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LOCATIONAL DETERMINANTS OF THE ICT SECTOR ACROSS ITALY

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Locational determinants of the ICT sector across Italy

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Abstract

Is the rapid growth of the Information and Communication Technology (ICT) activities shaping new local specialization and industrial concentration? Does the analysis of local economic conditions help to explain the formation of "places" specialized in ICT?

We use 2001 Census data by Local Labour Systems (LLS) to investigate the characteristics of ICT specialization in Italy. Our investigation is based on a cross-sectional regression model using data for 686 LLS in which the dependent variable is an index of ICT local employment concentration. The measure of concentration we adopted is the location quotient (LQ) index. The LLS specialized in ICT activities in Italy account for 7.3% of total LLS. They are distributed all over the country, although those with highest LQ values are mainly in North-west and Central-south Italy.

Our regression analysis provides the following results. The general econometric specification, i.e. that applied to all LLS, supports a positive and significant relationship between LLS specialized in some manufacturing industries (machinery, equipment and instruments; petrochemicals, rubber and plastic products; transport equipment; and paper, publishing and printing) or business services and relatively high localization of ICT employment. Besides, the model indicates that for LLS characterized by manufacturing SMEs there is a low probability of attaining a greater-than-the-national-average ICT employment specialization. These econometric results are in line with the general opinion that product specialization of Italian industries (the so-called "Made in Italy") and SMEs are less likely to be involved in ICT diffusion to business. Nevertheless, this pattern of results does not justify the interpretation that the industrial districts (where SMEs employment has the largest share) are at the origin of inadequate ICT diffusion to business in Italy. In fact, when the analysis is focused on industrial districts the results are slightly different. In particular, the variable SMEs does not produce a significant coefficient, while textile and clothing industries show a positive association with ICT, even though significant only at 10% level.

What is the main policy implication of these empirical findings? National government's policy makers should become aware that industrial districts are an appropriate instrument to promote the development of the ICT sector, although so far they have been neglected.

JEL: L60, O14, R12, O52.
Keywords: Information and Communication Technologies, Local Labour Systems, geographical concentration, local specialization.

1. Introduction

In the recent decades of economic importance of Information and Communication Technology (ICT) has emerged as crucial for the interpretation of fundamental stylised facts such as the impressive growth of the USA or the lower productivity performance of European economies (Stiroh, 2002; Van Ark, Inklaar and McGuckin, 2003; Daveri, 2004).

Even though most contributions focus on the impact of ICT on productivity and growth at macro, industry and firm level, it is clear that the so-called "IT revolution" is also raising important questions from the geographical point of view (see Daveri and Mascotto, 2006, for a study of U.S. states).

As recalled by Van der Laan, Van Oort and Raspe (2005), there are two classical and opposing perspectives on the effects of ICT on spatial economic development: dispersion and concentration. On the one hand, ICT enables firms to become less location bound: there is a liberalising or centrifugal effect, summarised as the 'death of distance' or the "weightless economy". In this view, the physical distance to customers, suppliers, services and labour supply becomes unimportant for the functioning of economic activities. It is argued that agglomeration of economic activities is no longer necessary because the positive effects on productivity growth are generated by connectivity instead of by proximity. This results in spatial convergence by which ICT industries become geographically more uniformly distributed (Kolko, 2002; Koski *et al.*, 2002). On the other hand, theoretical and empirical economic literature has traditionally attempted to explain local agglomeration forces. Factors like diversified production structures, labour supply and physical and social infrastructures all create externalities that also determine the location of ICT-using activities (Van Oort and Atzema, 2004). If actual territorial patterns confirm agglomeration of ICT activities, the hypothesis of liberalising spatial effects would be defended only on an anecdotal basis.

