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INNOVATING ROUTINES AND ROUTINIZING INVENTION: A STUDY ON THE DIFFUSION OF PATENT APPLICATIONS IN ITALIAN REGIONS, 1981-2001

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ABSTRACT.

This paper investigates the pattern of cross-regional diffusion of innovating routines in Italy, in the period 1981-2002. The Italian case is relevant due to the persisting dualism between regions led by manufacturing and business-services industries, as already noted in the 1970s by the scholars of the Ancona group. The main point is that the routinizing of invention activities emerges as a specific stage of industrial development. We have eventually analyzed the role of structural change and knowledge stocks availability in this process. Both the descriptive and the econometric evidence strongly support the hypothesis of diffusion of innovating routines as closely related to the pattern of diffusion of industrialization and the development of absorptive capacity.

JEL classification codes: O14, O31, O33, R11

Keywords: Innovating Routines, Diffusion, Growth Retardation

1. Introduction

The process of economic growth is not uniform across countries and across industries within the same country. Within any country the growth process is led by a succession of different branches of economic activities, whereby the industries in the later stages of life cycle undergo a slowing down of output growth rates (Klepper, 1997; Metcalfe, 2003). According to the so-called retardation theory, this implies that different countries are supposed to be the economic leaders in different historical times, according to their main sector of specialization (Kuznets, 1930). Such an approach has fed the argument of economic convergence in the post-war era, put forth by economic historians. Slackening growth rates in the US have accordingly been considered at roots of the observed convergence of OECD countries' labour productivity towards American levels (Abramovitz, 1986; Nelson and Wright, 1992).

However according to Kuznets, "a rapidly developing industry does not continue its vigorous growth over time indefinitely, but slackens its pace after a time, and is overtaken by industries whose period of rapid development comes later" (Kuznets, 1930: p. 6). The recent evidence about the surge in US productivity levels in the late 1990s fits this framework. Indeed the US economy has been able to successfully adapt to the erosion of the manufacturing base by creating a suitable environment for the transition towards the knowledge-based economy. At the core of this process stands a three-pronged thrust, i.e. the boosting effect of information and communication technologies (ICT), the complementary growth of business service industries, and the increasing relative endowment of skilled human capital (Jorgenson, 2001 and Jorgenson et al., 2006; Antonelli, 1997 and 2003; Acemoglu, 1998).

Empirical cross country comparisons confirm this by highlighting a renewed increase in productivity gap between the US and Europe. While data about ICT's adoption provide somehow

mixed pictures, many scholars agree on attributing the major source of productivity gap to the inability of laggards to elicit the productivity effects of ICT adoption (Daveri, 2002; Timmer and Van Ark, 2005). As far as Italy is concerned, from Figure 1 it is pretty clear that the decrease of manufacturing share of value added is far slower than in the US and in the UK. As a result, the share of manufacturing industries in Italy turns out to be still high in the late 1990s, while that of service sectors increase very slowly (Antonelli et al., 2007).

INSERT FIGURE 1 ABOUT HERE

The graft of economics of innovation into this framework sheds a new light upon persisting dualisms. The main underpinning of the analysis is the concept of innovating routines, defined as the combination of the activities through which managers accomplish the tasks of producing scientific and technological knowledge, transforming knowledge into artefacts and matching artefacts with users' requirements (Pavitt, 2002). Learning dynamics are of paramount relevance in the routinization of a pattern of behaviour. That is why the routinization of innovation emerges only some time after the spread of an industry. We thus argue that retardation affecting innovating routines follows the spread of industrialization, consolidating as a feature of advanced stages of the industry life cycle (Metcalfe, 2003).

The case of Italy within this picture is very peculiar. Indeed, already in the 1970s eminent scholars maintained that the Italian economic system was characterized by a dualism in the industrial structure. This consisted in the coexistence of two processes of retardation of industrial growth, i.e. the one concerning the manufacturing and the one concerning the business services industries, impinging upon North-Eastern-Central (NEC) regions and North-Western regions respectively (Fuà, 1983). It follows that the Italian case provides a good benchmark to investigate the patterns of diffusion of innovating routines, and its relationships with the stages of industrial development.

In this direction, the contribution of this paper to the literature is twofold. On the one hand it aims at rejuvenating a field of enquiry which has been lacking appropriate consideration since the 1980s. For this reason, the debate about the economic development of Italian regions has somehow missed the important opportunity of investigating cross-regional differences in the light of the economics of innovation. On the other hand, such an analysis also turns out to be relevant due to the theoretical implications concerning the relationships between development patterns and technological change.

The remainder of the paper is organized as follows. In Section 2 we provide empirical evidence of the persistence of industrial dualism in Italy, drawing upon employment data. In Section 3 the theoretical framework is outlined, elaborating upon the issues of innovation, routines and diffusion. Section 4 presents the working hypotheses, while in Section 5 we describe the methodology and the data we used. In Section 6 the results of the econometric estimations are provided and finally, in Section 6, conclusions follow.

2. Routines and Diffusion of Innovation. A Seeming Oxymoron

In this Section we provide the theoretical underpinnings to the analysis of the diffusion of innovating routines. In particular we merge together two streams of literature. On the one hand the evolutionary view of the firm stresses the role of routines in shaping its performances. On the other hand, the literature on diffusion of innovation analyzes the determinants of observed differences in adoption rates. Considering the adoption of innovating routines as an innovation itself allows for the investigation of its diffusion patterns.

Firms innovate in order to react to the pressure of the surrounding environment (Schumpeter, 1942). The literature on induced technological change stressed on the one hand the role of changes in

relative prices (Hicks, 1932; Fellner, 1961; Kennedy, 1964) and on the other hand the effects of changes on the demand side (Young, 1928; Kaldor, 1957; Schmookler, 1954). In the theory of localized technological change firms innovate as a reaction to mismatches between their plans and the actual conditions of factor and product markets. Such changes are strongly shaped by the specific conditions of markets, industries and regions in which firms operate, and they emerge out of a sequence of path-dependent choices (Antonelli, 2003 and 1995).

Within innovating firms, innovation activity itself is object of specific routines. Along the lines of Nelson and Winter (1982), routines can be pretty generically defined as repetitive patterns of activity in an entire organization, allowing the firm to cope with a world of continuous change. Such habitual patterns of behaviour involve both coordination and useful productive – and mostly tacit – knowledge. In other words, routines reflect "knowledge how" to do something (Langlois and Savage, 2001). In some cases such useful knowledge can be about how to innovate.

Pavitt (2002) explicitly maintained that innovating routines deserve great attention. He identified three dimensions of knowledge production and use, i.e. the production of scientific knowledge, the implementation of knowledge in working artefacts, the matching of working artefacts with user needs. Innovating routines are hence defined as the patterns of behaviour that should accomplish the managerial tasks related to these three processes. Some of these tasks are well established, while some of them emerge in response to changes in economic and social environment. Innovating firms have indeed to deal with the increasing specialization in knowledge production, complexity of artefacts and the matching of technology opportunities and organizational practices (Pavitt, 2002). In this direction routines are major sources of change both because sometimes they are explicitly designed to produce change, and because they provide access to sources of new knowledge (Becker et al., 2005).

By changing their routines, firms may decide to introduce innovating routines within their boundaries and recombine them with the existing ones. This necessarily is a process taking time to emerge and eventually consolidate. The new routines embodying the set of activities necessary for the management of innovation may be the outcome of dynamic increasing returns stemming from repeated iterations of innovative efforts. They may also ultimately result from the incorporation of external routines, i.e. routines already in place in other firms. While it is likely to engender internal conflicts, this process of routines innovation driven by imitation can nonetheless turn out to be successful if properly managed (Nelson and Winter, 1982).

Thus, innovating and routinizing, while representing two apparently opposite terms of an oxymoron, are nonetheless closely intertwined. As put forth by Becker et. al., "a central proposition of routine theory is that organizations change what they are doing and how they are doing it by changing their routines" (2005, p. 776). Innovative efforts are carried out by following specific routines. Firms which are not innovating may decide to do it, under the competitive pressure faced in the market they operate. In so doing they change their existing routines by introducing innovating routines on the basis of an imitation process of their direct competitors. Routinizing represents the last stage of this process, whereby innovation is incorporated within the regular activities of the organization (Rogers, 2003).

In this framework, the challenges coming from increased international competitive pressure on product markets, are likely to engender a creative reaction, inducing firms to adopt innovating routines adapting them to their idiosyncratic conditions. The adoption choice requires creative efforts, in turn bringing about costs for the involved firms. For this reason the adoption is not instantaneous. In a population of heterogeneous firms, where the cost of the innovation is constant

or decreases over time[1], agents adopt when their benefits outperform their costs. In addition, according to the epidemic models, imperfect information makes it gradual the learning about the innovation and its related benefits, which are intrinsically uncertain. The working of communication channels is hence crucial to the diffusion of an innovation within a system. Communication is by no means immediate, and agents need a further effort to acquire the relevant knowledge. This gradually reduces the uncertainty about the innovation, and stimulate its adoption. According to Griliches (1957) "In a world of imperfect knowledge, it takes time to realize that things have in fact changed" (Griliches, 1957: p. 516). The increase in the number of adopters makes it available more information about the possible applications and consequence of the innovation, and hence helps the diffusion process within the particular subset of the social system which is defined by the potential adopters (Mansfield, 1961). The simultaneous working of these forces, reinforced by the bounded cognition characterizing economic agents (Loasby, 2002), gives the diffusion process the characteristic S-shape (Hall, 2004a; Antonelli, 1989).

The benefits stemming from the adoption are thus not that granted. Learning processes are of paramount importance in determining the rate of adoption, because they allow for subsequent improvements and adaptation of the innovation, making it more attractive for a wider set of adopters (Rosenberg, 1972). The diffusion of innovating routines hence turns out to be a timely process fed by the potential users efforts of creative adoption (Antonelli, 2006).

Network effects, in this direction, are likely to represent a further element affecting the benefits perception by adopters. On the opposite the costs, once born, are not recoverable anyhow. These include both the physical costs involved in the adoption, and the costs stemming from the complementary changes within firms' boundaries, like training of workers or purchase of necessary equipment (Hall, 2004a).

[1] As long as the distribution of benefits over consumers is normal.

In sum, information asymmetries, bounded rationalities and network externalities interact in delaying the adoption of innovations. When the innovation concerns the adoption of new routines the process is even more complicated. It must be noted that at the very beginning what is going to be adopted is a pattern of activities that does not represent a routine yet. Routines eventually emerge in a context shaped by adaptive learning, whereby the activities are gradually tuned to the idiosyncratic conditions of production, beginning to yield improvements in economic performances. The routinization is hence likely to occur over a quite long time span. The typical diffusion dynamics are reinforced by the working of organizational mechanisms leading to the routinization of innovating activities.

