Available online at www.sciencedirect.com
ScienceDirect
Int. J. Production Economics 104 (2006) 30–45
international journal of production economics
www.elsevier.com/locate/ijpe

Innovation in industrial districts: An agent-based simulation model

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Received 29 March 2004; accepted 21 December 2004
Available online 5 February 2005

Abstract

Despite the wideness of the literature on industrial districts (IDs), the driving processes of ID innovation have not still received much attention: Questions about how new innovation processes emerge, how, when and where they evolve are minimally addressed in the literature. To address these questions new theoretical approaches and methodologies are needed. In the paper we approach this topic by adopting complexity science and by using the agent-based simulation methodology. In particular, an agent-based simulation is conducted to investigate how innovation processes in IDs have to be modified to assure their survival in a highly competitive environment.

Keywords: Industrial districts; Innovation; Agent-based simulation model

1. Introduction

Industrial districts (IDs) are geographically defined production systems, characterized by a large number of small and medium-sized firms that are involved at various phases in the production of a homogeneous product family. These firms are highly specialized in a few phases of the production process, and integrated through a complex network of inter-organizational relationships.[1]

The reasons underlying the ID competitiveness have been profoundly studied in the related

[1]The industrial district is a specific type of geographical cluster. The latter is defined by Porter (1998) as a geographically proximate group of interconnected companies and associated institutions (for example universities, standards agencies, and trade associations) in particular fields, linked by commonalities and complementarities. Geographical clusters also promote knowledge sharing, learning processes, and innovation development. Therefore, the topic we investigate in the paper is of interest not only in Italy but also in other countries.

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0925-5273/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.ijpe.2004.12.023

literature by adopting different theoretical perspectives coming from many research streams, namely social sciences, regional economics, economic geography, political economy, and industrial organization. These studies have developed different notions and models, such as: the flexible specialization production model conceptualized by Piore and Sabel (1984); the localized external economies concept anticipated by Marshall (1920) and further formalized by Becattini (1987) and Krugman (1991); the industrial atmosphere notion conceived by Marshall (1919); and the innovative milieux notion developed by the GREMI (Aydalot and Keeble, 1988; Maillat et al., 1995). Each study emphasizes different and complementary aspects of IDs, yet most of them recognize the ID innovative capabilities as one of the major factors of their success. In particular, since Marshall (1920) developed the notion of industrial atmosphere, the inner property of IDs to easily transfer information, knowledge, and skills among firms has been identified as a critical success factor. It is widely recognized that such a property acts as a very powerful intangible factor for the ID competitiveness as it generates what it is known as the ID "*widespread innovative capacity*" (Bellandi, 1989). The notion of "*milieux innovateur*" (Maillat et al., 1995) underlines that the creation of successful technology IDs is mainly related to phenomena of dissemination and accumulation of the new knowledge favored by the firms' proximity, both geographical and cultural.

Most studies on innovation in IDs have investigated the nature of innovations developed, so recognizing that the ID innovative capabilities mainly produce incremental innovations on both products and processes. These capabilities are strictly linked to ID distinctive organizational features, such as the high level of firm specialization, the co-location of similar and complementary firms in the same narrow geographic area, and the complex and recurrent interactions among firms (Marshall, 1920; Bellandi, 1989; Maillat et al., 1995).

Despite this wide literature, questions about how new innovation processes emerge, how, when and where they evolve are minimally addressed in the literature (Brenner, 2001; Lane, 2002). This lack seems to be particularly critical in the current context, because IDs are undergoing profound changes to face the new competitive scenario rapidly changing and characterized by clients demanding more and more innovations both in products and process. In this context, empirical evidence shows that the most competitive ID firms have recently activated new innovation processes with the aim of producing radical innovations: For example, by developing joint research projects with universities and research centers, by exploring the external environment to seek new production technologies to be adopted in the production processes, and by investing in R&D activities.

We are thus spurred into filling this gap of the literature mainly focusing on the following issues: Are the IDs adopting traditional innovation processes still competitive in the new competitive scenario? Are new innovation processes necessary to guarantee IDs survival? How do the ID changes modify their innovative capability?

To answer questions like these new theoretical approaches and methodologies are needed. In fact, the few studies on this topic are mainly conceptual and empirically based (Baptista, 2000; Mackinnon et al., 2002; Maskell and Malmberg, 1999; Tallman et al., 2004). They analyze the problem by focusing on the system as a whole, observing the phenomena when they are already happened, and describing them in terms of cause–effect relations by adopting a top-down approach. These approaches tend to simplify much the process and do not really explain the processes underlining dynamics. In addition, these approaches do not allow *what-if* analysis to be made on the system's behavior in contexts different from those that have been studied.

To overcome this problem we propose to adopt the complexity science approach (Cowan et al, 1994) and to investigate ID innovation dynamics by using agent-based simulation (Axelrod, 1997; Weiss, 2000). With regard to the complexity science approach, IDs are considered as complex adaptive systems (CASs), consisting in an evolving network of heterogeneous, localized and functionally integrated interacting agents. The latter interact in a non-linear fashion, can adapt and learn, thereby evolving and developing a form of self-organization that enables them to acquire collective properties that each of them does not