

Innovation Ecosystems and Sustainable Development

ABSTRACT

Innovation is an inherent element for economic growth and development. The nature of innovation requires a comprehensive framework for complex economic relations. From a global perspective and with diminishing limited resources, sustainable development outweighs exponential growth which is generally considered as a mechanical progress. Innovation is the most significant factor for sustainable development. The interactive system of economic environment with both external and internal effects creates innovation ecosystems. In this paper, we examine the close connection between innovation ecosystems and sustainable development in order to search possibilities for improving economic, environmental and social well-being. Besides optimizing internal innovation processes, it is also important to take into account the external social and environmental issues. The analysis of dynamic innovation ecosystems in the context of sustainable development is a quest for new ways of production that provide high standards of life in every part of society not only in the short-run but also in the long-run.

Keywords: Innovation, Sustainable Development, Innovation Ecosystems, Technology, Entrepreneurship.

İnovasyon Ekosistemleri ve Sürdürülebilir Kalkınma

ÖZ

İnovasyon, iktisadi büyüme ve gelişmenin ayrılmaz bir unsurudur. İnovasyonun doğası, karmaşık iktisadi ilişkilerin kapsamlı bir çerçevesinin çizilmesini gerektirir. Küresel bir perspektiften ve azalan sınırlı kaynaklarla, sürdürülebilir kalkınma genellikle mekanik bir süreç olarak düşünülen üstel büyümeden daha önemlidir. Sürdürülebilir kalkınmanın en önemli faktörü inovasyondur. Hem dışsal hem içsel etkileriyle iktisadi çevrenin interaktif sistemi, inovasyon ekosistemlerini oluşturmaktadır. Bu çalışmada, iktisadi, çevresel ve sosyal refahın gelişmesinin olanaklarını araştırmak amacıyla inovasyon ekosistemleri ile sürdürülebilir kalkınma arasındaki yakın ilişki incelenmektedir. İçsel inovasyon süreçlerinin optimize edilmesinin yanı sıra dışsal sosyal ve çevresel konuların da dikkate alınması önem taşımaktadır. Sürdürülebilir kalkınma bağlamında dinamik inovasyon ekosistemlerinin analizi sadece kısa vadede değil, fakat uzun vadede de toplumun her kesimine yüksek hayat standartları sağlayacak yeni üretim yollarına dair bir araştırmadır.

Anahtar Kelimeler: İnovasyon, Sürdürülebilir Kalkınma, İnovasyon Ekosistemleri, Teknoloji, Girişimcilik.

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Sorumlu yazar

1. INTRODUCTION

The conceptual and functional connections between economics and ecology provide useful insight for a dynamic analysis. The social and economic structures change gradually similar to that of biological organism. The use of metaphors in economics helps abstract thinking to theorize and understand difficult economic relations which are not convenient for artificially isolated laboratory experiments. Classical economists defined the economic systems as a closed cyclical system such as the current economic national accounting which is generally shown on a flow diagram. Classical national innovation systems are examples of this kind of cyclical flow. Among the classical static systems of innovation approaches, Quesnay's *Tableau Économique* (1758) and Leontief's (1951) input-output analysis are most important works. Philips (1950) invented a mechanical machine to measure the monetary circulation in the economy through hydraulic macroeconomic system.

As phrased by Schumpeter (1951) ‘the circular flow of economic life is conditioned by given circumstances.’ The conditioning by given circumstances is deterministic. Human conduct and economic conduct together determine social and economic facts, and they are mutual functions of one another. The closed system of economic rhythms, cyclical ups and downs assumed to operate with great precision were mechanistic conception and flawed in many ways *per se*. The general framework of circular flow of economic events was a static—or at best a comparative static—and highly abstract view of real life.

This system, although static in nature, is sometimes constructed under the title of ‘dynamic model’ fashion just because of its employment of the element of time. However, without any formal learning model, the arrow of time cannot be integrated into a real dynamic model and will become exogenous. In other words, arrow of time is endogenized into the dynamic model with the inclusion of learning process. Hence this paper concentrates and considers on the important issue of innovation ecosystems in relation to sustainable development.

