**Preliminary version**

# LABOUR PRODUCTIVITY, ICT AND REGIONS. THE RESURGENCE OF THE ITALIAN "DUALISM"?

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**May 2004**

## 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 economy' and the contribution of the Information and Communication Technology (ICT) to socio-economic change are very likely to have a significant impact upon regional differentials in the 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 geographical distribution of ICT-producing small and medium enterprises (i.e. with less than 100 employees) in Italy, comparing locational patterns - as well as other crucial structural indicators - with labour productivity levels. Ultimately, the objective is to shed some light on the role that ICT-producing sectors might have on regional gaps in the Italian economy, traditionally characterised by geographical polarisation and imbalances which are among the sharpest in the "Europe of regions".

The first result of our analysis (carried out by using experimental micro data) is that a clear 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 the sectoral range, 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 has fully involved also Italy. In the 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., 2001b). According to the European Information Technology Observatory (2001), in 2000 the Italian ICT expenditure as a percentage of GDP reached 5.5% - it was 3.9% in 1997 – against a European average of 6.3% (EITO, 2001). Following the remarkable growth of the late 1990s (almost 15% per year), the weight of the Italian ICT market in the European Union reached 12% in 2000, gaining an intermediate position between the shares of the most technologically advanced EU economies – 23% in Germany, 20% in the United Kingdom and 17% in France – and those registered in the southern part of the Union (7.5% in Spain and around 1.5% in both Portugal and Greece). Furthermore, in 2000 the ICT market growth in Italy was 14% with respect to the previous year, higher than that (13%) recorded in Western Europe as a whole (EU + EFTA countries). Different demand segments contributed to such a positive change: 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 (EITO, 2001).

On the basis of these ongoing transformations, the first step in our research was to look at the distribution of Italian ICT production across space, focusing on the effects of such a distribution on value added, investment and employment (see Iammarino et al., 2001a). 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 sharpest 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]

This paper aims at providing a further step towards a more in-depth examination of the role of ICT on both regional differentials and the overall Italian economic growth. 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 labour productivity in ICT-producing firms *vis à vis* that of non-ICT firms. By looking at small and medium enterprises (SMEs) – i.e. 1-99 employees - the attempt is to test whether a linkage may be established between ICT production and productivity levels. The following section discusses some of the literature on the interaction between new technologies and productivity, with particular reference to its spatial dimension. Section 3 briefly presents the data, pointing out some measurement problems that arise when the regional dimension is taken into account, 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 location, sectoral diversity, investment behaviour and firm size; 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.

[1] Various reasons explain the converging trend shown by the Italian Mezzogiorno in the second half of the 1990s as, for example, the rather poor R&D performances of the North-West, the remarkable export growth, the rapid spread of Information and Communication Technologies, particularly evident among Southern SMEs, the emergence and consolidation of a few industrial districts (Evangelista et al., 2001). All these factors, however, have mostly pointed out the strikingly evidence of the increasing differentiation of the Italian South, and its articulation into "many Mezzogiorni" (see, for instance, Guerrieri and Iammarino, 2002, 2003).

## 2. New technologies and productivity: some background

A variety of factors have been indicated as the main determinants of productivity at the level of geographical system: 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 particular emphasis on some of these factors. However, there seems to be large consensus on the fact that productivity represents 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"[2] – 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 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).[3] Whilst these explanations have contributed to clarify 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

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[2] This refers to the famous claim by Nobel laureate Robert Solow: "we see computers everywhere except in the productivity statistics".
[3] See Brynjolfsson (1993) for a detailed and critical review.

‘information age’ (Brynjolfsson, 1993). Different authors have indeed make 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, organisation 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 subnational level, additional factors seem to emerge as key determinants in explaining differentials: industrial and spatial structure (sectoral spread, firms size, investment propensity, degree of urbanisation, network externalities), scale and scope of geographical agglomeration (labour markets, specialised suppliers, knowledge spillovers), and local demand conditions. Furthermore, following the technological gap theories, the concepts of *social capability* and *technological congruence* are particularly relevant in explaining 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). Following this approach, regions with stronger capabilities and knowledge base tend to have a higher level of value added per worker, as they are better equipped to exploit the new growth opportunities, to adapt existing activities to the new business environment, and to learn faster how to build new comparative 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 productivity differentials; on the other, the capacity to diffuse innovation, which tends to narrow them.

As far as structural aspects are concerned, the sectoral composition of industrial structures is considered critically linked to productivity gaps among countries and regions. The combination of different technological competencies leads to interrelated generations of new products and processes, and the pattern of sectoral diversification influences the scope for inter-industry spillovers (Fagerberg, 2000). Hence, particularly in the case of information and communication technologies, ICT firms may favour locations which offer greater opportunities of developing new combinations and applications with non-ICT firms. Besides, both the sectoral composition *within* the ICT industry (hardware, software, telecommunications, services) and the overall range and weight of services are central in explaining productivity levels and growth. In spite of the severe measurement constraints, the idiosyncratic nature of the bulk of service sectors is in part represented by the findings of recent empirical studies (Guerrieri and Meliciani, 2003), showing the remarkable variation in terms of productivity growth and performance between most traditional/regulated low productivity services (e.g. retail and whole sale trade, transports, telecommunications, etc.) and most knowledge-intensive service activities (e.g. IT services or financial and insurance services). The evidence of the massive substitution of computer services for other inputs in response to the outstanding drop in computer prices provides further support to the centrality and complexity of the still little known role of services in affecting productivity levels and dynamics (Jorgenson and Stiroh, 1995).