A set of additional factors may influence innovating routines, which are however related to features of the economic and institutional structure. While the threat of international competition may provide the stimulus, the combination of the increase in technological opportunities, the rise of public R&D procurement, and the strength of protection tools may increase the returns to R&D. The decision to adopt innovating routines can hence be delayed unless these conditions are realized, and unless firms have developed the set of necessary skills to manage complex innovation processes, characterized by the increasing science-based content, cooperation with external knowledge sources and mutual access to a common knowledge pool (Pavitt, 2002; Antonelli, 2001). The higher returns to R&D in turn may well determine an increase in patenting activities (Jaffe, 2000; Webster, 2004; Kortum and Lerner, 2003). Moreover, in such a context patents turn out to represent also a tool through which firms can exchange knowledge on the markets, making it easier for interactive learning to work in environments characterized by the existence of strong systemic ties (Lundvall, 1992; Arora, Fosfuri and Gambardella, 2001; Peeters and van Pottelsberghe, 2006). Patents may thus be understood as manifestations of innovating routines, i.e. as the artefacts layer, thus representing a reliable indicator of innovation activities (Pentland and Feldman, 2005; Eaton

and Kortum, 1999). The discussion carried out so far will lead us to argue that innovating routines – signalled by patent statistics – follow an S-shaped time path.

The analysis of the diffusion of innovating routines seems the appropriate tool for understanding the enduring territorial diffusion of manufacturing activities in the late-industrialized regions, chiefly Emilia-Romagna, Marche, Abruzzi and Umbria (Quatraro, 2007). To understand whether and to what extent the geographical patterns of this phenomenon are related to the stages of industrial development, let us investigate now the cross-regional patterns of structural change in Italy.

3. The Clues of Persistent Late Industrialization in Italy

3.1 The Origins of the Problem

In the 1950s most Italian regions were rural, and populated by a large share of small- and medium-sized enterprises, as opposed to North-Western regions, which specialized in manufacturing activities, carried out by large firms. Analyzing the distribution of growth rates and structural change at the regional level in the period 1950-1970, the Ancona School identified and found the clues of a successful diffusion process of manufacturing activities towards such rural regions in the North-East and eventually in Central Italy, along the Adriatic coast. For this reason they proposed to group such regions into a larger macro-area which has been eventually called NEC (North-East-Centre)[2]. At the same time, the growth of manufacturing industries was slowing down in the North-West, wherein the growth of business service industries was already *in nuce* (Pettenati, 1980; Fuà and Zacchia, 1983).

[2] The grouping of Italian regions is as follos. North-West: Piedmont, Lombardy, Valle d'Aosta and Liguria. North-East: Veneto, Emilia-Romagna, Friuli Venezia-Giulia,Trentino Alto-Adige. Centre: Tuscany, Abruzzi, Marches, Lazio, Umbria and Molise. South: Campania, Apulia, Calabria, Basilicata, Sicilia and Sardegna.

Different factors were proposed in the 1970s as conducive to the successful territorial diffusion of manufacturing activities towards the NEC. On the one hand it has been argued that the widespread presence of small- and medium-sized firms contributed to create a favourable environment, characterized by low costs of living, intense utilization of labour potential, and the persistence of pretty informal labour relationships. Firms in turn benefited from these peculiarities in terms of lower costs and better business efficiency. Moreover they maintained that the small size scale and the specialization in labour-intensive activities, permitted in many ways swifter adaptation to changes in markets and technologies (Fuà, 1983, 1991a and 1991b; Fuà and Zacchia, 1983; Garofoli, 1981 and 1983).

On the other hand the relevance of the features of the social texture has been stressed, whereby the traditions rooted into the sharecropping system largely drawing on the informal institution of the "extended family" were persisting. The gradual diffusion of manufacturing did not seem to be paralleled by a simultaneous change of the social organization. Low wages and temporary jobs were accepted because of the weakness of labour market as an institution, substituted by the "extended family" which worked as a real self-regulatory system. In such a context dynamic pressures and attitude toward self-employment represented a key factor for the successful creation of manufacturing enterprises[3] (Paci, 1973 and 1992). The boosting role of institutional factors (above all embedded in the labour market) and the peculiarities of the economic structure, were maintained to lead to the set of positive-feedbacks well described by the industrial district theorists (Brusco, 1982; Becattini, 1989).

[3] The empirical analysis carried out by Garofoli (1994) addresses the issue of firms creation very exhaustively.

3.2 The Recent Evidence

To investigate the persistence of late industrialization and its geographical distribution, we use time series data on employment at the regional level, drawn from the Italian National Institute of Statistics (ISTAT). The issue of territorial diffusion of manufacturing activities can be addressed by looking at the dynamics of regional specialization index, defined as the region's relative share of employment within an industry. Formally it is defined as employment in sector *i* located in region *j* at time *t* (IL_{ijt}), divided by the region's total employment in all industries, compared to the same measure at the national level:

$$\left(\frac{IL_{ijt}}{\sum_{i} IL_{ijt}}\right) \Bigg/ \left(\frac{\sum_{j} IL_{ijt}}{\sum_{i}\sum_{j} IL_{ijt}}\right) \qquad (1)$$

In Table 1 and Table 2 we report the results of the calculations for *manufacturing industries* and *finance, insurance, real estate and business services*[4]. As far as manufacturing is concerned, North-Western and NEC regions are characterized by well differentiated patterns. The former indeed show up decreasing values, both as an aggregate and singling out the regions. The Lombardy and Piedmont regions are characterized by the highest specialization indexes in 1982. It must be considered that, according to Fuà and his colleagues, the process of territorial diffusion started in the late 1960s. This is the reason why regions like Veneto, Emilia-Romagna, Umbria and Marches are characterized by values just slightly lower than in the above mentioned North-Western regions. The main important aspect is that the North-Eastern and Central regions are characterized by specialization indexes increasing over time. It is worth stressing that in Veneto and Marches the specialization in manufacturing grew very impressively along the 1980s (respectively +13.6% and +19.6% in the period 1981-1991), slowing down in 1990s (but still growing). In Emilia-Romagna

[4] Respectively ISIC 15-37 and ISIC 65-74.

and Molise its growth was sustained both in the 1980s and the 1990s, while in the Umbria region the index decreased until the first half of the 1990s, and then started increasing steadily. At the end of the observed period, it seems that North-Eastern and Central regions are characterized by specialization indexes very close to (and in the case of Marches even higher than) the values featuring North-Western regions. Moreover the trend appears to be soundly positive in the former, while the values in the latter are continuously decreasing since the early 1980s.

INSERT TABLE 1 ABOUT HERE

We turn now to the evidence about business service industries. Not surprisingly, the situation is pretty much the opposite. The specialization index is already higher than 1 in 1980 in all North-Western regions but Aosta Valley. For what concerns Piedmont, the index is increasing along the 1980s until 1992, then starting decreasing very slowly in the rest of the 1990s. As a result, in 2001 the specialization index for business services turned out to be 6.2% higher than in 1980 in Piedmont. The Lombardy is instead characterized by a fairly stationary index along the 1980s. Then it started decreasing slowly, such that the whole period growth rate appears to be negative, although the index in 2001 is still the highest of North-Western regions, and of all Italian regions (with the only exception of Latium). As far as the NEC regions are concerned, it seems quite clear that the specialization index, although growing in Central regions, is well below 1 over the whole period considered (with the only exception of Friuli Venezia Giulia), witnessing the substantial lack of specialization in service industries.

INSERT TABLE 2 ABOUT HERE

For what concerns Southern regions, the picture is completely different. The existence of existence of a “Southern problem” has been long recognized by economists and historians, and it’s not our

purpose to cope with it here. However, it is worth stressing that both the index for manufacturing and that for business service industries are well below 1 in all Southern regions. Among them the Apulia and the Basilicata regions are the ones characterized by positive dynamics. In Basilicata the index for manufacturing grows of about 89%, while the one for service sectors grows of 19.7%. In Apulia the long run growth rate is of about 5% for manufacturing and 12% for service sectors. While they are still far from the values expressed by the other regions, Apulia and Basilicata are likely to represent the latest bulwark of a process of industrialization that has been going over along the Adriatic coast for the last decades, but with sensible weaknesses.

In conclusion, it seems that the data on employment clearly show the persistence of a diffusion of manufacturing activities towards the NEC regions, in the same spirit of the works by Fuà. Moreover, in the North-West, the evidence about business services shows that their development is still far from overtaking manufacturing industries. In the next Section we thus outline the theoretical framework underlying the following analyses of the territorial diffusion of innovating routines which we argue is paralleling the persisting diffusion of manufacturing activities towards the North-Eastern and Central regions.

4. The Hypotheses

The main argument of this paper is that innovating routines emerges out of a very gradual process in which the interplay of different forces are likely to engender a S-shaped time path. Due to the role of learning dynamics and creative adoption, innovating routines begin to diffuse with some delay with respect to the spread of a new industry, as an effect of more systematic innovative efforts.

The Italian data provide puzzling evidence due to the retardation of innovating routines within the late-industrialized regions. The present features of innovation activities in Italy can be read as a consequence of the persisting dualism among North-Western regions on the one hand, and North-Eastern and Central regions on the other.

The process of territorial diffusion of manufacturing activities is at such an advanced stage that firms have now developed the necessary skills to manage more formalized innovation efforts[5]. This phenomenon can be inferred by the analysis of the territorial diffusion of patent applications. Insofar as the dualism counterpoise manufacturing and service industries, cross-industry differences in propensity to patent provide a good background to the analysis of the diffusion of innovation activities within manufacturing-intensive regions, as in the case of service sectors patents have proved to play a very marginal role[6]. The retardation of innovating routines is affected by many factors, which can be summed up as follows:

1) Firms decide to patent as soon as the benefits are higher than the costs[7]. As far as the EPO is concerned, the information about the working of the new patent system is gained through communication with neighbour firms, that are also likely to socialize their experience above all in areas characterized by the existence of strong systemic dynamics. This leads us to expect that the evidence about innovating routines follow an S-shaped path as far as all Italian regions are concerned, as an effect of the diffusion process of a new institutional device.

[5] Gershenkron (1962) already argued that differences in the economic performance between countries differently positioned within the industrial revolution process could be ascribed to the diffusion of technology. The same may also apply to differences in economic performances of regions in different stages of economic development.

[6] The debate about the nature of innovation activities within service sectors have recently received increasing attention. Tether (2005) and Consoli (2007) offer good critical syntheses of it. Evangelista and Sirilli (1998) and Evangelista (2000) present the Italian evidence, emphasizing the very marginal role played by patents in innovation dynamics within service sectors.

[7] The issue of the relevance of patents as protecting tools is a pretty controversial one. The expected value of patent protection seems to drive to some extent the decision to patent (Eaton and Kortum, 1999; Pavit, 1985). In this direction, the creation of a European Patent Office (EPO) in 1973 is likely to have determined a gradual switch to European Patents over time. On the one hand, indeed, the research efforts are likely to be better protected on the international scale, at least within the European boundaries, and thus the expected returns from European patenting turns out to be higher than patenting at the national patent office. On the other hand, the costs of filing an application to the EPO are likely to decrease over time, as an effect of learning dynamics.

2) Although the Italian economy is late with respect to the other OECD countries, nonetheless it is facing the same process of transition towards the service sector. The main hypothesis of this paper is that such transition is not equally distributed across Italian regions. In particular, we expect the adoption of innovative routines to be faster in the NEC regions than in the North-Western as an effect of the different stage of economic development. Moreover the speed of diffusion is expected to positively relate to the evolution of the manufacturing share of employment, rather than that of service industries, as an effect of the change in the industrial structure.

3) The adoption of innovating routines may stem from the increase in technological opportunities and the availability of the knowledge stock publicly available. The relevance of external knowledge sources in the innovation process (Griliches, 1992) makes it more likely for firms operating in contexts characterized by high levels of communication and interaction dynamics, to invest resources in the innovation process. According to many scholars, the positive dynamics featuring the industrial districts which flourished in late-industrialized regions in Italy, are responsible for fairly vigorous innovative activity[8]. High levels of trust and loyalty indeed are likely to lower transaction costs, and hence foster communication among firms within local production systems. It can be specified the proposition according to which the rate of diffusion of innovating routines is expected to be positively related with the rate of growth of R&D expenditure, both private and public, as a proxy of improved absorptive capacities.

[8] See for example the works by Patrucco (2005) concerning the Emilia-Romagna technology district, the works by Belussi (2003) and by Belussi and Arcangeli (1998) concerning both the North-Eastern regions, and Belussi (1999), Quatraro (2005) and Boschma and Ter Val (2005) for more recent evidence about Southern regions. The work at the aggregate level by Cainelli and De Liso (2005) is also particularly interesting in pinpointing innovation dynamics within Italian industrial districts. It is worth stressing that in some contexts the evolution of the industrial structure is led by the emergence of groups of firms within the districts, i.e. by peculiar forms of evolution of local capitalism (Brioschi et al., 2002; Cainelli et al., 2006).

5. Research Design

5.1 Methodology

The econometric strategy is articulated in two steps. Firstly, in order to estimate the different rates of diffusion of patent application across Italian regions, we use the standard logistic equations proposed by Griliches (1957) and Mansfield (1961). A similar exercise was put forth by Andersen (1999) in her analysis of differential growth rates at the industry level[9]. The logistic function can formally be written as follows:

$$P = \frac{K}{1 + e^{-\alpha - \beta t}} \tag{2}$$

where P is the level of adoption, t the time and K the ceiling. The features of this curve are well known, in that it is asymptotic to 0 and K, it is symmetric around the inflexion point and its time derivative is $dP/dt = -b/(P/K)(K-P)$, which confers the S-shape. Equation (2) is well suited to represent the diffusion process as the result of learning and imitation dynamics. Firms in late industrialized regions learn how to carry out more systematic and formalized innovation activities, by imitating firms in early industrialized regions, which have already successfully adopted such innovating routines. They in turn have to bear the adaptation costs in order to match these routines with the idiosyncratic conditions of production. Bounded rationality hence interacts with costs-benefits considerations, likely delaying the adoption choice.

Equation (2) can be rearranged dividing both sides by $(K-P)$ and taking logs, to obtain the following econometric specification:

$$\ln\left[\frac{P_t}{K - P_t}\right] = \alpha + \beta t \tag{3}$$

[9] S-shaped curves were used also in the study of business cycles, many years before they entered the study of technological change. It is fair to recall, in this direction, the works by Kuznets (1930) and Merton (1935).

Secondly, we investigate the relationships diffusion of innovating routines and structural change on the one hand, and the links with the availability of accessible knowledge stocks on the other. This is done by taking the estimated time coefficients from the logistic fit and regressing them as follows:

$$\beta_i = a + b \cdot MAN_i + c \cdot FIN_i + d \cdot TRA_i + u \quad (4)$$

$$\beta_i = e + h \cdot GRGFI_i + m \cdot GRPUR_i + n \cdot GRPRD_i + z \quad (5)$$

Where β clearly stands for the estimated time coefficients of the logistic equation, and u and z are the respective error terms. In Equation (4) *MAN*, *FIN* and *TRA* are respectively the average annual growth rates of the employment share of manufacturing, finance business services and trade industries. In Equation (5) the rates of diffusion are instead regressed against the average growth rate of public and private R&D (respectively *GRPUD* and *GRPRD*), plus the average annual growth rate of gross fixed investment (*GRGFI*) as control variable accounting for the embodiment hypothesis.

5.2 Data and Descriptive Evidence

The empirical analysis of the diffusion of innovating routines in Italy is based on the evidence about the evolution of patent applications to the EPO, broken down by regions. The limits of patent statistics as indicators of innovation activities are well known. The main drawbacks can be summarized in their sector-specificity, the existence of non patentable innovations and the fact that they are not the only protecting tool[10]. Moreover the propensity to patent tends to vary over time as a function of the cost of patenting, and it is more likely to feature large firms (Pavitt, 1985; Griliches, 1990).

Nevertheless, previous studies highlighted the usefulness of patents as measures of production of new knowledge, above all in the context of analyses of innovation performances at the regional level (Acs et al., 2002). Besides the debate about patents as an output rather than an input of

[10] On this point see the work by Levin et al. (1987) and the subsequent works inspired by the Yale survey.

innovation activities, empirical analyses showed that patents and R&D are dominated by a contemporaneous relationship, providing further support to the use of patents as a good proxy of innovation (Hall et al., 1986). Moreover, the application to the European Patent Office is a time- and resource-consuming process, which is likely to exert an ex-ante selection of the innovations to be patented. This allows us to identify high-value innovations stemming from systematic a more formalized innovation efforts, which are the object of our analysis.

Table 3 shows the breakdown of patent applications at the regional level[11], over the time span 1978-2002. In the first available year, at the national level only two patent applications can be found, issued in Lombardy. In the following year the patent applications submitted by inventors in the North West increased substantially, the greatest share still being in Lombardy. As far as the other regions are concerned, still in 1979 in the North-East the number of applications were just 10, out of which six were in Emilia-Romagna. In Central Italy there were 16, equally distributed between Lazio and Tuscany, while in Southern Italy one can find just five applications. In general, it seems from the figures in Table 3 that even with sensible differences in absolute values across Italian regions, patent applications at the EPO started spreading soon along the 1980s. This is fairly clear from the evidence about the North-West, where Lombardy and Piedmont having the highest shares of applications, while the Liguria region stays far below their levels, and the Aosta Valley doesn't seem to show any proper propensity to patent. Even in the North-East, the data about Friuli Venezia Giulia, Veneto and Emilia-Romagna show a faster diffusion of patent applications along the (late) 1980s. Among Central regions, the Umbria, Marches and, of course, Lazio[12] are the ones mainly interested by the diffusion process, while in the South in the 1980s Campania and Apulia are characterized by sustained growth of patent applications.

[11] Patent applications are classified according to the inventor's residence address.
[12] The Lazio region is expected to show high levels of patenting, as in this region are settled most of public funded research labs.

INSERT TABLE 3 ABOUT HERE

To be sure, in Table 4 we report the breakdown of quinquennial growth rates of patent applications by region. It is evident that in most Italian regions in the period such growth rates were higher in the first five years, then it lowers in the second one, becoming even negative in the third one. The last quinquennial is then characterized by very low growth rates. It is moreover fair to note that in the first five years the growth rates of Piedmont and Lombardy were higher than those of Emilia-Romagna, Marches and Umbria, while in the last five years the situation is reversed, the latter showing higher growth rates then the former. The evidence in Table 3 and Table 4 shows that, with obvious cross-regional differences in absolute levels, the dynamics of patent applications across Italian regions are interpretable as a diffusion process. Insofar as patents are reliable indicators of innovative activity, the sequence of growth rates suggests that innovating routines have diffused in most Italian regions following an S-shaped time path, and that the patterns characterizing North-Eastern-Central regions are different from those characterizing North-Western regions.

INSERT TABLE 4 ABOUT HERE

While very suggestive, the data about patent applications analyzed so far are not that suitable for comparative purposes, due to cross-regional dimensional differences. In order to investigate the diffusion of innovating routines the data about patent applications need to be standardized according to a measure of territorial dimension. Different alternatives could apply to the case. First of all we ruled out population statistics, in that their link with innovation variables is too weak and difficult to assess[13]. A variable related to the dimension of the production system would be more appropriate to our analysis. The alternatives are thus either the regional number of firms or the number of workers. The former seem to be inappropriate as there can be a bias towards those areas

[13] As also emphasized by Kuznets (1930).

characterized by a large number of small and medium-sized firms, with the consequent underestimation of dimensions in areas characterized by a lower number of large firms. Thus we decided to take the number of patent applications per worker as the indicator of the level of diffusion of innovating routines within each region.

Table 5 presents the dynamics of patent applications per thousands workers, broken down by region. The time span is reduced to the period 1980-2001 due to employment data constraints. With the help of Figure 2, we focus on the differences among early- and late-industrialized regions. As far as the former are concerned, the dynamics of Lombardy and Piedmont are characterized by high levels in the early 1980s in both of them, but in 1988 it can be noted a further speeding up of Lombardy which clearly overtake Piedmont, outperforming it until 2001. Around 1991 the growth of patent applications begins to slow down in both regions, but more markedly in Piedmont. The evidence about Emilia-Romagna is of much interest for the purpose of our analysis. Indeed the diffusion of patent applications seem to be more sustained all over the period observed. Innovating routines diffuse at a very fast pace, such that Emilia-Romagna outperformed Piedmont already in 1998 and Lombardy in 1999. Friuli-Venezia Giulia and Veneto are characterized by fairly opposite dynamics, as the former appears to grow sensibly along the 1980s and then slowing down in the 1990s, while the latter is characterized by modest growth rate until the late 1990s, and then a sudden acceleration. Finally Umbria, Marches and Abruzzi show up dynamics very similar to Veneto's, in that the hastening of growth in patent applications can be devised around 1995.

INSERT TABLE 5 AND FIGURE 2 ABOUT HERE

In conclusion, the preliminary evidence about data applications appears to suggest that the territorial diffusion of manufacturing activities is still ongoing in the North-East-Central regions, as they are carried by the diffusion of innovating routines, and the consequent advantages stemming from

innovation. Emilia-Romagna seems to be the leading region in such a process, whereby Marches, Abruzzi and to some extent Umbria are the immediate followers. The case for a possible extension towards Molise and Puglia seems very difficult to assess, as the data up to 2001 are not very supportive.