Innovation ecosystems are complex networks beyond markets. These networks are business networks that turn into ecosystems via cooperation networks. Cooperation networks become ecosystems for innovation created by collaborative networks. There is also a strategic interaction between global systems of innovation and national or regional systems of innovation. An innovation ecosystem network is built by surrounding economic agents such as corporations, entrepreneurs, employers, employees, producers, consumers, government agencies and so on.

The plan of this paper is as follows. In the second section, the definition of innovation ecosystem from metaphor towards theory is provided with reference to various economic connotations. The third section analyzes seven types of innovation ecosystems in their relevant economical contexts. The fourth section depicts the various stages of evolution of innovation ecosystem from closed to open innovation and Innovation Value Institute as an innovation ecosystem. The fifth section constructs the framework of a theory of innovation ecosystems in relation to sustainable economic and human development. The section six concludes the argument with prospects to achieve more general understanding of similarities between ecological and economic systems in the future.

2. THE DEFINITION OF INNOVATION ECOSYSTEM: FROM METAPHOR TOWARDS THEORY

Ecological system is open and subject to change. The natural ecological equilibrium is dynamic in contrast to the classical economic equilibrium. If society is a growing organism, then the economy which is formed by social life, and ecology that is nothing but a natural system have common features: “The social process is really one indivisible whole. Out of its great stream the classifying hand of the investigator artificially extracts economic facts. The designation of a fact as economic already involves an abstraction, the first of the many forced upon us by the technical conditions of mentally copying reality. A fact is never exclusively or purely economic; other—and often more important—aspects always exist” (Schumpeter, 1951, p. 3).

The innovation ecosystem is an intellectual economic environment centers around industrial atmosphere at a particular time and place. The ultimate end of an innovation ecosystem is sustainable economic development and growth. Jackson (2011, p. 2) defines innovation ecosystem as “the complex relationships that are formed between *actors* or *entities* whose functional goal is to enable technology development and innovation.” Similar to the residents who are living organisms and habitat of a biological ecosystem, the innovation ecosystem actors and entities which interact in the network of complex economic relationships. The first component of innovation ecosystem is economic actors that include human capital such as entrepreneurs, managers, dealers, faculty staff, industry researchers, business representatives, etc.

Another important component of innovation ecosystem is entities which are institutions such as corporations, universities, business schools, research institutes, economic development organizations etc. Besides these two basic components of an innovation ecosystem, there are two economies in which production process is in operation. The first one is knowledge economy which is fueled by research and development (R&D) activities of firms and government agencies. The other one is commercial economy organized by competitive market mechanism. The material inputs of commercial economy into the production function are rival goods whilst the immaterial inputs of knowledge economy into the production functions are not rival and most of the time they are complements.

3. TYPES OF INNOVATION ECOSYSTEMS: LITERATURE REVIEW AND TAXONOMY

There are different types of innovation ecosystems. Oh *et al.* (2016) distinguishes 7 types of innovation ecosystems in relation to economical contexts they are mentioned. These are corporate (open) innovation ecosystems, regional and national innovation ecosystems, digital innovation ecosystems, city-based innovation ecosystems, high-tech SMEs centered innovation ecosystems, hyper-local innovation ecosystems and university based ecosystems. Brief definitions of these different types of innovation ecosystems are as follows:

