44th European Congress of the European Regional Science Association

Regions and Fiscal Federalism

25-29 August 2004, Porto, Portugal

EFFECTS OF INNOVATION DIFFUSION ON THE DEVELOPMENT LEVEL FOR SOME EUROPEAN REGIONS IN THE EXPANSION PERIOD OF THE EUROPEAN UNION

Gündüz ATALIK

Seda KUNDAK

Department of Urban and Regional Planning,

Istanbul Technical University,

Taskisla, 80191, Taksim

Istanbul TURKEY

atalik@itu.edu.tr

kundak@itu.edu.tr

Abstract

It is argued that innovation diffusion, in other words the movement of the new ideas or articrafts within an area over a number of time periods could become widespread once introduced in the area. After Schumpeter the role of the innovator has been significant as the inventor, as the developer or as the promoter. It is clear now that a number of economists have one thing in common that profit rates would be pushed to minimal levels in the absence of technical development. In fact, in the new theories of development concepts related to knowledge development and its diffusion take precedence.

Moreover, concerning regional disparities and regional convergence issues in the European Union, it is pointed out that R&D investment in lagging areas could be the only way to avoid technology and development divergence between core and periphery.

In this connection, it might be worthwhile to consider the enlargement process of the European Union with further expansion period. In this way, the objective of this article will be to find out probable effects of R&D on the development level in a five-years period (1996-2001) in order to examine the efficiency rate of innovation diffusion on the development level and to derive some theoretical and practical results.

1. INTRODUCTION

In the new theories of development concepts related to knowledge development and its diffusion take precedence when innovation or technological change is fundamental base in the economic development of regions and countries (Malecki and Varaia 1986; Malecki 1991). It is argued that innovation diffusion, in other words the movement of new ideas or articrafts within an area over a number of time periods could become widespread once introduced in the area. After Schumpeter, the role of the innovator has been significant as the inventor, as the developer or as the promoter. It is clear now that a number of economists have one thing in common that profit rates would be pushed to minimal levels in the absence of technical development (Samuelson 1964).

Actually, spatial aspects of innovation have received increased attention from researchers and from policy makers (Molle 1983). Recently, it is recognized that the innovation process covers the use, application and transformation of technological knowledge in solving practical problems (Fischer 2002). Meanwhile, NIT (New Information Technology) is regarded as an innovative technology for a systemic transformation in economies (Giaoutzi and Stratigea 1991). It is argued that there has been a revolution by considering information as a fundamental component of technology when technology becomes the principal product of the process of innovation (Niento 2003).

Moreover, concerning regional disparities and regional convergence issues in the European Union, it is pointed out that R&D investment in lagging areas could be the only way to avoid the technology and development divergence between core and periphery (Rodriguez-Pose 2001). In examining the evolution of R&D investment in peripheral regions contradicting the Schumpeterian emphasis on increasing returns and investment, the principal points are whether the clustered economic landscape in Europe strengthens or weakens over time and to what extent economic integration influences the development (Maurseth 2001) when interregional interaction may have significant influence on relative performance (Suarez-Villa, Cuadrado-Roura 1993).

Recently, it is pointed out that, during the last decades of the Twentieth Century there has been widespread jump between European regions as a combined result of the effects of initial income, geographical localization and technology spillovers when sigma-convergence was strong for regions being geographically far away from each other and technologically different (Maurseth 2001). Meanwhile, it is argued that, different theories provide different points of view about the convergence of investing in R&D in lagging regions when recent growth of R&D investment in European peripheral regions contradicts the Schumpeterian emphasis on increasing returns and investment and as lagging regions achieved higher rates of growth (Rodriguez-Pose 2001; Armstrong 1995).

Accordingly, the main objective of this article will be to examine some effects of R&D on the development level for the EU regions within a certain period in the transformation process of the EU and to drive some inferences to be utilized for the convergence strategies and policies in the long run. In this way, Section 2 reviews the theoretical and empirical research on the subject "Innovation and Regional Development with reference to the EU" and attempts to explain regional differences with some R&D characteristics in the EU regions. Section 3 covers an empirical modeling technique to be developed to examine likely effects of R&D on the development level for a certain period of time. Section 4 consists of concluding remarks.

2. INNOVATION AND REGIONAL DEVELOPMENT WITH REFERENCE TO THE EU

Regional spread of innovation may be evolved in a number of ways as processes, products and services. This evolution is also involved in the Growth Pole Theory by innovation effects as successful introductions of the new ideas or articrafts into an urban and regional system by diffusion processes in which innovations are adapted through time and space (Perroux 1964, Berry 1972, Lakshmanan 1988). Adoption process of innovations over time is variated by threshold limitations, diffusion time and

accessibility (Berry 1972), when services play a decisive role in enhancing the prospects for attracting and retaining manufacturing and other firms and flexibility and control are the key concepts in operational demands (Coffey and Polese 1989; Maillat 1990).

In fact, the role of technology has been pointed out as a residual in the conventional Cobb-Douglas production function as a measure of technical progress: $Y = e^a K^b L^c$, where apriori values of b and c are imposed and a is calculated as a residual. However, empirical studies of the location of R&D, headquarters, high-technology industry or other indicators are not sufficient for understanding the role that technology plays in regional change. The complex interplay of technology with other factors of production has progressed only slightly toward incorporation of the dynamic context in which technology operates. The traditional focus on capital investment at the embodiment of technology into the nature of process innovation, capital-labor substitution and best-practice technology (Malecki and Varaia 1986; Fischer 2002).

