INNOVATION POLICY, COMPETITIVENESS, AND GROWTH: A STRATEGY TOWARDS CONVERGENCE OF EUROPEAN REGIONS

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Abstract:
This paper is aiming to examine the main topics related to innovation activities and to estimate the effects on competitiveness and economic growth process, as well as to measure the effects on convergence and cohesion of European member states. In addition, the paper emphasizes the role and the developments in innovation policies and the effects on the convergence process of Greece within the European Union. In particular, it also attempts to emphasize and to estimate the effects of innovation policies and related activities to competitiveness and growth process in Greece in an inter-comparison empirical study using statistical data for R&D activities for the E.U. member states, in order to conclude and reach in some safe results and policy implications. In methodological terms, the paper will attempt to analyze, using an econometric and benchmarking approach, the effects of innovation activities, in order to clarify the implication on competitiveness and growth process.

Key Words: Innovation Policy, Competitiveness, Growth, Modernization, Cohesion, Convergence
JEL Classification: O30, O47, R11

1. REGIONAL POLICY AND INNOVATION IN EUROPEAN UNION

In the past decades, important changes in the pattern of economic growth in countries worldwide have taken place. Recent improvements in productivity and employment have been interpreted as a movement towards a knowledge-based economy (OECD, 2003). Currently, output and employment are expanding fast in high-technology industries such as computers and electronics, as well as in knowledge-based services such as financial and other business services. More resources are spent on the production and development of new technologies, in particular on information and communication technology. Computers and related equipment are now the fastest growing component of tangible investments. At the same time, major shifts are taking place in the labour market in particular the increased demand for skilled labour whereas demand for low-skilled workers is falling across the OECD. 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 it is declared in the Third Report on Economic and Social Cohesion (2004), strengthening national competitiveness throughout the Union will boost the growth potential of the EU economy as a whole. And, by securing a more balanced spread of economic activity across the Union, it will reduce the risk of imbalances and divergence, making it easier to sustain the European model of economy and society. In policy terms, the objective is to help achieve a more balanced development by reducing existing disparities, avoiding regional imbalances, by making policies more coherent, improving integration and encouraging cooperation between states and regions. On the other hand, there are imbalances in the EU, which threaten the convergence path:

Table 1: Threatens to E.U. regional convergence

<table>
<thead>
<tr>
<th>Regional level</th>
<th>Threatens</th>
</tr>
</thead>
<tbody>
<tr>
<td>at EU level</td>
<td>high concentration of economic activity and population in the central metropolitan areas, which account for the major percentage of population, GDP and R&amp;D expenditure.</td>
</tr>
<tr>
<td>at national level</td>
<td>persistence of pronounced imbalances between the main metropolitan areas and the rest of the country in terms of economic development.</td>
</tr>
<tr>
<td>at regional level</td>
<td>persistence of territorial disparities beyond those measured by GDP or unemployment, such as, social exclusion, inadequate economic links and falling population.</td>
</tr>
<tr>
<td>within regions and cities</td>
<td>development of poverty and social exclusion in areas with often only limited availability of essential services.</td>
</tr>
<tr>
<td>in specific areas constrained by geographical features (islands, sparsely populated areas and certain mountain areas)</td>
<td>declining population and ageing, while accessibility continues to be a problem and the environment remains fragile and threatened.</td>
</tr>
<tr>
<td>in outermost areas, with a cumulation of natural and geographical handicaps</td>
<td>continuation of severe social and economic problems which are difficult to tackle because of their remoteness, isolation, topological features, climate, small size of market and dependence on a small number of products.</td>
</tr>
</tbody>
</table>

Source: Adaptation from the Third Report on Economic and Social Cohesion, 2004

Within this framework, the enhancement and convergence of growth and productivity are a major topic in the economic and social policy agenda of E.U. members, since governments seek to concentrate on problems not only related to growth, such as low
employment growth, high unemployment, fiscal deficits and public debt, but also to national disparities and convergence attainment.

