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Labour productivity, ICT and regions: The revival of Italian "dualism"?

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LABOUR PRODUCTIVITY, ICT AND REGIONS: THE REVIVAL OF ITALIAN "DUALISM"?

Simona Iammarino[*], Cecilia Jona-Lasinio[**], Susanna Mantegazza[**]

Abstract

Among the reasons underlying the slow economic convergence of some regions towards the national and the European Union average, the strong gap in technological endowment and innovation capacity has been indicated as one of the most important factors. The requirements of the current 'knowledge-based economy' and the contribution of Information and Communication Technology (ICT) to socio-economic change are very likely to have a significant impact upon regional differentials in the European Union. So far, however, it is rather unclear whether the new paradigm will spur greater socio-economic cohesion or, on the contrary, stronger territorial polarisation.

This paper looks at the distribution of ICT-producing small and medium enterprises in Italy, comparing structural variables – in particular spatial and sectoral dimensions - with labour productivity levels. Ultimately, the objective is to shed some light on the role that ICT-producing firms might play with respect to regional gaps in the Italian economy, traditionally characterised by geographical polarisation and imbalances which are among the most striking in the "Europe of regions".

The first result of our analysis (carried out by using experimental micro data) is that a linkage seems to emerge between high labour productivity and the IT industry. This is in line with the insights of the economic theory of technical change, suggesting that IT-producing sectors are those where gains in productivity are by far the most evident. As expected, the geographical location of firms accounts for a good deal when looking at labour productivity levels across sectors, casting some concern on the development perspectives of the Italian regional divide.

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1. Introduction

In spite of the relative delay shown during the 1990s, today the Information and Communication Technology (ICT) revolution is also happening all over Italy. In most recent years, along with the process of convergence between information and communication technologies, the national ICT industry has entered a new phase of expansion and technical innovation (Iammarino et al., 2001a, 2001b).

In 2001, Italian ICT expenditure as a percentage of GDP reached 5.2% – it was 3.9% in 1997 – compared to a European average of 7.5% (EITO, 2002). Following the remarkable growth of the late 1990s (almost 15% per year), the weight of the Italian ICT market in the European Union reached 11% in 2001, gaining an intermediate position between the shares of the most technologically advanced EU economies – 22% in Germany, 18% in the United Kingdom and 16% in France – and those registered in the southern part of the Union (above 7% in Spain and around 1.5% in both Portugal and Greece). In 2001, ICT market growth in Italy was 9.8%, slightly lower than that (11%) recorded in Western Europe as a whole (EU + EFTA countries).

Different demand segments have contributed to the positive trend: the outstanding growth in hardware – the PC sector grew by almost 18% in 2000 – was particularly boosted by investments carried out by small and medium enterprises (SMEs) and start-ups in fast-growing sectors such as telecommunications; the good performance of the ISDN market was again mainly supported by small firms; ADSL services were instead especially driven by medium-sized and large firms.

As is well known, Italy is characterised by strong geographical polarisation of wealth and imbalances of both economic and innovative activities, which are among the most striking in the "Europe of regions". A good deal of empirical evidence has shown that – despite some signs of convergence in the second half of the 1990s – the pronounced economic and technological divide between the South and the Centre-North of the country has not significantly decreased over the last decades (see, among others, Breschi and Palma, 2001; SVIMEZ, 2001; Evangelista et al., 2002; Guerrieri and Iammarino, 2002).[1]

[1] Various reasons explain the converging trend shown by the Italian Mezzogiorno in the second half of the 1990s, among which are the rather poor innovative performance of the North-west, the remarkable export growth in the South, the rapid spread of Information and Communication Technologies, particularly evident among southern SMEs, and the emergence of a few industrial districts in some areas of the Mezzogiorno (Evangelista et al., 2001). All these factors,

This paper aims at providing a description of the regional distribution of Italian ICT-producing SMEs and investigates the relationship between firm labour productivity and both spatial and industrial structural features. Given the crucial distinction between *production* and *use* of ICT – and its implications in terms of productivity measurement – it is necessary to highlight that the present work focuses on ICT-producing SMEs (1-99 employees). Indeed, the Italian economic system is characterised by a very small average firm size – found all the more in sectors like IT and related services – to the point that it is said to be affected by enterprise "dwarfism".[2]

The following section discusses some of the literature on the interaction between new technologies and productivity, with particular reference to its spatial and sectoral dimensions. Section 3 briefly presents the data, pointing out some measurement problems, whilst Section 4 provides a descriptive picture of the geography of the Italian ICT industry. Section 5 firstly describes the methodology applied to explore the relationship between productivity levels and different variables representing geographical and industrial structures; the results coming out from the data-set considered are then discussed. Section 6 concludes with some remarks relevant for public policy and highlights future research directions.

2. New technologies and productivity

The main determinants of productivity usually identified at the level of the geographical system include factor endowments, capital-labour ratios, technological and scientific progress, knowledge base and learning processes, as well as institutional and organisational change. Each theoretical approach to the economic analysis of productivity (neoclassical economics, new growth theory, economic geography, economics of technical change) has put somewhat different emphasis on these factors. However, there seems to be a consensus that high labour productivity is both an outcome and a crucial measure of the contribution of new technologies to economic growth.

Nevertheless, the relationship between ICT and productivity has been extensively discussed but still only partially understood. Among the main arguments put forward to explain the fuzzy evidence – the so-called "productivity paradox"[3] – there are: measurement difficulties (input and output measures of both ICT-producing and ICT-using industries are poorly accounted for in national account statistics); lags in learning (the novelty and complexity of the new technologies may require long-term learning processes that are still to be fully deployed, thus making the payoffs to ICT not

however, have pointed out the increasing differentiation of the Italian South, and its articulation into "many Mezzogiorni" (see, for instance, Guerrieri and Iammarino, 2002, 2003).

[2] For the data used in this paper see Section 3 below.

[3] This refers to the famous claim by Nobel laureate Robert Solow: "we see computers everywhere except in the productivity statistics".

yet clearly visible); structural and institutional adjustments (slow adaptation of "old" production systems and institutional settings to the new techno-economic paradigm); redistribution issues (ICT may benefit firms without substantial increases in total output); managerial practices (outdated criteria of decision making processes within firms); limited data availability (especially in terms of international comparisons and geographical breakdown); differences in methodological approaches (results are significantly affected by the estimate method chosen to assess the impact of ICT).[4]

Whilst these explanations have contributed in clarifying some aspects of the "productivity paradox", there is still a number of open questions on the link between ICT and productivity and on the role that the new technologies might play in both national and regional socio-economic change. More generally, the difficulties in understanding such a complex link lie essentially in the current transition of industrial societies to the rising 'information age' (Brynjolfsson, 1993). Different authors have indeed made analogies to the electrification age, or even to the industrial revolution. The possibility of 'extended learning curves' implies that, for the new technologies to fully deploy their benefits, it is necessary to develop complementary and related innovations – technical, organisational and institutional – which might require exceptionally long evolutionary processes of learning and adaptation (see, for example, Freeman and Soete, 1994; Wilson, 1995; David, 2000).

Especially when looking at productivity at the sub-national level, additional factors seem to be relevant in explaining differentials: industrial and spatial structures (sectoral range, firm size, investment propensity, degree of urbanisation, network externalities, etc.), scale and scope of geographical agglomeration (localised labour markets, specialised suppliers, knowledge spillovers), and local demand conditions.[5] Furthermore, following technological gap theories, the concepts of *social capability* and *technological congruence* are particularly crucial in explaining territorial productivity gaps (Abramovitz, 1986; Fagerberg, 1987, 1994; Fagerberg et al., 1994). Indeed, both concepts appear to be highly variable across space, even within the same national economy: while the first concept refers to the overall ability of the region to engage in innovative and organisational processes, the latter points to the distance of the region from the technological frontier, or, in other words, its capacity to implement the technical properties connected to the new technologies (Fagerberg et al., 1994). In this view, regions with stronger capabilities and wider knowledge base tend to have a higher level of value added per worker, as they are better equipped to exploit new growth opportunities, to adapt existing activities to new business environments, and to learn faster how to build new advantages. The technological gap models point to the ambiguous effect of two divergent forces: on the one hand, the capacity to generate innovation, which tends to widen

[4] See Brynjolfsson (1993) for a detailed and critical review.
[5] See McCann (1995).

productivity differentials; on the other, the capacity to diffuse innovation, which tends to narrow them.

This paper focuses in particular on the relationship between labour productivity and some industrial and spatial features. Indeed, the sectoral composition of the industrial base is often regarded as an explanation of productivity gaps among countries and regions. Sectoral diversity and the combination of different technological competencies lead to interrelated generations of new products and processes, and the pattern of sectoral specialisation influences the scope for inter-industry spillovers (Fagerberg, 2000). ICT firms in particular may favour locations that offer greater opportunities of developing new combinations and applications with other industries. Moreover, the range and weight of service activities are central when looking at productivity levels. In spite of the severe measurement constraints, the idiosyncratic nature of the bulk of service sectors is in part revealed in the findings of recent empirical studies (Guerrieri and Meliciani, 2003), showing the remarkable variation in terms of productivity growth and performance between the most traditional/regulated low productivity services (e.g. retail and wholesale trade, transports, telecommunications, etc.) and the most knowledge-intensive service activities (e.g. IT services or financial and insurance services).

Along with sectoral patterns – which interact with other factors such as average firm size, R&D-intensity, investment propensity, etc. – location is also important. It is a well-established fact that new and non-standardised types of industrial goods and services tend to be prevalently produced, at least initially, in metropolitan regions. These regions serve as hubs and often show the required magnitude, diversity and sophistication of both supply and demand to support the growth of new markets (Cheshire and Carbonaro, 1995; Dunford and Smith, 2000; van der Meer et al., 2003).[6] The economics of technical change have emphasised the systemic and interrelated nature of innovation and its foundation in dense networks of often geographically proximate firms engaged in related and complementary economic activities. The creation of new competencies relies increasingly on the establishment of links at all levels, from the 'global' to the 'local': networks at the regional level are often faster to be established, cheaper and more able to diffuse both explicit and tacit knowledge (Maskell, 1996; Storper, 1998). The necessity of being integrated in the global information networks has become a prerequisite for local development: the potential for network externalities, however, depends on social institutions and practices for the generation, absorption and diffusion of knowledge, information and innovations or, in other terms, on those localised social capabilities without which economic growth and change cannot be sustained.

[6] A long tradition in urban economics has justified the existence and growth of large urban centres on the basis of technological externalities involving direct interaction and communications between actors (see Duranton and Puga, 2004, for a review).

Furthermore, the ICT industry itself requires comparatively wider access to specialised goods and services (which include research laboratories, university research, legal services, etc.). The more such a variety of specialised suppliers concentrates in a particular region, the bigger the potential for pecuniary and knowledge spillovers. The occurrence of the latter depends on the local co-operative climate (which is largely culturally determined) and on social institutions and organisations that facilitate knowledge diffusion (among recent contributions see Antonelli, 2000; Jaffe et al., 2000; Castellani and Zanfei, 2003). It is difficult to assess whether the performance of a specific region corresponds simply to the sum of selected individual behaviours – e.g. the activities of resident firms – or to that of the regional *system* as a whole. Yet, as stressed by Feldman and Martin (2004), firm success and regional economic growth are mutually dependent and their interdependence may set up virtuous (or vicious) cycles. Firm success depends on their external environment: there is no unilateral causality nexus but, rather, a coevolutionary process (Iammarino, 2004).

On the other hand, the link between new technologies and productivity can only be partially captured by considering ICT-*producing* sectors, as a major role is actually played by ICT-*using* sectors. At the regional level, the demand side of the relationship between new technologies and productivity becomes even more crucial: the degree to which a region offers access to markets depends on the size and structure of the local economy, but also on the ease with which other markets can be served. It has been argued that a large part of the ICT industry can be considered as an 'ordinary' business service sector: the larger the region, the bigger the local market for ICT products (van der Meer et al., 2003).