As a result of this background, it could be observed that there are a number of factors affecting on the development level in a certain area to be involved, as expenditure on R&D, research personnel, agglomeration effects and cumulative causation as a whole.

2.1. EXPENDITURE ON R&D

It is argued that the rate of technical progress in a economy is assumed to be related directly to the rate of R&D investment or indirectly to the rate of growth in output, under the assumption that the latter is positively correlated with R&D expenditure (Malecki and Varaia 1986). The relationship between regional productivity increases and growth in regional output leads to a model of “cumulative causation”. In other words, increased investment occurs in faster growing regions by reinforcing higher growth.

The conventional economic reasoning that R&D leads to a rise in innovative capacity to a lowering of production costs and to greater regional competitiveness is more often wrong than correct. One reason for this is the emphasis placed on capital-embodied process innovation and competitiveness as indicated by production efficiency and cost reduction (Malecki and Varaia 1986; Fischer 2002). The nature of interregional competition more closely follows dimensions related to the professional-technical labor market, rather than capital investment variations. It should be pointed out that the conventional wisdom is strongly tied to the experience of the manufacturing sector, whereas recent empirical research frequently looks at the service sector.

In general, the empirical evidence tends to reinforce cumulative causation notions of regional change, although the mechanisms are much complex than theoretical frameworks have yet been able to capture effectively (Malecki and Varaia 1986). Actually, it is pointed out that, “Since according to Schumpeterian thought, returns of investment in R&D tend to be positively associated to the volume of investment and they benefit from strong cumulative effects, it is unlikely that lagging regions can benefit from limited R&D investment” (Rodriguez-Pose 2001).

With respect to the E.C. figures, the capacity for innovation varies across the EU. Expenditure on R&D relative to GDP has increased in recent years in the cohesion countries. Nevertheless, the rise has not been enough to close the gap with the rest of the Union significantly (E.C. 2001). The significant gap in R&D expenditure which exists between the cohesion countries and the other Member States, indicates a requirement for more encouragement for firms to undertake research activities and accordingly, the adaptation of R&D policies. In lagging regions, in particular, attempts need to be made to increase: the capacity of businesses to absorb new technology and know-how developed elsewhere; the capability of the labor force to use this technology and adapt to new techniques: to seek out new market opportunities and the availability of risk capital for innovation (E.C. 2001).

2.2. R&D PERSONNEL / RESEARCHERS

The empirical findings concerning the “spatial division labor” support cumulative causation conceptualizations of regional growth (Malecki and Varaia 1986). The ability of a region to innovate and retain its competitiveness is at the hearth of emerging Schumpeterian conceptualizations of regional development.

Innovations in one region are acquired by the workers in that region. Later, they can diffuse to other regions, thus maintaining regional differences in productivity, output and investment. “In the innovation stage of a product’s life cycle, production requires R&D and skilled labor for refinements and improvements. The growth stage permits production to be less skill-intensive and to take place away from R&D centers. The standardization stage is characterized by shifts of production to low cost locations”. Although process innovation resulting in productivity increases, forms the basis of most neoclassical and cumulative causation theories. It is product innovation that is associated and innovated activities in the innovation stage of the product cycle model (Malecki and Varaia 1986; Fischer 2002).

Actually, the quality of human resources is the major factor behind the invention and diffusion of technology and it is a precondition for increasing the capacity of a given economy to absorb new innovations. Respectively, the difference among the most advanced countries in the EU and the cohesion countries has been reduced during the 1990’s, but it remains the case that the former have around three times as many research staff in firms as the later (EU 2001). The human resource potential in R&D in many of the cohesion countries is relatively strong, as a legacy of the major role accorded to R&D under the socialist system, which means that they are well placed to catch up with actual EU Member States, so long as there is a fundamental restructuring of the R&D system.

2.3. AGGLOMERATION CONTEXT

It is pointed out that the role of technology in regional development is assumed to be largely based on a region's power to generate or adapt new innovations and to attract production plants within its borders. It is suggested that, spatial differentiation of technological change is largely the consequence of spatial differences in selection environment. In general, the selection environment is defined not with respect to a region or a community, but with respect to the progress of a particular technological trajectory. The type of environment is usually defined not in terms of geographical factors but rather in concepts of management science, systems analysis, or decision theory. The selection environment also requires to be seen in a spatial context (Molle 1983). On the other hand, spatial concentration of economic activity can produce agglomeration effects. Accordingly, regions with large urban concentrations allow greater technical progress.

Actually, agglomeration economies show a multiple role in promoting technical progress and higher productivity besides higher rates of innovation, more rapid adoption of innovations and higher proportions of skilled workers (Malecki and Varaia 1986; Malecki 1991). Additionally, large urban areas are the convergence points of communication networks, mobile capital and the decision-making places of firms (Richardson 1978). Consequently, innovations spread among regions in a sequence, from more populous regions to less populous ones. In developing countries, the gap in the levels of agglomeration economies between a nation's urban core and its periphery is typically very large. Accordingly, it is proved that polarization will tend to persist over time (Clapp and Richardson 1984).

2.4. CUMULATIVE CAUSATION

Technology and innovation in a regional context appear at present to be more appropriately modeled by cumulative causation frameworks than by the neoclassical prespectives. Understanding of the process by which technology and innovation affects

regional development has evolved over time. Rather than innovation being seen as a linear process from basic research to commercial success, a more interactive model has emerged, which recognises the importance of the environment. For this reason, innovation has been associated with concepts of network formation and management and of clustering (Hingel 1993). In this respect, it depends on how firms, universities, research institutes performance, on how they work together, particularly at the regional level. “In the EU today, capacity to innovate varies significantly from one region to another, both in quantitative and qualitative terms” (E.C. 2001). It is argued that, limited investment in R&D in lagging areas may not yield the expected returns in terms of technological progress, since most R&D activities lack optimal conditions to conduct competitive work (Rodriguez-Pose 2001). Meanwhile, researchers in lagging areas should be realized as to be more isolated than advanced centers.