Two complimentary sets of conditions need to be satisfied for regions in the Union to sustain economic development and employment in competitive environment. The first is that they must have suitable levels of both physical infrastructure and human capital. The second is that, in the new knowledge-based economy, regions must have the capacity to innovate and to use both existing and new technologies effectively. Community enterprise, industrial and innovation policy is aimed at strengthening the competitiveness of EU producers by promoting competition, ensuring access to markets and establishing an environment which is conducive to R&D across the Union. As is recognized, a lack of innovative capacity at regional level stems not only from deficiencies in the research base and low levels of R&D expenditure but also from weaknesses in the links between research centres and businesses, and slow take-up of information and communication technologies. Knowledge and access to it has become the driving force for growth in advanced economies like the EU known-how and intellectual capital, much more than natural resources or the ability to exploit abundant low-cost labor, have become the major determinants of economic competitiveness since it is through these that economies can not only increase their productive efficiency but also develop new products. Innovation, therefore, holds the key to maintaining and strengthening competitiveness which in turn is essential for achieving sustained economic development. To achieve both sets of conditions requires an effective institutional and administrative framework to support development. The cost of not pursuing a vigorous cohesion policy to tackle disparities is, therefore, measured in economic terms, as a loss of the potential real income and higher living standards. Given the interdependencies inherent in an integrated economy, these losses are not confined to the less competitive states but affect every state in the Union (Third Report on Economic and Social Cohesion, 2004).

European cohesion policy makes a major contribution to these objectives, especially in those countries where there is unused economic and employment potential which can be realized through targeted cohesion policy measures. From a policy perspective, for national 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 national 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

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1 Third Cohesion Report, 2004
entrepreneurship; and the existence of cooperation networks and clusters of particular activities.

### Table 2: Framework of productivity and competitiveness

<table>
<thead>
<tr>
<th>Phase</th>
<th>Inputs</th>
<th>Intermediate Output</th>
<th>Final Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; phase</td>
<td>Productivity enhancement</td>
<td>Productivity, Production factors cost, Prices and wages</td>
<td>Development, Employment, Living standards, Quality of life, Competitiveness</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; phase</td>
<td>Economic and technological infrastructure, Education and skills, Entrepreneurship and business development, Innovativeness and creativity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; phase</td>
<td>Macroeconomic, entrepreneurial and work environment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Based on the Annual Competitiveness Report 2004, Ministry of Development, Greece, page 4

Within this framework, the enhancement and convergence of growth and productivity are a major topic in the economic and social policy agenda. One of the focal points of the Treaty of the European Union (E.U., 1992) is ‘to promote economic and social progress along with a high level of employment, as well as to achieve balanced and sustainable development ….. through the strengthening of economic and social cohesion…..’. The framework of these policy objectives could be illustrated in the following figure:

**Figure 1: Economic and social Regional E.U. policy**

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<sup>2</sup> Third Cohesion Report, 2004
According to the Third Report on Economic and Social Cohesion (2004), strengthening regional competitiveness throughout the Union will boost the growth potential of the E.U. economy. Securing a more balanced spread of economic activity across the E.U. will reduce the risk of imbalances and divergence, making it easier to sustain the European model of economy and society. In policy terms, the objective is to help achieve a more balanced development by reducing disparities, avoiding regional imbalances, making policies more coherent, improving integration and encouraging cooperation between states and regions.

Within this framework, development and innovation consist two of the core subjects both in economic and political analyses. In E.U. there is an increasing interest in the contribution of knowledge in the sustainable long-term economic growth, taking into consideration the need that competition forces technological innovations, that increase productivity. Developments in the theory of economic growth have renewed the interest for the role of innovation in the development process, underlining the interaction between the investment in innovative activities, technological change and economic growth.

Technological change, innovation and technology creation and diffusion are an important factor to economic progress, as illustrated in the figure that follows:

**Figure 2: Innovation and Economic Growth**

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. 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 economic growth (Acs, Anselin and Varga, 2002). 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). 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).

Developments in the theory of economic growth have renewed the interest for the role of innovation in the development process, underlining the interaction between the investment in innovative activities, technological change and economic growth. Technology and innovation play an important role in economic growth and technology has become one of the most important factors in the models of growth (Geroski and Machin, 1993, Barro and Sala-i-Martin, 1995, 1997, Freeman and Soete, 1997, and Sternberg, 2000)\(^3\). The role of innovation is multiple: as motive force it directs the enterprises to ambitious and long-term objectives, it leads to the renewal of methods of production, as well as industrial structures and the appearance of new sectors of economic activity.