We argue that this debate is attaching much importance to the issues related to firm location choices, but it seems that socio-economic "places" – *where* an economic activity is in relation to other economic activities, and how it is embedded in local society – are only partially observed and analysed. In fact, if research is on aggregate (or national) ICT adoption or production by firms, no relationship with the features of places involved is revealed. Even if we move to a "sector" scenario, which allow us to focus on proximity or co-location phenomena, the results might fail to disclose important factors connected to questions like "what kind of place" ICT firms are concentrated in. The solution, we believe, is to investigate ICT as the "base industry" for places, that is, to analyse local specialization patterns. This different perspective, which we adopt in this paper, requires a radical change of the analytical approach. It involves the definition of appropriate units of analysis in order to move from sector to socio-economic places. The nature of these places is not that of *industrial cluster* (Porter, 1998; Ketels, 2003), but of *local labour market* (Sforzi-Istat, 1997; Sforzi, 2006).

This paper uses 2001 Census data for Local Labour Systems (LLS) to examine the characteristics of ICT local specialisation in Italy (Istat, 2006). The list of regressors include local manufacturing and services specialization indexes; firm size and geographical controls. Both measures of specialization are inserted at aggregate and disaggregated level, in order to capture some specific influences of local activities concentration.

The structure of the paper is as follows. Section 2 introduces briefly the main issues arising from Italian literature on economic impact of ICT diffusion to business. Section 3 introduces a definition of ICT and discusses the relative position of Italy in terms of ICT investment and employment. Section 4 examines the localization of ICT across Italy, and econometric results on the determinants of local specialization are illustrated in Section 5. To conclude, Section 6 outlines some policy implications of the main empirical findings.

2. The economic impact of ICT: key issues from Italian literature

In the last decade, in Italy the economic effects of ICT diffusion to business have been a focus of interest for many observers and researchers A good starting point is Rossi (2003), which includes a number of important findings from the Bank of Italy Economic Analysis Department. This contribution, like that of Sterlacchini (2005), is motivated by the "new paradigm" for understanding recent productivity growth observed in United States. Essentially, the main conclusion is that the introduction of new digital technologies in production processes has granted to US firms a significant gain in terms of efficiency. Subsequently, this gain was converted into a marked improvement for the US economy as a whole. The late arrival of the ICT "revolution" in Europe was responsible, according to these authors, for the slowdown of economic growth in EU since the end of 1990s. The consensus seems to be that ICT investment (generally speaking "more PCs and Internet for all") is a positive and critical factor for the dynamics of growth of a country or region, thanks to big gains of efficiency for local firms, innovative or traditional.

Is there empirical evidence for the same phenomenon in Italy too? What is the relative position of the Italian ICT sector? The results of Bassanetti, Iommi, Jona-Lasinio e Zollino (2004) suggest that the impact of ICT investment on the whole economy and industrial sectors appears modest, whilst is greater in the service sector. Becchetti, Londono Bedoya and Paganetto (2003) and, more recently, Atzeni and Carboni (2006) have investigated the effect of ICT investment on productivity at firm level. The results of these studies suggest that the ICT diffusion to business produce efficiency gains at firm level only when it is associated to important restructuring processes.

Within the literature on the so-called "new economy", it is possible to distinguish another stream of research focusing on the relationships between the ICT sector and the spatial structure of economic activity. In short, this approach argues that economic activities in the "digital age" are "weightless". Therefore, the increasing importance of ICT is connected to the so-called "death of the distance" phenomenon. As the same scholars have recognized, however, this conclusion seems particularly in contrast with a well documented and established fact: ICT firms are significantly agglomerated in particular places. The study of the ICT sector becomes, at this point, the study of ICT clusters. According to Quah (2001) and Maignan, Pinelli and Ottaviano (2003), the diffusion of ICTs to business can transform the equilibrium of agglomeration forces, as suggested by NEG models. But how does this happen? There is little empirical evidence to explain it.

Our impression is that the findings of this literature do not take convincingly into account the importance of local factors. Two main views of ICT diffusion to business are prevailing: adoption and spatial location.