Along with sectoral patterns – which influence other factors such as average firm size, R&D-intensity, investment, etc. – spatial structural features are 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 (van der Meer et al., 2003).[4] Fast-growing regional economies are often centred around large urban agglomerations or highly diversified global cities in which financial and business service functions predominate (Dunford and Smith, 2000). 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

[4] A long tradition in urban economics have 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).

related and complementary economic activities. Even the most specialised forms of knowledge are becoming a perishable resource due to the accelerating pace of technological change; valuable competencies have to be created fast; continuous learning and adaptation determine the innovative performance of individuals, firms and geographical systems (van der Meer et al., 2003). Creating competencies fast means to establish 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). The necessity to be integrated in the global information networks has become a crucial prerequisite for local sustainable 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 assured.

Turning to the influence of geographical agglomeration factors, the ICT industry 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 location, the bigger the potential for pecuniary spillovers. Also the availability of highly specialised or multi-skilled labour depends on the extent of spatial concentration of ICT or ICT-related firms. Furthermore, in the Marshallian tradition, agglomeration implies that knowledge spillovers are more likely to occur. In spite of the fact that the ‘region’ can by no means be considered a ‘cluster’ in the Marshallian sense (McCann, 1995; Gordon and McCann, 2000), the extent to which innovative clusters, as actual forms of industrial organisation (industrial districts, innovative milieaux, technological districts, etc.), are present in the region may affect substantially the overall regional productivity. Although knowledge spillovers are not only ‘localised’, spatial agglomeration favours access to external knowledge and the introduction of localised technological changes, leading to self reinforcing mechanisms based upon localised increasing returns (Antonelli, 2000, Cantwell and Iammarino, 2003, Castellani and Zanfei, 2003). Once more, the occurrence of knowledge spillovers depends on the local co-operative climate (which is largely culturally determined) and on social institutions and organisations that facilitate knowledge diffusion.

On the other hand, the link between new technologies and productivity can be only 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, as the size of local markets, and their degree of openness to international competition, may substantially vary at the subnational level. The degree to which a location offers access to markets depends, as previously mentioned, 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).

Recent empirical studies at the national level have demonstrated that ICT does not only show outstanding dynamics as a single industry, but also a great capacity to promote growth in other sectors, both traditional and technology-intensive (Gambardella and Torrisi, 2001; De Arcangelis et. al. 2002). ICTs may affect labour productivity through both capital deepening and total factor productivity (TFP) growth (Jorgenson and Stiroh, 2000). On the one hand, the rapid decline in the prices of high-tech goods stimulates ICT investment, thus resulting in a significant capital deepening (ICT-related capital deepening). On the other hand, the technological advancement in ICT raises TFP growth in the innovating sectors: the development and diffusion of the new technologies give rise to benefits which go beyond those accruing to ICT-producing sectors, and that may turn into increases in productivity at the macroeconomic level.

In summary, it can be argued that the ICT spread is not affecting uniformly sectors, firm size classes and regions, which vary greatly in terms of the basic capabilities for knowledge generation: 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, for example, Jaffe et al., 1993; Audretsch and Feldman, 1996; Baptista and Swann, 1998; Baptista, 2000; Ernst et. al, 2001; Zanfei, 2001). 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. As recently argued (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, which is generating a sort of ‘patchwork’ in the patterns of socio-economic development within the integrated area. These differences provide essential insights in order to better understand the macro-economic overall pattern (Storper, 1998). The subnational dimension appears to be increasingly meaningful also in terms of development and cohesion policies, even more so in view of the EU enlargement towards Central and Eastern European countries.

In spite of the difficulties in analysing productivity, especially on a subnational 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, summarized by overall productivity measures” (Berndt and Malone, 1995, p. 181). In what follows a simple attempt is provided to investigate, with reference to the Italian case, the relationship between labour productivity and some of its structural determinants mentioned above, namely geographical location, sectoral features, investment behaviour and firm size.

## 3. Data and measurement at the regional level

The data used in the analysis of ICT at the regional 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). 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.[5] According to the OECD definition (OECD, 2000) – perfectly compatible with ATECO91 - the ICT industry is subdivided in three categories of activity: manufacturing, goods-related services and intangible services (Appendix 1). In the following analysis we look at investment, value added and employment of SMEs producing ICT goods and intangible services.[6] The analysis is carried out with reference to the year 2000 and the subnational breakdown refers to the NUTS 2 level, corresponding to the 20 Italian administrative regions (Appendix 2).

The ICT phenomenon is a deep and fast technological transformation, comparable to those induced by the industrial revolution. A major drawback of such a change has been the growing complexity of the national accounts estimate arising from the necessity to grasp elements such as the speed of change, the interdependence and the intangibility of economic and innovative processes, the changes in variety and quality, etc. (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, 2003). 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 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 on the most innovative sectors. However, National

[5] The economic activity classification (ATECO 91) follows the Nace Rev.1 up to the fourth digit level, while the fifth level, that is used in the present analysis, is a further breakdown of the fourth.
[6] A further step in the future will certainly be to extend the analysis in order to cover also goods-related services.