The capacity for any space to generate and/or assimilate innovation and transform it into economic activity is depended upon to a series of structural factors. The transformation to economic activity is related to the to the industrial capacity of the region, to the average size and age of local firms, to the dominant production structure, to the ownership system and to the existence of cooperation among firms or even Networks of firms which are also related to the dynamics of different national innovation systems as well as to the local, social, institutional and legal structure (Rodriguez-Pose 2001).

Meanwhile, NIT (New Information Technologies) is characterized by its revolutionary impact on the regional development process, since the spread through of its application contributes to transforming of the traditional features of the present day production, exchange and distribution systems. This transformational potential is considered as the driving force allowing for the realization of a fundamental shift leading to a changing geography of competition (Giautzi and Stratigea 1991; Fratesi 2003). The economic significance of these technological developments to the competitive strategies of regions is highly appreciated.

3. IMPACT OF R&D EFFECTS IN A TRANSFORMATION STAGE

The theoretical and empirical research, basically suggests that interregional differences, in other words interregional disparities can be explained by cumulative causation analysis (Atalık 2002). In this chapter, it is aimed to examine some effects of R&D on the development level for some European regions, notably for the clustered economic landscape in Europe, strengthens or weakens over a certain time and to what extent economic integration influences the development. Nevertheless, the real difficulty for this attempt has been the availability and reliability of the data on R&D at the regional level in Europe (Eurostat Data). In this article, the relationship of GDP with Gross Domestic Expenditure on R&D per capita, R&D personnel by occupation (researchers), and the patent applications are taken into account in regional and national scale, beside convergence process for the same period in the transformation/expansion stage.

It is evident that for some purposes which can be compared with interregional shifts of R&D activities overtime in a given region to the corresponding shifts for all regions will be useful. Such a device is called “Relative Growth Chart” (Isard 1967). Since interregional convergence is aimed within the framework of the European Union, it is inevitable to examine the evolution with appropriate devices. Accordingly, essential device in this analysis will be relative growth charts beside convergence indicators in regional and national scales.

On a relative growth chart, the vertical axis of the figure measures, for the region, GDP per capita in year Beta as a percentage of GDP per capita in year Alpha. The horizontal axis measures, for the region, any likely R&D effect in year Beta as a percentage of likely R&D effect in a year Alpha correspondingly. The diagonal of the figure permits comparisons for any particular R&D activity of its growth in a given region relative to its growth in the total system in European scale. The steeper the diagonal, the faster has been the growth in the region’s GDP compared to the R&D factor. Obviously, the devices discussed in this article are essentially descriptive and cannot identify cause-effect relationships.

Accordingly, it should be worthwhile to examine a number of variables in national and regional scale by “relative growth charts” approach. In this way, the relationship between Gross Domestic Expenditure on R&D per capita (Year Beta as % of Year Alpha) and GDP per capita (Year Beta as % of Year Alpha) indicates a certain clustering beside cohesion countries (Figures 1-2). In regional scale, western clustering is also obvious (Figures 3-4). Meanwhile, the Figure 1 supports an earlier finding about higher rates of growth for cohesion countries: “Recent growth of R&D investment in European peripherial regions contradicts the Schumpeterian emphasis on increasing returns and investment. Lagging regions have not only increased R&D expenditure as a share of GDP, but have also – as defended by neoclassical growth models – achieved higher rates of growth” (Rodriguez-Pose 2001). Second, the relationship between R&D Personnel by Occupation/Researcher (Year Beta as % of Year Alpha) and GDP per capita (Year Beta as % of Year Alpha) indicates western clustering beside higher rates of growth for cohesion countries (Figures 5-6).

Third, the relationship between Total Number of Patent Applications to the “EPO per million inhabitants” (Year Beta as % of Year Alpha) and GDP per capita (Year Beta as % of Year Alpha) also supports the empirical observation mentioned above (Figures 7-8). Figure 9 reports results on coefficient of variation for the three data sets. The first graph indicates highest level of variation for the EU and cohesion countries while the second and the third graphs indicate lower levels of variation during a five years period in the transformation stage.

