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Resource allocation under a strategic alliance: How a cooperative network with knowledge flow spurs co-evolution

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ABSTRACT

This article explores how a cooperative network with knowledge flow spurs co-evolution under a strategic alliance. For this purpose, this article analyzes the principle of a strategic alliance's cooperative network with knowledge flow based on four different types of resource allocation patterns. Further, it presents a theoretical model of co-evolution by using co-evolution game and Synergetics order parameters while simulating the core order parameter density distribution and vector field. The result shows that the cooperative network with knowledge flow under a strategic alliance features path mutation, preferences and spontaneous symmetry breaking. Relationship-oriented and knowledge-embedded resource allocation patterns maintain the stability of network co-evolution. Both the technological network and social relationship network coexist in the course of co-evolution of a cooperative network with knowledge flow under a strategic alliance. If external actions have not been achieved, the cooperative network may still be self-sufficient until the network reaches stability.

1. Introduction

A strategic alliance is defined as a cooperative arrangement between two or more independent organizations that exchange or share resources for achieving certain strategic objectives; it is a mode by which to understand and deal with uncertain business activities [25]. Resource-based view theory [18] suggests that a strategic alliance is a product of organizational resource integration that is driven by strategic resource needs and social resource opportunities [7]. As an entity engaged in the division of labor, a feature exists in certain stages of the whole value chain, an organization is incapable of possessing everything that is needed to undertake all business activities. Consequently, opening a cooperative network relationship and constructing a variety of contracting cooperation between organizations may be an effective choice. Once a cooperative network is formed between alliances, it results in a knowledge flow [40] and exchange of knowledge resources between strategic alliances that can create highly valuable knowledge networks.

Knowledge flow functions in two ways. First, it helps to integrate and coordinate each other's limited resources and dominant technological knowledge thereby increasing revenues through cooperation and innovation [41]. Second, in the process of knowledge flow cooperation, organizations can transfer experience and some tacit knowledge, which has a direct impact in improving the cooperation between both parties [44]. Knowledge flow will consequently engage in the formation of two forms of a network-technological network in which technology is updated and evolves, and asocial network which affects and adjusts the interrelationship among cooperation organizations [12,36,41]. These two networks co-exist as a whole network of cooperation and influence each other during the evolution of a knowledge flow cooperative network. Therefore, it is integral to define the relationship between technology and social network and to analyze co-evolution of cooperative networks with knowledge flow under the strategic alliance.

In this article, we combine Synergetics and Evolutionary Game Theory to investigate co-evolution of cooperative networks with knowledge flow under a strategic alliance. We consider the various patterns of different resource allocation inside a network which may affect utilization efficiency and the value of knowledge [30], and explain the key issues and complexities of co-evolution of a cooperative network with the premise that four main resource allocation patterns correspond to different strategies. Specifically, we aim to answer the following four questions: First, what are the path characteristics of co-evolution of a cooperative network with knowledge flow under a strategic alliance based on different

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resource allocation patterns? Second, what kind of resource allocation patterns can steadily promote the evolution of a cooperative network? Third, in what form do technology and social network exist in a cooperative network? Fourth, can co-evolution of a cooperative network occur spontaneously when knowledge flow is under effective operation?

This study on the co-evolution of a cooperative network with knowledge flow under strategic alliance considers the literature from multiple research streams such as Evolutionary Game Theory, Synergetics, organizational learning, knowledge management, political economics, social communication and enterprise resources. There are two important challenges. First, the network is a very abstract concept that exists in the dimensions of space and time. Very few scholars discuss the co-evolution mechanism of technology and social network using Synergetics in a cooperative network with knowledge flow under a strategic alliance [14,22,34,36]. There is still a lack of research that identifies the interaction mechanisms of technology and social network and the complexities of a knowledge flow cooperation network. A few studies analyzed the theoretical process, such as the interpretation and transformation of knowledge flow of cooperation organizations under strategic alliance in different aspects and pointed out that the knowledge flow has interactive effects between technical cooperative performance and existing relationships among organizations [9,16]. However, these studies mostly viewed knowledge flow processes as a dominant resource or information transfer and relied on a result-orientation. They concluded that knowledge flow influences the strategic alliance cooperation, which means that the process of knowledge flow under a strategic alliance is considered to be tracked in physical space and a linear time frame. To date, existing research has measured the performance of knowledge flow cooperation with statistical analysis, such as the increase in the number of patents and technology types. However, knowledge flow is a dynamic process, thereby the cooperation of alliance organizations are influenced by knowledge flows dynamics, generating fluctuations [12]. It is essential to adopt procedural dynamic systems theory and closely combine dominant technological advances with the implicit relationship change as a whole to analyze cooperations based on knowledge flow under strategic allocation while adopting an integration perspective. Moreover, numerous scholars have assumed that cooperation with knowledge flow under a strategic alliance has limited resources, but that they have been allocated in only one pattern. These researchers seldom considered the effects of the multi-resources allocation patterns against network co-evolution. Consequently, studies on the relationship between technological network and social network are usually based on limited resources and rarely consider the different resource collaborative modes against co-evolution in the cooperative network. In resource management, different resources allocations have become a gap in research on cooperation with knowledge flow under a strategic alliance.

To thoroughly analyze and understand the complicated process of co-evolution of a knowledge flow network under a strategic alliance, it is crucial to respond to these challenges. To explain the co-evolution mechanism of a knowledge flow network under a strategic alliance, we adopt Evolutionary Game Theory [41]. Moreover, we (a) summarize four different resource allocation patterns based on the existing research results, (b) obtain order parameters of synergy evolution with a Nash game and conduct an equivalent simulation, and (c) determine the mechanism and characteristics of co-evolution of technology and social network based on an analysis of the co-evolution order parameter. This framework can explain the first three questions mentioned above. First, in the context of limited resources, the evolution of a technological and social network depends on the needs of the development in strategic alliances. Second, different resource allocation patterns can directly interpose and influence the result of the co-evolution of knowledge flow network under a strategic alliance. Third, as shown in the analysis and discussion section, knowledge flow network under a strategic alliance has some characteristics of the evolution of a complex system.

We analyze the co-evolution issues of cooperative networks with knowledge flow under a strategic alliance through a strategic selection of technological network and social network based on different resource allocation patterns. Different resource allocation patterns explain the premise of alliance cooperation under the constraints of limited resources. The adopted strategy represents the direction and the actual resource needs of organizations "here and now". By using different resource allocation as guidance, the order parameter analysis and the simulation based on the chosen strategy can offer results of co-evolution of technology and social network under knowledge flow collaboration. This framework and methodology has been applied in many fields of knowledge flow research. Therefore, this method can also offer a reference for expanding the discipline of knowledge management and strategy selection of strategic alliances.

The remainder of the article is structured as follows. First, we analyze the connotation of cooperative networks with knowledge flow under a strategic alliance. Second, we define the relationship between technology and social network for collaborative decision making and establish the collaborative decision-making matrix. Third, we propose four types of resource allocation patterns for a strategic alliance based on the actual situation and a summary of the literature. Fourth, we propose a hypothesis for the evolutionary game about the complementary knowledge resources and social capital and establish the evolutionary game model considering different resource allocation patterns. Fifth, we analyze and discuss the order parameter of the co-evolution and the results of the order parameter simulation of co-evolution. Lastly, we offer a conclusion, in which we discuss the importance of the current study and offer directions for future research.

2. Principle analysis

Within the strategic alliance, collaboration networks of knowledge flow are generated from knowledge-exchange with means such as equity or transfer contracts taken by different organizations [2,48]. When the collaboration is built between alliances, a cooperative network of knowledge flow is generated. Each node represents an owner of knowledge (organization) and this owner of knowledge may be either positive or negative when interacting with each other based on different levels of willingness with knowledge flow [3]. However, as long as the partnership is formed, organizations in the cooperative network with knowledge flow, regardless of their individual willingness, are bound to have close relationships when they carry on innovation activities of technological cooperation for "strategic complementarity and mutual benefit" [23]. A weak relationship with the corresponding organizations in the network is also formed in the process of establishing cooperation. Therefore, innovation rates and performance of technology cooperation will be improved with the change of links in organizations [6,11]. Moreover, the investment in social capital of cooperative organizations should be accumulated and transformed into new social capital during co-evolution of cooperative networks with knowledge flow. Furthermore, by attracting more organizations to join in the cooperative network, some implicit knowledge should be boosted to be transferred within this cooperative network, which consequently improves the strength of the relationship and trust among organizations [33], while actively enhancing the innovative efficiency of technological cooperation. Since the cooperative network with knowledge flow interactive