
Building innovation systems: an introduction to the special section

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1. Innovation systems theory: its history and components

The innovation systems approach is almost a quarter of a century old, if we start counting from Chris Freeman's seminal book on the Japanese national innovation system (NSI) (Freeman, 1987). With the publication of the reader edited by Dosi *et al.* (1988), incorporating the chapters by Freeman, Lundvall, and Nelson, the approach gained theoretical ground even if two slightly different perspectives competed. The one, epitomized by Lundvall (1992), suggested that innovation systems included all organizations and institutions (particularly interactions and norms) that contribute in one way or the other to innovation. This perspective is based on the OECD Oslo Manual, in which innovation is defined as any improvement on process or product. Nelson (1993) suggested instead that organizations that conduct R&D and institutions such as science, technology and innovation policy that support R&D form the core of the innovation system. The basic idea in both approaches is the same: OECD countries innovate in a different way. Their innovation organizations and policies are different. Yet innovation occurs in all of them. After 1990, the literature on national innovation systems increased exponentially, and the concept was adopted in several countries, where innovation policies were seen under a new, systemic light.

A few years later, the innovation system approach incorporated a regional perspective. The names of Cooke (1994) and Howells (1999) must be linked to this amplification toward regional systems of innovation (RSI). Again, the basic idea is simple and seminal: in each country, innovation is concentrated in a few regional centres. However, the extension brought new debates. Is the regional perspective to be privileged over the national one? Some authors suggested it was the case (de la Mothe and Paquet, 1998); others suggested the two perspectives were complementary (Niosi and Bellon, 1994; Howells, 1999). Yet, complexity increased because most

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innovation policies are national in scope, even if their results most often are produced at some regional levels.

The Sectoral Systems of Innovation (SSI) approach emerges from the work of Malerba (2002, 2004): “. . . different industries may have different competitive, interactive and organizational boundaries that are not necessarily national.” (Breschi and Malerba, 1997: 131). The SSI is as potentially fertile as the previous components of the innovation system perspective. A few examples will suffice. All countries, with maybe the exception of China, concentrate their innovation activities on a few industries. This observation is not confined to smaller countries such as Finland (where telecommunications equipment and forest products and equipment dominate the innovation system). It applies to every OECD and emerging country. The SSI addition sheds new light on the complexity of the innovation process. How do sectoral systems interact with national and regional ones? How are sectoral policies to be understood in the light of national ones? Why do some countries pull ahead or fall behind? Their SSI stories may help to understand such trajectories.

2. Building the innovation systems

Innovation systems are endowed with a variable degree of efficiency and effectiveness (Niosi, 2002). Their performance can be evaluated and improved, as can be the specific components of each system (innovation policies, research universities, public laboratories, and others). The issue applies not only to largely developed innovation systems, but also to incipient ones. Thus, the innovation system approach has a useful, applicable set of policy implications for OECD countries.

Lundvall (2007) suggested that the national innovation system approach was not only an analytical concept. It could also be used to build innovation systems in developing countries. On this topic, complexity increases, and new issues emerge. Let us summarize some of them:

1. Are there superior institutional practices to be learned and imitated? Are their inferior organizational and policy practices to be avoided? Some of us think yes, including, in this issue, the contributions of Mowery (2011), Niosi (2011), and Van Pottelsberghe (2011).
2. What are the time frames required to build national, sectoral, and regional innovation systems? Some authors suggest it takes decades to build an NSI (Mowery, 1992; Niosi, 2000). Yet there are examples of sectoral systems built in just over a decade, such as the Finnish telecommunication system (Ali-Yrkko and Hermans, 2004). Kenney (2011), but also Malerba and Nelson (2011), show that most often sectoral systems require decades of intensive investment.
3. Are innovation systems spontaneous, market-produced sets of organizations? A majority of the authors in innovation systems literature, as well as in this issue,

thinks that governments have a key role in orienting and funding technical innovation, at least at the national level, and particularly in the areas of innovation policy, academic and technological research, and higher education. However, all agree that markets have an important role in the building of innovative private-sector organizations and routines. Yet some authors (notably Teubal, 1996; Niosi, 2010) have underlined the fact that governments may have an influence in the choice of routines that private firms adopt. Well-designed innovation policies should induce innovating routines in private firms. Edquist (2011) points to the fact that policy design and implementation may fail.