As far as adoption is concerned, the issues discussed in the literature can be categorized as i) adoption of ICTs by Italian firms, and ii) adoption of ICTs by Italian firms in industrial districts. The main questions in this field of research are: do Italian firms invest in ICT? Are firms located in industrial districts more or less oriented to invest in ICT? Is ICT investment related to historical Italian dualism (North-South)? For example, Lucchetti and Sterlacchini (2005) show that "general purpose" ICT investment is not related to firm characteristics, while "specific and market-oriented" ICT choices are made by larger and more export-oriented firms. Similar results are found in Fabiani, Schivardi and Trento (2003).

Regarding spatial location, one can distinguish those studies that examine the geographical diffusion from those evaluating local specialization in ICT. Iammarino, Jona-Lasinio e Mantegazza (2001a) is a territorial analysis of ICT producing sector at region (NUTS 2) level. Iuzzolino (2003) presents a number of agglomeration indexes both for NUTS 2 regions and Local Labour Systems (LLS) using Census data. The contribution of Burroni (2006) permits to evaluate the degree of geographical concentration for LLS (by way of location quotients), but the exploration is limited to software sector. More recently, Bonaccorsi *et al.* (2006) model the ICT diffusion as a function of sub-regional (NUTS3) structural characteristics (innovation, infrastructures, etc.) and of spatial effects.

In essential terms, the issues raised in literature on economic effects of ICT in Italy can be summarized as follows. First, at aggregate level the Italian dynamics of productivity appears only marginally affected by ICT investment. Second, the adoption of ICTs by Italian firms is relatively limited to large companies. Third, the existing empirical results on the relationships between ICT sector and the places where this sector is concentrated are limited.

3. The diffusion of ICTs to business in Italy: a comparison with selected OECD countries

This section provides a brief overview of Italian position in terms of ICT compared to other industrialized countries. Two basic indicators have been selected: the share of ICT value added in the business sector value added and some recent estimates of ICT employment available for OECD countries.

Italy has a small ICT production sector compared with other OECD countries (OECD, 2002a), but it is a country with an intermediate level of consumption of ICT goods and services (OECD, 2002b).

In OECD countries the ICT sector represented between 4.8% and 14.9% of total business sector value added in 2003 (Table 3.1), and the supply of ICT goods and services has been growing in recent years. In Italy, the share of ICT on business sector value added is increased from 6.0% in 1995 to 6.9% in 2003. As Table 3.1 reports, Scandinavian countries and Ireland are the EU members showing the highest ranks in 1995 and their relative is generally improved.

Table 3.1 – Share of ICT value added in the business sector value added, 1995 and 2003 (percentages)

OECD Countries	1995	2003
Finland	8.3	14.9
Korea (7)	10.7	13.2
Ireland (7)	11.4	11.8
United Kingdom	9.6	10.8
United States	9.6	10.5
New Zealand (1,4,6)	9.7	10.0
Hungary	6.7	9.9
Netherlands	8.8	9.8
Sweden	8.1	9.1
OECD (2,5)	8.0	9.0
Austria	8.3	8.8
Norway	7.0	8.6
Denmark	8.2	8.5
France	8.0	8.5
Portugal (1,7)	7.7	8.4
EU 14	7.2	8.3
Belgium (7)	7.1	8.2
Australia (2,3)	8.0	8.1
Canada	7.0	7.6
Japan (5)	7.2	7.6
Germany (5,7)	5.7	6.9
Italy	**6.0**	**6.9**
Spain	6.2	6.7
Czech Republic (5,7)	5.2	5.7
Greece (5,6,7)	4.8	5.4
Slovak Republic (5,7)	4.6	5.1
Mexico	4.4	4.8

Notes: 1. 1996 instead of 1995. 2. 1998 instead of 1995. 3. 2000 instead of 2003. 4. 2001 instead of 2003. 5. ICT wholesale (5150) is not available. 6. Telecommunication services (642) included Postal services. 7. Rental of ICT goods (7123) is not available.

Source: OECD estimates, based on national sources; STAN and National Accounts databases, March 2006.

As far as ICT employment is concerned (Table 3.2), the Italian position appears closer to EU average than in the case of value added.

