ELSEVIER

Journal of Economic Behavior & Organization
Vol. 62 (2007) 215–236

JOURNAL OF
Economic Behavior
& Organization

www.elsevier.com/locate/econbase

The system dynamics of collective knowledge: From gradualism and saltationism to punctuated change

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Received 23 February 2004; received in revised form 28 February 2005; accepted 15 April 2005
Available online 25 January 2006

Abstract

The economics of localized technological change provides an original framework to model the dynamics of technological innovation as the result of the interaction between the inducement to change the technology, generated by the mismatch between plans and expectations, and the characteristics of the system. The interplay between networking costs and knowledge supermodularity can explain both punctuated and gradual change. Small variations in the parameters can generate either gradual or discontinuous changes. Punctuated technological change is likely to take place when the interplay between positive and negative knowledge externalities leads to the creation of commons of collective knowledge and hence new technological systems.

JEL classification: O33

Keywords: Gradualism; Saltationism; Punctuation; Localized technological change; Positive and negative knowledge externalities; Collective knowledge; Technological systems

1. Introduction

In the economics of localized technological knowledge each firm has a heterogeneous and distinct knowledge base, rooted in its own 'locus' defined by learning procedures that are specific to the techniques in place and the set of fixed tangible and intangible assets (Atkinson and Stiglitz, 1969; David, 1975). However, when knowledge exhibits high levels of supermodular complementarity and networking costs are low, firms have an incentive to implement the convergence of their own knowledge and competence to increase knowledge complementarity. Commons of

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0167-2681/$ – see front matter
doi:10.1016/j.jebo.2005.04.013

collective knowledge emerge when the active participation of firms pushes the direction of the internal research and learning activities towards higher levels of complementarity with the aim to build a systemic integration. Collective knowledge is characterized not only by imperfect appropriability and access to intellectual property rights that are either shared or often not specified or specifiable but also by the role of the intentional networking effort, participation and contribution of each agent. Collective knowledge is the result of the valorization of the elements of latent complementarity among the bits of knowledge possessed by each localized agent (Antonelli, 2001).

Knowledge networking activities help to identify and access the sources of external knowledge. On these bases the firm will select and focus the direction of internal learning and research activities in order to integrate them with the characteristics of the external knowledge available. By means of knowledge networking firms direct their research and learning efforts towards the emerging commons of collective knowledge. The emergence of technological systems is the ultimate result of such an effort of exploration, creation and exploitation of knowledge complementarities (Antonelli, 2001).

The analysis of the dynamics of collective knowledge within the framework of the economics of localized technological change can help to provide a synthesis of the divide between Schumpeterian saltationism and Marshallian gradualism.

Smooth, Marshallian dynamics can easily generate major Schumpeterian discontinuities. The gap between the theories of punctuated and gradual growth can be reconciled when the essence of the Schumpeterian and Marshallian approach is properly combined. The economics of localized technological change provides an original framework to model the dynamics of introduction of new technologies. In this approach, the introduction of technological innovations is the result of the interaction between the inducement to change the technology, generated by the mismatch between plans and related irreversible commitments and expectations, and the interplay between positive and negative externalities provided, respectively by technological spillover and networking costs.

The correct appreciation of the interactions between individual action and population dynamics makes room for a system dynamics framework able to explain in a single context both Marshallian gradualism and Schumpeterian discontinuities. Within the context of a punctuated approach, in fact, Marshallian gradualism and Schumperian saltationism can be considered as two extreme possibilities between which a continuum of solutions can be identified. Small variations in the parameters of the positive and negative externalities and in the feedback affecting the extent of the mismatch and hence the levels of the inducement can generate either gradual or discontinuous changes.

The rest of the paper is organized as follows. Section 2 presents a brief exposition of two contrasting views about continuity in economic and technological change. Section 3 introduces the notion of localized technological change, stresses the analysis of positive and negative externalities, and articulates the analysis of the dynamics engendered by the feedback between localized technological change and mismatch. This section provides also some anecdotal evidence about the relevance of such dynamics in the understanding of the long-term growth in the case of Piedmont, a region of Italy. The conclusions summarize the main results of the work and put them in a broader perspective.

2. Smooth versus discontinuous change

The difference between Marshallian gradualism and Schumpeterian abruptness about the rate and direction of economic evolution at large has strong implications for the economics of innovation and new technologies.