The regional aggregate data on R&D expenditure, both private and public, have been drawn from the ISTAT to provide a suggestive evidence of the increase in the availability of the knowledge stock accessible in the area[14]. To gain better understanding of the regional dynamics, in Tables 6 and 7 we calculated a regional specialization index for public and private R&D expenditure, defined as R&D in sector *i* (public vs. private) located in region *j* at time *t*, divided by the region's total R&D expenditure, compared to the same measure at the national level. It is straightforward from the data that North Western regions are characterized by strong concentration of private R&D expenditure, with the only exception of the Liguria region. The Piedmont region turned out to have the highest value for the index, followed by Valle d'Aosta and Lombardy. Some regions with an index value above 1 can be found also in the North-East. They are Veneto and Emilia-Romagna, which is not so surprising considering that high tech sectors increasingly gained relevance in the area, due to the local positive feedbacks characterizing the upgrading from consumer goods to dedicated capital goods of the manufacturing activity in the area. In the remainder regions the value of the index is below one, above all in the regions along the Adriatic coast.

As far as the public R&D expenditure is concerned, of course in the North-West the only region that can be defined public-R&D-intensive is the Liguria one. It is worth noting that in the North-East, the value of the index for Emilia-Romagna and Veneto is just slightly below 1. This means that in the area the public and the private inputs for innovative activity are pretty balanced. The highest

[14] Time series concerning public and private R&D expenditure at the regional level are available since 1982 on. Moreover, it is worth noting that public expenditure is not comprehensive of expenditure by Universities, as these data are available since 1993 on.

value for the index can be found in the regions along the Adriatic coast, and in Southern Italy in general.

INSERT TABLES 6 AND 7 ABOUT HERE

Thus the Italian case seems to be characterized by a clear and strong divide also according to the path of change followed by the old industrialized regions and the late industrializing ones. While within the former firms seem exposed to raising problems, unable to cope with the decline of performances in both domestic and international markets, in the latter they seem better able to take advantage of the new technologies by means of a process of creative adoption (Antonelli and Quatraro, 2007).

6. The Econometric Results

In order to investigate the cross-regional patterns of diffusion of innovating routines we fitted the data by using the logistic function specified in Equation (3)[15]. Before proceeding to the estimation for each region, we checked for the relevance of individual effects in our regional panel. First of all, we ran both fixed and random effects estimations. The comparison of the yielded coefficients through the Hausman test revealed that a random effects model was more efficient than a fixed effects. The results of this estimation are reported in Table 8. As is clear, the model fits very well the data and both the coefficient and the constant term are significant at 1%. Finally, the Breusch-Pagan Lagrangian Multiplier test allowed us to reject the null hypothesis of no individual effects (region being the group variable)[16].

[15] The fit of the logistic equation through linear techniques allow for estimating two parameters, requiring the ceiling to be specified ex-ante. As a reference, we used the overall maximum value of the dependent variable, and we multiplied it by the annual average growth rate of added value in manufacturing industries.
[16] In other words, had the value been much lower, we could have run a regression on pooled data without losing any relevant information.

INSERT TABLE 8 ABOUT HERE

Once found that individual effects matter, we turn to estimate the Equation (3) for every single region, in order to appreciate the variance in the speed of the diffusion of innovating routines across regions. Due to the problem of auto correlated disturbances affecting this kind of time series relationship, the choice of a Chi-square estimator seemed to be the most appropriate. We thus carried out a feasible GLS regression by region, yielding the results displayed in Table 9. The coefficient β is interpreted as the rate at which the innovation penetrates the system. In this case, through the diffusion of patents applications, we obtain a measure of how fast the innovating routines have spread across Italian regions in the period 1981-2001. Although this measure is affected by the definition of K, nonetheless it can provide very useful information to understanding regional differences in economic and industrial dynamics. In particular, we start with a simple comparison among the different levels of β yielded in each region.

Within the relevant North-Western regions, Lombardy shows up the fastest rate of acceptance, followed by Liguria and then Piedmont. A glance at the values featuring North-Eastern and Central regions is very instructive. Actually, within this subgroup the first rank goes to the Abruzzi region, immediately followed by Emilia-Romagna and Marches, while the Umbria region instead features a low coefficient. At a comparative level it is worth noting that the speed of innovating routines diffusion in the Abruzzi region is 76.6% greater than that of Piedmont and 40 than that of Lombardy. For what concerns the Emilia-Romagna region the magnitude of the difference is of +55.1% and +23% as compared to Lombardy and Piedmont respectively. The Marches region has a β value 25.2% higher than that of Piedmont, but almost equal to that of Lombardy. Considering that the diffusion speed in Liguria is in between that of Piedmont and that Lombardy, the results of the econometric estimations provide strong support not only to diffusion hypothesis, but even to the

hypothesis concerning cross-regional differences. Some regions in the North-East-Centre, specifically Emilia-Romagna, Marches and Abruzzi are characterized by diffusion rates systematically higher than those of Piedmont, and equal or higher to those of Lombardy. The Emilia-Romagna region, in particular, can be considered as the path-breaker region of the diffusion process towards the other regions in the North-East-Centre side of Italy, while Abruzzi and Marches seem to follow it with a slight delay.

INSERT TABLE 9 ABOUT HERE

As far as the relationship between the diffusion of innovating routines and the change in the economic structure is concerned, Equation (4) has been estimated through OLS with robust standard errors. The estimation yielded the following results:

$$\beta = 0.157 + \underset{(2.89)}{3.911} \cdot MAN^{**} - \underset{(-1.57)}{5.610} \cdot TRA + \underset{(0.59)}{1.128} \cdot FIN \qquad (6)$$

F = 2.93, *t* of Student between parentheses. As expected the coefficient on the growth rate of the employment share of manufacturing industries is positive and significant, while the coefficients for the two service industries are not statistically significant. The evidence of higher diffusion rates of innovating routines in some NEC regions is hence to be related to the evidence, already presented in Section 2, about the enduring growth of manufacturing activities in the area. This process could be thus interpreted as a specific stage in the development of manufacturing activities, according to which learning dynamics and the increasing international competition are likely to foster innovative efforts, as long as technological opportunities are at the same time on hand.

In this direction the availability of an accessible knowledge stock is supposed to be closely related to the diffusion of innovating routines. To this purpose Equation (5) has been estimated through

OLS with Huber-White heteroscedastic consistent standard errors. The econometric test yielded the following result:

$$\beta = 0.172 - \underset{(-1.06)}{0.026}\cdot GRGFI + \underset{(3.05)}{0.076\cdot 10^{-3}}\cdot GRPRD*** + \underset{(3.74)}{0.379\cdot 10^{-3}}\cdot GRPUR\ *** \qquad (7)$$

F=84.9, *t* of Student between parentheses (coefficients on R&D are both significant at 1%). It is worth emphasizing that the coefficient on public R&D is far larger than that on private one. This confirms that faster rates of diffusion of innovation, and faster rates of public R&D, are at the heart of the process leading to faster growth rates in late-industrializing regions. The stronger impact of public R&D also suggests that the absorption of formal inventive activity within firms' productive routine doesn't imply necessarily a parallel process of dimensional growth. It is likely that within areas characterized by local capitalism, firms may also outsource R&D services, particularly relying on the public knowledge infrastructure. In this direction, it is worth mentioning that also the organization of public R&D labs (say the National Research Council) is becoming more and more functional to the needs of local production systems, trying to exploit the advantages of the competencies and the reputation that such areas gained in some particular markets[17] (CNR, 2005).

7. Concluding Remarks

In this paper we tried to shed further light to understand the persistent process of diffusion of manufacturing activities, integrating the analysis with the study of the regional patterns of innovation within the NEC regions. While in the 1970s the explanations were mainly based on aspects related to institutional conditions and the structure of local economic and social systems, we proposed an interpretation in the light of the economics of innovation. The graft of the diffusion

[17] It is fairly impressive to read about a project for the realization of an electronic nose for agro-food applications. This kind of electronic device is intended to use to test the organoleptic features of agriculture products, mainly olive oil and wine, to obtain a more accurate certification against unfair competitors on international markets.

theory in the analysis of such a process has allowed us to appreciate the role of the adoption of innovating routines within the late-industrializing regions.

The results obtained through the analysis of the diffusion of patent applications strongly support the hypothesis according to which the NEC regions are still exploiting the advantages of the late industrialization. The exploitation of the innovative potential stemming from learning dynamics is actually fed by the parallel growth of technological opportunities and the strengthening of the productive system. Indeed the thickening of the manufacturing production system and the increasing availability of accessible knowledge stock proved to be positive related to the rate of diffusion of innovating routines across Italian regions.

It is also fair to note that in the econometric test the impact of public R&D expenditure on the speed of diffusion of innovating routines, turned out to be far higher than that of private R&D expenditure. This suggests that the idiosyncratic features of the regions mostly affected by the process played a crucial role. The increasing availability of public knowledge represents a competitive advantage, provided the existence of conditions enabling knowledge communication and absorption. This is the case for many areas in the NEC regions, wherein the dynamics typical of industrial districts have allowed for the evolution towards either technology districts, or technology-based industrial districts.

Along the lines of Kuznets, industrial development does not take a unique shape, but followed different paths according to the specific regional characteristics of economic activities. The capitalization of the benefits stemming from innovation can be, in this light, interpreted as a distinct stage in the industrialization process, which characterizes an industry as old enough to properly manage emerging technological opportunities, but not so mature to incur in the slackening of growth rates.

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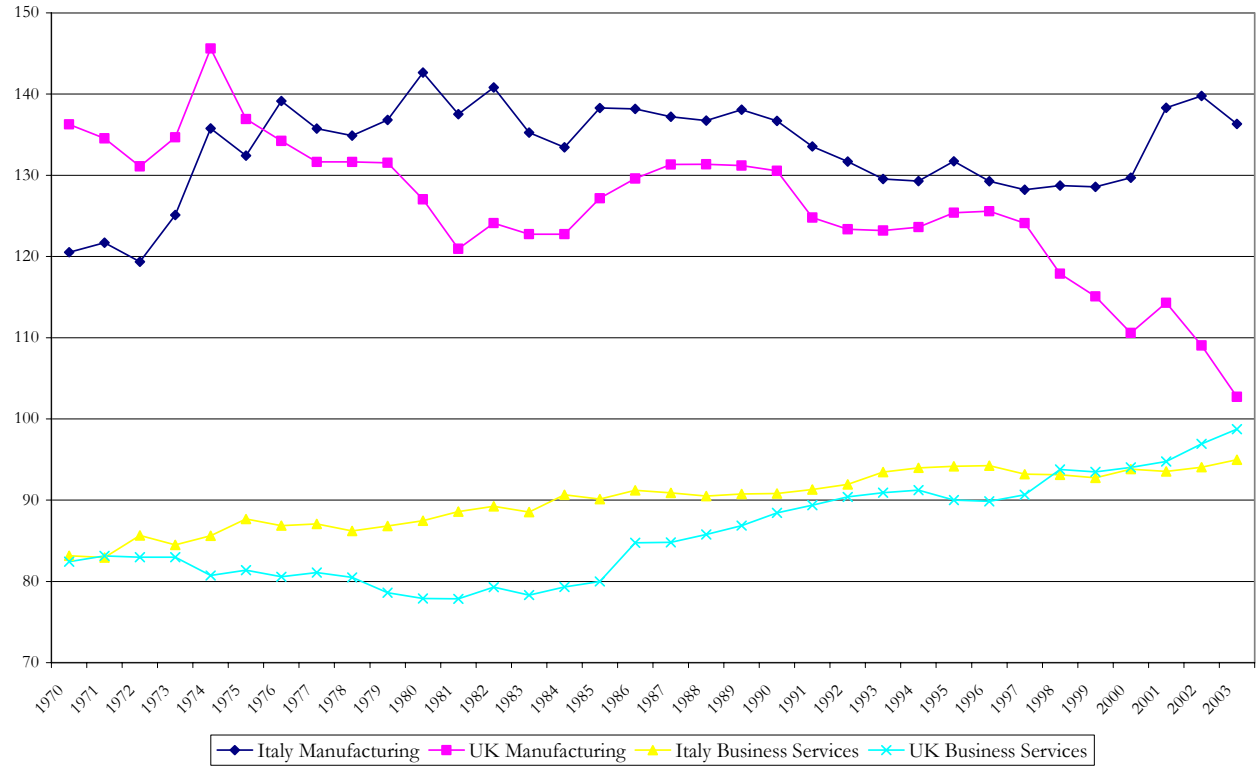
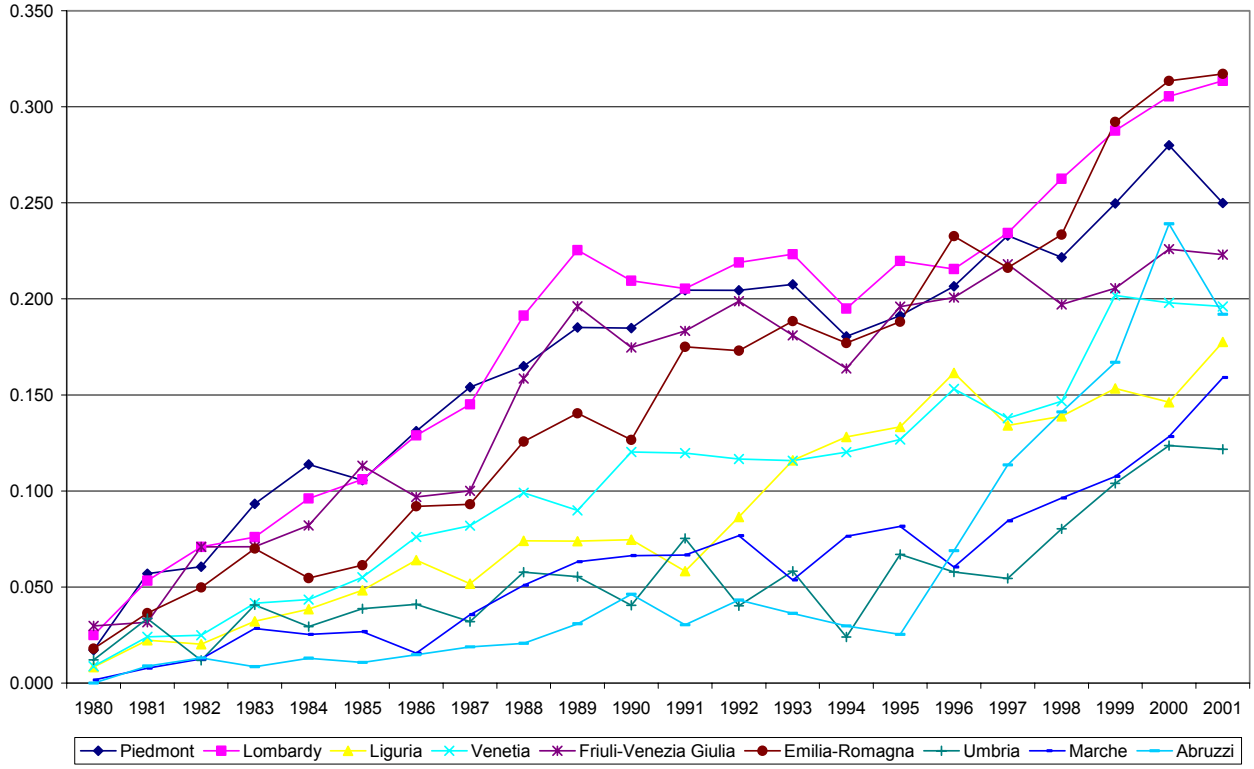
Figure 1 - Manufacturing and Business Services Shares of Value Added, as % of US



Source: Antonelli et al. (2007).

Figure 2 – Diffusion of Innovating Routines in Early- and Late-Industrialized Regions



Source: Elaborations on EPO and ISTAT Data.
Note: Patent Applications per 1000 Workers on Y-axis.

Table 1 - Regional Specialization Index for Manufacturing Sectors†

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Piedmont	1.362	1.359	1.381	1.369	1.319	1.333	1.350	1.376	1.389	1.380	1.358	1.313	1.290	1.257	1.277	1.291	1.290	1.300	1.306	1.285	1.280	1.278
Aosta Valley	0.720	0.737	0.781	0.823	0.786	0.744	0.711	0.655	0.668	0.594	0.578	0.583	0.579	0.558	0.561	0.531	0.538	0.548	0.567	0.554	0.536	0.548
Lombardy	1.505	1.503	1.499	1.500	1.478	1.469	1.459	1.440	1.407	1.416	1.445	1.416	1.428	1.447	1.434	1.404	1.395	1.377	1.381	1.361	1.355	1.355
Liguria	0.783	0.769	0.756	0.758	0.740	0.698	0.681	0.700	0.657	0.670	0.659	0.652	0.658	0.619	0.631	0.627	0.626	0.615	0.602	0.615	0.655	0.644
North West	***1.377***	***1.374***	***1.379***	***1.378***	***1.346***	***1.339***	***1.338***	***1.337***	***1.317***	***1.321***	***1.333***	***1.303***	***1.305***	***1.303***	***1.304***	***1.290***	***1.285***	***1.275***	***1.278***	***1.262***	***1.261***	***1.259***
Trentino-Alto Adige	0.657	0.655	0.641	0.643	0.696	0.656	0.654	0.697	0.724	0.698	0.691	0.688	0.725	0.709	0.708	0.701	0.709	0.718	0.705	0.713	0.716	0.733
Venetia	1.230	1.198	1.213	1.213	1.265	1.343	1.320	1.307	1.326	1.344	1.346	1.361	1.349	1.383	1.360	1.372	1.384	1.397	1.397	1.403	1.381	1.370
Friuli-Venezia Giulia	0.971	0.898	0.911	0.909	0.910	0.927	0.953	0.978	0.993	1.001	0.993	1.014	0.999	1.016	1.005	1.054	1.082	1.101	1.080	1.049	1.061	1.036
Emilia-Romagna	1.112	1.141	1.157	1.162	1.213	1.220	1.222	1.270	1.280	1.274	1.247	1.196	1.200	1.207	1.215	1.218	1.218	1.222	1.233	1.242	1.249	1.257
North East	***1.101***	***1.090***	***1.104***	***1.105***	***1.150***	***1.183***	***1.179***	***1.200***	***1.216***	***1.219***	***1.208***	***1.196***	***1.195***	***1.212***	***1.205***	***1.216***	***1.225***	***1.235***	***1.235***	***1.239***	***1.234***	***1.231***
Tuscany	1.155	1.176	1.161	1.213	1.199	1.212	1.230	1.187	1.167	1.104	1.126	1.132	1.168	1.170	1.162	1.157	1.158	1.150	1.153	1.131	1.131	1.142
Umbria	1.133	1.072	1.075	1.132	1.135	1.106	1.049	0.959	1.014	1.006	1.005	1.042	1.057	1.020	1.001	0.992	0.998	0.990	1.011	1.026	1.052	1.058
Marche	1.154	1.133	1.168	1.186	1.224	1.239	1.239	1.342	1.323	1.365	1.328	1.355	1.333	1.371	1.329	1.339	1.347	1.332	1.349	1.376	1.351	1.390
Latium	0.591	0.591	0.581	0.569	0.583	0.555	0.574	0.546	0.536	0.546	0.530	0.551	0.547	0.542	0.544	0.528	0.521	0.518	0.514	0.517	0.525	0.517
Abruzzi	0.799	0.802	0.792	0.814	0.831	0.811	0.820	0.805	0.831	0.812	0.830	0.926	0.910	0.925	0.935	0.935	0.975	0.986	0.988	1.021	1.034	1.013
Molise	0.505	0.532	0.526	0.536	0.569	0.565	0.541	0.642	0.683	0.696	0.699	0.673	0.735	0.726	0.737	0.763	0.776	0.787	0.817	0.833	0.820	0.837
Central Italy	***0.913***	***0.914***	***0.906***	***0.918***	***0.922***	***0.911***	***0.919***	***0.899***	***0.888***	***0.881***	***0.872***	***0.890***	***0.897***	***0.898***	***0.891***	***0.883***	***0.882***	***0.875***	***0.877***	***0.876***	***0.879***	***0.884***
Campania	0.689	0.699	0.700	0.704	0.690	0.674	0.622	0.631	0.639	0.637	0.632	0.688	0.679	0.667	0.676	0.685	0.676	0.682	0.666	0.682	0.680	0.688
Abulia	0.665	0.694	0.682	0.687	0.692	0.701	0.726	0.727	0.743	0.728	0.713	0.717	0.727	0.686	0.694	0.694	0.684	0.708	0.720	0.719	0.706	0.700
Basilicata	0.441	0.436	0.465	0.453	0.439	0.458	0.477	0.429	0.420	0.440	0.498	0.493	0.482	0.492	0.544	0.657	0.678	0.685	0.698	0.748	0.793	0.837
Calabria	0.363	0.369	0.387	0.370	0.388	0.346	0.388	0.362	0.342	0.312	0.348	0.389	0.393	0.359	0.371	0.377	0.366	0.363	0.351	0.358	0.385	0.392
Sicily	0.502	0.507	0.507	0.493	0.482	0.485	0.471	0.457	0.462	0.482	0.460	0.476	0.466	0.465	0.467	0.457	0.446	0.452	0.450	0.467	0.470	0.471
Sardinia	0.580	0.567	0.542	0.554	0.574	0.580	0.560	0.551	0.536	0.537	0.563	0.560	0.569	0.577	0.527	0.522	0.511	0.496	0.491	0.483	0.495	0.532
South	***0.598***	***0.606***	***0.605***	***0.605***	***0.604***	***0.597***	***0.588***	***0.583***	***0.589***	***0.586***	***0.588***	***0.617***	***0.615***	***0.601***	***0.606***	***0.610***	***0.605***	***0.612***	***0.609***	***0.622***	***0.625***	***0.630***