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,

\(^3\) Arrow (1962) was the first to systematically appreciate the importance of innovation and technological change in the capital formation and economic growth. He observed that increases in income per capita couldn’t be explained by increases in capital to labour ratio, and concluded that the power behind the increase in productivity is the acquisition of knowledge and learning experience created and acquired during the production procedure.
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 pursue and invest on it.\(^4\) 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 1994, Barro and Sala-i-Martin, 1997) and economic growth is sustained because of the continuous creation and diffusion of knowledge.

\(^4\) Cohen and Levinthal (1989) called this double role of innovation ‘dual role’.
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.

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 endogenous development capabilities. 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).

2. E.U. REGIONAL POLICY OBJECTIVES

Nowadays, economies all over the world are described taking part in a race seeking the most appropriate and effective ways that could provide them with the strengths and opportunities necessary to obtain and sustain a competitive advantage over their rivals. Within this framework, at the Lisbon Summit (2000), European Union set itself the goal of becoming the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth and closer regional as well as social cohesion. At the Lisbon European Council, E.U. defined a comprehensive strategy aiming at long term economic growth, full employment, social cohesion and sustainable development in a knowledge - based society. Into doing, it has identified a number of priorities:

Table 3: Economic development priorities

<table>
<thead>
<tr>
<th>Priority</th>
<th>Means and actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• give priority to innovation</td>
<td>• creating closer links between research institutes and</td>
</tr>
</tbody>
</table>
entrepreneurship

- ensure full employment
- ensure an inclusive labour market
- ‘connect’ Europe
- protect the environment

industry, developing conditions favourable to R&D, improving access to finance and know-how and encouraging new business ventures;

by emphasizing the need to open up employment opportunities, to increase productivity and quality at work and to promote lifelong learning;

unemployment is reduced and social and regional disparities in access to employment are narrowed;

closer integration and by improving transport, telecommunications and energy networks;

stimulating innovation and introducing new technologies, for example, in energy and transport.

Source: Based on the Third Report on Economic and Social Cohesion, 2004

Four Community initiatives aim to find solutions to these problems common to a number of regions: a) Interreg III for the development of crossborder, interregional and transnational cooperation; b) URBAN II to support innovative strategies in cities and urban neighbourhoods; c) Leader+ to promote rural development initiatives; d) EQUAL to combat discrimination in the labour market.

More than a third of the budget of the Union is devoted to regional development and economic and social cohesion5. For 2000 - 2006, EUR 213 billion has been earmarked for all structural instruments for the 15 Member States. In addition, about EUR 22 billion in pre-accession aid, and another EUR 22 billion in structural interventions for the new Member States have been spent through multiannual development programmes, managed jointly by Commission services, the Member States and regional authorities6.

To enhance its impact and secure the best possible results, 94 % of structural funding for the period 2000–06 is concentrated on three objectives:

- Objective 1: Helping regions whose development is lagging behind to catch up.
- Objective 2: Supporting economic and social conversion in industrial, rural, urban or fisheries dependent areas facing structural difficulties.
- Objective 3: Modernizing systems of training and promoting employment. Measures financed by Objective 3 cover the whole Union except for the Objective 1 regions, where measures for training and employment are included in the catch-up programmes.

The total budget allocation for Structural and Cohesion Funds is illustrated in the following figure:

**Figure 3: Total budget allocations for Structural and Cohesion Fund 2000-2006 (1999 prices).**

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5 The Structural Funds and the Cohesion Fund cover about one third of the EU budget
6 European Commission, Union, Regional Policy, Inforegio, http://europa.eu.int
3. E.U. REGIONAL INNOVATION PERFORMANCE

As far as the E.U. regional innovation is concerned, there are 3 main reports which conduct surveys about the innovation performance of countries and regions, extract results, and illustrate the comparative situation of each country or region. These reports are:

- The European Innovation Scoreboard (EIS)
- The Summary Innovation Index (SII)
- The Regional Innovation Scoreboard

3.1 THE EUROPEAN INNOVATION SCOREBOARD (EIS)

The European Innovation Scoreboard (EIS) is the instrument developed at the initiative of the European Commission, under the Lisbon Strategy, to evaluate and compare the innovation performance of the EU Member States. The EIS 2006 includes innovation indicators and trend analyses for the EU25 Member States, plus the two new Member States: Bulgaria and Romania, as well as for Croatia, Turkey, Iceland, Norway, Switzerland, the US and Japan. The 25 EIS innovation indicators have been classified into five dimensions to better capture the various aspects of the innovation process, namely:

