4. The European national and regional systems of innovation

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1. INTRODUCTION

Innovation has been recognized as a major source of competitiveness of firms and regions. It is recognized as highly relevant to economic performance and sustainability and thus it has been gaining increased support and attention. Public policies in new technologies aim exactly to reinforce technological capabilities in order to enhance productivity, competitiveness and economic growth. Public support is usually given in the form of 'direct and indirect measures', namely grants, loans, tax concessions and equity capital. Regional differences remain the prime source of competitive advantage. A long-term approach to development of regional knowledge economies must therefore combine local (regional) bottom–up approaches with global or European top–down approaches.

This chapter attempts to examine the structure and role of national and regional systems of innovation and their implications for sustainable development and integration and convergence in the EU.

2. NATIONAL AND REGIONAL SYSTEMS OF INNOVATION

The interaction between technological innovation, social learning and economic development is crucial for the survival and growth of the systems of innovation, at national or regional level. Technological policies aim to support and promote the new technologies through different 'direct and indirect measures'. 'Direct measures' usually include different subsidies, or different favourable tax treatments for research and technological activities. 'Indirect measures' are carried out in the pursuit of other policy objectives (e.g. competition policy, monetary, fiscal policies etc.), and, consequently, affect different research and technological activities. The interactive model demonstrates the main interconnections between three

systems: society, technology and economy (Mahdjoubi, 1998). Innovation, as a socio-technical comprises system, two main divisions (Korres, 2012):

- Social innovation (social structures, human resource development).
- Technological innovation (technical development).

These two structures foster the development process.

Freeman and the 'Aalborg version' of the national innovation system approach (Freeman, 1987; Freeman and Lundvall, 1988) aim at understanding 'the innovation system in the broad sense'. The definition of 'innovation' is broader. Innovation is seen as a continuous cumulative process involving not only radical and incremental innovation but also the diffusion, absorption and use of innovation and a wider set of sources of innovation is taken into account. In this respect, innovation is seen as reflecting, besides science and R&D, interactive learning taking place in connection with ongoing activities in procurement, production and sales. A wide definition of innovation should be used, including product innovations (both material goods and intangible services) as well as process innovations (both technological and organizational ones).

While there are competing conceptions regarding what constitutes the core elements of an innovation system, it might still be useful to see what the different definitions have in common.

- One common characteristic is the assumption that national systems differ in terms of specialization in production, trade and knowledge (Archibugi and Pianta, 1992). The focus is on the co-evolution between what countries do and what people and firms in these countries know how to do well. This implies that both the production structure and the knowledge structure will change only slowly and that such change involves learning as well as structural change.
- A common assumption behind the innovation system perspective is that knowledge is something more than information and includes tacit elements (Polanyi, 1966). Important elements of knowledge are embodied in the minds and bodies of agents, in routines of firms and not least in relationships between people and organizations (Dosi, 1999).
- Another feature of the idea of innovation systems is a focus on interactions and relationships. The relationships may be seen as carriers of knowledge and interaction as processes where new knowledge is produced and learnt (Johnson, 1992; Edquist and Johnson, 1997).
- A final common assumption behind the different approaches to innovation systems is that elements of knowledge important for

economic performance are localized and not easily moved from one place to another.

We can use the term 'innovation' rather broadly in order to include processes through which firms master and practise product designs and manufacturing processes that are new to them. The term indicates a set of institutions whose interactions determine innovative performance. The term 'system' refers to a set of institutional actors who play a major role in influencing the innovative performance. We use the term 'national systems of innovation' to indicate policies that are related to research and technological activities planning (from both a macro- and microeconomic view) in a country (Korres, 2012).

Systems of innovation may be delimited in different ways; spatially/geographically or sectorally, accordingly to the breadth of activities they consider.

- Geographically defined innovation systems may be local, regional, national or supranational. This type of delimitation presumes that the area in question has a reasonable degree of 'coherence' or 'inward orientation' with regard to innovation processes.
- Sectorally delimited systems of innovation include only a part of a regional, national or international system. They are limited to specific technological fields (generic technologies) or product areas. They can be, but are not necessarily, restricted to one sector of production. Both 'technological systems' (Carlsson and Stankiewicz, 1995) and 'sectoral innovation systems' (Breschi and Malerba, 1997) belong to this category. Whether a system of innovation should be spatially or sectorally delimited – or both – depends on the object of study.

The system of innovation approach is also associated with problems and weaknesses. One example is the term 'institution', which is used in different senses by different authors – some refer to social norms, such as trust, while others refer to types of organizations, such as universities.