Source: Elaboration on ISTAT data.
Note: † ISIC codes 15-37

Table 2 - Regional Specialization Index for Finance, Insurance, Real Estate and Business Services†

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Piedmont	1.033	1.011	0.995	1.026	1.045	1.053	1.052	1.079	1.025	1.039	1.064	1.091	1.137	1.120	1.084	1.077	1.083	1.064	1.047	1.062	1.072	1.074
Aosta Valley	0.719	0.731	0.705	0.750	0.770	0.792	0.801	0.801	0.809	0.888	0.901	0.885	0.794	0.857	0.842	0.859	0.842	0.828	0.795	0.755	0.729	0.706
Lombardy	1.258	1.247	1.264	1.281	1.265	1.259	1.230	1.214	1.235	1.234	1.212	1.212	1.168	1.181	1.194	1.200	1.188	1.191	1.184	1.189	1.197	1.209
Liguria	1.306	1.334	1.258	1.313	1.322	1.324	1.294	1.236	1.198	1.189	1.221	1.232	1.141	1.127	1.136	1.126	1.136	1.118	1.107	1.090	1.060	1.037
North West	***1.192***	***1.183***	***1.179***	***1.204***	***1.203***	***1.204***	***1.183***	***1.175***	***1.168***	***1.172***	***1.169***	***1.178***	***1.154***	***1.156***	***1.155***	***1.156***	***1.151***	***1.146***	***1.136***	***1.141***	***1.145***	***1.151***
Trentino-Alto Adige	0.847	0.791	0.781	0.774	0.791	0.779	0.747	0.720	0.684	0.715	0.707	0.703	0.739	0.704	0.665	0.678	0.665	0.665	0.684	0.685	0.676	0.674
Venetia	0.860	0.884	0.925	0.904	0.890	0.860	0.842	0.848	0.824	0.812	0.839	0.830	0.890	0.861	0.836	0.816	0.816	0.803	0.801	0.818	0.822	0.838
Friuli-Venezia Giulia	0.937	0.993	1.108	1.101	1.042	1.044	1.027	1.013	1.064	1.088	1.113	1.116	1.148	1.076	1.070	1.042	1.027	1.019	1.003	1.037	0.999	1.010
Emilia-Romagna	0.978	0.976	0.979	0.959	0.911	0.904	0.898	0.893	0.899	0.889	0.857	0.897	0.885	0.901	0.872	0.885	0.892	0.911	0.907	0.892	0.887	0.886
North East	***0.915***	***0.924***	***0.954***	***0.935***	***0.906***	***0.890***	***0.875***	***0.871***	***0.866***	***0.863***	***0.863***	***0.875***	***0.901***	***0.884***	***0.858***	***0.854***	***0.853***	***0.854***	***0.852***	***0.857***	***0.852***	***0.859***
Tuscany	0.966	0.968	0.970	0.931	0.866	0.908	0.854	0.823	0.834	0.852	0.832	0.856	0.858	0.901	0.887	0.899	0.909	0.923	0.919	0.934	0.936	0.920
Umbria	0.761	0.808	0.837	0.825	0.800	0.867	0.879	0.787	0.717	0.718	0.750	0.762	0.764	0.796	0.799	0.834	0.818	0.850	0.829	0.843	0.875	0.854
Marche	0.759	0.732	0.769	0.822	0.768	0.724	0.745	0.737	0.699	0.688	0.713	0.694	0.712	0.733	0.767	0.778	0.774	0.798	0.776	0.792	0.816	0.785
Latium	1.497	1.496	1.406	1.426	1.475	1.461	1.461	1.427	1.401	1.390	1.344	1.318	1.304	1.293	1.361	1.364	1.347	1.342	1.358	1.338	1.325	1.332
Abruzzi	0.634	0.667	0.696	0.689	0.697	0.735	0.774	0.828	0.838	0.887	0.781	0.765	0.823	0.767	0.730	0.714	0.702	0.717	0.720	0.695	0.703	0.713
Molise	0.648	0.686	0.671	0.686	0.750	0.728	0.845	0.714	0.797	0.860	0.800	0.881	0.779	0.774	0.771	0.742	0.805	0.802	0.781	0.775	0.823	0.865
Central Italy	***1.146***	***1.145***	***1.120***	***1.126***	***1.120***	***1.130***	***1.118***	***1.084***	***1.067***	***1.062***	***1.044***	***1.039***	***1.036***	***1.051***	***1.080***	***1.090***	***1.084***	***1.092***	***1.094***	***1.092***	***1.093***	***1.085***
Campania	0.813	0.806	0.796	0.790	0.827	0.875	0.907	0.895	0.937	0.940	0.979	0.943	0.990	1.003	0.949	0.954	0.961	0.956	0.969	0.955	0.950	0.933
Apulia	0.776	0.775	0.811	0.778	0.802	0.758	0.834	0.917	0.912	0.890	0.916	0.941	0.977	0.904	0.909	0.900	0.908	0.890	0.862	0.876	0.892	0.872
Basilicata	0.611	0.617	0.627	0.654	0.686	0.716	0.754	0.775	0.808	0.736	0.722	0.759	0.794	0.812	0.805	0.788	0.805	0.825	0.836	0.834	0.848	0.808
Calabria	0.683	0.667	0.624	0.650	0.688	0.697	0.773	0.763	0.775	0.768	0.790	0.752	0.779	0.744	0.785	0.780	0.798	0.806	0.813	0.786	0.820	0.819
Sicily	0.831	0.826	0.830	0.793	0.828	0.805	0.817	0.893	0.909	0.944	0.982	0.939	0.849	0.912	0.953	0.948	0.953	0.956	0.989	0.973	0.963	0.968
Sardinia	0.707	0.753	0.730	0.727	0.704	0.691	0.683	0.707	0.754	0.710	0.679	0.708	0.748	0.812	0.835	0.802	0.840	0.858	0.902	0.900	0.863	0.871
South	***0.767***	***0.768***	***0.770***	***0.756***	***0.784***	***0.786***	***0.824***	***0.858***	***0.880***	***0.882***	***0.897***	***0.883***	***0.892***	***0.893***	***0.892***	***0.885***	***0.895***	***0.895***	***0.906***	***0.897***	***0.898***	***0.891***

Source: Elaboration on ISTAT data.
Note: † ISIC codes 65-74

Table 3 – Patent Applications in Italian Regions, 1978 – 2002.

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Piedmont	0	13	34	111	117	181	215	197	246	290	317	357	356	396	388	379	330	355	385	433	412	471	540	483	515
Aosta Valley	0	0	0	0	2	2	0	1	4	0	1	3	4	4	6	1	2	0	3	4	1	1	2	4	12
Lombardy	2	41	97	207	275	294	372	416	518	590	791	944	895	886	929	919	799	904	893	976	1107	1220	1307	1367	1434
Liguria	0	2	6	16	14	22	27	35	46	37	53	53	53	41	60	78	83	86	104	87	91	100	97	120	106
North West	***2***	***56***	***137***	***334***	***408***	***499***	***614***	***649***	***814***	***917***	***1162***	***1357***	***1308***	***1327***	***1383***	***1377***	***1214***	***1345***	***1385***	***1500***	***1611***	***1792***	***1946***	***1974***	***2067***
Trentino-Alto Adige	0	2	4	7	8	11	15	9	9	13	19	18	29	31	18	24	36	32	44	38	39	45	37	58	63
Venetia	0	2	16	45	47	78	82	104	148	163	203	184	248	249	243	235	244	259	316	288	308	426	429	428	460
Friuli-Venezia Giulia	0	0	16	17	38	38	44	60	51	53	85	107	94	99	106	92	83	102	105	114	104	109	122	123	127
Emilia-Romagna	0	6	33	67	91	128	101	114	172	176	242	270	246	341	335	358	335	359	447	418	453	573	628	642	707
North East	***0***	***10***	***69***	***136***	***184***	***255***	***242***	***287***	***380***	***405***	***549***	***579***	***617***	***720***	***702***	***709***	***698***	***752***	***912***	***858***	***904***	***1153***	***1216***	***1251***	***1357***
Tuscany	0	7	10	23	44	42	54	68	83	99	94	103	141	150	157	158	121	121	147	107	155	162	207	196	231
Umbria	0	1	4	11	4	14	10	13	14	11	20	19	14	26	14	20	8	22	19	18	27	36	44	44	35
Marche	0	0	1	5	8	18	16	17	10	23	33	41	43	43	49	33	47	51	38	53	61	69	83	105	83
Latium	0	8	18	29	38	74	55	70	109	104	101	122	140	188	187	143	143	148	136	153	176	201	235	232	225
Abruzzi	0	0	0	4	6	4	6	5	7	9	10	15	23	15	21	17	14	12	33	54	67	78	115	96	76
Molise	0	0	0	2	2	0	1	0	0	2	1	3	1	1	2	1	3	0	2	4	4	6	3	2	4
Central Italy	***0***	***16***	***33***	***74***	***102***	***152***	***142***	***173***	***223***	***248***	***259***	***303***	***362***	***423***	***430***	***372***	***336***	***354***	***375***	***389***	***490***	***552***	***687***	***675***	***654***
Campania	0	2	2	8	10	9	8	10	11	15	21	26	24	19	28	39	34	40	31	42	45	53	69	61	62
Apulia	0	1	2	3	4	6	9	7	4	15	18	15	20	10	15	17	16	18	20	19	32	29	38	54	45
Basilicata	0	1	0	0	0	2	1	1	1	0	6	3	2	0	3	0	2	3	3	6	18	17	14	13	3
Calabria	0	0	2	1	2	1	1	3	3	9	7	3	3	3	5	6	5	2	1	10	6	10	13	8	13
Sicily	0	1	0	6	5	8	6	9	15	9	28	25	25	39	27	25	30	51	65	51	44	44	88	82	83
Sardinia	0	0	0	4	1	2	3	5	3	8	8	6	6	9	7	9	3	6	10	8	13	10	18	13	20
South	***0***	***5***	***6***	***22***	***22***	***28***	***28***	***35***	***37***	***56***	***88***	***78***	***80***	***80***	***85***	***96***	***90***	***120***	***130***	***136***	***158***	***163***	***240***	***231***	***226***
Italy	2	87	245	566	716	934	1026	1144	1454	1626	2058	2317	2367	2550	2600	2554	2338	2571	2802	2883	3163	3660	4089	4131	4304

Source: European Patent Office (EPO)

Table 4 – Patent Applications Growth Rates, by Region†

	1980-1984	1985-1989	1990-1994	1995-1999
Piedmont	0.307	0.099	-0.013	0.047
Aosta Valley	-	0.183	-0.116	-
Lombardy	0.224	0.137	-0.019	0.050
Liguria	0.251	0.069	0.075	0.025
North West	***0.250***	***0.123***	***-0.012***	***0.048***
Trentino-Alto Adige	0.220	0.116	0.036	0.057
Venetia	0.272	0.095	-0.003	0.083
Friuli-Venezia Giulia	0.169	0.096	-0.021	0.011
Emilia-Romagna	0.186	0.144	0.051	0.078
North East	0.209	0.117	0.021	0.071
Tuscany	0.281	0.069	-0.025	0.049
Umbria	0.153	0.063	-0.093	0.082
Marche	0.462	0.147	0.015	0.050
Latium	0.186	0.093	0.004	0.051
Abruzzi	-	0.183	-0.083	0.312
Molise	-	-	0.183	-
Central Italy	***0.243***	***0.093***	***-0.012***	***0.074***
Campania	0.231	0.159	0.058	0.047
Apulia	0.251	0.127	-0.037	0.079
Basilicata	-	0.183	0.000	0.289
Calabria	-0.116	0.000	0.085	0.268
Sicily	-	0.170	0.030	-0.025
Sardinia	-	0.030	-0.116	0.085
South	***0.257***	***0.134***	***0.020***	***0.051***
Italy	***0.239***	***0.118***	***-0.002***	***0.059***

Source: Elaborations on EPO data.
Note: † Missing values are due to high number of zeros in some regions.

