational sector, based on functional roles played within the alliance, members have targeted, highlighted core functions, and weakened out-of-role functions. This makes organization docking more consistent with the required knowledge and alliance knowledge.

Increase the targeted ratio of R&D funds, and public organizations must create a compatible external environment. As in Figure 6, market demand and government and other public service organizations provide a major environmental support for collaborative innovation. under unchanging R&D funds condition, alliance selects right location to increase the targeted delivery of funds according to market demand where R&D products are facing. This will significantly increase efficiency and benefits in R&D collaborative innovation, and increase input-output ratio. Conversely speaking, targeted delivery of R&D funds will increase internal resource reserve rate of alliance, and make alliance more confident in the face with knowledge spillover risks. In addition, stability of environment within alliance requires support of external environment. In addition to the necessary government policies for collaborative innovation, public organizations such as technical association and patent protection association must also uphold the “meet local conditions” knowledge protection regulations. Giving collaborative innovation centering pill.

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