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 involve also 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, which are a regional specification of the corresponding accounts of the total economy. As far as investment is concerned, the current definition used by Eurostat describes regional gross fixed capital formation as “resident producers’ acquisitions, less disposals, of fixed (tangible and intangible) assets during a given period, plus certain additions to the value of non-produced assets realized by the productive activity of producer or institutional units” (Eurostat, 1996, par. 3.102). Therefore, the concepts of “acquisition” and “residence” are particularly relevant, as users and owners of activities may be classified in different economic sectors and, moreover, may be located in different regions. In fact, the general principle of allocating gross fixed capital formation by region is ownership (just as in the accounts of the total economy), and fixed assets owned by a multiregional unit are allocated to the local KAU (local kind-of-activity unit) where they are used (Eurostat, 1996, par. 13.20).

As a broad rule, aggregates on production activities should be allocated to the region where the unit carrying out the relevant transactions is resident (Eurostat, 1996, par. 13.19). However, in the Sample Survey on small and medium firms[7] the relevant variables are estimated assuming that the firm is located in only one region (excluding in principle multilocated firms). Therefore, the data on value added, investment and employment used in the present work are attributed to the region where the firm is resident.

[7] Since 1998 the survey has been addressed to firms with less than 100 employees, whilst previously it covered only the 1-19 size class.

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

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 on 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 non–ICT 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 ICT industry.

(Charts 1a and 1b, Page 29)

In the North-east (with overall shares of 26.8% and 26.1% with respect to the two variables considered), Emilia Romagna displays the highest share of value added (9.9%), while Veneto – confirming the reinforcement of its high-tech orientation experienced since the second half of the 1990s (Ferrari et al., 2001) – leads in terms of employment (9%). It is worth to remind 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 specialised in the 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 (CAM and CAD) and of the high degree of inter-sectoral integration along the *filiére* (often "induced" by the district) (Guerrieri and Iammarino, 2001, Sterlacchini and Quaglia, 1999).

SMEs active in the ICT industry located in the Centre turn out to have similar weight on 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 capital region is the administrative core of the country and the relevance of the public sector in terms of demand of ICT goods and services cannot obviously be disregarded in looking at the locational patterns of the industry.[8]

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 poor technological performances of firms but also, and more importantly, to the absence of any systemic dimension of innovation processes (Evangelista et al. 2002).

(Chart 2, Page 30)

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: these are all areas where the pattern of specialisation is highly shaped by ‘made in Italy’ sectors (clothing, leather products, furniture, ceramic tiles, etc.).

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[8] Whilst Lombardia and Piemonte represent the technological heart of the 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, while the strongest concentration of R&D carried out by the private sector is found in Piemonte and Lombardia (more than 50% of the total 20 regions). 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.

## 5. Productivity levels and the geographical location of ICT

### *5.1 Methodology*

As is stated above, our principal concern is to investigate, with reference to the Italian case, the relationship between labour productivity and some of its structural determinants mentioned in Section 2, namely geographical location, sectoral features, investment behaviour and firm size. Arguably, the overall impact of ICT on economic growth is likely to depend on the relative weight of the industry in the regional productive structure: therefore, the contribution of technical progress in the ICT-producing sectors is 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.

A first step was to check whether, having allowed 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 the one-way ANOVA bear out such a hypothesis: the value of F, significant at 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.[9] This is in line with other empirical studies pointing out that, although broad sectoral regularities (for instance, in the importance of R&D, investment, 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).

[9] 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 remind, however, that the Survey on SMEs is a sample survey, thus preventing any rigorous comparison over time.

The econometric analysis adopted is probabilistic. The model used is a logit model, that is a multivariate binary model. For the dependent variable $Y_i$ (assuming only values of either one or zero) and 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 $\beta$ is the parameter to be estimated, and F is the logistic cumulative distribution function. Rearrange 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.

The model estimates how the independent variables affect the relative probability that the firm has high (low) labour productivity. The dependent variable (PROD) in the two specifications of the model takes the value of 1 when the firm has a high (low) level of labour productivity, and 0 otherwise. The categories were established on the basis of quartiles, where the upper quartile defines the High Productivity variable, whilst the lower quartile identifies Low labour Productivity (with Medium Productivity used as the base category). The independent variables, which may affect the probability that the firm falls into one of the two categories above, are all dummies. The *geographical* dimension is considered by taking into account three macro-regions: North, Centre and South. Sixteen *sectoral* variables were created according to the main product/service produced by the firm. Such an industry breakdown was chosen with specific reference to the Italian industrial model, in order to better characterise the link between sectoral dimension and high (low) labour productivity levels. The *investment* behaviour is proxied by investment per employee and has been categorised according to the same quartile procedure used in the case of productivity (High, Medium and Low Investment). The last independent variables refer to the *firm size*, where the Micro variable groups firms with 0-5 employees, the Small category includes firms between 6 and 19 employees, and the Medium variable gathers together all firms between 20 and 99 employees. Appendix 3 reports the description of the variables used in our analysis. It should be noted that, due to the computational effort necessary to estimate the model (usable database size is 28,263 observations), we preferred to fit several smaller models including a reduced number of variables each time[10].