- Input – Innovation Drivers
- Input – Knowledge Creation
- Input – Innovation & Entrepreneurship
- Output – Applications
- Output – Intellectual Property

Table 6 identifies for each indicator the three European countries with the highest scores and the results for the EU25 and EU15. The innovation leaders take up more than 50% of the leading places, the innovation followers take up 20% and the trailing countries and catching-up countries each 10% of the leading places. The innovation leaders are

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particularly dominant in knowledge creation, innovation & entrepreneurship and intellectual property. The innovation followers are most dominant in innovation drivers. The ranking of the E.U. countries according to the EIS 2006 are presented in the following table:

Table 4: Innovation performance leaders

<table>
<thead>
<tr>
<th></th>
<th>EU25</th>
<th>EU15</th>
<th>European ‘innovation leaders’</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INNOVATION DRIVERS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 S&amp;E graduates</td>
<td>12.7</td>
<td>13.6</td>
<td>IE (23.1) UK (18.1)</td>
</tr>
<tr>
<td>1.2 Tertiary education</td>
<td>22.8</td>
<td>24.0</td>
<td>FI (34.6) DK (33.5)</td>
</tr>
<tr>
<td>1.3 Broadband penetration rate</td>
<td>10.6</td>
<td>12.0</td>
<td>IS (22.5) NL (22.4)</td>
</tr>
<tr>
<td>1.4 Life-long learning</td>
<td>11.0</td>
<td>12.1</td>
<td>SE (34.7) UK (29.1)</td>
</tr>
<tr>
<td>1.5 Youth education</td>
<td>76.9</td>
<td>74.1</td>
<td>NO (96.3) SK (91.5)</td>
</tr>
<tr>
<td><strong>KNOWLEDGE CREATION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Public R&amp;D expenditures</td>
<td>0.65</td>
<td>0.66</td>
<td>IS (1.17) FI (0.99)</td>
</tr>
<tr>
<td>2.2 Business R&amp;D expenditures</td>
<td>1.20</td>
<td>1.24</td>
<td>SE (2.92) FI (2.46)</td>
</tr>
<tr>
<td>2.3 Share of medium-high/high-tech R&amp;D</td>
<td>--</td>
<td>89.2</td>
<td>SE (92.7) DK (92.3)</td>
</tr>
<tr>
<td>2.4 Share of firms receiving public funding</td>
<td>--</td>
<td>--</td>
<td>LU (39.3) IE (27.8)</td>
</tr>
<tr>
<td><strong>INNOVATION &amp; ENTREPRENEURSHIP</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1 SMEs innovating in-house</td>
<td>--</td>
<td>--</td>
<td>IE (47.2) IS (46.5) DE (46.2)</td>
</tr>
<tr>
<td>3.2 Innovative SMEs co-operating with others</td>
<td>--</td>
<td>--</td>
<td>DK (20.8) SE (20.0) FI (17.3)</td>
</tr>
<tr>
<td>3.3 Innovation expenditures</td>
<td>--</td>
<td>0.023</td>
<td>SE (3.47) EL (3.08) DE (2.93)</td>
</tr>
<tr>
<td>3.4 Early-stage venture capital</td>
<td>6.4</td>
<td>6.4</td>
<td>EE (9.8) LV (9.6) SE (8.6)</td>
</tr>
<tr>
<td>3.5 ICT expenditures</td>
<td>6.4</td>
<td>6.4</td>
<td>CH (63.0) LU (58.4) DK (57.1)</td>
</tr>
<tr>
<td>3.6 SMEs using organisational innovation</td>
<td>--</td>
<td>--</td>
<td>CH (63.0) LU (58.4) DK (57.1)</td>
</tr>
<tr>
<td><strong>APPLICATIONS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1 Employment in high-tech services</td>
<td>3.35</td>
<td>3.49</td>
<td>SE (5.13) IS (4.97) DK (4.69)</td>
</tr>
<tr>
<td>4.2 High-tech exports</td>
<td>18.4</td>
<td>17.7</td>
<td>MT (55.9) LU (29.5) IE (29.1)</td>
</tr>
<tr>
<td>4.3 Sales share of new-to-market products</td>
<td>--</td>
<td>--</td>
<td>MT (13.6) SK (12.8) PT (10.8)</td>
</tr>
<tr>
<td>4.4 Sales share of new-to-firm products</td>
<td>--</td>
<td>--</td>
<td>PT (15.1) DE (10.0) ES (10.0)</td>
</tr>
<tr>
<td>4.5 Employment in medium-high/high-tech manufacturing</td>
<td>6.66</td>
<td>6.71</td>
<td>DE (10.43) SI (9.63) CZ (9.42)</td>
</tr>
<tr>
<td><strong>INTELLECTUAL PROPERTY</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1 EPO patents</td>
<td>136.7</td>
<td>161.4</td>
<td>CH (425.6) DE (311.7) FI (305.6)</td>
</tr>
<tr>
<td>5.2 USPTO patents</td>
<td>50.9</td>
<td>60.2</td>
<td>CH (168.4) DE (123.0) SE (109.7)</td>
</tr>
<tr>
<td>5.3 Triad patents</td>
<td>32.7</td>
<td>38.9</td>
<td>CH (108.9) FI (101.7) DE (85.2)</td>
</tr>
<tr>
<td>5.4 Community trademarks</td>
<td>100.7</td>
<td>115.7</td>
<td>LU (782.7) CH (225.2) AT (187.6)</td>
</tr>
<tr>
<td>5.5 Community designs</td>
<td>110.9</td>
<td>127.6</td>
<td>LU (377.6) DK (243.2) CH (210.0)</td>
</tr>
</tbody>
</table>