The diffusion of ICT is not uniform across sectors, firm size classes and regions, which vary greatly in terms of the basic capabilities for knowledge creation, that is absorption and diffusion capacity. Considerable evidence has shown that the spatial diffusion of new technologies remains highly variable and that the externalities promoting their adoption are stronger at the regional/local level (see, among others, Jaffe et al., 1993; Audretsch and Feldman, 1996; Baptista and Swann, 1998; Baptista, 2000; Ernst et al., 2001; Zanfei, 2001; Cantwell and Iammarino, 2003). Although time and space constraints have been increasingly reduced – if not seemingly eliminated – by the pace of technological change and globalisation processes, geography continues to matter and new challenges arise from the increasing integration between "physical" and "virtual" space (Mandelli, 2001). As in the case of the 'old' technologies, not all firms and regions are expected to be on the frontier of the prevailing paradigm, but all need to understand and adapt to the information age,

build the competence to participate in it and take advantage of its increasing social and economic rewards (Mansell and Wehn, 1998).[7]

In spite of the difficulties in analysing productivity, especially at a sub-national scale, we agree with Berndt and Malone that "productivity is a critical determinant of standards of living, quality of life, and international competitiveness, and that even factors like product quality, time-to-market, and customer service are, in some sense, summarised by overall productivity measures" (Berndt and Malone, 1995, 181). In what follows, a simple attempt is provided to investigate, with reference to the Italian case, the relationship between the labour productivity of small and medium enterprises and some spatial and industrial variables.

3. The data

The data used in the analysis of ICT at the sub-national level comes from the Sample Survey of the System of Accounts of Business Units addressed to Italian small and medium firms (i.e. firms with less than 100 employees). The survey conforms to the European Union regulation on business statistics (no. 58/97). The sample design and selection follow a casual stratification procedure, where the data is expanded to the population by economic activity and region.[8]

In order to grasp the information on the ICT industry, it was necessary to work at the level of micro data. This is the only way to identify ICT firms at the regional level according to the economic activity classification (ATECO91) based on NACE Rev.1.[9] In accordance with the OECD definition (OECD, 2000) – perfectly compatible with ATECO91 – the ICT industry here has been subdivided into three sub-sectors: hardware, software (together forming IT) and communication equipment (CT). Also on the basis of the peculiar characteristics shown by the Italian ICT sector (SMAU, 2003), we hypothesise a different behaviour of IT versus CT firms with respect to the generation and application of new technologies. The analysis is carried out with reference to the year 2000 and the sub-national breakdown refers to the NUTS 2 level, corresponding to the 20 Italian administrative regions (Appendix 1).

[7] As argued by a number of scholars (e.g. Fagerberg and Verspagen, 1996; Fagerberg at al. 1997; Rodriguez-Pose, 1999; Breschi, 2000; Paci and Usai, 2000; Guerrieri and Iammarino, 2002), there are signs of growing differentiation of EU regional disparities (particularly when looking at innovation and technology variables) which is generating a sort of 'patchwork' in the patterns of socio-economic development within the integrated area.

[8] The sample represents about 1.2% of the total population of Italian SMEs (approximately 4,000,000).
A complementary source of information is the Provisional Estimate of Value Added of Enterprises, directed to large firms (i.e. those with 100 or more employees). As the latter covers the whole universe (census-based), providing opportunities for dynamic analyses, it cannot be compared with the Sample Survey used here.

[9] The economic activity classification (ATECO 91) follows the Nace Rev.1 up to the fourth digit level, while the fifth level, which is used in the present analysis, is a further breakdown of the fourth.

The ICT phenomenon is a deep and fast technological transformation, comparable to those induced by the industrial revolution, and very difficult to measure by means of traditional national accounting techniques (Iammarino et al., 2001b). As stressed in Section 2, difficulties in measurement have been at the core of explanations for the "productivity paradox". Both ICT and ICT-intensive industries face serious problems in accounting for changes in quality and variety. Because information is intangible, any increase in the information content of goods and services is likely to be underestimated compared to any increase in traditional inputs (Brynjolfsson, 1993). Nonetheless, progress has been made since the adoption, at the EU level, of the new System of National Accounts (ESA95), allowing for the ease of some of the problems faced in the estimation of intangible activities. For example, software has been reclassified as a capital good, advance has been made in the harmonisation of estimates at constant prices and, in particular for Italy, a new statistical file of production units is now available, together with both a system for statistical surveys on the accounts of enterprises encompassing all economic activities, and the first results of a few specific surveys of the most innovative sectors.

However, National Accounts are virtually more suitable to measure an economy with a relatively stable composition and whose output is univocally measurable through largely widespread and approved methodologies. Even greater difficulties emerge when measuring those economic activities that are generally indicated as part of the service sector, but actually also involve some manufacturing activities (for instance, all sectors related to electronics) whose production measurement is less obvious or for which the elaboration of a specific deflator is more complex.

In the following analysis, the general problems of measuring ICT-related activities couple with those connected to the estimation of regional aggregates. In this respect, one of the most serious drawbacks concerns multilocation. As a broad rule, aggregates on production activities should be allocated to the region where the unit carrying out the relevant transactions (local kind-of-activity unit, i.e. KAU) is resident (Eurostat, 1996, par. 13.19). However, in most surveys the variables are estimated assuming that the firm is located in only one region, thereby excluding in principle multilocated firms. This is a rather severe bias in territorial investigations, as users and owners of economic activities may be classified under different sectors and may be located in different regions. Yet, in surveys on small and medium firms[10] the multilocation problem can be considered relatively small, as it is more stringent in the case of larger firms.

4. The spatial distribution of ICT-producing SMEs in Italy

[10] Since 1998 the Italian Sample Survey on SMEs has been addressed to firms with less than 100 employees, whilst previously it covered only the 1-19 size class.

Arguably, the overall impact of ICT on economic growth is likely to depend upon the relative weight of the industry in the regional productive structure: therefore, the contribution of technical progress in the ICT-producing sectors should be smaller the lower their relative weight in the regional economy. On the other hand, spillovers can be a side-product of technical progress in the ICT-producing sectors, but they also stem from complementarities with innovations generated in other sectors: thus, given the localised nature of spillovers, which remain substantially constrained by space, the geographical location of ICT firms is a crucial factor for an assessment of the link between new technologies and labour productivity.

The geographical distribution of Italian SMEs operating in the ICT industry shows, as expected, a strong concentration in the northern part of the country. As it emerges from Charts 1a and 1b, in 2000, the North-west accounts for 35.8% and 34.2% of national value added and employment respectively. Lombardia, in line with its role of regional 'core' of the Italian industrial innovation (cf., among others, Silvani et al., 1993; Iammarino et al., 1998; Evangelista et al., 2002), displays the highest shares in the national total of both employment (20.1%) and value added (21.2%) of ICT-producing SMEs. The latter figures are higher than the regional contribution in terms of all other industries, where Lombardia's small firms account for 18.3% and 16.4% of value added and employment respectively. The other regional industrial centre of the North-west is Piemonte, which represents almost 10% of both value added and employment of the Italian ICT industry.