1. *Corporate (open) innovation ecosystems.* Zhang *et al.* (2014) pointed out that corporate innovation ecosystems are open innovation ecosystems of which focus is external and collaborative. This type of innovation ecosystems consists of suppliers, consumers, trade partners. The external factors of innovation ecosystems such as government agencies and industry associations play an important part in the functioning of open innovation ecosystem.
2. *Regional and national innovation ecosystems.* This type of innovation ecosystem distinguished from earlier regional and national innovation systems. The 'National System of Innovation' is invented by List (1841). However, the classical regional and national innovations systems were closed innovation systems. They were by their very nature centralized and inward looking systems. The regional and national innovation ecosystems are open innovation ecosystems that "behave in new ways, create civic spaces and plant new seeds," Morrison (2013).
3. *Digital innovation ecosystems.* A digital innovation ecosystem is related with the diffusion of innovation via virtual networks. These virtual networks are online platforms through which users, producers, developers interact in synergistic relationships. Rao and Jimenez (2011) examine the digital ecosystems at Apple Inc. and Google as case studies.
4. *City-Based Innovation Ecosystems.* This type of innovation ecosystems focus on districts where small companies operate. The formation of creative spatial network on the territorial basis is planned by municipalities and universities from a perspective of government strategies (Lin, 2014).
5. *High-tech SMEs Centered Innovation Ecosystems.* Innovation ecosystems centered on small and medium sized enterprises in high-tech industry. The example for this type of innovation ecosystem is Taiwan. Lorré *et al.* (2006) construct a collaborative distributed framework for SME ecosystems.
6. *Hyper-Local Innovation Ecosystems.* The hyper-local innovation ecosystems are generally driven by universities to improve their strategic potential and develop innovations in science and technology. Commercialization of leading-edge technology is an important aspect of this ecosystem. The hyper-local innovation ecosystem has an exponential impact in comparison to the asymptotic impact of systematic programs.
7. *University-Based Ecosystems.* Similar to the hyper-local innovation ecosystems, university based ecosystems stress upon vertical organic activities by university and external people over horizontal systematic activities. Periodically marketing innovative products to industry from campus is the central idea. Léon (2013) makes an analysis of university driven open innovation ecosystems in a case study.

4. THE EVOLUTION OF INNOVATION ECOSYSTEM

The evolution of innovation is in relation to the diffusion of innovation through the different layer of society. There are mainly three stages from a static and closed mechanical system to the dynamic and open organic ecosystem. The first stage is centralized and introverted closed innovation which heads upon one direction. The second stage is external and extraverted collaborative open innovation. The third and last stage is organic and dynamic centered on an ecosystem.

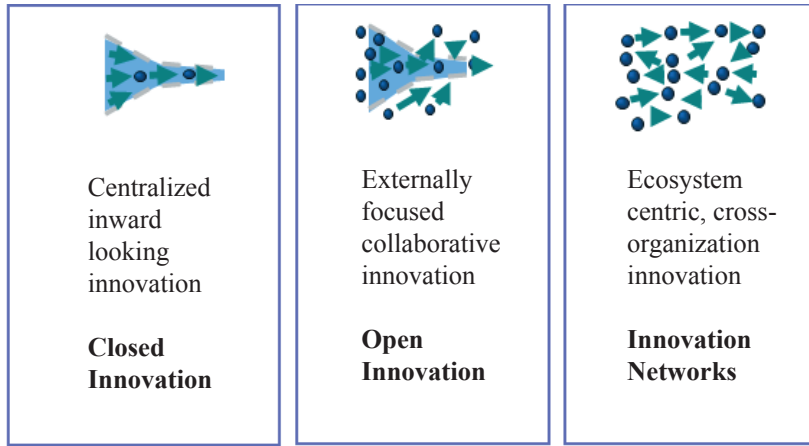


Figure 1. The Stages of the Evolution of Innovation Ecosystem Source: Curley et al. (2013)

Figure 1. helps us to improve a framework for ecological systems theory (EST) first introduced by Bronfenbrenner (1979) on the ecology of human development. The ecological systems theory is a meta-theoretical framework for innovation ecosystems (Costello and Donnellan, 2012). Innovation ecosystems are complex networks in which synergy of interacting agents are central for performance. An innovation ecosystem of business world is defined under the concept of knowledge driven entrepreneurship which is a key factor for social and economic transformation (Andersson *et al.*, 2010).

There are seven components that constitute a complete innovation ecosystem. These are (i.) government agencies, (ii.) invention and innovation, (iii.) infrastructure, (iv.) funding and outsourcing, (v.) culture, (vi.) demand for innovative products and (vii.) innovative entrepreneurs. An innovation ecosystem consists of five subsystems of which the individual is placed at the center. These subsystems are macrosystem, exosystem, mesosystem and microsystem. Each of these systems correspond a functional dynamic counterpart in economic life. Individual is researcher and microsystem is research group. Mesosystem is community. Exosystem is industry sector and macrosystem is public policy. The Innovation Value Institute (IVI) which was co-founded in 2006 by Maynooth University and Intel is depicted as a simple innovation ecosystem.