Source: The EIS 2006 report

Best performance across the indicators is scattered across Europe, with as much as 22 countries being among the best 3 performing countries in at least one indicator. Sweden does best being among the best 3 performing countries in 10 indicators, followed by Denmark and Germany each taking up 8 of the leading slots. For many indicators, differences among the best performers are too small to identify an overall best performing country. The indicators of innovation performance suggest that a country can be an innovation leader only if it has a well established innovation system with all elements in place. While practically all EU member states excel in one or the other innovation dimension, only some of them have achieved the overall performance to become world innovation leaders.

3.2 SUMMARY INNOVATION INDEX (SII)
The Summary Innovation Index (SII) gives an overview of aggregate national innovation performance. Figure 6 shows the Summary Innovation Index (SII) on the vertical axis and the average growth rate of the SII on the horizontal axis. Countries above the horizontal dotted line currently have an innovation performance above that of the EU25. Countries to the right of the vertical dotted line had a faster average increase in the SII than the EU25.

**Figure 4: SII 2006**

Sweden, Finland, Switzerland and Denmark are the European innovation leaders. Slovenia, Estonia and Czech Republic are the best performing new Member States, outperforming as many as four EU15 countries. More specifically, based on their SII score and the growth rate of the SII, the countries included in the analysis can be divided into four groups or clusters (European Innovation Scoreboard, 2006):

- **Sweden, Switzerland, Finland, Denmark, Japan and Germany** are the innovation leaders, with SII scores well above that of the EU25 and the other countries. The lead of the innovation leaders has been declining compared to the average of the EU25, with the exception of Denmark.
- **The UK, Iceland, France, Netherlands, Belgium, Austria and Ireland** are the innovation followers, with SII scores below those of the innovation leaders but above that of the EU25 and the other countries. The above EU25 average innovation performance of the innovation followers has been declining. Also, the gap of the innovation followers with the innovation leaders has on average slightly increased.
- **Slovenia, Czech Republic, Lithuania, Portugal, Poland, Latvia, Greece and Bulgaria** make up the group of catching-up countries, with SII scores well below that of the EU25 and the innovation leaders, but with faster than average innovation performance improvement.
- **Estonia, Spain, Italy, Malta, Hungary, Croatia and Slovakia** seem to be trailing, with SII scores well below that of the EU25 and the innovation leaders, and innovation performance growth which is either below or only just above that of the EU25.

Cyprus and Romania form a separate fifth cluster of fast growing, catching-up countries. Cyprus being one of the smallest EU countries and Romania starting from very low levels of innovation performance, this cluster is less robust than the other clusters, and is
therefore not considered to be a real cluster. Luxembourg, Norway and Turkey do not fit into any of these groups.