[Charts 1a and 1b about here]

In the North-east (with overall shares of 26.8% and 26.1% with respect to the two indicators considered), Emilia Romagna displays the highest share of value added (9.9%), while Veneto – confirming a reinforcement of its high-tech orientation observed since the middle 1990s (Ferrari et al., 2001) – leads in terms of employment (9%). It is worth remembering that the two regions of the North-east are fundamental poles of *made in Italy* sectors, with a large presence of small innovative firms often organised in industrial districts and specialising in traditional strengths of the Italian industrial model (i.e. textiles and clothing, machinery and mechanical equipment, etc.). The remarkable ICT spread in the area is to be interpreted also as a consequence of the wide diffusion of computer-assisted production processes and of the high degree of inter-sectoral integration along traditional *filiéres*, often "induced" by the presence of a district (Guerrieri and Iammarino, 2003).

SMEs active in the ICT industry located in the Centre turn out to have the same weight on both national value added and employment (around 23%). The leading region in the area is, not surprisingly, Lazio, showing shares of 8.6% and 8.3% for the two variables respectively. As a matter of fact, the region of the capital, Rome, is the administrative core of the country and the

relevance of the public sector in terms of demand of ICT goods and services cannot be disregarded in looking at the locational pattern of the industry.[11]

The eight regions of the Mezzogiorno account for 14.4% of value added and 16.4% of employment of all Italian ICT-producing SMEs. The highest geographical concentration is found in Puglia (3.5% and 3.8%) and Campania (2.8% and 3.7%), both characterised by a relatively stronger presence of specialised local systems and innovative firms as compared to the rest of the southern area (ISTAT, 2003). Indeed, it has been shown that the technological weakness of the Italian South as a whole does not only refer to the insufficient technological capabilities of firms but also, and more importantly, to the absence of any systemic dimension of innovation processes (Evangelista et al., 2002).

[Chart 2 about here]

As emerges from Chart 2, Central and North-western regions are the most ICT-oriented. Indeed, the contribution of the ICT industry to the overall regional value added and employment is above the national average in Lazio, Molise and Marche in the Centre, and in Lombardia and Piemonte in the North-west. Liguria and Trentino are above the national figure only in terms of value added. Conversely, among the least ICT-oriented regions there are some from the Mezzogiorno (Sicilia and Calabria), but also a few North-eastern regions (Friuli and Veneto) and Toscana. In spite of the strengthening of ICT shares on the national total in Veneto, these are all regions where the pattern of specialisation is highly shaped by *made in Italy* sectors (clothing, leather products, furniture, ceramic tiles, etc.), which therefore account for the bulk of regional production.

Charts 3a and 3b give a picture of the relative position of each region with respect to both value added per employee and investment per employee, for ICT-producing and other SMEs respectively. The Italian Mezzogiorno is characterised by a higher intra-area differentiation in the ICT-producing sectors than in all other industries: whereas in Chart 3b the whole area is below the national average in terms of productivity levels, in Charts 3a both Calabria and Basilicata are above the Italian figure. Lombardia is above the national average in both the ICT industry and the rest of the economy; however, the value added per employee is relatively higher for non-ICT SMEs.

[Charts 3a and 3b about here]

[11] Whilst Lombardia and Piemonte represent the technological heart of Italian industry, Lazio accounts for a large share of the Italian public R&D infrastructures and activities. It is worthwhile to recall the different contribution given by the Italian regions to national R&D activities broken down according to the nature (public or private) of the performing institution. More than 25% of total public R&D is performed in Lazio, whereas the strongest concentration of R&D carried out by the private sector is found in Piemonte and Lombardia (more than 50% of the national total). With the exception of Campania, Southern regions play a very marginal role with respect to private R&D, although they show a relatively more significant contribution in terms of public resources devoted to R&D.

As a further step we checked whether, allowing for cross-sectoral variance, cross-regional variations do matter, supporting our expectation that the differentiation of value added per employee is stronger at the spatial than at the sectoral level. The results of one-way ANOVA bear out such a hypothesis: the value of F, significant at the 5% level, is evidence against H_0 of equality of all population means, implying that the sectoral variance *between* regions prevails on the variance *within* them.[12] This is in line with other empirical studies pointing out that, although broad sectoral regularities (for instance, in R&D-intensity, investment propensity, product versus process innovation, etc.) are found in all areas, regional specificities in the patterns of innovation do not disappear when sectoral diversity is controlled for (Evangelista et al., 2002).

5. Labour productivity in Italian SMEs and structural features

5.1 Methodology

As is stated above, our principal concern is to investigate, with reference to the Italian case, the relationship between SME labour productivity and some structural spatial and industry characteristics, namely geographical location, sectoral composition, investment behaviour and firm size.

The econometric analysis adopted is probabilistic. The model used is a logit model, that is a multivariate binary model.[13] The model estimates how the independent variables affect the relative probability that the firm has high labour productivity. The dependent variable (*Labour productivity*) is a dummy variable. The categories were established on the basis of quartiles, where the upper quartile defines the High Labour Productivity variable, the 2nd and 3rd quartiles identify Medium Productivity, and the lower quartile refers to Low Labour Productivity. Quartiles were used to identify categories of equal weight with respect to the original distribution: as the latter turned out to be unimodal between the first and the third quartile, this partition reflects the original

[12] The ANOVA was performed also for 1999 and 1998: interestingly, the F becomes significant - though at the 10% level - only in 1999, somehow supporting the increasing interregional diversity observed in Italy in most recent years. It is important to remember, however, that the Survey on SMEs is a sample survey, thus preventing any rigorous comparison over time.