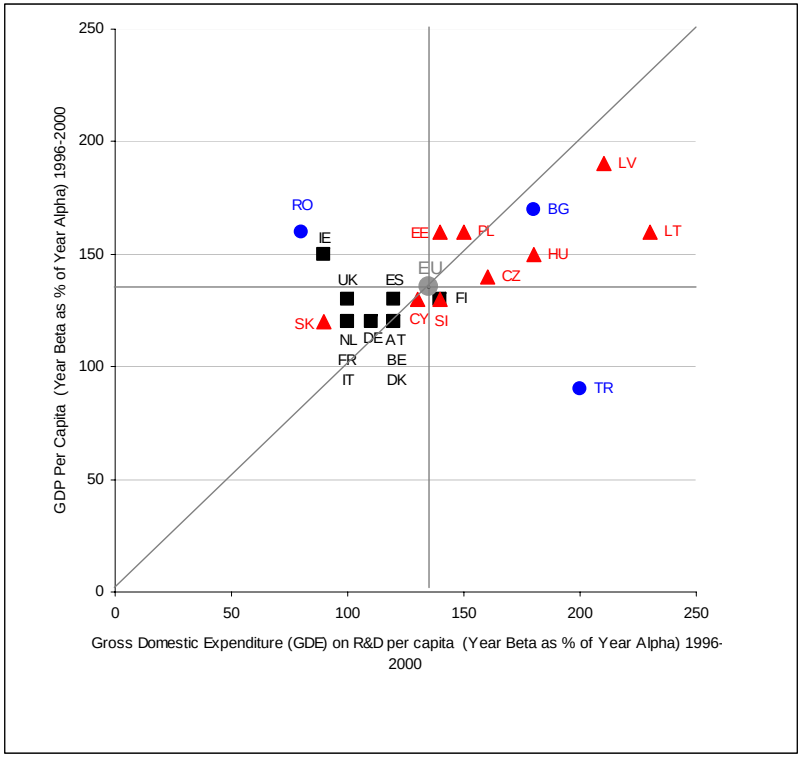


Figure 1 – Relative Growth Chart, EU Countries and Cohesion Countries

Source: Own elaboration using EUROSTAT Data

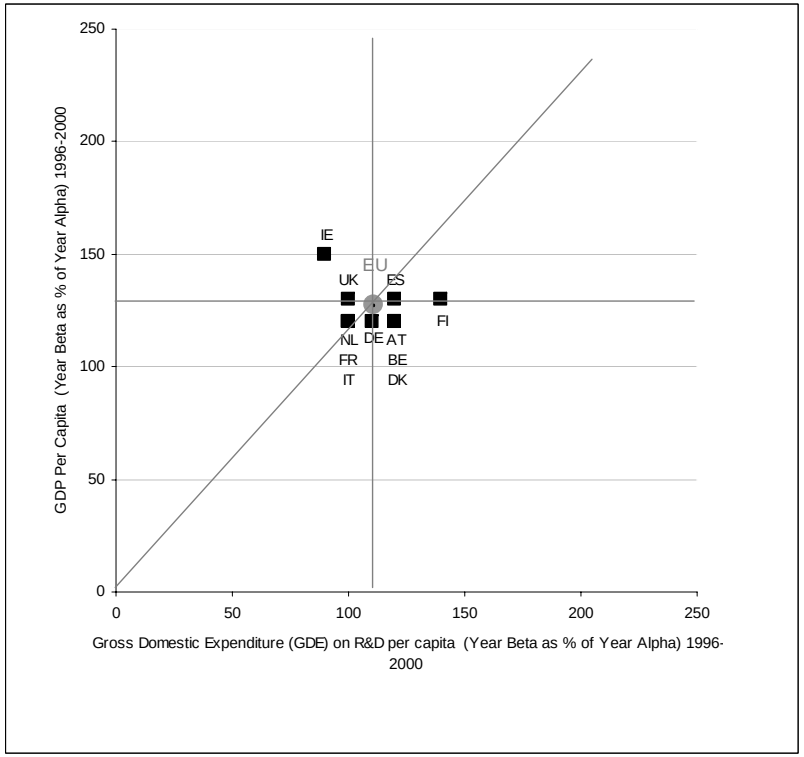


Figure 2 - Relative Growth Chart, EU Countries

Source: Own elaboration using EUROSTAT Data

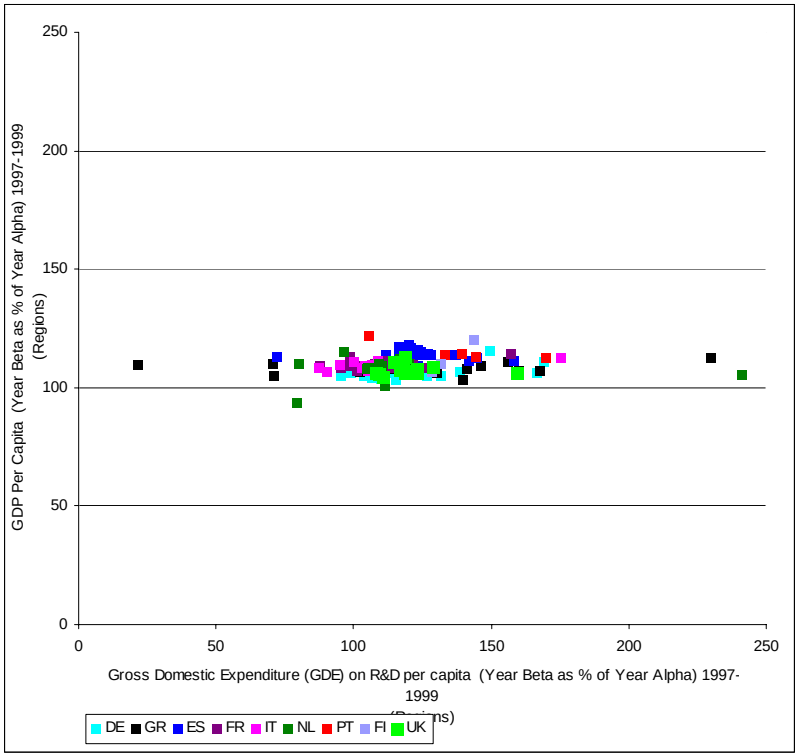