Another important point is that there is no agreement among scholars regarding what should be included in and what should be excluded from a 'system of innovation'. It should also be pointed out that 'systems of innovation' is not a formal theory, in the sense of providing propositions regarding established and stable relations between well-defined quantitative variables. According to the World Bank (2002, p. 8), institutions have three main objectives: they channel information about market conditions, goods and participants; they define and enforce property rights and

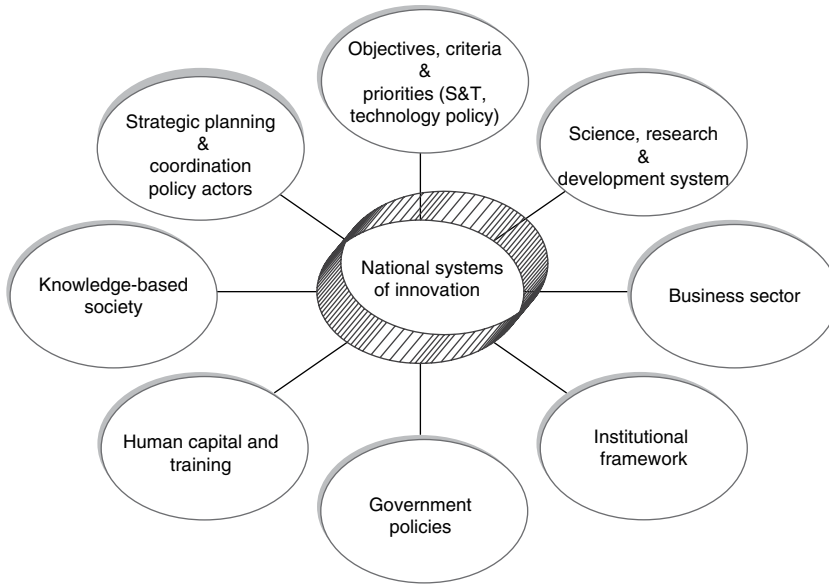


Figure 4.1 National systems of innovation (NSI)

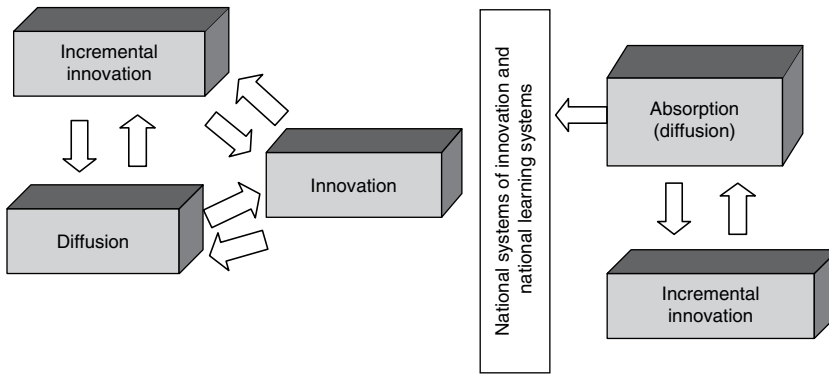


Figure 4.2 National systems of technical change

contracts; and they regulate competition. The overall structure of the functionality of national systems of innovation (NSI) is shown in Figure 4.1.

Figure 4.2 illustrates national and regional systems of innovation and technical change. Regions are considered to play a crucial role in the European Research Area, because they bring policy measures close to the citizen, thereby following the subsidiarity principle, and because they

bridge the EU level and the local level (CEC, 2001). Regions can differ substantially with respect to their industrial specialization, their connections at the national and global level and, in particular, with respect to their potential to face national and global competition. Therefore policy measures are best adapted to the region at hand. It makes sense to regionalize innovation policy for the following four reasons (Korres, 2012):

- Innovation processes take place unevenly in geographic space.
- Innovation networks function differently in various regions.
- Innovation activity is crucial for economic development and growth on the regional as well as on the national level.
- Using various policy approaches in different regions enables countries to gain much more varied experiences, thereby enabling regions to learn from one another.

Recently, academics and policy makers have begun to refine the idea of national innovation systems, considering the utility of 'regional innovation systems' as both a theoretical concept and a policy objective (Cooke et al., 1997). Whilst the regional innovation systems perspective is clearly a development of the innovation systems literature, it can also be considered part of the 'new regionalism'.

The concept of regional innovation systems has been gaining much attention from policy makers and academic researchers since the early 1990s. The approach has been seen as a promising analytical framework for advancing our understanding of the innovation process in the regional economy (Asheim et al., 2003; Cooke and Memedovic, 2002). The popularity of the concept of regional innovation systems is closely related to the emergence of regionally identifiable nodes or clusters of industrial activity as well as the surge in regional innovation policies where the region is deemed as the most appropriate scale at which to sustain innovation-based learning economies (Asheim and Isaksen, 1997).

Most of the new contributions in regional economics are clearly indebted to the pioneering works and intuitions of Marshall, who stressed the importance of local externalities in favoring the geographical concentration of economic and innovative activities. 'Regional innovation systems' has no commonly accepted definition, but is usually understood as a set of interacting private and public interests, formal institutions and other organizations that function according to organizational and institutional arrangements and relationships conducive to the generation, use and dissemination of knowledge (Doloreux, 2003). The basic argument is that this set of actors produces pervasive and systemic effects that encourage firms within the region to develop specific forms of capital derived

from social relations, norms, values and interaction within the community in order to reinforce regional innovative capability and competitiveness (Gertler et al., 2000).

As Asheim and Gertler (2005) point out, regional innovation systems are not sufficient on their own to remain competitive in a globalized economy and production systems seem to be rather important to innovation systems at the regional level. Moreover, as these authors assent, local firms must also have access to national and supranational innovation systems, as well as to corporate innovation systems. This line of reasoning is followed to a point where the regional innovation system expands beyond its own boundaries through a process of economic integration and globalization.

Many elements characterizing a national system could be, in principle, transferred to a smaller territorial scale and used also to define the regional system of innovation, including Korres (2012):

- the internal organization of firms
- interfirm relationships
- role of the public sector and public policy
- institutional set-up of the financial sector
- R&D intensity and organization
- institutional framework, for instance regional governance structure, political, legal, fiscal, financial and educational arrangements etc.
- production system (including the competition and collaboration faced by firms, market structure, the division of labor and sectoral specialization)
- degree of openness and the capacity to attract the external resources and core hierarchical forces taking into account the peculiarities of different geographical scale.

Many studies of regional innovation systems are motivated by the relation between technical advances and regional growth, depending on the amount of technological knowledge in a region. The concept of regional systems of innovation (RSI) is distinctly different from that of national systems of innovation (NSI). A schematic illustration of the structuring of RSIs is shown in Figure 4.3, which distinguishes between the two subsystems that constitute the main building blocks of RSIs. These are the knowledge application and exploitation subsystem and the knowledge generation and diffusion subsystem. (The main external influences on RSIs take the form of NSI institutions and policy instruments, other RSIs, and international institutions and policy instruments.)

The first subsystem consists mainly, but not exclusively, of industrial companies, while the second comprises various (mostly public sector)

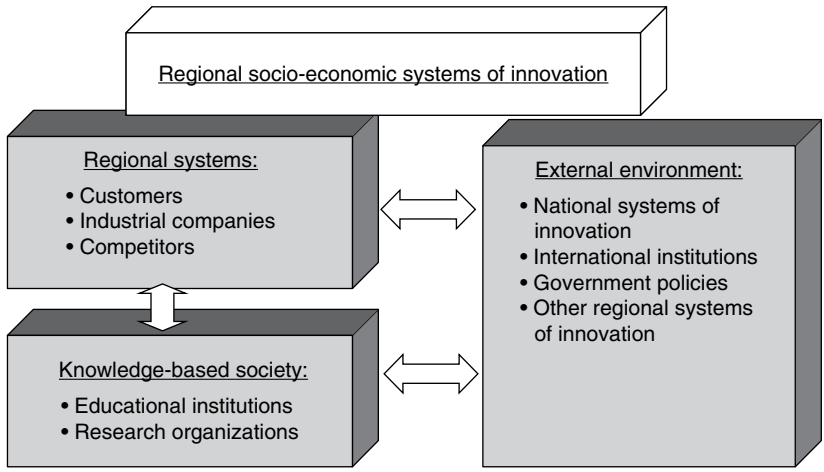


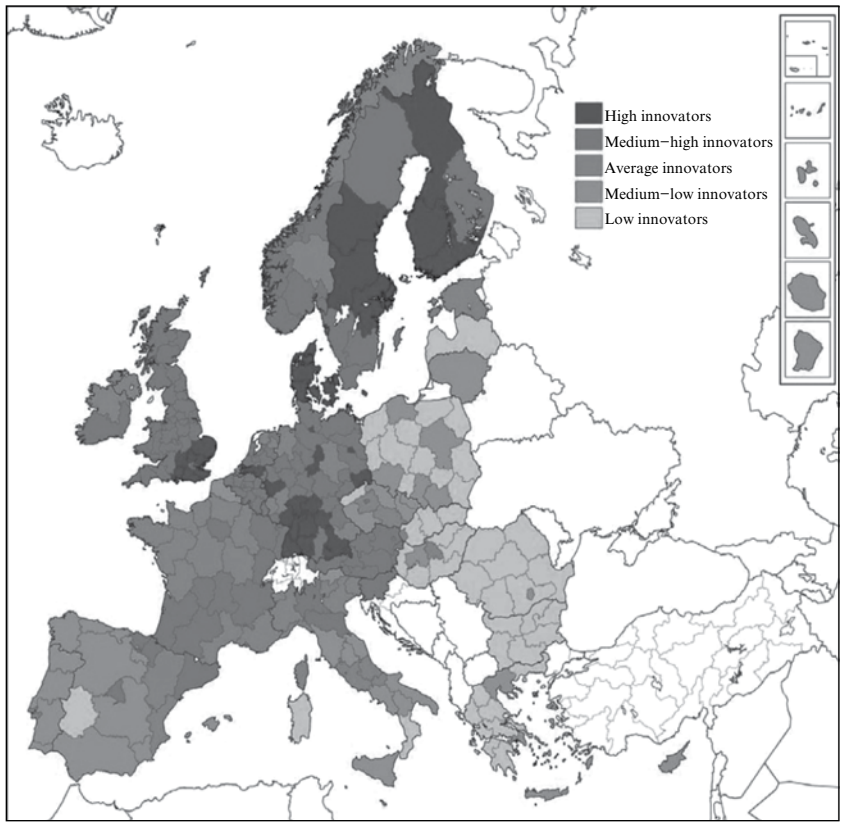
Figure 4.3 The structuring of regional systems of innovation

institutions involved in knowledge creation and diffusion. The distinction between these two subsystems largely corresponds to the division between public and private sectors and between non-commercial and commercial activities.

3. THE EUROPEAN REGIONAL SYSTEMS OF INNOVATION

The EU is one of the most prosperous economic areas in the world but the disparities between its member states are striking, especially if we look at the EU's 250 regions. To assess these disparities, we must first measure and compare the levels of wealth generated by each country, as determined by gross domestic product (GDP). For instance, in Greece, Portugal and Spain, average per capita GDP is only 80 percent of the Community average. Luxembourg exceeds this average by over 60 percentage points. The ten most dynamic regions in the EU have a GDP almost three times higher than the ten least developed regions. Figure 4.4 illustrates the European regional innovation performance groups. We can summarize some of the main results (INNO-Metrics, 2009):

- There is considerable diversity in regional innovation performance. The results show that all countries have regions at different levels of performance. The most heterogeneous countries are Spain, Italy



Source: European Commission (2010).

Figure 4.4 European regional innovation performance groups

and the Czech Republic, where innovation performance varies from low to medium-high.

- The most innovative regions are typically in the most innovative countries. North Brabant in the Netherlands is a highly innovative region located in an innovation follower country. Prague (Czech Republic), Basque Country, Navarre, Madrid and Catalonia in Spain, Lombardy and Emilia-Romagna in Italy, Oslo and Akershus, Agder and Rogaland, and Western Norway are all medium to highly innovating regions from moderate innovators. The capital region in Romania, Bucharest–Ilfov, is a medium–low innovating region in a catching-up country.

- Regions have different strengths and weaknesses. There are no straightforward relationships between the level of performance and relative strengths; many of the 'low innovators' have relative weaknesses in the dimension of innovation enablers, including human resources.
- Regional performance appears relatively stable since 2004. Most of the changes are positive and relate to Catalonia, Valencia, the Balearic Islands and Ceuta (Spain), Paris Basin, East and South-west France, Lower Franconia (Germany), Közep- Dunántúl (Hungary), the Algarve (Portugal) and Hedmark and Oppland (Norway).
- In terms of scientific publications, Europe's strong growth seems to have halted. Actual numbers are still rising, but the EU share of world publications is declining, whereas the US share is recovering.
- Regarding per capita shares, the EU generates fewer patents with high economic value than the USA or Japan.
- The EU is lagging behind the USA in its share of patents in biotechnology and information and communications technology.
- There has been a slight increase in the EU share of global exports of high-tech products in value terms between 1996 and 2001. Japan's share fell sharply in 2001, hit by falling sales of electronic goods.
- Since the middle of the 1990s, the EU has stopped catching up with the USA in terms of labor productivity.
- Large disparities persist among EU countries in high-tech manufacturing. Japan outperforms the EU in high-tech manufacturing indicators while the Central European countries perform better than the EU average.
- The production of scientific research and technological know-how increasingly depends on research conducted in other countries. Indicators of cross-border co-authorship of scientific articles and co-invention of patents seek to shed light on this trend.
- Scientific collaboration with advanced countries is generally much more widespread than with smaller ones. Researchers in 160 countries co-authored at least 1 percent of their internationally co-authored papers with US researchers. The UK, France and Germany also play a leading role in international scientific collaboration.
- By the late 1990s, about 6 percent of patents were the result of international collaborative research. Several factors may affect the degree of a country's internationalization in science and technology: size, technological endowment, geographical proximity to regions with high research activity, language, industrial specialization, existence of foreign affiliates and so on.

- Internationalization tends to be higher in smaller European countries. For example, 56 percent of Luxembourg's patents have foreign co-inventors compared with 30 percent of Iceland's and Belgium's. International cooperation in science and technology is also relatively high in Poland, the Czech Republic and the Slovak Republic.
- International collaboration in patenting is lower in the EU than in the USA. In Japan, international cooperation in science and technology is rather limited.

'Europe Strategy 2020' is a ten-year growth strategy proposed by the European Commission in March 2010 for reviving the economy of the EU to become a smart, sustainable and inclusive economy.

The EU identifies three key drivers for growth, to be implemented through concrete actions at EU and national levels (Korres, 2012):

- smart growth (fostering knowledge, innovation, education and digital society);
- sustainable growth (making production more resource efficient while boosting competitiveness); and
- inclusive growth (raising participation in the labor market, the acquisition of skills and the fight against poverty).

Table 4.1 illustrates the objectives of the European regional innovation strategy for the period 2010–13. The EU strategy towards regional innovation policy emphasizes the following points:

- enhance the scientific and innovation framework and the related structural changes;
- encourage and expand the creation and growth of innovative enterprises; and
- improve the key interfaces in the innovation system.

The main objectives of technological policy may be summarized under five headings:

- improve the efficiency of the transfer of technology from foreign suppliers to local users;
- increase the efficiency of operation of technology;
- strengthen the industrial base;
- develop the indigenous technological capability; and
- smooth adjustment forced by new technologies.

Table 4.1 Objectives of the European regional innovation strategy, 2010–13

General objective: increase of innovation and competitiveness of the regions		
Pillars		
I	II	III
Economy based on knowledge	**Innovation culture**	**Innovative management**
Objective: Transition of the regions into the region based on knowledge and the center for innovation	*Objective:* Improvement of intangible environment supporting innovations (culture, attitudes, norms and behavior patterns, human capital) and the increase of the susceptibility of local authorities and society to innovations	*Objective:* Higher efficiency and innovativeness in the development process support
Priorities		
• Increased financial support, especially from the state, on R&D • Enhancing regional R&D potential and the effectiveness of the R&D institutions • Support to development of high technology industries • Transition of traditional industries into the more scientific-based • Development of information society and knowledge-based economy services	• Promotion of innovation and entrepreneurship • Education for innovation	• Durable partnership • Anticipating the future • Effective mechanisms of implementation

Source: ec.europa.eu/regional_policy/conferences/od2006/doc.

In addition, science and research policies should be oriented towards two main objectives:

- to assess the possibilities and needs of private and public enterprises with respect to research and technological activities;
- to choose those priority objectives that can delineate government technological action.

Small countries are likely to need a more comprehensive and targeted policy of cooperative innovative effort in order to develop their future capabilities and make the necessary choices for technological priorities. The participation of member states in the EU research and technological programmes can increase the opportunities for promotion and improvement of research activities, creation of new research institutions so as to support innovation and diffusion of new technologies and, therefore, to improve the level of economic and regional growth and induce social development.

4. CONCLUSIONS

New technologies imply some direct and indirect effects or, more specifically, some micro effects (such as firms or organizations) and macro effects (such as inter- and intra-industrial and regional effects) for the whole economy. New technologies play an important role in sectoral productivity, overall growth, employment, modernization, industrialization, socio-economic infrastructure and competitiveness of a country.

The Community's research programmes also attempt to establish cooperation between theoretical research through the different research bodies of the public sector (such as research institutes and universities) and industrial research through private enterprises.

We can summarize the main conclusions and policy implications as follows: technology policy has been heavily concerned with the external gap of the EU *vis-à-vis* Japan and the USA. However, the same size of gap also exists among EU countries. It is true that technological competition among Japan, the USA and the EU is intense. Moreover, one tends to find most of the European countries in a position of catching up from relatively low levels of S&T output. Although there are some noticeable encouraging tendencies in several European countries, one can expect that with the enlargement of the EU the 'European paradox' will be, at least temporarily, further accentuated. In other words, in relation to its enlarged population, the EU-27's strong performance in science will

contrast increasingly with its weaker development and commercialization of technology.

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