[13] For the dependent variable Y_i (assuming only values of either one or zero) and the vector of independent variables X_i:

$$(1) \qquad \text{Prob}\,(Y_i = 1) = F\,(\alpha + \beta X_i) = \frac{\exp\,(\alpha + \beta X_i)}{1 + \exp\,(\alpha + \beta X_i)}$$

Where β is the parameter to be estimated, and F is the logistic cumulative distribution function. By rearranging equation (1), the probability of the event occurring is determined by:

$$(2) \qquad \log_e\,[\text{Prob}\,(Y_i = 1)/1 - \text{Prob}\,(Y_i = 1)] = \alpha + \beta X_i$$

The effect of a unit change in X_i on the log odds ratio of the event occurring is given by the beta coefficient. As logit models are not linear in the parameters, they were estimated by using maximum likelihood techniques. Taking into consideration the log odds ratio is very useful since the interpretation of the coefficient is immediate.

distribution. In the model here reported (both specifications) the dependent variable is High Labour Productivity. [14]

The independent variables may affect the probability that the firm falls into the high productivity category. The *geographical* dimension is considered by taking into account three macro-regions: North, Centre and South. Sixteen *sectoral* dummy variables were created according to the main product/service produced by the firm: the industry breakdown was chosen with specific reference to the Italian industrial model, in order to better characterise the link between sectoral dimension and labour productivity levels. The last two variables are control variables: *investment* behaviour is represented by the log of investment per employee, whilst for *firm size* the log of the number of employees is considered. Appendix 2 reports the description of the variables used in our analysis.

5.2 Results

Table 1 summarises the results of the econometric analysis. We tested two specifications of the model. While the first (model 1) aims at identifying whether ICT-producing SMEs have a higher probability of recording high labour productivity than the rest of the economy, the second one (model 2) includes all other industries (using ICT sectors as the control group).

All variables tested in model 1 are significant at the 1% level. This is a rather satisfactory result and, as the logit model is stable in the variables at least considering the signs, it provides support for the interpretation attempted. Moreover, the percentage of correct predictions over the total number of observations yields a rather high correct prediction rate (about 75%).

[Tables 1 and 2 about here]

A positive value of the coefficient of North means that being a firm located in the North increases the probability of having high labour productivity with respect to firms located in the Centre. The magnitude of this increase is given by the percentage change in the probability, reported in Table 2 for all dummy variables. As expected, South has a negative coefficient, thus indicating that the location in the Italian Mezzogiorno is likely to hamper the probability of being a high productivity firm (in model 1 the percentage change in the probability is –40%).[15]

As far as the sectoral variables are concerned, being an ICT producer increases significantly the probability of having a higher level of labour productivity than operating in all other industries. This seems in line with the theory, which predicts that ICT-producing sectors are those where gains in productivity are by far the most evident. In order to give account of differences *within* the ICT

[14] The model was estimated also by using as dependent variable the Low Labour Productivity category: the results are not shown here.

[15] With respect to the reference base, i.e. firm with average size, average investment per employee, located in the Centre, belonging to the rest of the economy in model 1.

industry, we analyse separately the three ICT sub-sectors, trying to grasp the division between IT and CT. The results indeed underline a striking difference between Hardware and Software (IT) on the one hand, and Communication equipment (CT) on the other. Producing Hardware highly increases the probability of having high labour productivity as compared to the control group (the change in the probability is 46%). Software firms show less marked but similar results. Conversely, the probability of recording high productivity decreases for SMEs producing Communication equipment. Hence, a notable distinction appears to emerge between IT and CT producing firms, offering interesting insights on the influence that the new technologies may have on productivity differentials. In fact, such a result might be ascribed to the different nature of the technology employed in hardware and software productions as compared to communication equipment manufacturing. Actually, the technology implemented in IT industries is relatively younger than that employed in the CT sector. Moreover, Italian firms producing communication equipment are typically specialised in more traditional products requiring relatively mature technologies. Furthermore, hardware and software firms – and in particular Italian SMEs active in hardware production or assembly – are subject to a tougher market competition that entails high labour productivity to ensure market survival.

Given the comparatively weak orientation of the Italian specialisation pattern towards high-tech productions, it is relevant to consider labour productivity with respect to all other industries, which can be broadly grouped in terms of Pavitt's taxonomy: *made in Italy*, science-based, scale-intensive, specialised suppliers and services. The sectoral dummies indeed show interesting results. *Made in Italy* industries (with the exception of Food and beverages), Electrics and electronics and Transport equipment display a lower probability of recording high labour productivity than ICT SMEs.[16] The opposite is true for Chemicals, Refined Petroleum and Machinery firms – all points of relative strength in the Italian specialisation model – for which the change in the probability is 114%, 195% and 28% respectively.

The results for services are in line with previous empirical findings. Being Financial intermediaries substantially raises the probability of having high labour productivity (percentage change almost 150%); for Trade and Other service firms the increase is smaller (both around 45%). It should be noted that ICT investments provided a relevant contribution to output growth in the Italian financial sector after 1997: it has been shown that, in the whole service industry, financial services have recorded the highest rate of growth of total factor productivity (Bassanetti et al., 2004).

[16] It is worth pointing out that the estimate on Low Labour Productivity (as dependent variable) supports these outcomes, showing an even more pronounced effect: operating in *made in Italy* industries (Textiles and Leather products) significantly raises the probability of being low productivity firms.

Turning to our control variables, as expected, a high investment per employee significantly raises the probability of being a very productive firm, whilst the smaller the size of the firm, the higher the probability of having high labour productivity, although the magnitude of the increase is rather tiny.[17] Whereas the outcome for investment is the same as in model 1, firm size in model 2 is not significant. This might be interpreted as a consequence of the predominance of micro-firms in ICT sectors as compared to traditional industries, thus affecting the significance of the coefficient in both specifications.[18]

In order to provide additional insights on the relationship between labour productivity and geographical location, a separate analysis was carried out only with reference to southern firms.[19] The results for the Mezzogiorno are striking: whilst all sectoral dummies follow by and large the same pattern found for the country as a whole (in terms of sign of the coefficients and significance levels), the ICT industry does not have any impact on the probability of being a high productivity producer as compared to all other industries, as none of the three sectors (IT and CT) turn out to be significant. Such results seem to give support to the relative weakness of the Mezzogiorno as a whole in absorbing and diffusing new technologies and in translating them into successful economic performance. On the other hand, southern SMEs engaged in the most advanced IT segments are less likely to be low labour productivity firms than those operating in the more mature communication productions.[20] Finally, the service industry confirms the general results: the probability of being a highly productive producer is significantly increased by operating in all service sectors, showing even stronger percentage changes in the probability for the firms located in the Mezzogiorno regions than for the sample as a whole.

6. Conclusions

The Italian case shows that the spread of new technologies differs remarkably across regions and that the efforts to adapt to the shift of techno-economic paradigm are not evenly transformed into higher economic performance. Overall, our results confirm that a close association emerges between labour productivity levels (as measured by value added per employee) and the geographical location of the ICT industry, raising some worries on the future evolution of the historical Italian North-South divide (in spite of some encouraging trends in the late 1990s). As

[17] For both variables the marginal effect was computed: 0.035 (model 1) and 0.026 (model 2) for investment per employee, and –0.005 (model 1) for the number of employees.
[18] The firm size effect may substantially differ in the analysis of large-sized firms: this will be the next step in our research.
[19] Actually, different attempts were performed across all models at various levels of geographical aggregation (by considering different regions, e.g. North-west and North-east separately, etc.) but none yielded significant differences from the general results reported here.
[20] Using the Low Labour Productivity dummy as dependent variable.

large differences in terms of absorptive capacity give rise to a considerable degree of geographical agglomeration of highly productive and innovative activities, knowledge would flow more easily and economic activity in general would be more spread out if absorptive capacity differentials were reduced across space. Access to advanced knowledge flows is therefore preliminary to any other action geared to its effective use, improvement and further creation.

The analysis reported, however, sheds light only on one side of the relationship between new technologies and productivity. Indeed, much of the productivity gains attributed to the ICT-producing industry should actually be ascribed to ICT-using sectors. Furthermore, and more importantly, data on performance in general does not reveal whether regional behaviour *actually* affects firm behaviour, or whether it is simply their aggregation.

Nonetheless, the exercise here presented can provide some basic insights for public policy. We believe that the main rationale for the latter should lie precisely in the role that governments – at the international, national and local levels – can play in bridging the supply and demand of ICT within the relevant environment. As argued by Bell and Pavitt (1997), whilst public policies generally facilitate the accumulation of production capacity, they often fail to provide incentives and opportunities for technological learning, thus not supporting the accumulation of technological capabilities and absorptive capacity in both firms and regions. The success of economic actors is strongly related to their adaptability to emerging techno-economic requirements and to their collective capabilities for institutional change.

The idea that the ICT drift will not only help individuals, organisations and localities to produce more, but to produce *new* things in *new* ways, has fundamental implications for government intervention (Steinmueller, 2001). In this respect, the same ICTs might be used in a variety of different ways in order to enhance socio-economic conditions and reduce regional gaps (Mansell and Steinmueller, 2000), that is for supporting the introduction of new organisational forms that foster innovation and learning; for improving local absorption of technology produced elsewhere; for securing access to codified knowledge and developing a critical mass of sticky and tacit knowledge; for helping to achieve a sufficient 'institutional thickness', with reference to both informal institutions (collaboration, trust, norms, etc.) and formal organisations and institutions (firms, universities, research centres, technology centres, legal systems etc.). ICT markets are undoubtedly global; but ICT policies may, and often should, have a strong local scope.

The picture here described is both partial and static. It is a preliminary step towards more refined research which will focus specifically on: a) extension of the analysis to large firms; and b) introduction of the time variable into the analysis. An investigation of such aspects, and particularly a dynamic perspective, is essential to broaden and generalise the findings provided here. Yet, in

spite of all its limits, we hope that our contribution may offer some useful insights and stimulate further research in a topic of major interest for development and cohesion policies at regional, national and European levels.

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APPENDIX 1

THE ITALIAN REGIONS

MACROREGION	REGION (NUTS 2)
NORTH-WEST	PIEMONTE
	VALLE D' AOSTA
	LOMBARDIA
	LIGURIA
NORTH-EAST	TRENTINO ALTO ADIGE
	FRIULI VENEZIA GIULIA
	VENETO
	EMILIA ROMAGNA
CENTRE	TOSCANA
	LAZIO
	UMBRIA
	MARCHE
SOUTH (MEZZOGIORNO)	ABRUZZI
	MOLISE
	CAMPANIA
	PUGLIA
	BASILICATA
	CALABRIA
	SICILIA
	SARDEGNA

APPENDIX 2

Dependent Variable		
Labour productivity	High	1 if the firm has a high labour productivity, 0 otherwise.
	Medium	1 if the firm has a medium labour productivity, 0 otherwise.
	Low	1 if the firm has a low labour productivity, 0 otherwise.
Independent variables		
Geography	North	
	South	
	Centre	
Sectors	**ICT**	
	Hardware	Manufacture of office machinery and computers
	Software	Computer and related activities
	Communication equip.	Manufacture of radio, television and communication equipment and apparatus
	Made in Italy	
	Food and beverages	Manufacture of food products, beverages and tobacco
	Textiles	Manufacture of textiles and textile products
	Leather	Manufacture of leather and leather products
	Science based	
	Electrics and electronics	Manufacture of electrical machinery and apparatus n.e.c. - Manufacture of industrial process control equipment - Manufacture of optical instruments and photographic equipment - Manufacture of watches and clocks
	Chemicals	Manufacture of chemicals, chemical products and man-made fibres
	Scale intensive	
	Refined petroleum	Manufacture of coke, refined petroleum products and nuclear fuel
	Plastic	Manufacture of rubber and plastic products
	Metal	Manufacture of other non-metallic mineral products, Manufacture of basic metals and fabricated metal products
	Transport equipment	Manufacture of transport equipment
	Specialised suppliers	
	Machinery	Manufacture of machinery and equipment n.e.c.
	Services	
	Trade	Wholesale and retail trade; Repair of motor vehicles, motorcycles and personal and household goods; Hotels and restaurants; Transport, storage and communication
	Financial intermed.	Financial intermediation, Real estate activities, Renting of machinery and equipment without operator and of personal and household goods
	Other services	Research and development, Other business activities, Education, Health and social work, Other community, social and personal service activities
Investment	Log (investment per employee)	
Firm Size	Log (number of employees)	

Chart 1a - ICT-producing small firms: shares of value added by macroregion, 2000 (Italy=100)