Figure 3 – Relative Growth Chart, EU Regions

Source: Own elaboration using EUROSTAT Data

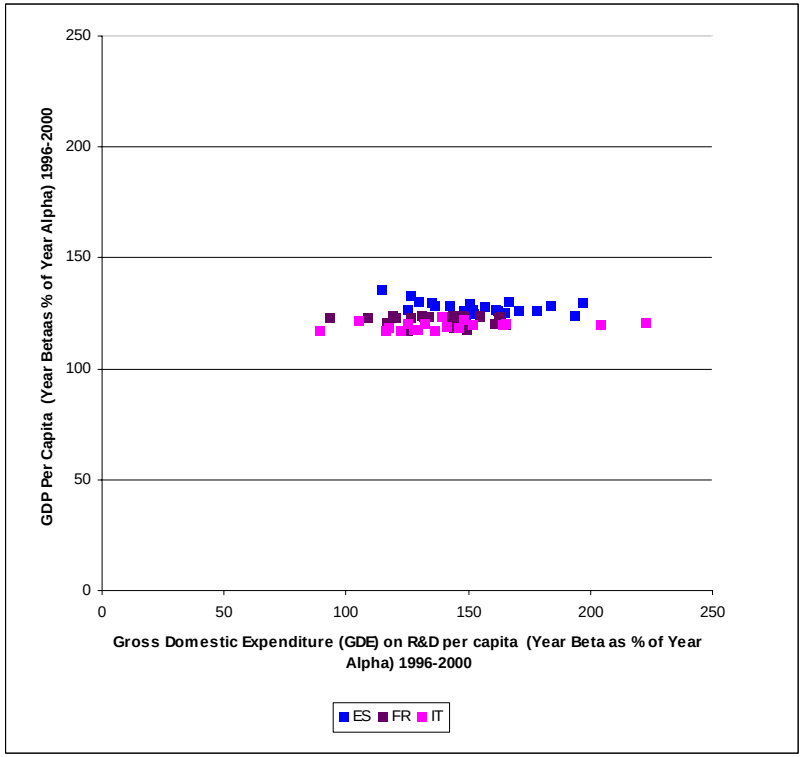


Figure 4 – Relative Growth Chart, EU Regions

Source: Own elaboration using EUROSTAT Data

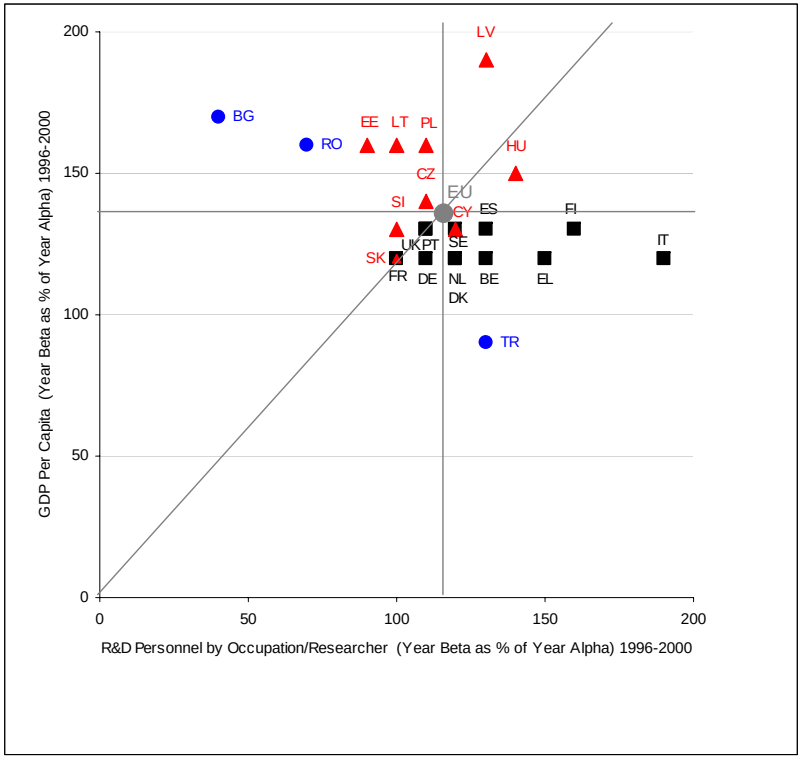


Figure 5 – Relative Growth Chart, EU Countries and Cohesion Countries

