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ScienceDirect
Technological Forecasting & Social Change 73 (2006) 1121–1143
Technological Forecasting and Social Change

Knowledge integration and network formation

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Received 1 June 2005; received in revised form 30 November 2005; accepted 2 December 2005

Abstract

In this paper, we highlight how inter-firm collaboration networks are influenced by the knowledge composition of goods in an industry. For this purpose, we carry out an agent-based simulation study in which firms integrate their competencies under different knowledge-based regimes. In this way networks form. The results reveal that knowledge regime significantly influences the network structure, and interaction among firms not only is very intensive when the products are specialized but also have common knowledge among them.

Keywords: Networks; Knowledge; Learning; Agent based simulation

1. Introduction

In recent decades, the intensity of horizontal and vertical relations among firms has increased to a large extent, especially in the case of knowledge intensive industries. The rapid innovations and increasing product complexity in these industries have not only raised the requirements for compatibility among product components, but have also been accompanied by richer technological opportunities. These developments prepared the grounds for intensive relations among firms, in the face of difficulties faced by a single firm to be self sufficient in serving a rapidly changing market. Mostly, interdependencies among products, compatibility requirements, specialization and collaboration accompany each other in these systems. Task complexity, combined with time pressure, makes cooperation among firms more efficient than vertical hierarchies [1,2].

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doi:10.1016/j.techfore.2005.12.007

In such an environment, knowledge has become a central factor in influencing industry dynamics. In most industries, firms need to pursue strategies that favour external relations, not only in subcontracting components but also to share knowledge and make use of knowledge spillovers. A major process that accompanies the inter-firm relations is the significant knowledge flow that takes place between the firms, which is usually considered to be an important engine for innovation. These knowledge spillovers are not only caused by formalized arrangements between firms, but may also be the result of informal communications, a concept which Allen [3] termed to be collective invention (see also [4]). The structure of networks among firms is inevitably influenced by the competencies needed in production and the architecture of these networks yield insights into effectiveness and efficiency with which knowledge is transferred, created and also the innovative performance of firms [5–7].

There is a rich literature that addresses in a broad sense the relation between knowledge-specific characteristics and networks. Among these, studies that focus on uncertainty and industry events [8–10]; complementarities in goods [11], similarities in knowledge bases [12,13] the stage in the industry life cycle [14]; interdependence in products [15], system embeddedness and observability of knowledge [16]; hierarchical organization of knowledge base [17], characteristics of knowledge in terms of technological opportunities and tacitness [18] can be cited. Although most of these studies focus on different aspects of knowledge and networks, there has been no systematic study in the literature about how the network structure responds to different ways in which knowledge is embodied in goods in the economy as we investigate in this paper.

The question addressed in this paper is how the network structure responds to different knowledge-based regimes. The approach that is used differs from previous studies in that a dynamic network approach is adopted. The paper is composed of two parts, where firstly we present a very simple economy with two producers, two products and two types of competencies, and analyse via an analytical model, how and under which conditions producers collaborate and integrate their knowledge. In the second part, we extend the model to many producers, competencies and products. Because of the analytical complexity in this part, we perform a simulation study and analyse the collaboration dynamics in this case. Specifically, in the agent-based simulation model, self-interested actors who have competencies in different areas chose partners to integrate their knowledge and produce. Actors also learn from each other in this process, and networks form by the interactions among them. We analyse these networks and highlight the relation between patterns of interaction and knowledge base of the industry. We model the knowledge base using the concept of relatedness among products (similarity in their knowledge requirements) and the level of specialization of products. The results reveal that interaction among actors not only is very intensive when the products are specialized but also have common knowledge among them.

An important result of this paper is that we show how a simple economy with two producers behaves differently from an economy with many producers, competencies and products. In this sense, we show that the results pertaining to a duopoly case cannot be generalized to a case where there are many firms. As far as the relationship between knowledge base and networks are considered, in an economy with two producers specialization of the goods places stricter restrictions on collaboration possibilities than the case where there are many producers.

The paper is organized as follows. In the second section, we explain the main model and present some preliminary analytical results. In the third section, we present an agent-based simulation study where self-interested economic actors form networks to integrate their knowledge. We analyse the