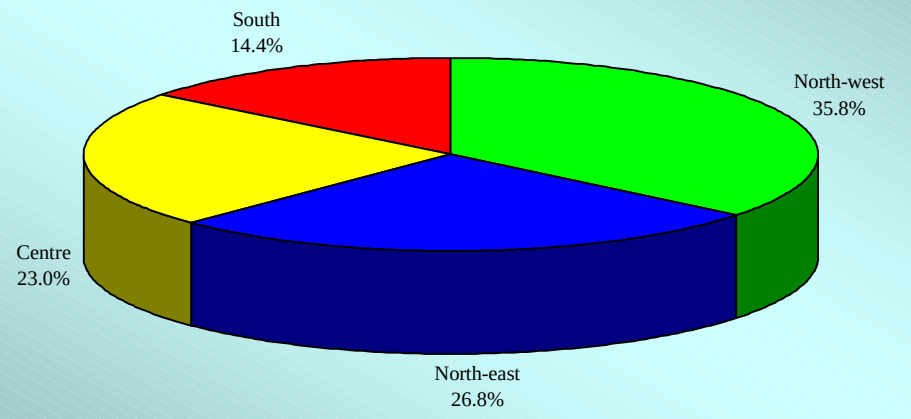

Chart 1b - ICT-producing small firms: shares of employment by macroregion, 2000 (Italy=100)

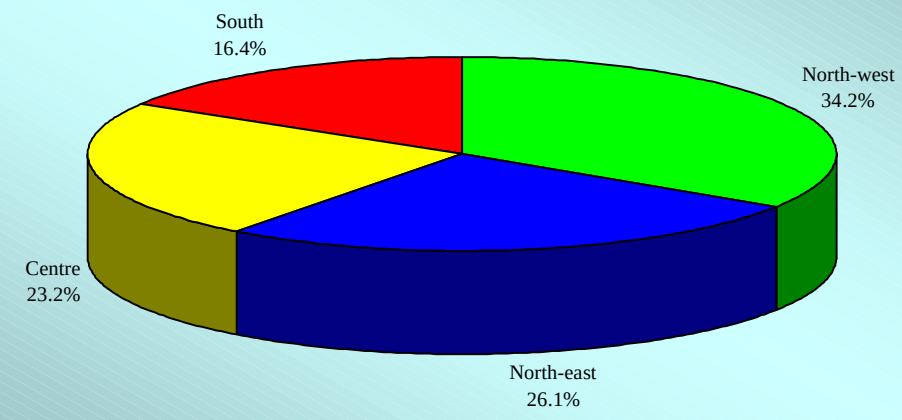

Chart 2 - ICT-producing small firms: shares on total regional value added and employment, 2000