### *5.2 Econometric results*

Tables 1 and 2 summarise the results of the econometric analysis. As emerges from Table 1, all variables tested in models 1, 3 and 4 are significant at the1% 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 number or percentage of correct predictions over the total number of observations yields a rather high correct prediction rate (about 75.0% for both the High Productivity and Low Productivity estimates).

(Table 1, Page 31)

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. The magnitude of the increase is given by the marginal effect (me), which ranges from 0.066 in model 2 to 0.148 in model 4. 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. Conversely, both geographical dummies show the opposite sign for the Low Productivity estimation (Table 2).

(Table 2, Page 32)

[10] As a further development we are checking other models specifications (always logit regressions) comparing models trough ANOVA.

As far as the sectoral variables are concerned, being an ICT producer increases significantly the probability of having a high level of labour productivity. 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 industry, however, we analyse separately three ICT sectors, trying to grasp the division between IT (hardware and software) and CT (telecommunications). Our results underline a striking difference between hardware and software productions, on one side, and communication equipment on the other. Producing hardware highly increases the probability of having high labour productivity: the marginal effect ranges from 1.735 in model 1 to 0.071 in model 4. Software firms show less marked but very similar results. Conversely, the probability of recording high productivity decreases for firms producing communication equipment. Hence, a remarkable difference appears to emerge between IT and CT producing sectors, offering interesting insights on the influence that the new technologies may have on labour productivity levels.

The results for the Low productivity specification confirm this picture. Being a telecommunication producer raises the probability of having low productivity by 0.176 (model 4) at most. Such a result might be ascribed to the different nature of 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. 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 relatively tougher market competition that entails high labour productivity to ensure market survival (EITO, 2001).

As expected, the high level of investment raises significantly the probability of being a high productivity firm. The corresponding marginal effect ranges from 0.112 in model 6 to 0.228 in model 1, that is the highest estimated value. On the contrary, Low Investment decreases, even if to a lesser extent, the same probability. These results are also supported by those obtained in the Low Productivity specification.

Given the comparatively weaker orientation of the Italian specialisation pattern towards high-tech productions, it is particularly relevant to consider labour productivity in the context of a wider sectoral range. The other sectoral dummies indeed show interesting results. *Made in Italy* industries (such as Textile and Leather) and Machinery – both points of strength of the Italian specialisation model – display a lower probability of recording high labour productivity. In this case, the probability decreases by 0.126 and 0.139 respectively. The opposite is true for Chemicals and Refined Petroleum firms, for which the probability raises by 0.128 and 0.188 correspondingly. Low productivity estimates support these outcomes showing an even more pronounced effect: operating in *made in Italy* industries significantly rises the probability of being low productivity firms (by 0.282 and 0.277 for the two sectors respectively).

The results for services are in line with previous empirical findings. Being financial intermediaries substantially raises the probability of having high labour productivity by 0.221; for trade and other service firms the increase is fairly small (0.066 and 0.067 respectively). The outcome of the Low productivity specification supports these results. It should be noted that ICT investment 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).

Somehow surprisingly, the dummies relative to the firm size do not seem to affect the likelihood that the firm falls into a particular productivity category.[11] This might be partially explained by the fact that our sample includes only small-size firms (1-99 employees), hence resulting in a null size effect which might instead become evident by extending the analysis to larger firm size classes.[12]

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

[11] Thus, results are not reported in Tables 1 and 2.
[12] As highlighted in Section 6, this will be the next step in our research.

southern firms.[13] The results for the Mezzogiorno are striking: whilst all non-ICT sectoral dummies follows 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 probablility of being a high productivity producer, as none of the three sectors (IT and CT) turn out to be significant. In the Low Productivity specification, however, whilst hardware is still not significant, both software and telecommunication are significant at 1%, with the same sign as in the case of the whole Italian sample: positive for telecommunications and negative for software. Such results overall give support to the relative weakness of the Mezzogiorno regions in absorbing and diffusing the new technologies and in translating them into a 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. Finally, the service industry provides additional indications: contrary to the general case, the probability of being a highly productive producer is strongly and significantly risen by operating in all service sectors (the result is confirmed also in the Low Productivity model), indicating an interesting peculiarity of firms located in the Mezzogiorno regions.

## 6. Conclusions

The Italian case shows that the spread of new technologies differ remarkably across regions and that the efforts to adapt to the shift of socio-economic paradigm are not evenly transformed into higher economic performance. Overall, our results confirm that a close association emerge between 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 Italian historical North-South divide. As 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 if absorptive

[13] Actually, different attempts were performed across all models at various geographical aggregations (i.e. by considering different regions, North-west and North-east separately, etc.) but none yielded significant differences with the results reported here.

capacity differentials were reduced across space. The 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 regional productivity. Indeed, much of the productivity gains attributed to the ICT-producing industry is to be actually ascribed to ICT-using sectors. Nonetheless, the story here depicted can provide some basic insights for policy intervention. We believe that the main rationale for the latter should lie precisely in the role that governments – at the international, national and local level – can play in bridging the supply and the demand of ICT. Indeed, as argued by Bell and Pavitt (1997), whilst public policies generally facilitates the accumulation of production capacity, they often fail to provide incentives and opportunities for technological learning, thus to support accumulation of technological capabilities and absorptive capacity in both firms and regions. The success of the economic actors is strongly related to their adaptability to the emerging techno-economic environment. The competitiveness of these actors is based on their socio-economic base and adjustment capacity to the changing techno-economic and socio-institutional paradigms (Schienstock and Hämäläinen, 2001).

The idea that the ICT drift will not only help individuals, business actors 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): 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 to develop 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 (universities, research centres, technology centres, legal systems etc) (Amin and Trift, 1995). ICT markets are undoubtedly global; but ICT policies may, and often should, have a strong local nature.

The picture here described is both a partial and a static one. It is a preliminary step towards more refined research which will focus specifically on: a) the extension of the analysis to large firms; b) the introduction of the time variable into the analysis. An investigation of such aspects is essential to broaden and generalise the findings provided here. Yet, in spite of all its limits, we hope that our contribution could offer some useful insights and stimulate further research in a topic of major interest for development and cohesion policies at local, national and European level.

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## APPENDIX 1

ATECO91 – THE ICT INDUSTRY (excluding goods-related services)

*Manufacturing*

| | |
|---|---|
| 30010 | Manufacture of office and accounting machinery |
| 30020 | Manufacture of computing machinery |
| 31300 | Manufacture of insulated wires and cable |
| 32100 | Manufacture of electronic valves and tubes and other electronic components |
| 32201 | Manufacture of television and radio trasmitters |
| 32202 | Manufacture of apparatus for line telephony and line telegraphy |
| 32203 | Repairing of television and radio trasmitters and apparatus for line telephony and line telegraphy |
| 32300 | Manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods |
| 33201 | Manufacture of instruments and appliances for measuring |
| 33202 | Manufacture of gas water and other liquids meters for measuring, checking, testing |
| 33203 | Manufacture of navigational aids, hydrological, geophysical and meteorology instruments |
| 33204 | Manufacture of instruments and appliances for other purposes, except industrial process control equipment |
| 33205 | Repairing of scientific and precision instruments (optical ones excluded) |
| 33300 | Manufacture of industrial process control equipment |

*Intangible services*

| | |
|---|---|
| 64200 | Telecommunications |
| 72100 | Hardware consultancy |
| 72200 | Software consultancy and supply |
| 72300 | Data processing |
| 72400 | Data base activities |
| 72500 | Maintenance and repair of office, accounting and computing machinery |
| 72601 | Services of telematics, robotics, computer graphics |
| 72602 | Other computer related activities |

**APPENDIX 2**

THE ITALIAN NUTS 2 REGIONS

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

## APPENDIX 3 – List of variables

| | | |
|---|---|---|
| **Dependent Variable** | | |
| Labour productivity | High | 1 if the firm has a high labour productivity, 0 otherwise. |
| | Low | 1 if the firm has a low labour productivity, 0 otherwise. |
| | Medium | 1 if the firm has a medium labour productivity, 0 otherwise. |
| **All dummies** | | |
| Geographical | North | |
| | South | |
| | Centre | |
| Sectors | Hardware | Manufacture of office machinery and computers |
| | Software | Computer and related activities |
| | Telecommunication | Manufacture of radio, television and communication equipment and apparatus |
| | Food and beverage | Manufacture of food products, beverages and tobacco |
| | Textile | Manufacture of textiles and textile products |
| | Leather | Manufacture of leather and leather products |
| | Refined petroleum | Manufacture of coke, refined petroleum products and nuclear fuel |
| | Chemical | Manufacture of chemicals, chemical products and man-made fibres |
| | Plastic | Manufacture of rubber and plastic products |
| | Metal | Manufacture of other non-metallic mineral products, Manufacture of basic metals and fabricated metal products |
| | Machinery | Manufacture of machinery and equipment n.e.c. |
| | Electric motors | 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 |
| | Transport equipment | Manufacture of transport equipment, |
| | Trade | Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods, Hotels and restaurants, Transport, storage and communication |
| | Financial intermediate | 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 | High | |
| | Low | |
| Size | Micro | |
| | Small | |
| | Medium | |

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

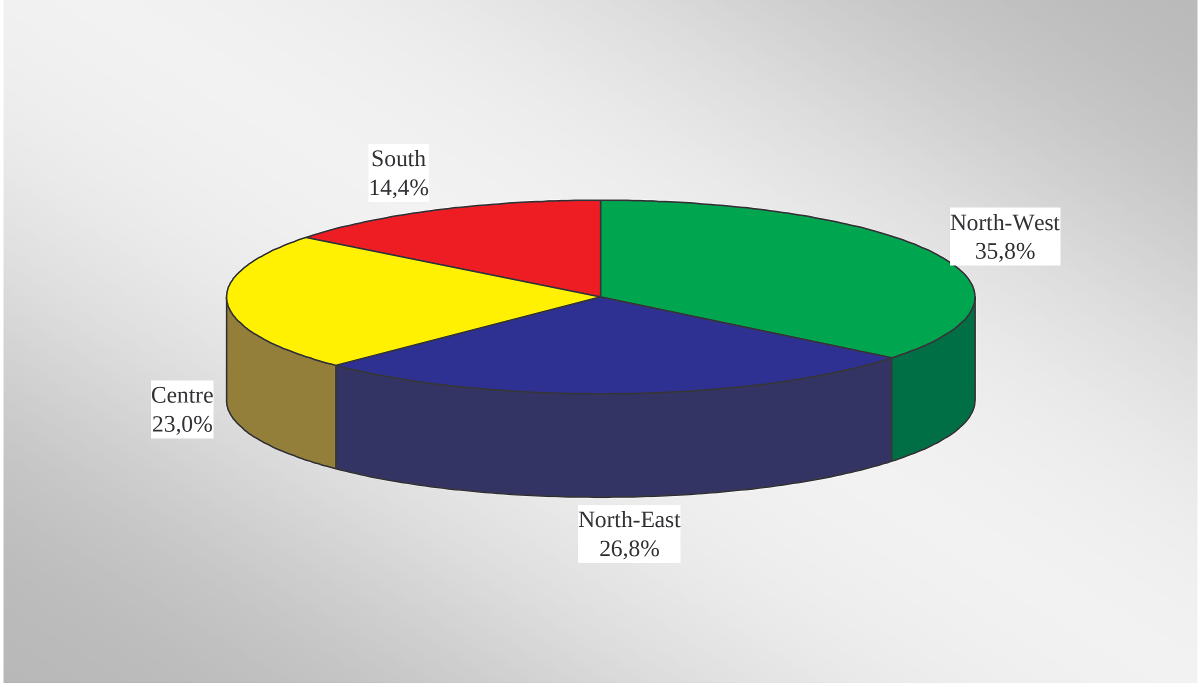



**Chart 1b - ICT-producing small firms: shares of employment by macroregion, 2000 (Italy=100)**

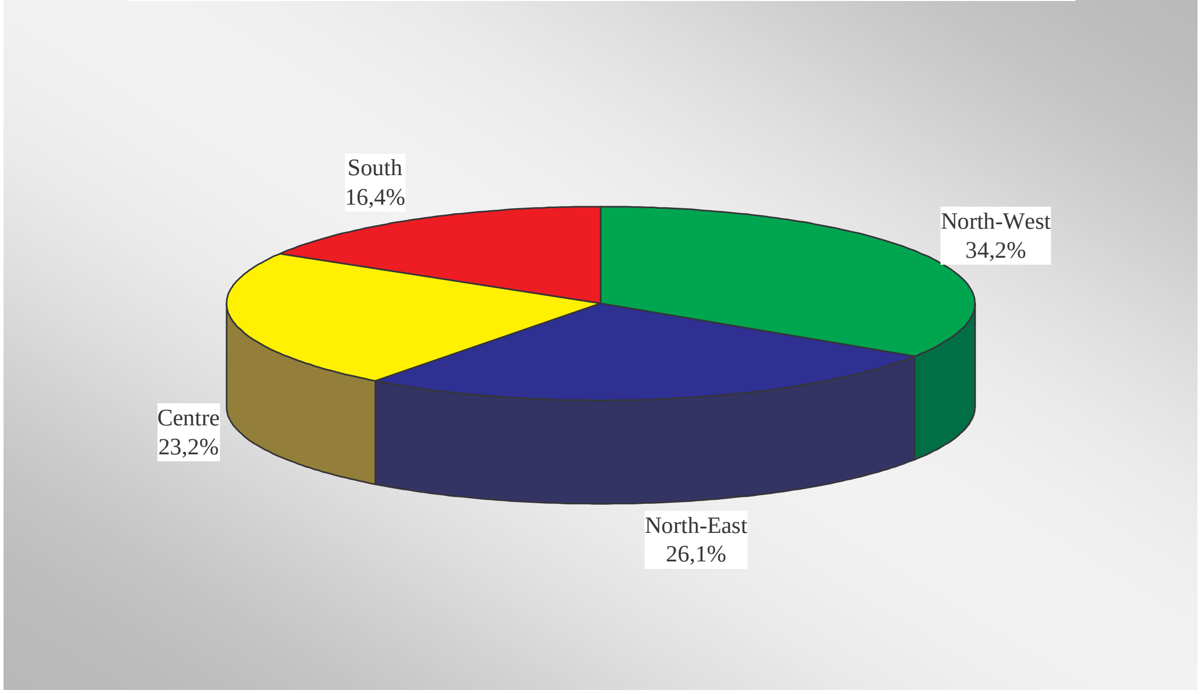
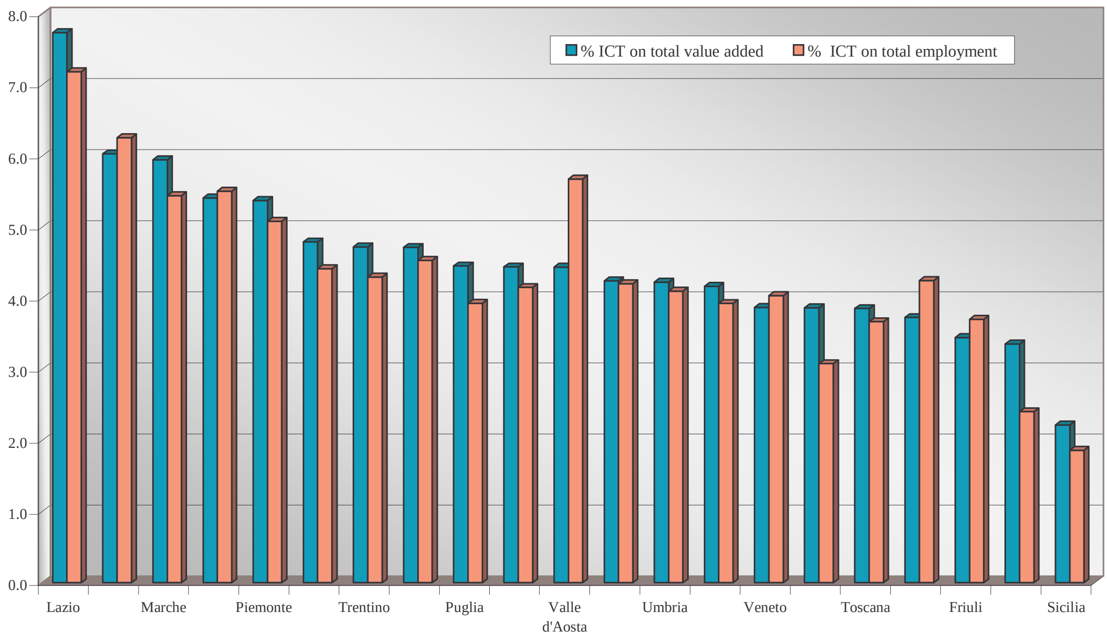


**Chart 2 - ICT-producing small firms: shares on total regional value added and employment, 2000**



## Table 1 – High Productivity

| | model 1 | | model 2 | | model 3 | | model 4 | | model 5 | | model 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | coeff. | me | coeff. | me | coeff. | me | coeff. | me | coeff. | me | coeff. | me |
| Constant | -1.394 (0.036) | --- | -1.294 (0.036) | --- | -1.395 (0.036) | --- | -1.362 (0.036) | --- | -1.393 (0.036 | --- | -1.699 (0.040) | --- |
| North | 0.408 (0.037) | 0.144 | 0.358 (0.037) | 0.067 | 0.408 (0.037) | 0.073 | 0.418 (0.037) | 0.149 | 0.409 (0.037) | 0.141 | 0.397 (0.037) | 0.083 |
| South | -0.523 (0.052) | 0 | -0.587 (0.051) | -0.082 | -0.525 (0.051) | -0.07 | -0.527 (0.051) | -0.049 | -0.523 (0.051 | -0.049 | -0.557 (0.052) | -0.052 |
| Hardware | 0.554 (0.204) | 0.174 | *0.495 (0.204)* | 0.095 | 0.557 (0.204) | 0.103 | 0.519 (0.204) | 0.071 | *0.554 (0.204)* | 0.077 | 0.882 (0.205) | 0.136 |
| Software | 0.369 (0.093) | 0.136 | 0.311 (0.092) | 0.057 | 0.371 (0.092) | 0.066 | 0.333 (0.092) | 0.043 | 0.368 (0.092) | 0.048 | 0.700 (0.094) | 0.102 |
| Telecommunic. | -0.616 (0.140) | -0.01 | -0.673 (0.140) | -0.092 | -0.614 (0.140) | -0.08 | -0.652 (0.140) | -0.058 | -0.617 (0.140) | -0.056 | *-0.283 (0.141)* | -0.029 |
| High investment | 0.803 (0.032) | 0.228 | 0.790 (0.032) | 0.162 | 0.795 (0.032) | 0.155 | 0.800 (0.032) | 0.12 | 0.803 (0.032) | 0.121 | 0.758 (0.032) | 0.113 |
| Low investment | -0.603 (0.039) | -0.008 | -0.590 (0.039) | -0.083 | -0.600 (0.039) | -0.078 | -0.610 (0.039) | -0.055 | -0.603 (0.039) | -0.055 | -0.628 (0.040) | -0.057 |
| Food and bev. | | | **-0.045 (0.072)** | -0.007 | | | | | | | | |
| Textile | | | -1.031 (0.088) | -0.126 | | | | | | | | |
| Leather | | | -1.208 (0.179) | -0.139 | | | | | | | | |
| Chemical | | | | | 0.674 (0.095) | 0.128 | | | | | | |
| Electric motors | | | | | -0.485 (0.103) | -0.066 | | | | | | |
| Refined petr. | | | | | | | 1.133 (0.297) | 0.188 | | | | |
| Plastic | | | | | | | -0.429 (0.153) | -0.042 | | | | |
| Metal | | | | | | | -0.320 (0.054) | -0.032 | | | | |
| Transport equip. | | | | | | | -0.667 (0.151) | -0.059 | | | | |
| Machinary | | | | | | | | | **-0.017 (0.080)** | -0.002 | | |
| trade | | | | | | | | | | | 0.486 (0.034) | 0.066 |
| Financial interm. | | | | | | | | | | | 1.281 (0.054) | 0.221 |
| Other services | | | | | | | | | | | 0.493 (0.042) | 0.067 |
| Obs. (A) | 28,263 | | 28,263 | | 28,263 | | 28,263 | | 28,263 | | 28,263 | |
| Cases corr. (B) | 21,198 | | 21,198 | | 21,217 | | 21,210 | | 21,213 | | 21,426 | |
| % B/A | 0.750 | | 0.750 | | 0.751 | | 0.750 | | 0.751 | | 0.758 | |
| Log - likelihood | -14,962 | | -14,850 | | -14,926 | | -14,923 | | -14,925 | | -14,641 | |
| Pseudo - R sq | 0,066 | | 0,073 | | 0,068 | | 0,068 | | 0,068 | | 0,088 | |

