Physica A 502 (2018) 21–28

Contents lists available at ScienceDirect

Physica A

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

The impact of innovation intermediary on knowledge transfer

Min Lin *, Jun Wei

School of Economics and Management, University of Science and Technology Beijing, Beijing 100083, China

HIGHLIGHTS

- Innovation intermediary is conducive to knowledge diffusion and knowledge growth.
- Scale of innovation intermediary has little effect on the growth of knowledge.
- Innovative ability based intermediary selection is optimal for knowledge growth.

ARTICLE INFO

Article history:
Received 11 January 2018
Received in revised form 21 February 2018
Available online 28 February 2018

Keywords:
Knowledge transfer
Innovation intermediary
Network
Absorptive capability
Innovative ability

ABSTRACT

Many firms have opened up their innovation process and actively transfer knowledge with external partners in the market of technology. To reduce some of the market inefficiencies, more and more firms collaborate with innovation intermediaries. In light of the increasing importance of intermediary in the context of open innovation, we in this paper systematically investigate the effect of innovation intermediary on knowledge transfer and innovation process in networked systems. We find that the existence of innovation intermediary is conducive to the knowledge diffusion and facilitate the knowledge growth at system level. Interestingly, the scale of the innovation intermediary has little effect on the growth of knowledge. We further investigate the selection of intermediary members by comparing four selection strategies: random selection, initial knowledge level based selection, absorptive capability based selection, and innovative ability based selection. It is found that the selection strategy based on innovative ability outperforms all the other strategies in promoting the system knowledge growth. Our study provides a theoretical understanding of the impact of innovation intermediary on knowledge transfer and sheds light on the design and selection of innovation intermediary in open innovation.

1. Introduction

Knowledge plays an increasingly important role in the economic development and social progress [1]. A growing body of empirical evidence indicates that organizations that are able to transfer knowledge effectively from one unit to another are more productive and more likely to survive than those that are less adept at knowledge transfer [2]. Several key elements have been identified that affect knowledge transfer, such as the stickiness of knowledge [3], the absorptive capacity of receivers [4], and the intermediary and context for knowledge transfer [5,6].

More recently, with the development of network science [7], the effect of network structure on knowledge transfer has attracted much attention [8–13]. Luo et al. proposed an agent-based model to study the coevolutionary dynamics of knowledge diffusion and network structure [14]. They showed that the bi-directional influences between knowledge transfer and neighborhood adjustment give rise to the coevolution of network structure and knowledge diffusion at global level.

* Corresponding author.
E-mail address: linm@ustb.edu.cn (M. Lin).

https://doi.org/10.1016/j.physa.2018.02.207
0378-4371/

In particular, the rise and fall of small-world structure of the network can be observed during the process of knowledge transfer [15]. Allen [16], and An and Kiefer [17] investigated the technology diffusion by an Ising model based on regular networks. Steyer and Zimmermann [18] used random graph model to study technology diffusion. Cowan and Jonard [19], and Kim and Park [20] compared the knowledge diffusion in regular, random and small-world networks [21]. They all found that the small-world network is the most efficient structure to diffuse the knowledge. Besides the small-world property, the scale-free property [22] is another important topological structure of social networks. Tang et al. [23], and Lin and Li [24] argued that the scale-free structure is more effective for knowledge diffusion. All the above studies indicate that the underlying network structure is one of the key factors that determine the efficiency of knowledge transfer.

On the other hand, due to the rapid development of technology and increasingly fierce market competition, many firms actively transfer knowledge with external partners in the markets for technology [25–29]. Innovation intermediaries are gradually introduced in knowledge transfer and play more and more important roles as companies have started to adopt "open innovation" to increase the efficiency and effectiveness of their innovation process [30,31]. Concerning research on innovation intermediaries, some earlier works concentrated on the role of innovation intermediaries, and these works have highlighted partner identification, supplier selection, technology packaging, and negotiation support [32–34]. A few other works have studied the brokering function of these organizations in the process of transferring technology [35,36]. In addition, some works have focused on the importance of service firms in bridging important linkages in an innovation system [37]. Recent studies indicate that firms can reduce their transaction costs in technology markets by collaborating with intermediaries [38].

Although innovation intermediary is increasingly important, a theoretical understanding on how innovation intermediary influences the knowledge transfer performance is still lacking. Motivated by the above considerations, in this article, we systematically investigate the effect of innovation intermediary on knowledge transfer by studying a simple model of technology innovation and diffusion process on networked systems. The growth and diffusion of knowledge are examined in detail with different configurations and scales of innovation intermediaries in the system. We further investigate the selection strategies of intermediary members. Four selection strategies are introduced: random selection, initial knowledge level based selection, absorptive capability based selection, and innovative ability based selection. We compare the performances of knowledge transfer under the four selection strategies to find out the mechanism that make innovation intermediary work the most efficiently. Our study offers a clear picture about the impact of innovation intermediary on knowledge transfer and provides a guidance for the design and selection of innovation intermediary in open innovation.

This paper is organized as follows. In Section 2, the models of knowledge transfer process and networks are introduced. In Section 3, the simulation results are presented and analyzed. Finally in Section 4 we summarize the article and discuss the managerial enlightments of our study.

2. The model

2.1. Schematic description

In our model, agents are located on a network and every agent has direct connections with a small number of neighboring agents. Each agent has a scalar knowledge endowment. Agents are heterogeneous in two respects: innovative abilities and absorptive capacities. Each agent i has an idiosyncratic absorptive capacity (α_i) and an idiosyncratic innovative ability (β_i). We can interpret α_i as the ability to acquire new information and β_i the innovative potential of the agent. At each time step, one agent is selected at random and given the opportunity to learn. In order to increase its knowledge level, the randomly selected agent will search for a proper knowledge broadcaster as the source of innovation.

Generally, there are three knowledge sources: (1) Local knowledge. According to regional innovation theory, innovators first seek among localized outside innovation source due to the searching cost, convenience, and time. Therefore, each agent will search for knowledge source from the neighboring agents as its first choice. If the agent successfully find a proper knowledge source which is also called broadcaster, knowledge transfer will happen. (2) Knowledge from innovation intermediary. If the agent fails in finding knowledge source from its neighboring agents, he will turn to innovation intermediary for help. Innovation intermediaries are organizations that facilitate innovation by providing the bridging, brokering, and knowledge transfer necessary to bring together the range of different organizations and knowledge needed to create successful innovation. Each innovation intermediary has the information of a certain number of agents from the whole system, which are defined as the members of innovation intermediary. The innovation intermediary helps broaden the scale of knowledge source for the agent. (3) Self-developed knowledge. If the agent still cannot find proper knowledge source through the above two ways, it will develop new knowledge by himself, which is called self-innovation.

2.2. Knowledge transfer model

We assume agents are located on the nodes in an undirected and connected graph $G(S, E)$, where $S = \{1, \ldots, N\}$ is the set of nodes (agents) and E is the list of connections. Specially, $\Gamma_i = \{j \in S - \{i\} | d(i, j) = 1\}$ is the neighboring nodes of i, where $d(i, j)$ is the length of the shortest path from node i to node j on the graph. Only neighboring agents can interact with each other. Each agent $i \in S$ is characterized by a knowledge stock which evolves over time. Formally, let $v_i(t)$ denote agent i's knowledge stock at time t. At each time step t, a randomly chosen agent i will update its knowledge according to the following procedures: