European Journal of Geography Volume 4, Issue 2: 6-16, 2013

THE ROLE AND THE EFFECTS OF NATIONAL SYSTEMS OF INNOVATION IN EUROPEAN REGIONAL GROWTH

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Abstract:
Research and Development is directly related with industrial infrastructure, productivity effects and regional development, through "national system of innovation" indicating the national technological capabilities, as well as the underlying structure and planning on Research and Development. European technological policy has an important role for the economies of member states. Technological policy aims to reinforce national competitiveness along with convergence between member states. The purpose of this paper is to analyse and examine the evaluation and the development of European Union policy and how it can be implemented to member states. This paper also attempts to examine the effects of innovation activities and the impact of innovation policy on growth, productivity and integration process.

Keywords: *Innovation, National System of Innovation, Integration, Convergence.*

1. INTRODUCTION

The growing importance of technological change in world production and employment has been one of the characteristics of the last decades. Technological change has not been only a determinant of growth, but it has also affected the international competition and the modernization of European Union countries. The choice of technology depends upon a large

number of factors: the availability of technologies, the availability of information, the availability of resources, the availability of technology itself and its capacity for successful adoption to suit the particular needs and objectives. Technologically advanced countries, being among the leaders in technological change, tend to put a great deal of emphasis on policies which aim to enhance the development of research and technological activities.

Within the economic growth context, the adoption and diffusion of new technologies affect the structure and the competitiveness level of a national economy. The principal effects of technological policy can be distinguished in demand and supply driven. Economic performance in the majority of European Union manufacturing industries and services depends to a large extent on technology creation and diffusion, along with the collaboration of private and public research and technology efforts, as well as public policies on innovation-enhancing environment. This paper focuses on the importance of R&D innovation activities towards the productivity level enhancements (through increases in production value added).

2. TECHNOLOGICAL FRAMEWORK AND THE NATIONAL SYSTEM OF INNOVATION

National system of innovation helps to understand and explain, why the development of technology is necessary in a certain direction and at a certain rate. The term "innovation" is used rather broadly, in order to encompass the processes by which firms master and get into practice innovative product designs and manufacturing processes. The term "system" indicates a set of institutions whose interactions determine the innovative performance, in other words a set of institutional actors that play the major role, influencing innovative performance (Nelson, 1993). We use the term "system of innovation", in order to indicate coordinating policies that are related with research and technological activities planning (both in a macro and micro economic view).

The first broad approach of "system of innovation" is that, it is a social system that is constructed by a number of elements, which interact in the production and diffusion of new technologies, including different parts of economic structure (such as the production system, and the marketing system). The second narrow approach of "system of innovation" is that, it includes organizations and institutions involved in new technologies creation and diffusion (such as technological institutes and research departments) (Lundvall 2010, Nelson 1993).

Even though the firm-specific factors are important determinants of innovation activity, technological opportunities and favorable entrepreneurial environment have a positive effect on innovation activity, as well. Technological change, innovation and technology creation and diffusion are an important factor to economic progress. While innovation may lead to divergence between firms or nations, imitation through diffusion and dissemination tends to erode differences in technological competencies, and hence lead to convergence (Fagerberg and Verspagen, 2002). On the other hand, combining the production functions in order to create and disseminate innovations leads to improvements in productivity and economic development (Malecki and Varaia 1986; Malecki 1991, Fagerberg and Verspagen, 2002).

The economic processes that create and diffuse the new knowledge are critical in the development process and there are powerful contacts between the investment in the human capital, the technological change and finally the economic growth (Acs, Anselin and Varga, 2002). As a motive force, it prompts the enterprises to long-term development objectives and the advancement of productive structures, so that they maintain the elements of growth, competitiveness and employment. Investments in new technologies aim to the modernisation of productive process and the qualitative upgrade of products, which is one from the basic factors of

increase of enterprises. The reason is that the new technologies lead to increase of productivity of factors of production, contributing in the long-term improvement of competitiveness (Griliches, 1980). The technology, also, contributes in the growth of economy, on the one hand because the new or improved products that result from innovations improve the level of existence, and on the other hand, because, with regard to the international trade, the record of open economy depends also from the propensity to innovativeness (Fagerberg, 1988). One additional reason is that via innovation the individual and collective needs are satisfied better which constitutes fundamental element of entrepreneurial spirit. The same holds also for countries and economies, which in order to maintain the elements of growth, competitiveness and employment, owe to change fast the new ideas in technical and commercial successes.

Innovative actions are considered to be rather important to economic growth, development and welfare. Firstly, they stimulate investments which introduce new commodities and processes, which improve the living standards of the society. Moreover, they lead to new developments, which increase the comparative advantage of an economy and affect positively the trade performance and competitiveness of a country worldwide. These effects result in a greater level of economic growth. On the other hand, innovation is rather important to an individual firm for two main elements, namely a double role in the incentives of the companies to pursuit and invest on it.[1] Firstly, a corporation, which undertakes R&D programmes, acquires new information and knowledge to embody in the new commodities, as well as new production and marketing processes, ready to be employed in product and process innovation. As a result, through innovation, a company is able to develop directly new products and processes and bring them to the market acquiring an advantage over its competitors. Furthermore, it can enhance the ability of the firm to develop and maintain capabilities to absorb and expand technology information available by external sources, and identify, assimilate and exploit new knowledge and technology produced elsewhere (Cohen and Levinthal, 1989).

The systematic analysis and the theoretical framework of the effects of innovation on the economic efficiency, productivity and growth is based on endogenous growth theory developed by Solow, 1957, Arrow, 1962, Romer 1986 and 1990, Lucas, 1990 and 1993. Endogenous growth theory claimed that not only the accumulation of capital, but mainly the development and accumulation of knowledge and technological change leads to increased and sustainable growth. The reason is that the long-run productivity decrease is avoided, due to capital accumulation through the qualitative-technological improvements of natural and human capital. According to Romer (1986, 1990), knowledge and technological progress are the main engines of economic dynamism and the economy grows endogenously through the accumulation and spillover of knowledge. Growth rate depends on the amount of technological activity within the economy and on the ability of the economy to exploit external technological achievements (Martin and Ottaviano, 1999, Grossman and Helpman, 1994, Coe and Helpman, 1995). Increasing returns and technical change are incorporated within the production function as determinants of the endogenous growth rate (Romer 1986, Lucas 1988, Grossman and Helpman 1991, Barro and Sala-i-Martin, 1997) and economic growth is sustained because of the continuous creation and diffusion of knowledge.

In the modern knowledge economy, growth depends extensively on the presence or the formation of a network and environment favorable to innovation, which is based on the

[1] Cohen and Levinthal (1989) called this double role of innovation ‘dual role’.

endogenous development capabilities, creating systems of innovation, either in national, international and regional level.

Figure 1 illustrates the flows of National, International and Regional Innovation Systems:

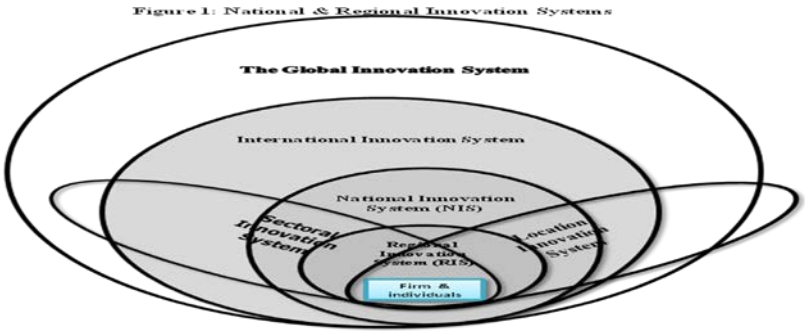
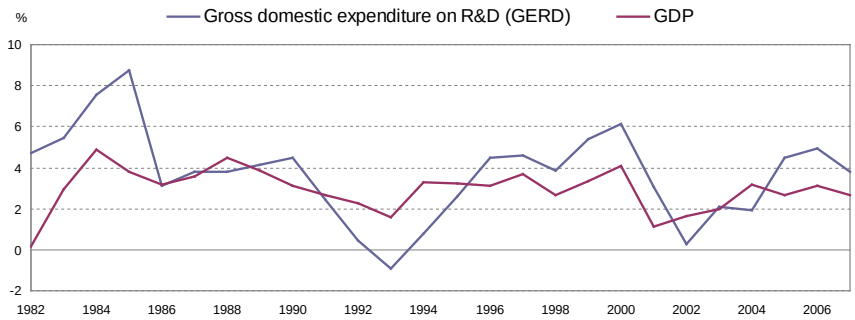


Figure 1. National, International and Regional Innovation System

As it has been broadly described above, innovation is a key factor to determine productivity growth. Innovation helps in understanding the sources and patterns of innovative activity in the economy, as a fundamental prerequisite to develop better policies. As such, innovation assists Member States in identifying their own strengths and weaknesses and in designing corresponding policies and programmes.

3. INNOVATION ACTIVITIES WITHIN THE EUROPEAN UNION SYSTEM OF INNOVATION

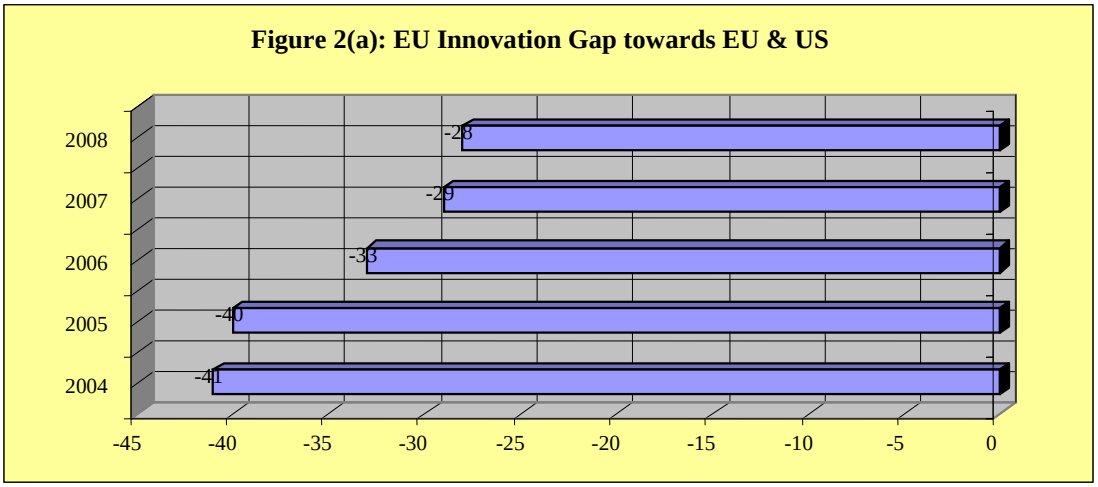
Within this framework, an important contribution of the endogenous growth theory (Romer, 1987 and 1990) has been to identify the central role that knowledge and knowledge spillovers play in creating and sustaining growth. Pavitt and Soete (1982) examined growth as a result of the development of new knowledge in a country and the diffusion of knowledge between countries. According to Fagerberg (1987) there is a close relation between a country's economic and technological level of development. The rate of economic growth of a country is positively influenced by technological level of the country and its ability to increase it through imitation and exploitation of the possibilities offered by technological achievements elsewhere. Krugman (1991) identified the major role that knowledge spillovers play in generating increasing returns and higher growth. Geroski and Machin (1993) asserted that innovations positively affect the development of enterprises and economies. Moreover, according to Silverberg and Verspagen (1995), technological change and diffusion constitute important factors in long-run macroeconomic growth and development. Moreover, Barro and Sala-i-Martin (1995 and 1997) asserted that growth rate may increase in correlation with technological growth. Furthermore, Freeman and Soete (1997) focused on the importance of technology and innovation claiming that lack of innovation leads to economic death. At the same point of view. Sternberg (2000) said that in industrialized economies the rate of long-term macroeconomic growth depends on the ability of constant development of innovative products and processes. Figure 2 illustrates the gross domestic expenditure on R&D, as well as the GDP growth rate in European Union during the period 1981-2007. It is apparent that there is a common trend, as far as the evolution of these two indicators is concerned:

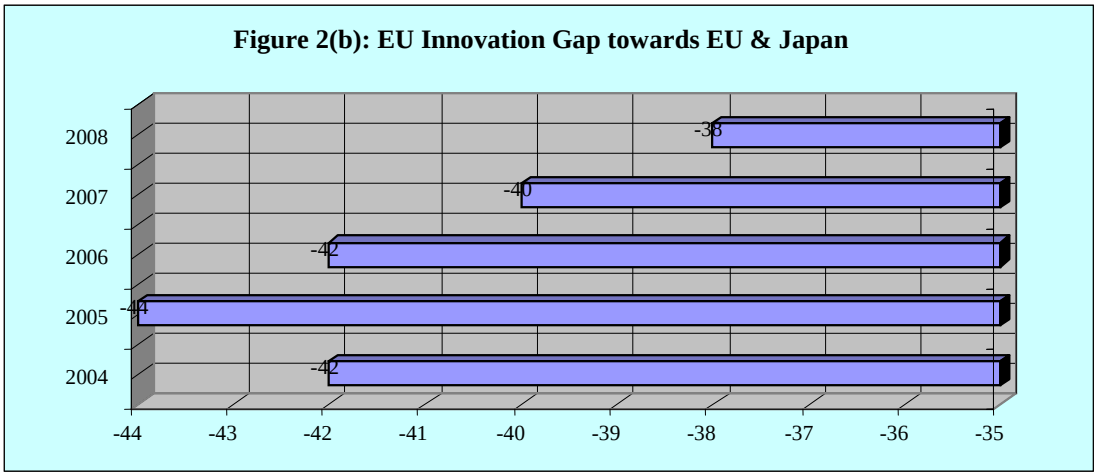


Source: Data derived from EU KLEM Database

Figure 2. Gross domestic expenditure on R&D, 1981-2007

Even though there is a certain level of gross expenditure on R&D, which moves along the GDP growth evolution, there is still a significant gap between European Union compared to USA and Japan. Figure 3 illustrates this innovation gap between EU, Japan and USA.





Source: Data derived from EU KLEM Database.

Figure 3. E.U. Innovation Gap

Figure shows that the innovation performance of the US and Japan is well above that of the EU27.

The 2009 European Innovation Scoreboard (EIS) provides a comparative assessment of the innovation performance of EU27 Member States, under the EU Lisbon Strategy, reporting overall innovation performance as calculated on the basis of 29 indicators covering five dimensions of innovation, (European Commission, 2009a and 2009b):

- **Innovation drivers** measure the structural conditions required for innovation potential;
- **Knowledge creation** measures the investments in R&D activities;
- **Innovation & entrepreneurship** measures the efforts towards innovation at the firm level;
- **Applications** measures the performance expressed in terms of labour and business activities and their value added in innovative sectors; and
- **Intellectual property** measures achieved results in terms of successful know-how.

The 2009 EIS report shows that most Member States until 2008 were steadily improving their innovation performance. The economic crisis may, however, be hampering this progress. Early indications show that the worst hit are Member States with lower levels of innovation performance, potentially reversing the convergence process witnessed over recent years. Meanwhile, the latest statistics show that the EU is having difficulty in catching up with the US in innovation performance, although it maintains a clear lead over the emerging economies of Brazil, Russia, India and China, despite rapid improvements in China. More specifically, the members states of the EU - 27 fall into the following four country groups ((European Commission, 2009a and 2009b):

- Denmark, Finland, Germany, Sweden and the UK are the **Innovation leaders,** with innovation performance well above that the EU27 average and all other countries. Of these countries, Germany and Finland are improving their performance fastest while Denmark and the UK are stagnating.
- Austria, Belgium, Cyprus, Estonia, France, Ireland, Luxembourg, the Netherlands and Slovenia are the **Innovation followers,** with innovation performance below those of the Innovation leaders but close to or above that of the EU27 average. Cyprus, Estonia and Slovenia have shown a strong improvement compared to 2008, providing an explanation why these countries have moved from the Moderate innovators in the EIS 2008 to the Innovation followers,
- Czech Republic, Greece, Hungary, Italy, Lithuania, Malta, Poland, Portugal, Slovakia and Spain are the **Moderate innovators,** with innovation performance below the EU27 average. The EIS 2009 Moderate innovators are a mix of 5 Member States which were Moderate innovators in the EIS 2008 and 5 Member States which were Catching-up countries in the EIS 2008.
- Bulgaria, Croatia, Latvia, Romania, Serbia and Turkey are the **Catching-up countries.** Although their innovation performance is well below the EU27 average, this performance is increasing towards the EU27 average over time. All the countries are rapidly closing their gap to the average performance level of the EU27, and Bulgaria and Romania have been improving their performance the fastest of all Member States. This year's assessment shows that there continues to be convergence amongst the groups, with Moderate innovators and the Catching-up countries growing at a faster rate than the Innovation leaders and Innovation followers.

As far as each country is concerned, Germany, Cyprus, Malta and Romania are the EU27 countries displaying the largest improvement within their peer groups. Within each of the country groups there is variation in growth performance, with Finland and Germany showing the

best growth performance of the Innovation leaders. Cyprus, Estonia and also Slovenia are the fastest growing Innovation followers. Czech Republic, Greece, Malta and Portugal are the fast growing Moderate innovators and Bulgaria and Romania are not only the fastest growers among the Catching-up countries but also overall.

On the other hand, an impressive average annual growth rate over the last five years has led Estonia and Cyprus to catch up with the EU27 average innovation performance in 2009. Both Cyprus and Estonia have improved their performance from below the EU27 average in the EIS 2008 to an above average performance in the EIS 2009. For Cyprus strong growth in Finance and support, Linkages & entrepreneurship and Throughputs have been the main drivers of its improvement in innovation performance. For Estonia strong growth in Firm investments and Throughputs have been the main drivers of its improvement in innovation performance.

Although the EU27 has been, overall, improving its innovation performance, the economic crisis may threaten this good progress, particularly in moderate innovators and catching - up countries. The EU27 is making overall progress, with particularly strong increases in the numbers of graduates in science, engineering, social sciences and humanities, venture capital, private credit, broadband access, community trademarks, community designs, technology balance of payments flows and sales of new-to-market products.

4. INNOVATION ACTIVITIES AND SYSTEM OF INNOVATIONS IN EU

As the regional level is important for economic development and for the design and implementation of innovation policies, it is important to have indicators to compare and benchmark innovation performance at regional level. Such evidence is vital to inform policy priorities and to monitor trends. As a result, the 2009 RIS is able to replicate the methodology used at national level in the European Innovation Scoreboard (EIS), using 16 of the 29 indicators used in the EIS for 201 Regions across the EU27 and Norway. Changes over time are considered using principally data from 2004 and from 2006, (European Commission, 2009a and 2009b).

The 2009 Regional Innovation Scoreboard (2009 RIS) adopts the European Innovation Scoreboard approach at regional level and provides richer analysis compared to previous reports due to the availability of more comprehensive regional Community Innovation Survey data. The analysis shows that all major EU27 countries have diverse levels of performance and relative strengths within their regions, and that Spain, Italy and the Czech Republic are the most heterogeneous. The 2009 RIS marks a significant step forward in measuring regional innovation performance although it also shows that more progress is needed on the availability and quality of innovation data at regional level. Despite this progress, the data available at regional level remains considerably less than at national level. Due to these limitations, the 2009 RIS does not provide an absolute ranking of individual regions, but ranks groups of regions at broadly similar levels of performance. The main findings of the 2009 Regional Innovation Scoreboard are (European Commission, 2009a and 2009b):

- **There is considerable diversity in regional innovation performances.** The results show that all countries have regions at different levels of performance. This emphasizes the need for policies to reflect regional contexts and for better data to assess regional innovation performances. The most heterogeneous countries are Spain, Italy and Czech Republic where innovation performance varies from low to medium-high.
- **The most innovative regions are typically in the most innovative countries.** Nearly all the "high innovators" regions are in the group of "Innovation leaders" identified in the European Innovation Scoreboard (EIS). Similarly all of the "low innovators" regions are located in

countries that have below average performance in the EIS. However, the results also show regions that outperform their country level: Noord-Brabant in the Netherlands is a high innovating region located in an Innovation follower country, the same holds for Pais Vasco, Comunidad Foral de Navarra, Comunidad de Madrid and Cataluρa in Spain, Lombardia and Emilia-Romagna in Italy, Oslo og Akershus, Agder og Rogaland and Vestlandet in Norway are all medium-high innovating regions from Moderate innovators.

- The capital region in Romania, Bucuresti – Ilfov, is a medium low innovating region in a Catching-up country.

5. PROSPECTS

As it has been asserted in this paper, globalization and worldwide competition has shifted the comparative advantage of economies towards the factor of knowledge and innovation, where productivity based on the endogenous development capabilities plays a rather important role, as far as growth and competitiveness enhancement are concerned. In order to promote innovation activities and technological opportunities, productivity enhancement seems to have a significant to the long run performance of the economy as a whole.

European cohesion policy makes a major contribution to these objectives, especially in those regions where there is unused economic and employment potential which can be realized through targeted cohesion policy measures, so adding to the growth of the EU economy's a whole. From a policy perspective, for regional development to be sustained requires favorable conditions being established at the national level, in particular a macroeconomic environment conducive to growth, employment and stability and a tax and regulatory system which encourages business and job creation. At the regional level, two complimentary sets of conditions need to be satisfied. The first is the existence of suitable endowment of both basic infrastructure (in the form of efficient transport, telecommunications and energy networks, good water supplies and environmental facilities and so on) and a labor force with appropriate levels of skills and training, strengthening of both physical and human capital, together with improvements in institutional support facilities and the administrative framework in place. The second set of conditions, which directly relates to the factors of regional competitiveness which are important in the knowledge-based economy, is that innovation should be accorded high priority, that information and communication technologies (ICT) should be widely accessible and used effectively and that development should be sustainable in environmental terms.; a business culture which encourages entrepreneurship; and the existence of cooperation networks and clusters of particular activities.

Small countries are likely to need a more comprehensive and oriented policy of co-operative innovative effort, in order to develop their future capabilities and to make the necessary choice for technological priorities. Looking first at scientific and technological output, the EU is still ahead of the US and Japan in its share of scientific publications, but lags behind in most of the other performance indicators, especially patents. There is, nonetheless, a substantial variation within the EU and certain EU Member States often score better than the US and Japan (most notably Sweden and Finland), yet the overall situation in the EU-27 is far from satisfactory. Although there are some noticeable encouraging tendencies in several acceding countries, one can expect that with the enlargement of the Union, the «European Paradox» will be, at least temporarily, further accentuated. In other words, in relation to its enlarged population, the EU-25's strong performance in science will contrast increasingly with its weaker development and commercialization of technology. The slowing down of EU-27 investment in the knowledge-

based economy is likely to be reflected sooner or later in a significant decline in its performance. This trend underlines the urgency of implementing the Lisbon Strategy. In particular, the EU needs to increase its efforts, so as to give renewed impetus to the catching up of some countries with the rest of the EU-27 and to close the gap as soon as possible with the US, following actions towards (Korres 2011):

1. fostering a strong active learning process
2. building the right set of institutions and incentives in order to foster active learning.
3. building firm's technological capabilities
4. fostering academic, basic research and R&D institutions
5. focusing mainly on some specific fields that are promising for the future development of an innovation process within the country.
6. motivating R&D for adaptation and improvement, manufacturing extension, technical assistance, demonstration and diffusion, networking of producers – suppliers and labs.
7. motivating issues like labour, education and training, a cooperative environment between management and workers, few hierarchical layers and total quality management become very important
8. elaborating macro – economic, industrial and educational policies for active learning

The countries that are technologically backward have a potentiality to generate more rapid growth even greater than that of the advanced countries, if they are able to exploit the new technologies which have already employed by the technological leaders. The pace of the catching up depends on the diffusion of knowledge, the rate of structural change, the accumulation of capital and the expansion of demand. The member states that are lagging behind in growth rates can succeed in catching up, if they are able to reduce the technological gap. An important aspect of this is that they cannot rely only on the combination of technology imports and investment, but they should increase their innovation activities and improve locally produced technologies (such as in the case of new industrialized countries Korea and Singapore).

Under this perspective, growth policies should focus on creating favorable environment for the co-operation between firms and institutions that support the development and exploitation of knowledge and innovation. Furthermore, policies should promote the entrepreneurial relations between firms and institutions, fostering the development and dissemination of the expertise, the mobility of human and physical capital and the enhancement of the relationships between business and research entities. Specifically, they should encourage actions such as, promoting innovation, technology transfer and interactions between firms and higher education and research institutes, networking and industrial co-operation and support for research and technology supply infrastructure.

As it has already been mentioned, innovation and technology is an important source of regional competitiveness through facilitating cooperation between the various parties involved in both the public and private sectors. In particular, they can improve collective processes of learning and the creation, transfer and diffusion of knowledge and transfer, which are critical for innovation. Such cooperation and the networks that are formed help to translate knowledge into economic opportunity, while at the same time building the relationships between people and organizations which can act as a catalyst for innovation. Such actions should extend to all the policy areas relevant for economic, scientific and social development and should ideally establish a long-term policy horizon.

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