Nonlinear dynamism of innovation and business cycles*

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Abstract. The aim of this paper is to describe the nonlinear dynamism of innovation and to clarify the role of innovation for economic development in terms of Kondratiev business cycles, especially the causal relation of the bubble economy and depressions with innovations. Any paradigm of technological innovation develops within a definite time span reaching maturity. This nonlinear nature clarifies many characteristic features of innovation. Schumpeter's innovation theory on business cycles is examined through this dynamism. Trunk innovation is defined as that which plays a decisive role in building infrastructures and inducing subsequent innovations. Every innovation has its own technological development period just before the innovation diffusion. The emergence of new markets can be estimated by chasing the ongoing technologies.

Keywords: Nonlinear dynamism of innovation – Infrastructure – Business cycles – Bubble and depression – Technology foresight

JEL Classification: E32, L16, O11, O14, O30

1 Introduction

This paper is based on awareness of the nonlinear nature of innovation and elucidates the dynamism of innovation as the origin of the economic development, focusing on Kondratiev business cycles.

The correlation of economic development with technological innovation has not been explicitly clarified with decisive evidence since Schumpeter. This paper throws light on this issue by using the novel concept of the nonlinearity of innovation. First of all, it is clarified that diffusion of innovation is a physical phenomenon with a

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definite diffusion coefficient penetrating into a market towards maturation. The locus of the diffusion directly corresponds to the transition of increasing value-added produced by innovation and is used as a measure of the contribution of innovation to the economy. By this means it is possible to examine the innovation theory of business cycles. The bubble economy and recession that follows are discussed on the basis of innovation dynamism and an interpretation is offered. It is interesting to watch the synchronizing behavior of business cycles and role of late comers.

The innovation that plays a decisive role in the formation of economic infrastructures is specifically named "trunk innovation," and includes resources such as coal and oil. This category is closely related to the notion of the techno-economic paradigm and to the institutional change of society. Thus, trunk innovations more strictly exhibit a clear-cut correlation between innovation and economic development and induce subsequent innovation. As an example of such induction effect, the evolution of retail businesses is dealt with.

An innovation paradigm is composed of a technological development period and a market diffusion period. That is, before the diffusion of innovation products to the market, there is a long latent period of technological development. This correlation makes it possible to estimate the emergence of new innovation markets, a kind of technology foresight. From the analysis of ongoing science and technologies, emerging industries are estimated.

This paper is prepared on the basis of data and discussion of our previous works: Hirooka (1992, 1994a,b, 1999, 2000 , 2002, 2003a,b), Hirooka and Hagiwara (1992).

2 Logistic dynamism of innovation

Since the first Industrial Revolution, the economy has developed through innovations creating economic infrastructures. The diffusion of innovation is described by a logistic equation, as pointed out by Griliches (1957) and many others, e.g., Mansfield (1961, 1963, 1969), Metcalfe (1970), Fisher and Pry (1971), Nakićenović and Grübler (1991), Modis (1992), Marchetti (1997, 1988, 1995, 1996), who have all confirmed this relationship. Some authors, e.g. David (1975), Davies (1979), Metcalfe (1981, 1984), and Stoneman (1984), however, have proposed alternative or modified models for the diffusion of innovation products. Actually, the diffusion of new products in the market is quite often retarded by various economic turbulences, such as recessions, wars and so on. Thus, it makes it rather difficult to evaluate which equation is valid. The author, however, has found that the diffusion of products proceeds according to a logistic equation in a sound economy, but is disturbed by economic turbulence. This is clarified when diffusion is analyzed according to the Fisher Pry plot.

The logistic equation is expressed by (1):

$$dy/dt = ay(y_o - y) \tag{1}$$

where y is product demand at time t, y_o is the ultimate market size, and a is constant.