Source: Own elaboration using EUROSTAT Data

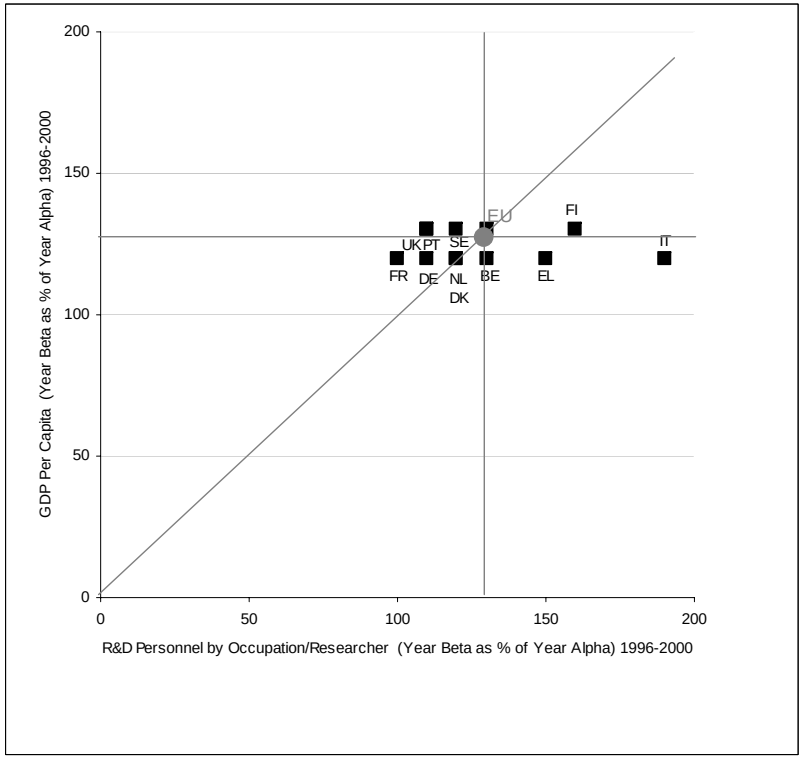


Figure 6 – Relative Growth Chart, EU Countries

Source: Own elaboration using EUROSTAT Data

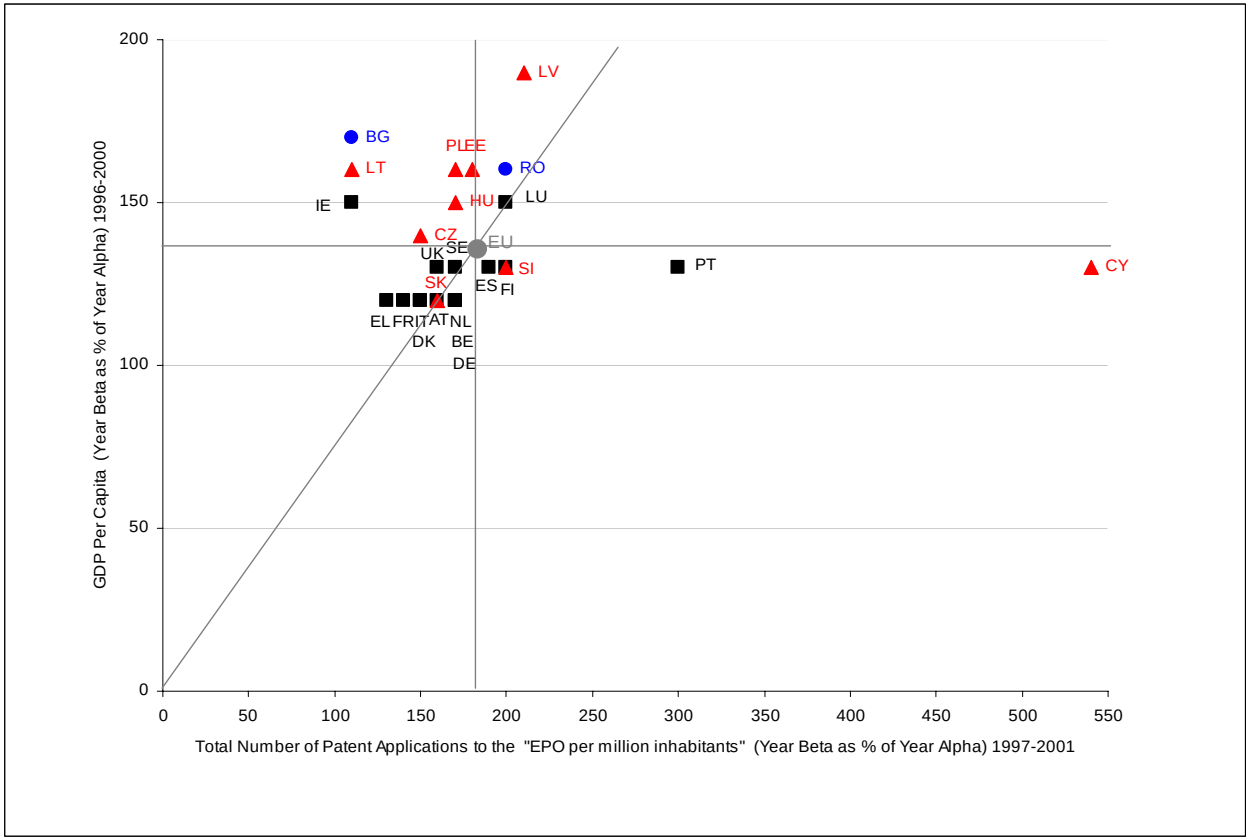


Figure 7 – Relative Growth Chart, EU Countries and Cohesion Countries / Source: Own elaboration using EUROSTAT Data