3.3 THE REGIONAL INNOVATION SCOREBOARD

The 2006 Regional Innovation Scoreboard provides the relative position of the EU regions. As far as the regional technological performance is concerned, it is presented in the following figure:

**Figure 5: Regional Innovation performance in E. U. 2006**

![Regional innovation performance in Europe, 2006](image)

Source: Hollanders (2006)

The Top-10 performing regions are Stockholm in Sweden, followed by Västsverige (SE), Oberbayern (DE), Etelä-Suomi (FI), Karlsruhe (DE), Stuttgart (DE), Braunschweig (DE), Sydsverige (SE), Île de France (FR) and Östra Mellansverige (SE).

4. ECONOMETRIC APPROACH

Under this picture, growth rate is considered to be the result of a wide range of economic, social and political factors. Firstly, economic growth may be the result of physical, as well as human, capital accumulation (Jones and Manuelli, 1990; Rebelo, 1991). Secondly, economic growth may be attributed to the existence of external economies and the interactions among the investments of different private or public enterprises and business entities (Arrow, 1962, Lucas, 1988). Thirdly, growth may result from the creation and adoption of new ideas and the accumulation of technological knowledge (Romer 1990, Grossman and Helpman 1991, and Aghion and Howitt 1992). In this
perception, science, technology and innovation are major elements towards economic
growth and development.

A production function is a relationship between output and inputs. For a single country
the production function may be written as:

\[ y_{it} = F_i(X_{11t}, X_{12t}, \ldots, X_{imt}, t) \]

where: \( y_{it} \) is the quantity of output produced per producer unit and \( X_{ijt} \) is the quantity of
the jth input employed per producer unit (\( j=1,2,\ldots,m \)) in the ith country for the period t. In
order to specify the inputs and output relationship, we begin with an aggregate production
function:

\[ Y_t = F(K_t, L_t, t) \]

where: \( Y_t \), \( K_t \), and \( L_t \), are the quantities of aggregate real output, physical capital and
labor respectively at time t, in order to assess what proportion of any increase in the
output over time can be attributed first to increases in the inputs of factors in the
production. Solow (1956) postulated that the level of output depended on the level of
productivity

\[ Y = A(t).F(K, L) \]

where \( Y \) is the level of aggregate output, namely economic growth, \( K \) is the level of the
capital stock, \( L \) is the size of the labor force, \( A \) is total factor productivity (a measure of
the current level of technology) and \( t \) is time. Total-factor productivity is measured as the
difference between output and input change, in addition to increases in aggregate output
due to capital or labour accumulation and endogenous growth theory asserts that
increases in TFP are seen as the key to long-term economic growth.

Under this approach, Fagerberg (1987, 1988) created a model of endogenous
technological change, focusing on the importance of innovation on economic growth.
According to Fagerberg (1987, 1988) economic growth is explained as the combined
result of three factors, namely the potential for innovation creation (proxied by patent
growth), the potential for innovation diffusion (proxied by the level of productivity or
GDP per capita) and the exploitation of these potentials (proxied by complementary
factors, such as investment as a fraction of GDP). Extending this model, and following
the theory presented in this paper, an additional complementary factor is included, that is
entrepreneurship (proxied by the number of self employed persons in the economy).

Referring to the above mathematical equation, as well as to the above mentioned model,
we obtain our estimating equation for the specification for the growth rate of real GDP:

\[ Y_t = F(RD_t, Prod_t, Invest_t, Entrepr_t) \]

Where
RD$_t$ refers to innovation creation activities, proxied by Research and Development expenditure measure,
Prod$_t$ refers to innovation diffusion, proxied by the level of GDP per capita, representing productivity,
Invest$_t$ refers to the exploitation of these potentials, proxied by the investment level as a fraction of GDP, and finally,
Entrepr$_t$ refers also to the exploitation of these potentials, proxied by the the number of self employed persons

The data apply to the economy of EU and they cover a period of 56 years. The measures of GDP and GDP per capita are adjusted in constant PPPs standards, the Research and Development expenditure is also measured in constant prices and the investment level is represented by the Gross Fixed Capital Formation, also in constant prices. The data have been extracted from the OECD, Eurostat and the University of Pennsylvania databases.

The econometric analysis is to be added in the paper…

5. PROSPECTS

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.

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. From a policy perspective, at the regional level, growth policies should focus on creating favorable environment for the cooperation 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. 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.

6. REFERENCES


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