Table 5 – Patent Applications per 1000 Workers, by Region, 1980 – 2001.

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Piedmont	0.017	0.057	0.061	0.093	0.114	0.106	0.131	0.154	0.165	0.185	0.185	0.205	0.204	0.208	0.180	0.191	0.207	0.233	0.222	0.250	0.280	0.250
Aosta Valley	0.000	0.000	0.034	0.034	0.000	0.017	0.064	0.000	0.017	0.050	0.065	0.064	0.096	0.017	0.034	0.000	0.053	0.070	0.017	0.018	0.034	0.067
Lombardy	0.025	0.053	0.071	0.076	0.096	0.106	0.129	0.145	0.191	0.225	0.209	0.205	0.219	0.223	0.195	0.220	0.216	0.234	0.263	0.288	0.305	0.314
Liguria	0.008	0.022	0.020	0.032	0.039	0.048	0.064	0.052	0.074	0.074	0.075	0.058	0.087	0.116	0.128	0.133	0.161	0.134	0.139	0.153	0.146	0.178
North West	***0.021***	***0.051***	***0.062***	***0.076***	***0.094***	***0.099***	***0.122***	***0.136***	***0.170***	***0.197***	***0.188***	***0.189***	***0.201***	***0.206***	***0.183***	***0.202***	***0.206***	***0.223***	***0.237***	***0.262***	***0.281***	***0.281***
Trentino-Alto Adige	0.009	0.016	0.018	0.025	0.034	0.020	0.020	0.029	0.041	0.038	0.061	0.065	0.038	0.051	0.077	0.070	0.094	0.081	0.081	0.094	0.075	0.117
Venetia	0.009	0.024	0.025	0.042	0.043	0.055	0.076	0.082	0.099	0.090	0.120	0.120	0.117	0.116	0.120	0.127	0.153	0.138	0.147	0.202	0.198	0.196
Friuli-Venezia Giulia	0.030	0.032	0.071	0.071	0.082	0.113	0.097	0.100	0.159	0.196	0.175	0.183	0.199	0.181	0.164	0.196	0.201	0.218	0.197	0.206	0.226	0.223
Emilia-Romagna	0.018	0.036	0.050	0.070	0.055	0.061	0.092	0.093	0.126	0.140	0.127	0.175	0.173	0.188	0.177	0.188	0.233	0.216	0.233	0.292	0.314	0.317
North East	***0.015***	***0.029***	***0.039***	***0.054***	***0.051***	***0.061***	***0.079***	***0.083***	***0.110***	***0.116***	***0.123***	***0.143***	***0.140***	***0.144***	***0.143***	***0.153***	***0.183***	***0.171***	***0.179***	***0.227***	***0.234***	***0.238***
Tuscany	0.007	0.015	0.028	0.027	0.035	0.043	0.053	0.064	0.060	0.066	0.090	0.094	0.098	0.101	0.078	0.078	0.095	0.069	0.099	0.102	0.128	0.119
Umbria	0.012	0.034	0.012	0.041	0.029	0.039	0.041	0.032	0.058	0.055	0.041	0.075	0.040	0.058	0.024	0.067	0.058	0.055	0.080	0.104	0.124	0.122
Marche	0.002	0.008	0.013	0.028	0.025	0.027	0.016	0.036	0.051	0.063	0.066	0.067	0.077	0.054	0.076	0.082	0.060	0.084	0.096	0.108	0.128	0.159
Latium	0.010	0.016	0.020	0.037	0.027	0.033	0.051	0.049	0.047	0.058	0.065	0.086	0.085	0.067	0.068	0.071	0.065	0.073	0.082	0.093	0.107	0.104
Abruzzi	0.000	0.009	0.013	0.009	0.013	0.011	0.015	0.019	0.021	0.031	0.046	0.030	0.043	0.036	0.030	0.025	0.069	0.114	0.141	0.167	0.239	0.192
Molise	0.000	0.017	0.017	0.000	0.009	0.000	0.000	0.016	0.008	0.026	0.008	0.009	0.017	0.009	0.027	0.000	0.018	0.036	0.036	0.054	0.026	0.017
Central Italy	***0.007***	***0.015***	***0.020***	***0.030***	***0.028***	***0.033***	***0.042***	***0.047***	***0.049***	***0.057***	***0.068***	***0.079***	***0.080***	***0.071***	***0.065***	***0.068***	***0.072***	***0.075***	***0.093***	***0.104***	***0.127***	***0.122***
Campania	0.001	0.005	0.006	0.005	0.004	0.006	0.006	0.009	0.012	0.015	0.014	0.011	0.016	0.023	0.020	0.024	0.019	0.025	0.026	0.031	0.040	0.035
Apulia	0.002	0.002	0.003	0.005	0.007	0.005	0.003	0.011	0.014	0.011	0.015	0.007	0.011	0.013	0.012	0.014	0.016	0.015	0.025	0.023	0.029	0.041
Basilicata	0.000	0.000	0.001	0.010	0.005	0.005	0.005	0.000	0.029	0.015	0.010	0.000	0.016	0.000	0.011	0.016	0.016	0.032	0.095	0.088	0.071	0.066
Calabria	0.003	0.002	0.003	0.002	0.002	0.005	0.005	0.014	0.011	0.005	0.005	0.005	0.008	0.009	0.008	0.003	0.002	0.016	0.010	0.017	0.021	0.013
Sicily	0.000	0.004	0.003	0.005	0.004	0.006	0.010	0.006	0.019	0.017	0.016	0.025	0.018	0.017	0.021	0.036	0.045	0.035	0.030	0.030	0.059	0.054
Sardinia	0.000	0.008	0.002	0.004	0.006	0.010	0.006	0.014	0.014	0.010	0.010	0.015	0.012	0.016	0.005	0.011	0.018	0.014	0.023	0.018	0.032	0.022
South	***0.001***	***0.004***	***0.004***	***0.005***	***0.005***	***0.006***	***0.006***	***0.009***	***0.015***	***0.013***	***0.013***	***0.013***	***0.014***	***0.016***	***0.015***	***0.021***	***0.023***	***0.024***	***0.027***	***0.028***	***0.041***	***0.038***
Italy	**0.011**	**0.026**	**0.032**	**0.042**	**0.046**	**0.051**	**0.064**	**0.071**	**0.089**	**0.100**	**0.101**	**0.108**	**0.111**	**0.112**	**0.104**	**0.114**	**0.124**	**0.127**	**0.138**	**0.159**	**0.174**	**0.173**

Source: Elaborations on ISTAT and EPO data.