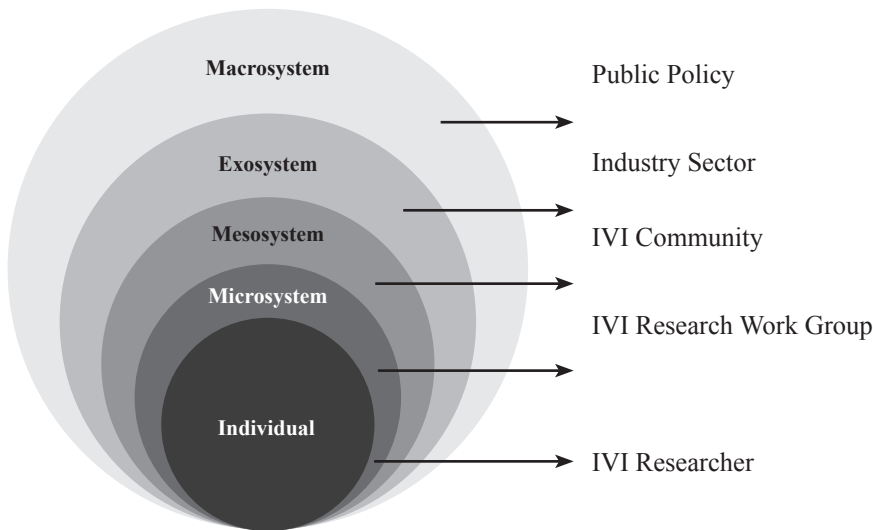


Figure 2. Innovation Value Institute as an Innovation Ecosystem Source: Curley et al. (2013).

The evolution of innovation is multidimensional. It works inside out from a closed static system to an open dynamic ecosystem. The static system of innovation approach is mechanic, whilst the dynamic ecosystem of innovation approach is organic.

5. TOWARDS A THEORY OF INNOVATION ECOSYSTEM IN RELATION TO SUSTAINABLE ECONOMIC AND HUMAN DEVELOPMENT

The ecological systems framework for innovation ecosystem is based on Bronfenbrenner’s (1979) study on the ecology of human development. He defined the ecology of human development as follows: “The ecology of human development involves the scientific study of the progressive, mutual accommodation between an active, growing human being and the changing properties of the immediate settings in which the developing person lives, as this process is affected by relations between these settings, and by the larger contexts in which the settings are embedded,” Bronfenbrenner (1979, p. 21). He continued to investigate the interpersonal structures as contexts of human development. His theoretical framework was a modification of Lewin (1935).

Lewin’s (1935, p. 73) classical equation expresses human behavior (*B*) as a combined function of interaction between the person (*P*) and environment (*E*):

$$B = f(PE). \tag{5.1}$$

In his theoretical framework Lewin (1935) places human behavior in “situational, interpersonal, sociological, cultural, historical and above all theoretical” context (Teece, 2006, p. 43).

Bronfenbrenner (1979) introduced the element of time into Lewin’s (1935) behavioral function to reach a much more complete picture of human action.

$$D = f(PE). \tag{5.2}$$

In this formulation, the dependent variable of *B* which expresses behavioral pattern in (5.1) is replaced by the dependent variable of *D* which expresses development pattern in (5.2). Bronfenbrenner (1979) analyzed the individual, social and economic development surrounded by an environment of different subsystems.