3. The work ahead in innovation systems

The fertility of a theory relies in the areas it can integrate from other approaches and the new areas it opens to subjects not yet studied or just barely touched in the literature. Some of the major ones include:

1. What are the public administration requirements for organizational learning within the government sector? How does a developing country build a meritocratic government bureaucracy, one that is able and willing to design, evaluate, implement, and modify innovation policies? The innovation systems literature is very much centered in rich countries, where the efficiency and transparency of public sector bureaucracy is taken for granted. Yet a low quality, corrupt, and/or politicized and/or permanently changing bureaucracy based on loyalty (instead of efficiency) cannot learn or build innovation systems. Those that have studied developing countries believe that constructing such a meritocratic bureaucracy is a key condition for building new national, regional and sectoral innovation systems (Bellows, 1995; Rauch and Evans, 2000). The replacement of patronage by examination and meritocratic recruitment criteria occurred in Britain in the 1850s (Edwards, 2011). It is still a pending task in most developing and even emerging countries.
2. What are the interactions between different policies and organizations in innovation systems? What are the preferred sequences, if any, in building innovation systems? Are developing countries better off if they start building national sets of policies and institutions, then picking sectors, or regions, or the other way around? A few provisional responses have been suggested in the literature (Teubal, 1996; Niosi, 2010). But the evolution of national and regional innovation systems, including their failures and new starts, must be studied in more depth in order to understand what the most effective ways of building innovation systems are.

4. The special section

The papers in this special section bring some responses and some new issues to the forefront within this vast construction site.

Two papers examine the possibility of catching up in different sectors. Franco Malerba and Richard Nelson (2011) study (in their paper “Sectoral systems and catching up”) the building of sectoral systems in the context of catching up nations. The paper makes clear that each sector involves different types of innovating firms, public policies for learning and innovation, different market dynamics and technological trajectories, as well as different types of interaction among agents. By comparing six different sectors (agro-food, automobile, pharmaceuticals, semiconductors, software, and telecommunications) Malerba and Nelson show how varied sectors are, and how emerging countries have managed to overcome high barriers to entry in order to incorporate these sectors in their economies.

Martin Kenney (2011) analyzes the rise of the venture capital industry in the United States. In a sense, the venture capital industry is one that the United States has mastered and that many other nations have tried to imitate, but—as Kenney underlines—without much success. Kenney’s paper (“How venture capital became a component of the US NSI”) is complementary with the one by Malerba and Nelson. Is catching-up possible in a financial sector such as venture capital, where experience is at least as important and proper rules and regulations? Kenney echoes Lerner (2009), in that imitation in this sector has been fairly ineffective, particularly in developing countries.

Four other papers shed light on policy implementation, institutional performance, and policy failures. Innovation policy failures thus occur in all systems “developed”, “emerging” or “developing.” In his contribution, “Design of innovation policy through diagnostic analysis: identification of system problems (or failures),” Charles Edquist (2011) proposes a methodology to identify systemic policy problems, using diagnostic analysis. Such an analysis requires an understanding of how the system operates its performance, its innovation intensity, as well as the division of labor between public and private organizations such as innovative firms, incubators, venture capital organizations, and the like. The paper is very much in the same line as those by Teubal (1996) and Niosi (2002) already mentioned. Performance is judged by comparison (“benchmarking”) with other systems, and innovation institutions are not optimal but simply shaped by historical contingencies.

Bruno van Pottelsberghe de la Potterie’s paper (2011) deals with one dimension of innovation systems: patent policy. His contribution (“The quality factor in patent systems”) compares the European, the Japanese and the US patent systems in order to assess their cost and quality. He finds that the European system provides a high-quality evaluation of patents but at much higher cost than the American

system, while the Japanese patent system lies in-between in both cost and quality. He proposes that such systems need to converge in order to reduce costs by increasing mutual recognition of patents, and enhancing the demand for patents. The paper illustrates the “system failure” issue that several authors have underlined.

The many necessary institutions that are needed to grow biotechnology are often deficient and sometimes absent in several OECD countries. Jorge Niosi’s paper (2011) (“Complexity and Path Dependence in Biotechnology Innovation Systems”) goes a long way in that direction. He suggests that in biotechnology there is no international convergence, the United States maintaining its early leadership. Most potential catchers-up are either trapped in less efficient institutions, or they plainly do not understand the nature of the advantages that the leader has built in order to keep its supremacy. Such advantages include a much higher public investment in higher education and public research, global recruitment of academics and researchers, a better patent system, a strong venture capital industry, and cultural acceptance of biotechnology in all its applications.

David Mowery’s paper (2011), “Learning from one another? International policy emulation and university-industry technology transfer”, studies policy emulation in academic intellectual property rules. More precisely he analyzes the emulation of the Bayh-Dole Act that the United States implemented in 1980 and that is widely (and wrongly according to him) credited with having increased university–industry technology transfer. His article suggests, like Niosi’s paper, that US performance is the result of a large set of institutional factors, particularly at the higher education level. The simple imitation of Bayh-Dole will not—according to him—substantially increase university–industry links and technology transfer. The US high performance at the creation and growing of new technology-based firms is the result of a complex and tangled set of institutions.

In sum, this issue explores some of the frontier developments in innovation systems theory. It shows that the building of national, regional, and sectoral systems (like all human activity) is loaded with uncertainty, trial and error, and tinkering. The simple coping and pasting of institutions and policies from one context to another will not produce economic development or innovation. A deep understanding of the institutional conditions under which policies produce results is needed to move forward and create innovation systems in developing and emerging nations, or modify existing policies in affluent ones.

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