Table 6 – Regional Specialization Index for Private R&D Expenditure

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Piedmont	1.341	1.327	1.352	1.338	1.302	1.312	1.300	1.284	1.292	1.344	1.322	1.634	1.612	1.601	1.583	1.660	1.705	1.651	1.639	1.647
Aosta Valley	1.148	0.911	1.428	1.407	1.321	1.379	0.995	0.865	1.359	1.408	1.257	1.292	1.517	1.704	1.673	1.369	1.908	1.960	1.928	1.598
Lombardy	1.333	1.306	1.300	1.275	1.243	1.250	1.238	1.228	1.202	1.244	1.234	1.413	1.429	1.430	1.404	1.450	1.506	1.487	1.477	1.470
Liguria	1.060	1.100	1.134	1.142	1.079	1.054	1.036	0.985	1.027	0.926	0.964	0.942	0.889	0.848	0.651	0.894	0.839	0.925	0.898	0.856
North West	***1.308***	***1.293***	***1.306***	***1.287***	***1.253***	***1.256***	***1.245***	***1.229***	***1.226***	***1.266***	***1.254***	***1.459***	***1.450***	***1.442***	***1.398***	***1.469***	***1.516***	***1.496***	***1.489***	***1.493***
Trentino-Alto Adige	0.611	0.983	0.521	0.839	0.708	0.633	0.477	0.632	0.678	0.864	0.581	0.415	0.684	0.790	0.861	0.881	0.821	0.907	0.920	0.792
Venetia	1.042	1.031	1.026	1.088	1.042	1.006	1.059	1.088	1.053	1.018	0.978	0.761	0.903	0.875	0.901	0.824	0.882	0.861	0.953	1.029
Friuli-Venezia Giulia	0.890	0.882	1.142	1.076	0.965	1.058	0.941	0.896	0.971	0.967	1.040	0.821	0.992	1.067	1.122	1.047	1.084	0.978	0.941	0.911
Emilia-Romagna	0.444	0.570	0.424	0.433	0.498	0.664	0.774	0.828	0.960	0.995	0.925	0.756	0.871	0.950	0.970	0.974	1.029	1.042	1.031	1.128
North East	***0.626***	***0.725***	***0.617***	***0.647***	***0.678***	***0.817***	***0.878***	***0.921***	***0.981***	***0.992***	***0.943***	***0.754***	***0.891***	***0.939***	***0.968***	***0.938***	***0.985***	***0.972***	***0.988***	***1.048***
Tuscany	0.972	0.929	0.842	0.744	0.894	0.831	0.807	0.819	0.825	0.893	0.892	0.705	0.681	0.636	0.626	0.534	0.505	0.620	0.594	0.693
Umbria	1.129	0.986	1.048	0.996	1.075	0.918	1.050	0.936	1.008	0.997	0.995	0.332	0.409	0.334	0.293	0.268	0.256	0.272	0.339	0.391
Marche	0.478	0.730	0.556	0.685	0.712	0.550	0.670	0.809	0.864	1.011	0.936	0.376	0.536	0.529	0.519	0.744	0.489	0.480	0.532	0.723
Latium	0.509	0.495	0.494	0.561	0.549	0.498	0.491	0.516	0.480	0.461	0.498	0.579	0.575	0.615	0.658	0.659	0.633	0.619	0.624	0.520
Abruzzi	1.304	1.277	1.327	1.291	1.247	1.245	1.199	1.132	1.154	1.145	1.121	1.005	1.007	0.998	1.216	1.108	0.866	0.801	0.935	0.930
Molise	0.411	0.546	0.000	0.000	-	0.000	0.000	0.000	1.154	1.238	0.572	0.192	0.175	0.013	0.775	0.000	0.630	0.000	0.529	0.160
Central Italy	***0.618***	***0.591***	***0.575***	***0.620***	***0.645***	***0.581***	***0.581***	***0.599***	***0.573***	***0.567***	***0.606***	***0.616***	***0.615***	***0.628***	***0.679***	***0.646***	***0.598***	***0.605***	***0.618***	***0.583***
Campania	0.843	1.113	1.073	1.047	0.979	1.024	0.907	0.858	0.927	0.906	0.942	0.828	0.740	0.641	0.645	0.620	0.566	0.619	0.691	0.630
Apulia	0.366	0.721	0.914	0.834	0.727	0.772	0.743	0.869	0.936	0.924	0.921	0.684	0.645	0.655	0.988	0.602	0.428	0.455	0.432	0.446
Basilicata	0.410	0.395	0.405	0.518	0.211	0.196	0.229	0.210	0.258	0.433	0.425	0.441	0.396	0.328	0.321	0.319	0.407	0.548	0.431	1.013
Calabria	0.122	0.235	0.176	0.768	0.777	0.727	0.500	0.533	0.719	0.768	0.709	0.205	0.176	0.098	0.025	0.028	0.053	0.052	0.040	0.112
Sicily	0.666	0.578	0.837	0.849	0.759	0.819	0.783	0.768	0.694	0.691	0.740	0.231	0.256	0.139	0.112	0.163	0.419	0.379	0.494	0.455
Sardinia	0.261	0.422	0.798	0.506	0.931	0.810	0.745	0.647	0.550	0.479	0.550	0.305	0.301	0.243	0.263	0.252	0.169	0.192	0.173	0.166
South	***0.627***	***0.837***	***0.935***	***0.919***	***0.843***	***0.883***	***0.798***	***0.782***	***0.820***	***0.803***	***0.838***	***0.566***	***0.518***	***0.443***	***0.464***	***0.437***	***0.442***	***0.465***	***0.512***	***0.499***

Source: Antonelli and Quatraro (2007)

Table 7 – Regional Specialization Index for Public R&D Expenditure

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Piedmont	0.216	0.210	0.202	0.193	0.199	0.212	0.206	0.223	0.187	0.155	0.181	0.265	0.312	0.311	0.329	0.345	0.341	0.366	0.359	0.377
Aosta Valley	0.658	1.216	0.029	0.030	0.148	0.041	1.014	1.369	0.000	0.000	0.347	0.662	0.419	0.193	0.226	0.633	0.150	0.065	0.069	0.423
Lombardy	0.234	0.260	0.320	0.345	0.354	0.368	0.370	0.375	0.436	0.402	0.406	0.522	0.517	0.507	0.535	0.553	0.527	0.526	0.521	0.547
Liguria	0.862	0.759	0.697	0.660	0.791	0.864	0.904	1.040	0.926	1.182	1.092	1.067	1.125	1.175	1.402	1.105	1.151	1.073	1.102	1.139
North West	***0.291***	***0.293***	***0.306***	***0.315***	***0.327***	***0.354***	***0.352***	***0.373***	***0.370***	***0.346***	***0.356***	***0.468***	***0.494***	***0.493***	***0.542***	***0.534***	***0.517***	***0.517***	***0.510***	***0.525***
Trentino-Alto Adige	1.896	1.041	2.085	1.383	1.776	1.930	2.385	2.007	1.897	1.334	2.065	1.678	1.356	1.241	1.160	1.118	1.168	1.090	1.080	1.201
Venetia	0.904	0.925	0.942	0.790	0.890	0.984	0.843	0.759	0.852	0.955	1.057	1.277	1.109	1.143	1.114	1.175	1.111	1.135	1.047	0.972
Friuli-Venezia Giulia	1.253	1.284	0.677	0.820	1.092	0.854	1.155	1.284	1.079	1.081	0.899	1.207	1.009	0.923	0.860	0.953	0.922	1.022	1.060	1.086
Emilia-Romagna	2.281	2.040	2.306	2.353	2.334	1.850	1.598	1.472	1.112	1.013	1.191	1.282	1.145	1.057	1.035	1.026	0.973	0.959	0.969	0.877
North East	***1.861***	***1.664***	***1.868***	***1.842***	***1.855***	***1.464***	***1.323***	***1.215***	***1.052***	***1.020***	***1.145***	***1.284***	***1.122***	***1.070***	***1.036***	***1.061***	***1.014***	***1.027***	***1.012***	***0.954***
Tuscany	1.065	1.170	1.358	1.611	1.283	1.427	1.510	1.496	1.488	1.262	1.275	1.341	1.359	1.418	1.430	1.463	1.463	1.370	1.407	1.296
Umbria	0.703	1.034	0.892	1.010	0.800	1.207	0.869	1.176	0.978	1.008	1.013	1.773	1.664	1.764	1.813	1.728	1.697	1.708	1.663	1.587
Marche	2.201	1.653	2.006	1.751	1.766	2.137	1.875	1.524	1.378	0.974	1.163	1.723	1.522	1.539	1.553	1.254	1.478	1.506	1.469	1.266
Latium	2.129	2.221	2.146	2.046	2.197	2.271	2.348	2.325	2.447	2.322	2.275	1.487	1.478	1.441	1.393	1.339	1.343	1.370	1.377	1.462
Abruzzi	0.301	0.331	0.258	0.307	0.345	0.380	0.474	0.640	0.571	0.644	0.694	0.994	0.993	1.002	0.752	0.892	1.126	1.194	1.065	1.068
Molise	2.355	2.096	3.267	3.385	-	3.530	3.646	3.736	0.571	0.417	2.086	1.935	1.928	2.131	1.259	1.993	1.346	1.973	1.472	1.809
Central Italy	***1.880***	***1.988***	***1.963***	***1.906***	***1.943***	***2.061***	***2.110***	***2.099***	***2.188***	***2.062***	***2.000***	***1.444***	***1.433***	***1.426***	***1.369***	***1.352***	***1.377***	***1.384***	***1.383***	***1.402***
Campania	1.361	0.726	0.834	0.888	1.056	0.941	1.246	1.388	1.202	1.232	1.148	1.199	1.293	1.411	1.408	1.378	1.406	1.370	1.310	1.356
Apulia	2.460	1.673	1.195	1.397	1.724	1.578	1.679	1.358	1.179	1.186	1.201	1.366	1.400	1.395	1.014	1.395	1.536	1.530	1.570	1.534
Basilicata	2.357	2.460	2.350	2.150	3.094	3.035	3.040	3.161	3.065	2.392	2.460	1.648	1.679	1.770	1.781	1.677	1.556	1.440	1.570	0.988
Calabria	3.020	2.848	2.868	1.553	1.591	1.690	2.324	2.277	1.781	1.570	1.739	1.920	1.927	2.034	2.121	1.966	1.886	1.923	1.962	1.856
Sicily	1.770	2.018	1.370	1.361	1.640	1.457	1.574	1.635	1.853	1.758	1.660	1.890	1.837	1.986	2.021	1.831	1.544	1.604	1.507	1.525
Sardinia	2.701	2.395	1.457	2.178	1.182	1.482	1.675	1.965	2.253	2.279	2.142	1.804	1.786	1.868	1.848	1.743	1.778	1.787	1.829	1.803
South	***1.859***	***1.394***	***1.148***	***1.193***	***1.418***	***1.297***	***1.535***	***1.597***	***1.501***	***1.482***	***1.412***	***1.503***	***1.543***	***1.639***	***1.617***	***1.559***	***1.522***	***1.520***	***1.490***	***1.483***

Source: Antonelli and Quatraro (2007)

Table 8 - Results of Random Effects Estimation of Equation (3)

Dependent Variable: $\ln\left(\frac{P_t}{K-P_t}\right)$		
Ln(*Time*)	.142***	sigma_u = 1.541
	(11.15)	sigma_e = 1.587
Constant	-286.354***	rho = .485 (fraction of variance due to
	(11.24)	individual effects)
Breusch Pagan	Chi-sq = 937.53	
Lagrangian Multiplier Test	Pr > chi-sq = 0.000	

Note: *z* statistics between parentheses.

Table 9 - Results of GLS Estimation of Equation (3), by Region

Dependent Variable: $\ln\left(\frac{P_t}{K-P_t}\right)$

Code	Region	Const	Time	Wald-χ^2
1	Piemonte	-218.49 (-7.95)	.110 (7.94)	63.01
2	Val d'Aosta	-444.82 (-1.94)	.221 (1.92)	3.71
3	Lombardia	-292.13 (-8.82)	.142 (8.81)	77.67
7	Liguria	-253.38 (-11.48)	.127 (11.42)	130.47
4	Trentino Alto Adige	-212.29 (-11.32)	.106 (11.22)	125.80
5	Veneto	-254.57 (-9.57)	.127 (9.53)	90.83
6	Friuli Venezia Giulia	-223.69 (-6.85)	.112 (6.83)	46.69
8	Emilia Romagna	-332.97 (-18.98)	.170 (18.95)	359.03
9	Toscana	-201.04 (-6.43)	.100 (6.38)	40.67
10	Umbria	-161.70 (-6.68)	.080 (6.60)	43.60
11	Marche	-279.33 (-8.89)	.139 (8.83)	77.92
12	Lazio	-185.14 (-6.99)	.092 (6.93)	47.96
13	Abruzzo	-376.36 (-7.03)	.188 (6.99)	48.83
14	Molise	-474.67 (-1.91)	.235 (1.89)	3.57
15	Campania	-231.80 (17.51)	.114 (13.05)	170.19
16	Puglia	-232.66 (-8.98)	.115 (8.84)	78.18
17	Basilicata	-750.42 (-3.18)	.374 (3.16)	10.00
18	Calabria	-184.71 (-3.28)	091 (3.21)	10.28
19	Sicilia	-289.45 (-12.51)	.144 (12.38)	153.17
20	Sardegna	-173.02 (-5.90)	.085 (5.77)	33.33

Note: *z* Statistics between parentheses.