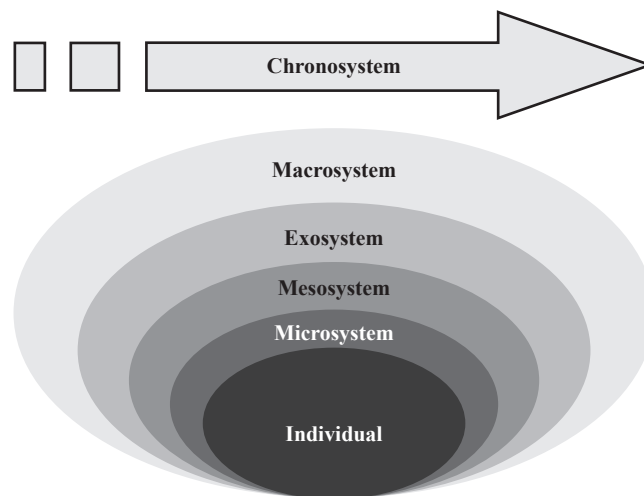


Figure 3. Ecological Systems Framework Source: Costello & Donnellan (2012).

Curley *et al.* (2013) revises Lewin and Bronfenbrenner by including technology as an integral component of information systems and the network of interaction of economic agents for the innovation process. First, Curley *et al.* (2013) reformulate Lewin (1935) and Bronfenbrenner (1979) equation by stating the element of time overtly

$$I_t = f(P_t E_t). \tag{5.3}$$

The explicit formulation of the ecological systems theory for information systems innovation is given by

$$ISI_t = f(P_t, R_t, E_t, T_t), \quad (5.4)$$

where the dependent variable ISI is information systems innovation, P is a subject person, we replace the Person with Entrepreneur. R is a network of relational connections to collaborators within the innovation context, E is environment, T is technological capability. All variables are annotated with a subscript t for the particular point in time.

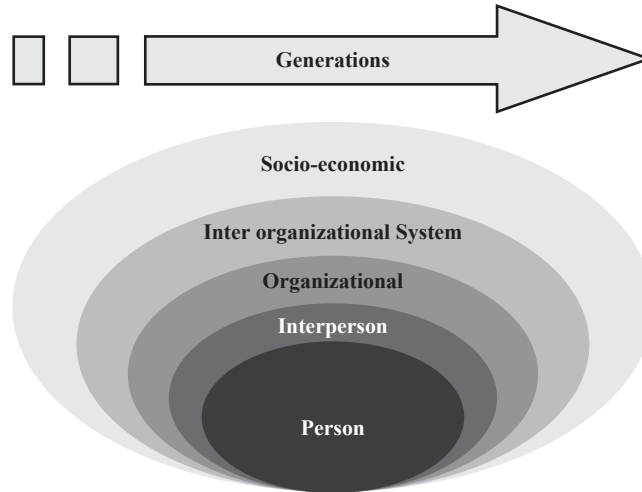


Figure 4. The Ecological Systems Framework for Innovation Source: Curley et al. (2012).

Figure 4 shows the revised ecological systems framework for innovation. The environment of the subject person -who is innovative entrepreneur from our perspective- is no longer consists of subsystems. Microsystems become interpersonal environment. Mesosystem turns out to be an organizational space. Exosystem is replaced by inter-organizational systems. Macrosystem is placed in a socio-economic context.

6. CONCLUSION

Innovation ecosystems and sustainable development require a theoretical framework for understanding of macro-meso-micro levels of economic analysis. Innovation ecosystem is a relatively new concept in economic literature. The definition and meaning of innovation ecosystem differs in relation to the level of analysis. We traced the evolution of innovation ecosystems from a metaphor toward a theory. Economic life is generally assumed to be better understood if it is seen as a living organism. However this assumption's practical importance and consequences have never hitherto investigated in detail. In this paper we traced the background of this assumption through its original premises to contrast a theoretical framework upon it.

Although there is no universally accepted general theory of innovation ecosystems, the different theoretical frameworks from different perspective help improve the understanding the similarities of ecological and economic systems. Types of innovation ecosystems are various and apt to vary through time and place. Global innovation ecosystems are comprised of regional innovation ecosystems which consist of quite complex networks within themselves. This aspect also changes the dynamics of demand and supply functions of market economies around the world.

Innovation technologies and information infrastructure of market economies determine the competitive power of countries. In order to understand these complex networks of digital and non-digital economies, connecting different types of innovation ecosystems and constructing a comprehensive theory of innovation ecosystems in relation to social, economic and human development is a challenge for future researches.

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