Table 3.2 – Share of ICT-related occupations in the total economy: broad and narrow definitions[1], 1995 and 2004[2] (percentages)

OECD Countries	Broad definition		Narrow definition	
	1995	2004	1995	2004
EU15	20.6	21.9	2.6	3.0
United States	21.2	20.3	3.3	3.7
Australia	21.0	20.1	3.4	3.6
Canada	20.7	19.9	3.0	4.0
Luxembourg	23.0	29.5	2.9	3.5
United Kingdom	27.8	28.7	2.9	3.1
Netherlands	23.0	24.5	3.3	4.2
Sweden	20.4	24.4	3.9	4.4
Denmark	20.4	24.1	3.0	4.0
Finland	20.0	23.8	2.7	4.0
Ireland	17.3	22.2	2.8	2.8
Germany	20.4	21.5	2.2	3.0
Belgium	18.7	20.6	2.1	2.7
Italy	**20.9**	**20.4**	**2.4**	**2.8**
France	18.6	19.8	2.9	3.1
Spain	15.8	18.4	2.2	2.7
Austria	15.1	17.2	2.5	3.8
Portugal	13.0	15.5	2.3	2.1
Greece	10.3	14.4	2.2	2.4

Notes: 1. Broad and narrow definitions based on methodology described in OECD (2004, Chapter 6) and van Welsum and Vickery (2005). According to these authors "[...] narrow measure captures ICT specialists (e.g. programmers, software developers but also cable layers)", while "[...] broad measure includes those people who use ICTs intensively in order to do their work (both basic and advanced intensive users), as well as the specialists. These measures are calculated for the economy as a whole, and also by sector.". The shares for non-European countries are not directly comparable with shares for European countries as the classifications were not harmonised. Includes estimates where classification changes have occurred. The EU15 aggregate does not contain estimates for missing years – where a full data set was not available, countries were left out of the EU15 aggregate.
2. Except: Australia, Finland and Sweden 1997 instead of 1995; Portugal 1998 instead of 1995; Ireland 1999 instead of 1995; Austria, Canada 2003 instead of 2004.

Source: Based on EULFS, US Current Population Survey, Statistics Canada, Australian Bureau of Statistics.

The point is that looking at the "narrow" definition, the gap compared to other countries was not reduced, and this seems an important signal regarding the quality of ICT characterizing the Italian economy. In fact, Table 3.2 shows that the US, Canada, Austria and other countries have experienced a significant growth in employment for computer professionals, electrical and electronic equipment mechanics and other very specialized skill-intensive jobs.

Table 3.3 provides a fuller details of Italian ICT activities.

Table 3.3 – Number of employees and firms in the ICT activities in Italy, 2001

ICT Activities	No.	%
Employees		
ICT manufacture	186,369	28.7
ICT services	354,856	54.6
ICT telecommunication	108,454	16.7
Total	649,679	100.0
Establishments		
ICT manufacture	15,541	15.3
ICT services	84,102	82.6
ICT telecommunication	2,186	2.1
Total	101,829	100.0

Source: Istat, 8° *Censimento generale dell'industria e dei servizi*, Roma.

The dominance of ICT services is striking: they account for 54.6% of total employment and 82.6% of establishments. Manufacturing sector is also important, but its employees account for one-half of services, while telecommunications is relatively unimportant.

4. The localization of ICTs across Italy: methodological issues and empirical results

4.1 Data and territorial unit of analysis

The data and territorial units of analysis used in this study are from the Italian National Institute of Statistics (Istat). In particular, employment data is from the data archive of 2001 Census of Industry and Services, and the territorial units of analysis are based on commuting-to-work data from the 2001 Census of Population and encompass all the municipalities of the country.

4.1.1 *The territorial units of analysis*

The territorial units for which the Census data appearing in this study are the 686 Local Labour Systems (LLS) of Italy as defined in 2005 by Istat, supported by the Department of Economics of Parma University (Istat, 2005). The boundaries of LLS are commuting-to-work based, so that LLS are highly self-contained geographical areas encompassing both the place of work and the place of residence of a local population (Sforzi-Istat, 1997).

Istat defined LLS to serve as reference for socio-economic analyses, as it is clear that local economy and its labour market are not bounded by institutional divisions (regions, provinces or municipalities). LLS represent the basic units of social and economic organization appropriate to conduct comparative research across Italy.

In our study LLS are utilised to asses the influence of different specialised local economies on ICT employment growth. In fact, the local socio-economic environment may influence the demand for ICT activities.

4.1.2 *Description of data*

The data on employment by economic activities was collected to measure the level of the specialisation of LLS in different industries. According to the Istat definition of manufacturing and services used for studying the geography of Italian economy (Istat, 2006) we distinguish between ten manufacturing macro-sectors (excluding miscellaneous manufacturing n.e.c. and recycling) and one service sector (excluding consumer, traditional and social services). Two further economic variables related to the size of manufacturing establishments are introduced to capture the influence of small and medium-sized establishments on ICT activities. These variables are particularly important as a measure of the degree to which a local environment strongly characterized by manufacturing SMEs is an obstacle to the diffusion of ICTs to business in the Italian economy[1]. It is well known that the Italian model of industrialisation is chiefly based on manufacturing LLS of SMEs specialised in personal and housing goods (textile, leather products, etc.; wooden furniture, ceramic tiles, etc.) and the related mechanical industries which produce them (Quadrio Curzio and Fortis, 2000). The opinion of a large number of researchers, as documented by the survey of the literature (Section 2), is that this characteristic feature of the Italian economy is the major impediment to growth of ICT activities.

This group of variables is completed by two other variables: the first is introduced as a measure of North-South divide characterizing the Italian economy; the second to take into account the potential role of higher education.

In Italy, a subset of institutional regions are classified as regions "lagging behind in their economic development" (Objective 1) by Structural Funds of the European Union (European Union, 2006). These regions correspond to the historical Italian North-South divide. This justifies the inclusion of a specific variable reflecting the disadvantages for a LLS located in one of these regions. Finally, the presence of institutions like a university has been suggested as a possible measure of ICT-conducive environment when used in a LLS rather than a regional context (Azzolina and De Luca, 2004-05). For this reason "university" is included as appropriate variable in our study (see Appendix for details).

4.2 Measuring local specialization

To measure the local specialization of LLS in ICT activities we adopted a Location Quotient (LQ) index. This is probably the most commonly utilized analytical tool to evaluate the economic base[2]. LQ is also a measure generally employed in regional planning and economics to evaluate economic structure and specialization in the local economy (Isserman, 1977).

The basic principle is to compare the local economy to a reference economy (the national economy as a whole), and in the process attempting to identify

[1] In particular, Lucchetti and Sterlacchini (2004) found that the production-integrating ICTs depends instead on the firms' size, while other market-oriented technologies are not associated to this factor.

[2] A possible interpretation of LQ use is to identify those local industries that are producing more than is needed for use by the local population and selling outside the place (exporting) and those that are not meeting local needs and are a source of consumption leakage (importing).

specializations in the local economy. The same idea is at the basis of Hoover-Balassa revealed comparative advantage (RCA), frequently used in international economics literature (Hoover, 1936 and 1971; Balassa, 1965).

In our study, the calculation of LQ aims to identify the LLS that are more specialized in ICT activities.

The way to calculate LQ for ICT activities is the following:

$$LQ_{ICT} = (ICT\_EMP_{LLS} / ICT\_EMP_{ITA}) / (TOT\_EMP_{LLS} / TOT\_EMP_{ITA}) \quad (1)$$

where ICT_EMP_{LLS} is ICT sector employment in each LLS, while ICT_EMP_{ITA} is ICT sector employment at national level, and TOT_EMP indicates the same values for all sectors. The numerator signifies the share of a given LLS in total (Italian) employment of ICT sector. The denominator represents the share of a given LLS (total employment) in total (national) employment for all sectors (manufacturing and services). For a given sector, say ICT, a LQ index value greater than one means that the percentage share of that sector is greater than the national average. Therefore that LLS is (relatively) specialized in that sector.

4.3 Local specialization in ICT

The LLS specialized in ICT activities in Italy number 50 and they account for 7.3% of total LLS. The LQ index ranges from 1.004 in Udine (located in North-east Italy) to 6.020 of Ivrea (North-west Italy). Ivrea is the town where Olivetti, the historical Italian ICT company, was founded in 1908. Figure 4.1 shows the top ten LLS specialized in ICT activities ranked by LQ values. Collectively, they have 21.6% of ICT national employment.

Ivrea is the most specialized LLS in ICT activities, and Milan LLS accounts for the higher employment level (Figure 4.2). As the empirical literature on ICT diffusion to business in European countries shows, large urban areas have the highest ICT employment levels (Koski *et al.*, 2002), so it is not surprising to find Rome and Turin ranked just below Milan.

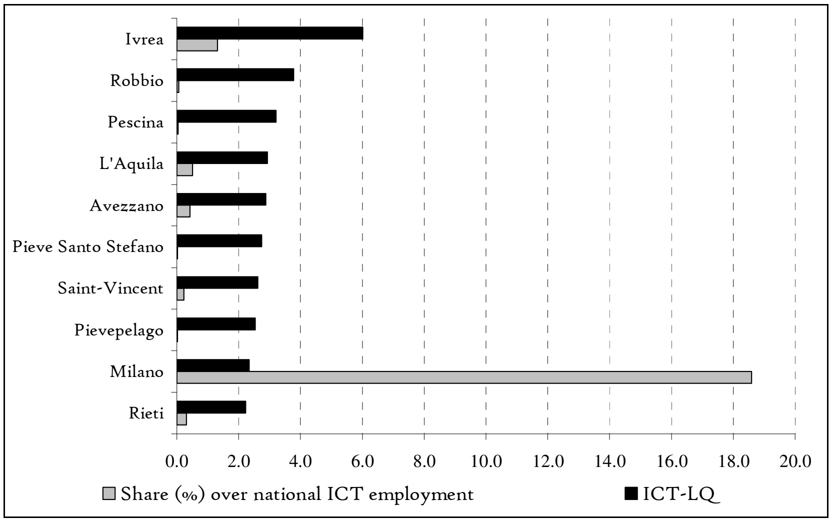

Figure 4.1 – The top 10 LLS specialized in ICT activities in Italy ranked by LQ values, 2001

Source: Istat, 8° *Censimento generale dell'industria e dei servizi*, Roma.

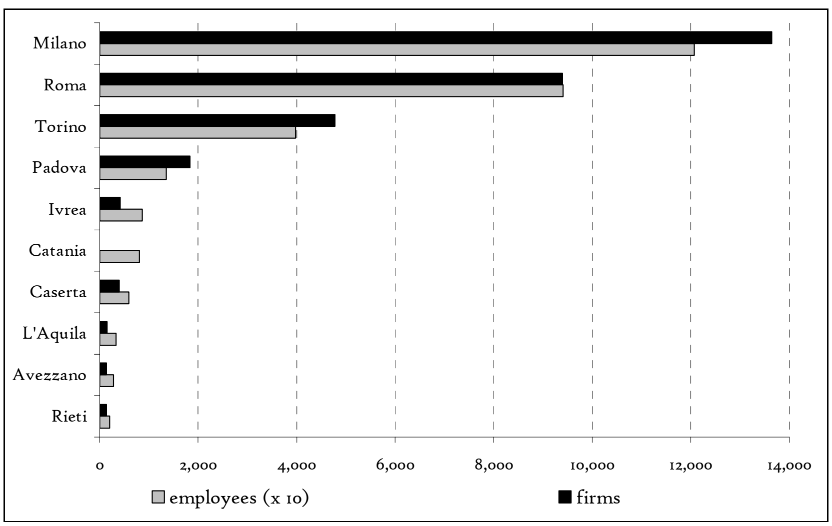

Figure 4.2 – The top 10 LLS specialised in ICT in Italy ranked by employment size, 2001

Source: Istat, 8° *Censimento generale dell'industria e dei servizi*, Roma.

Figure 4.3 maps the LLS specialized in ICT activities. The figure shows that LLS are distributed all over the country, although those with highest LQ values are mainly in North-west and Central-south Italy.

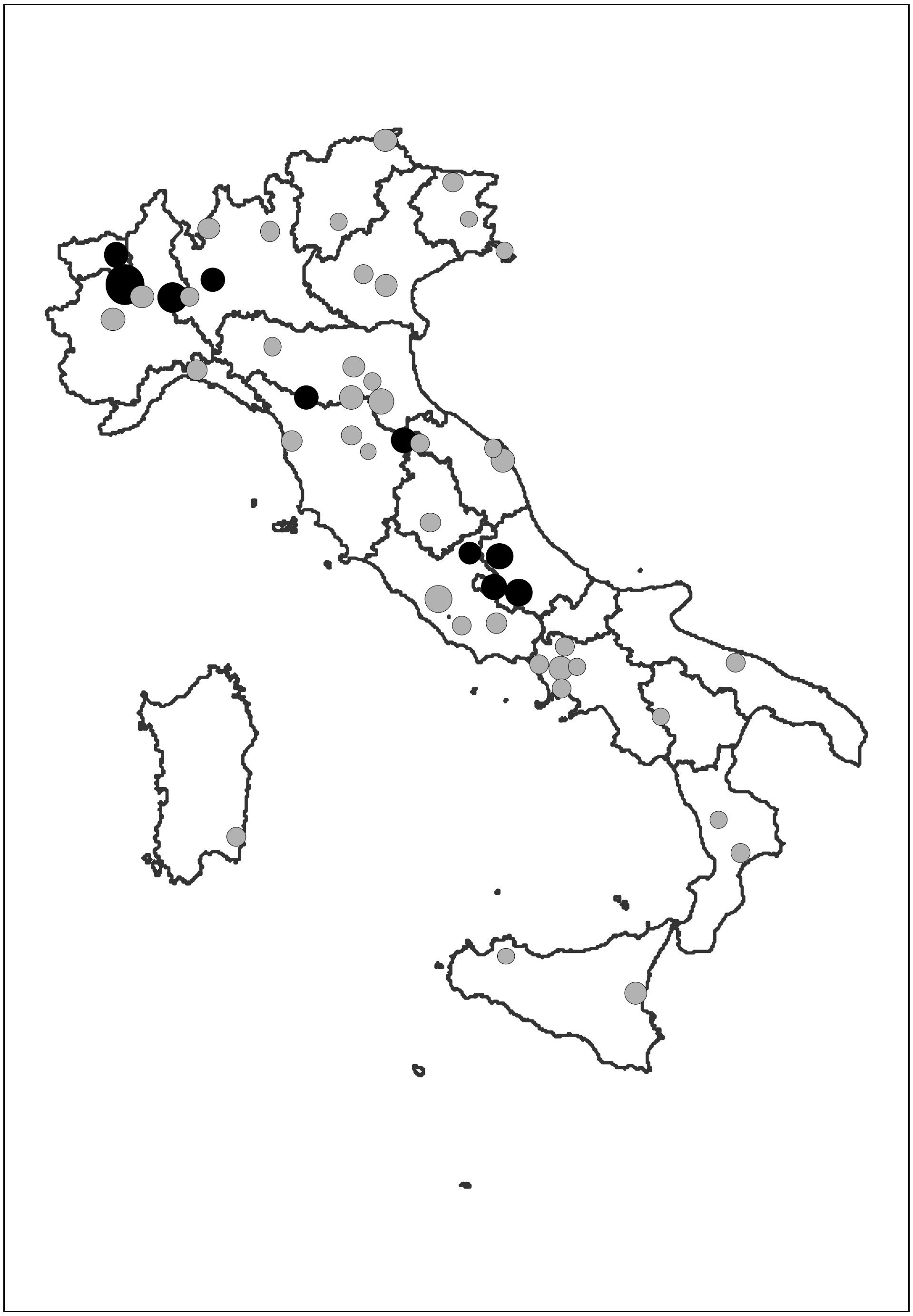

Figure 4.3 – The location of LLS specialized in ICT activities in Italy, 2001. (the size of circles is proportional to LQ values).