note: standard errors in parentheses; normal means significative at 1%; italics means significative at 5%, boldface at 10%.

## Table 2– Low Productivity

| | model 1 | | model 2 | | model 3 | | model 4 | | model 5 | | model 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | coeff. | me | coeff. | me | coeff. | me | coeff. | me | coeff. | me | coeff. | me |
| Constant | -1.019 (0.034) | --- | -1.214 (0.042) | --- | -1.023 (0.33) | --- | -1.036 (0.34) | --- | -1.010 (0.33) | --- | -0.728 (0.36) | --- |
| North | -0.407 (0.36) | -0.182 | -0.311 (0.037) | -0.05 | -0.408 (0.36) | -0.072 | -0.412 (0.36) | -0.182 | -0.404 (0.36) | -0.176 | -0.396 (0.36) | -0.127 |
| South | 0.509 (0.042) | 0 | 0.644 (0.043) | 0.132 | 0.510 (0.042) | 0.11 | 0.511 (0.042) | 0.125 | 0.510 (0.042) | 0.125 | 0.562 (0.042) | 0.138 |
| Hardware | *-0.634 (0.257)* | -0.215 | *-0.520 (0.257)* | -0.079 | *-0.630 (0.257)* | -0.104 | *-0.617 (0.257)* | -0.13 | *-0.644 (0.257)* | -0.135 | -0.960 (0.258) | -0.187 |
| Software | -0.586 (0.112) | -0.208 | -0.472 (0.112) | -0.073 | -0.582 (0.112) | -0.097 | -0.569 (0.112) | -0.121 | -0.596 (0.112) | -0.126 | -0.912 (0.113 | -0.18 |
| Telecommunic. | 0.699 (0.100) | 0.045 | 0.816 (0.100) | 0.173 | 0.703 (0.100) | 0.156 | 0.717 (0.100) | 0.176 | 0.689 (0.100) | 0.169 | 0.376 (0.101) | 0.091 |
| High investment | -0.717 (0.040) | -0.226 | -0.697 (0.040) | -0.1 | -0.711 (0.040) | -0.114 | -0.715 (0.040) | -0.147 | -0.720 (0.040) | -0.148 | -0.692 (0.040) | -0.143 |
| Low investment | 0.669 (0.031) | 0.038 | 0.657 (0.032) | 0.135 | 0.668 (0.031) | 0.148 | 0.671 (0.032) | 0.165 | 0.667 (0.031 | 0.164 | 0.707 (0.032) | 0.174 |
| Food and bev. | | | **0.081 (0.075)** | 0.015 | | | | | | | | |
| Textile | | | 1.260 (0.057) | 0.283 | | | | | | | | |
| Leather | | | 1.239 (0.104) | 0.277 | | | | | | | | |
| Chemical | | | | | -0.370 (0.123) | -0.066 | | | | | | |
| Electric motors | | | | | 0.343 (0.084) | 0.072 | | | | | | |
| Refined petr. | | | | | | | *-1.847 (0.726)* | -0.286 | | | | |
| Plastic | | | | | | | *0.337 (0.134)* | 0.082 | | | | |
| Metal | | | | | | | *0.126 (0.052)* | 0.03 | | | | |
| Transport equip. | | | | | | | 0.364 (0.118) | 0.088 | | | | |
| Machinary | | | | | | | | | -0.297 (0.087) | -0.066 | | |
| Trade | | | | | | | | | | | -0.714 (0.035) | -0.147 |
| Financial interm. | | | | | | | | | | | -1.262 (0.080) | -0.228 |
| Other services | | | | | | | | | | | -0.399 (0.042) | -0.088 |
| Obs. (A) | 28,263 | | 28,263 | | 28,263 | | 28,263 | | 28,263 | | 28,263 | |
| Cases corr. (B) | 21,215 | | 21,389 | | 21,219 | | 21,213 | | 21,223 | | 21,327 | |
| % B/A | 0.751 | | 0.757 | | 0.751 | | 0.751 | | 0.751 | | 0.755 | |
| Log - likelihood | -14,941 | | -14,647 | | -14,927 | | -14,925 | | -14,934 | | -14,622 | |
| Pseudo - R sq | 0.067 | | 0.087 | | 0.068 | | 0.068 | | 0.067 | | 0.088 | |

note: standard errors in parentheses, normal means significative at 1%; italics means significative at 5%, boldface at 10%.