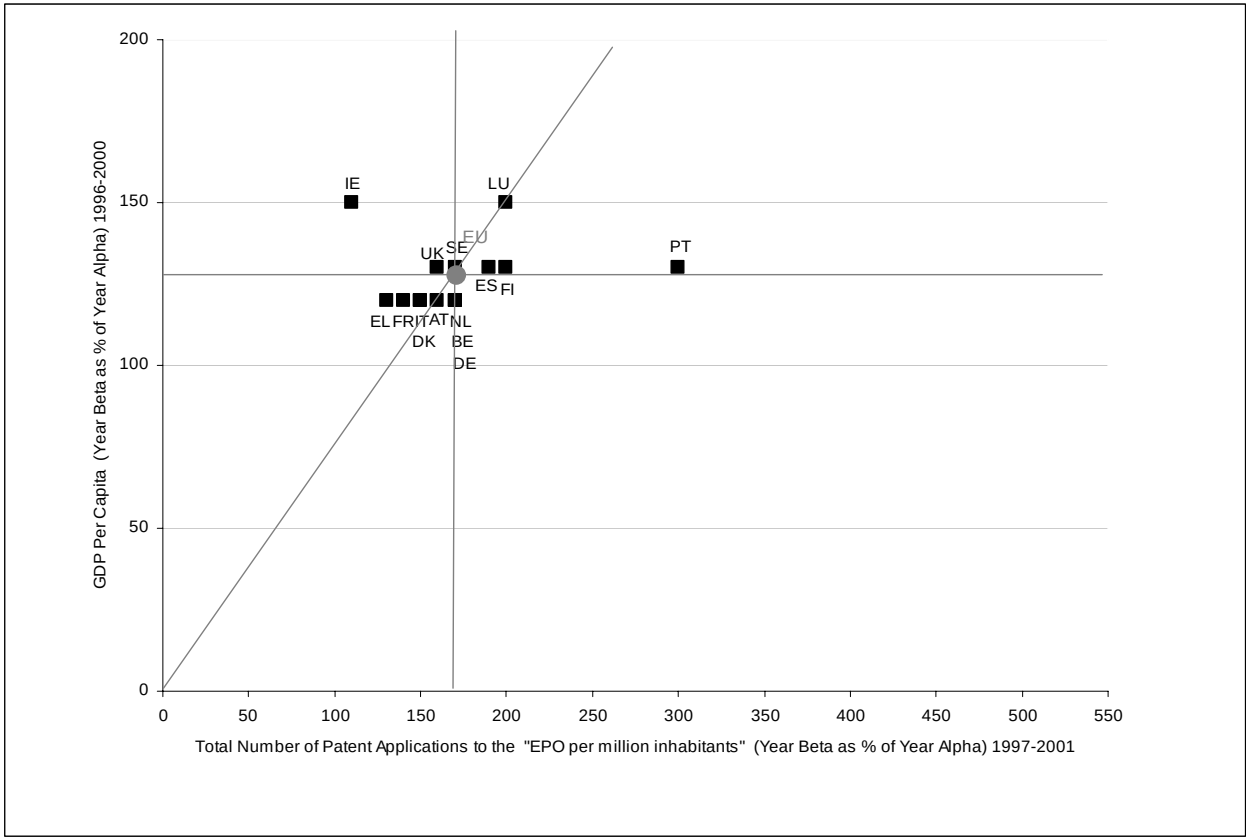
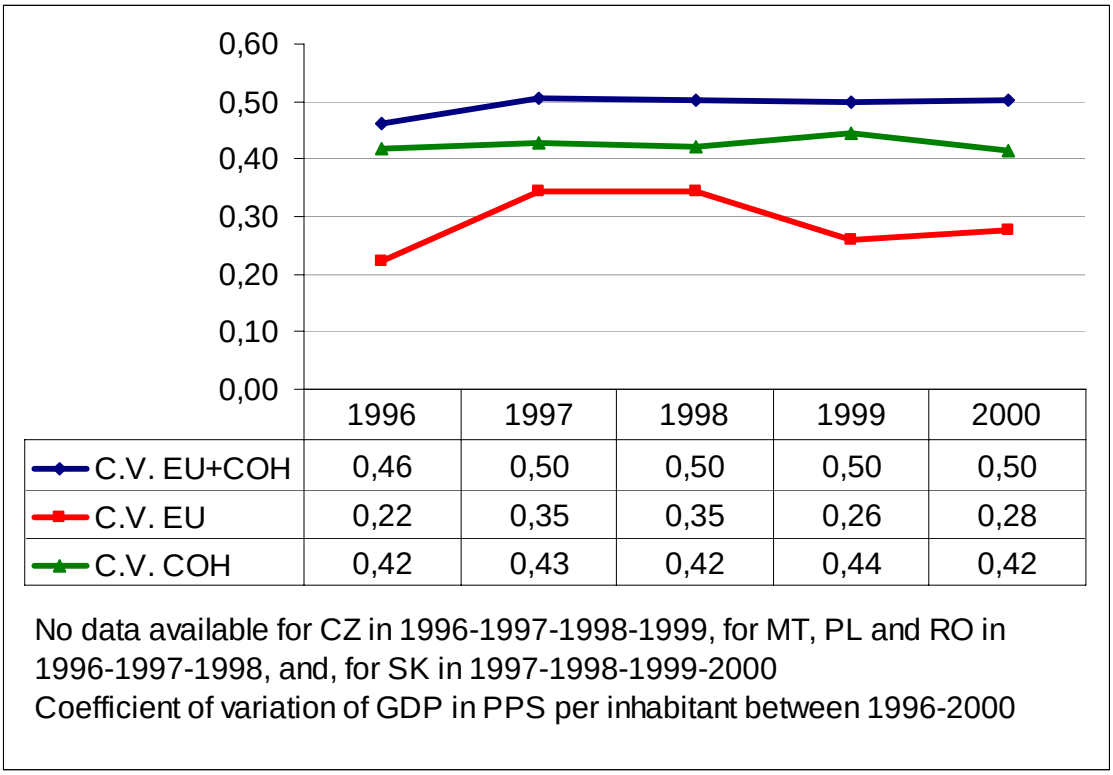


Figure 8 – Relative Growth Chart, EU Countries / Source: Own elaboration using EUROSTAT Data



	1996	1997	1998	1999	2000
C.V. EU+COH	0,46	0,50	0,50	0,50	0,50
C.V. EU	0,22	0,35	0,35	0,26	0,28
C.V. COH	0,42	0,43	0,42	0,44	0,42

No data available for CZ in 1996-1997-1998-1999, for MT, PL and RO in 1996-1997-1998, and, for SK in 1997-1998-1999-2000
Coefficient of variation of GDP in PPS per inhabitant between 1996-2000

Figure 9 – Relative Growth Chart, EU Countries and Cohesion Countries

Source: Own elaboration using EUROSTAT Data

4. CONCLUDING REMARKS

- The regional distribution of innovative capacity in the EU corresponds the structure of national scientific and technological systems, despite of regional differences within the EU serve to widen disparities further.
- High R&D intensity in the private sector and operative links between the scientific sector and businesses are key to innovation and, in turn, economic growth.
- Structural differences in science and technology cannot explain the weakness of the structure of economic activity in lagging regions. There is a consensus that the failure of firms in the regions concerned to innovate is not due primarily to scientific or technological problems, but to deficiencies in the institutional and organizational environment in which firms have to operate.