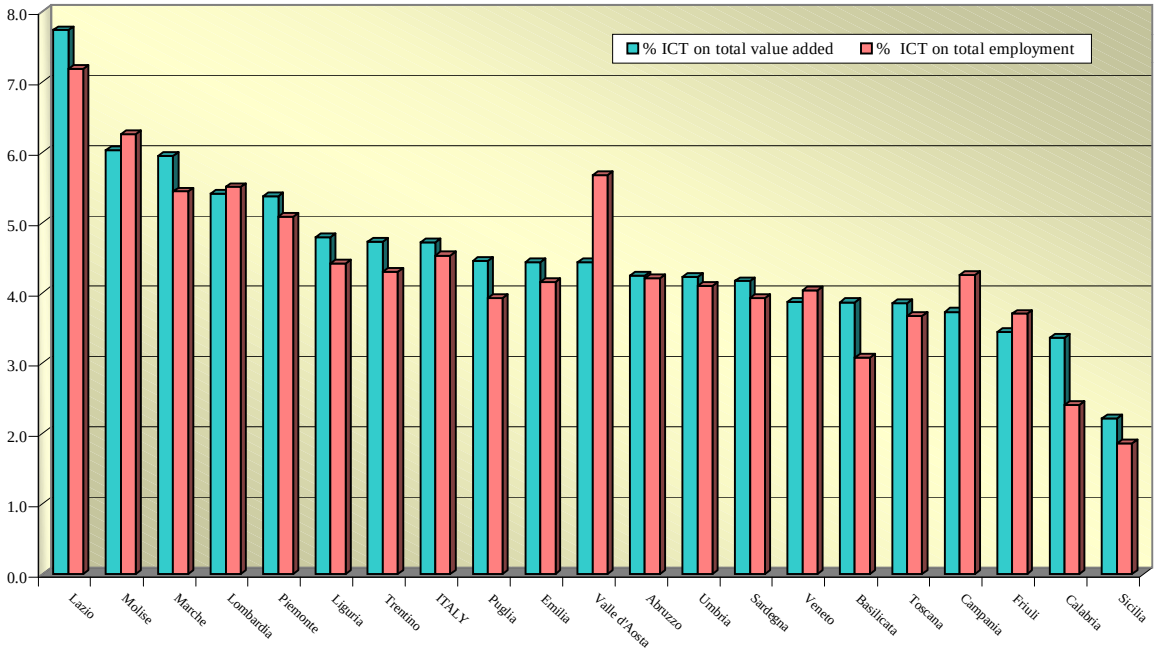

Chart 3a - ICT SMEs: value added and investment per employee, 2000

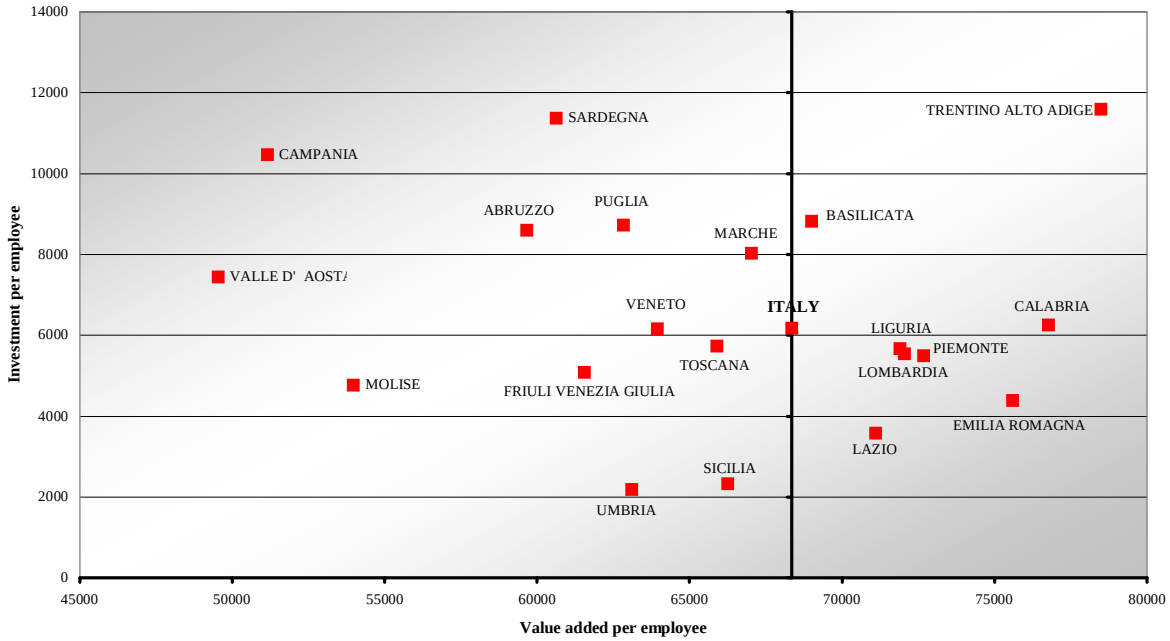

Chart 3b - non-ICT SMEs: value added and investment per employee, 2000

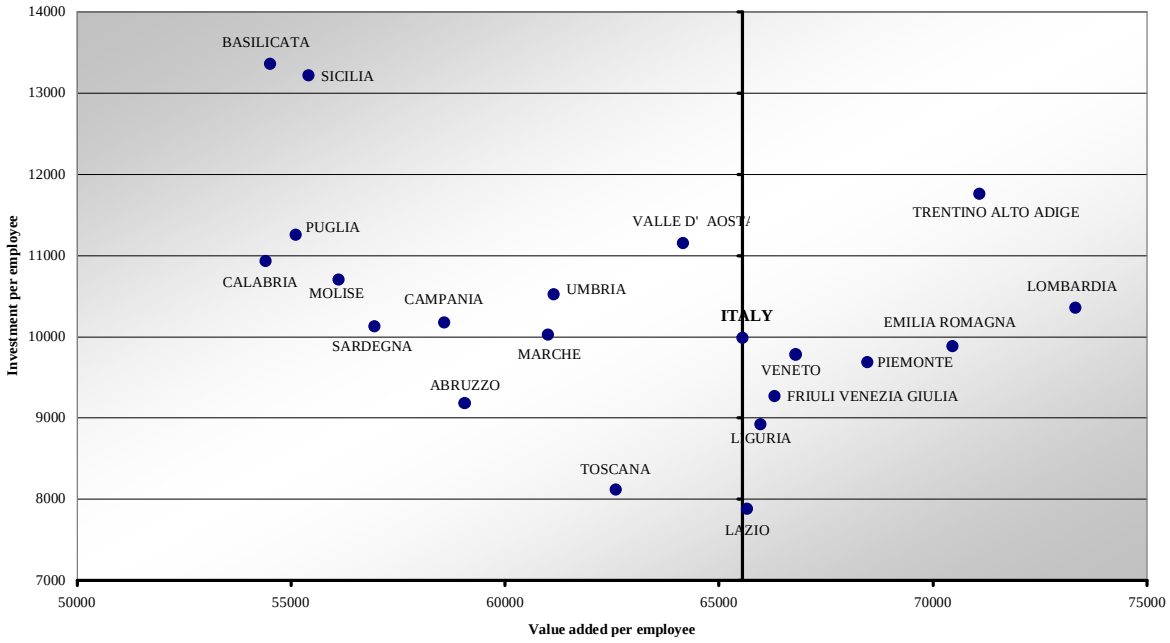

Table 1 – Results of the Logit Model

	High Labour Productivity	
	model 1	**model 2**
Constant	-2.646*** (0.077)	-2.935*** (0.085)
North	0.308*** (0.037)	0.270*** (0.037)
South	-0.626*** (0.051)	-0.712*** (0.052)
Investment	1.187*** (0.008)	0.170*** (0.008)
Firm size	-0.085*** (0.011)	-0.003 (0.012)
Hardware	0.526*** (0.202)	
Software	0.306*** (0.091)	
Communication equip.	-0.664*** (0.139)	
Food and beverages		0.407*** (0.077)
Textiles		-0.671*** (0.093)
Leather		-0.879*** (0.181)
Chemicals		1.046*** (0.098)
Electrics and electronics		-0.180* (0.107)
Refined petroleum		1.637*** (0.293)
Plastic		-0.012 (0.153)
Metal		-0.076 (0.061)
Transport equipment		-0.321** (0.153)
Machinery		0.311*** (0.085)
Trade		0.478*** (0.049)
Financial intermediation		1.304*** (0.060)
Other services		0.478*** (0.049)
Obs. (A)	28,263	28,263
Correct cases (B)	21,269	21,401
% B/A	75.3	75.7
Log - likelihood	-15,283	-14,865
Pseudo - R sq	0.043	0.073
Wald χ^2	506.225 [0.000]	540.288 [0.000]

Note: standard errors in parentheses; *** denotes significance level at 1%; ** denotes significance level at 5%;. * denotes significance level at 10%. χ^2 test for the cumulative significance of sectoral dummies; [ ] p-values.

Table 2 - Interpretation of the coefficients (dummy variables)

	P(Y=1|X=1)	P(Y=1|X=0)	% change
Model 1			
North	0.285	0.227	25.9%
South	0.136	0.227	-40.2%
Hardware	0.332	0.227	46.3%
Software	0.285	0.227	25.6%
Communication equip.	0.131	0.227	-42.2%
Model 2			
North	0.223	0.845	24.9%
South	0.096	0.845	-46.2%
Food and beverage	0.247	0.845	37.9%
Textile	0.100	0.845	-44.0%
Leather	0.083	0.845	-53.7%
Chemicals	0.383	0.845	113.9%
Electricals and electronics	0.154	0.845	-13.9%
Refined petroleum	0.528	0.845	195.3%
Plastic	0.177	0.845	-1.0%
Metal	0.190	0.845	6.4%
Transport equipment	0.136	0.845	-23.7%
Machinery	0.229	0.845	28.1%
Trade	0.260	0.845	45.3%
Financial intermediation	0.445	0.845	148.9%
Other services	0.260	0.845	45.3%

Note: the reference situation is computed at average size and investment per employee