- There is no indication whether the clustered economic landscape in the EU weakens over time in the short run, when interregional interaction have significant influence on relative performance. Higher rates of growth are observed for the lagging areas or cohesion countries, on the relative growth charts.
- Since agglomeration effects cumulative causation and disparities are inevitable in the diffusion process of innovation on likely effects of R&D expenditure and personnel, clustering on the relative growth will be inevitable.

REFERENCES

ARMSTRONG, H.W. (1995), "Convergence Among Regions of the European Union: 1950-1990", Papers in Regional Science, 74/2

ATALIK, G. (2002), "Some Effects of Regional Differentiation on Integration in the European Community", in Regional Development Reconsidered, eds. G. Atalık-M.M. Fischer, Springer.

ATALIK, G., CIRACI, H. (1992), "Role of Services in the Process of Urban and Regional Development: Impact of Quaternary Activities in Turkey", 32nd ERSA Congress, Louvain-la-Neuve.

BERRY, B.J.L. (1972), "Hierarchical Diffusion: The Basis of Development Filtering and Spread in a System of Growth Centers" in Growth Centers in Regional Economic Development, ed N.M. Hansen, The Free Pres: New York.

BRADFORD, M.G., KENT, W.A. (1989), Human Geography / Theories and Applications. Oxford Univ. Press.

CAMAGNI, R.P. (1991), "Technological Change, Uncertainty and Innovation Networks: Towards a Dynamic Theory of Economic Space" in Regional Science/Retrospect and Prospect, eds D.E. Boyce, P. Nijkamp, D. Shefer, Springer.

CHESHIRE, P.C.; MALECKI, E.J. (2004), "Growth, Development, and Innovation: A Look Backward and Forward", Papers in Regional Science, Vol:83/1.

CLAPP, J.M., RICHARDSON, H.W. (1991), "Technical Change in Information-Processing Industries and Regional Income Differentiates in Developing Countries", Int. Regional Science Review 9.

COFFEY, J.M., POLESE, M. (1989), "Producer Services and Regional Development: A Policy-Oriented Perspective", Papers of the RSA, Vol:67

E.C. (1996), The Impact of the Development of the Countries of Central and Eastern Europe on the Community Territory, Luxembourg.

E.C. (2001), Unity, Solidarity, Diversity for Europe, Its People and Its Territory.

EUROSTAT (2003), Statistical Yearbook on Candidate Countries.

EUROSTAT (2004), Regional Statistics in Europe on Science and Technology.

FISCHER, M.M. (2002), "A Systemic Approach to Innovation" in Regional Development Reconsidered, eds. G. Atalık-M.M. Fischer, Springer.

FRATESI, U. (2003), "Innovation Diffusion and the Evolution of Regional Disparities", 43rd ERSA Congress.

GIAOUTZI, M., STRATIGEA, A. (1991), "The Impact of New Information Technologies on Spatial Inequalities" in Regional Science/Retrospect and Prospect, eds D.E. Boyce, P. Nijkamp, D. Shefer, Springer.

HAGERSTRAND, T. (1967), Innovation Diffusion as a Spatial Process, Univ of Chicago Press.

HINGEL, A.J. (1993), "The Prime Role of Regional Cooperation in European Integration" in Regional Networks, Border Regions and European Integration, eds. R. Cappellin, P.W.J. Batey, Pion Ltd.

ISARD, W. (1967), Methods of Regional Analysis, The M.I.T. Press.

LAKSHMANAN, T.R. (1988), "Knowledge Technologies and Networks and Economic Change", 28th ERSA Congress, Stockholm.

MALECKI, E.J., VARAIA, P. (1986), "Innovation and Changes in Regional Structure" in Handbook of Regional and Urban Economics. Vol.I, ed. P. Nijkamp, Elsevier Science Publishers.

MALECKI, E.J. (1991) Technology and Economic Development: The Dynamic of Local, Regional and National Change, Longman Scientific & Technical.

MAURSETH, P.B. (2001), "Convergence Geography and Technology", Structural Change and Economic Dynamics, 12.

MOLLE, W. (1983), "Technological Change and Regional Development in Europe" Papers of the RSA, Vol:52.

MOLLE, W., BOECKHOUT, S. (1995), "Economic Disparity Under Conditions of Integration: A Long Term View of the European Case", Papers in Regional Science, Vol:74/2.

NIETO, M. (2003), "From R&D Management to Knowledge Management: An Overview of Studies of Innovation Management", Technological Forecasting and Social Change, 70.

PERROUX, F. (1964), "Economic Space: Theory and Application" in Regional Development and Planning, eds. J. Friedmann, W. Alonso, The M.I.T. Press.

RICHARDSON, H.W. (1978), Regional and Urban Economics, Penguin.

RODRIGUEZ-POSE, A. (2001), Is R&D Investment in Lagging Areas of Europe Worthwhile? / Theory and Empirical Evidence", Papers in Regional Science, Vol.80/3.

SAMUELSON, P.A. (1964), Economics / Introductory Analysis, McGraw-Hill.

SUAREZ-VILLA, L., CUADRADO-ROURA, J.R. (1993) "Regional Economic Integration and the Evolution of Disparities" Papers in Regional Science, Vol:72, 4