Source: Istat, *8° Censimento generale dell'industria e dei servizi*, Roma.

5. Locational determinants of ICT specialization: econometric evidence

Our investigation into main determinants of ICT specialization is based on a cross-sectional regression model using data for 686 LLS in which the dependent variable is an index of ICT local employment concentration in 2001.

There is little discussion of local ICT specialization in the empirical literature. In general, most research asked other questions, such as:

–Q1: "Are ICT firms agglomerated and why?"

–Q2: "Is the number of new ICT firms influenced by the existence of manufacturing and business services agglomeration?"

Alecke *et al.* (2006) look into Q1 with data for Germany, discovering that Ellison-Glaeser indexes of agglomeration are relatively low in most of high-tech sectors. The analysis by Van Ort and Stam (2006) is concerned with Q2 using Netherlands data. They show that manufacturing agglomeration is not significant, while high values of LQ for business services are positively correlated with rapid growth of new ICT activities. Moreover, no significant firm size effects are found in their estimates. A recent study of ICT diffusion to business, proxied by Internet domain name registrations, by Bonaccorsi, Piscitello and Rossi (2006) provided new results of spatial dimensions and effects at regional (NUTS3) level in Italy.

5.1 The dependent variable: a index of ICT local specialization

The basis of our dependent variable is the location quotient (LQ), which is traditionally employed as a measure of the relative concentration of a given industrial employment in a given "place" (here defined as LLS) and was discussed in the previous section as a point estimate for local specialization.

For empirical testing however, the LQ measure implies a risk of non-normality of residuals, because it takes values between zero and infinity. Since a value between zero and one represents a lack of specialization (indicating that the local measure is at a degree that is less or equal to the national average), while a value between one and infinity represents the presence of specialization, regression analyses using LQ give too much weight to values above one. In this study we adopt the Box-Cox transformation to convert the LQ data into a normal distribution[3]. The objective of using this methodology is to make the residuals of the regression more homoskedastic and closer to a normal distribution.

The formula (see Appendix for details) is:

[3] Another solution for transforming the LQ index symmetrically would be:

$$LQS = (LQ-1)/(LQ+1)$$

Each LQS index lies between minus and plus one (and avoids the problems of an undefined value which can occur in the logarithmic transformation if ICT employment is zero in a LLS). The values of LQ index above and below one are now treated symmetrically. We tried to adopt this solution, but the Kolmogorov-Smirnov one-sample test rejects the hypothesis of a normal distribution.

$$\begin{cases} LQ_{ICT}^{(\lambda)} = \left(LQ_{ICT}^{\lambda} - 1\right)/\lambda & \lambda > 0 \\ \ln(LQ_{ICT}) & \lambda = 0 \end{cases} \qquad (2)$$

Box and Cox (1964) developed the transformation and proposed estimating the lambda parameter by maximum likelihood.

5.2 The regressors and the specification of the model

The baseline specification of our econometric model includes the following list of regressors:

– MANUF: this variable (or group of variables) is (are) a specialisation index(es) (LQ as described in Section 4) based on manufacturing employment for each LLS. We introduce this variable adopting two different level of definition: in *ict01* model we use an aggregate index, while in *ict02* model the specialization refers to manufacturing macro-sectors (textile and textile products, leather and leather products, machinery and equipment, etc.; see Appendix). For each macro-sector variable we introduce a step-wise indicator, i.e. a dummy equal to 1 if the corresponding LQ index is greater than 1. The choice of converting the continuous LQ data into dichotomous variables is suggested by the results of multicollinearity test[4]. The model with continuous LQ variables might generate very high standard errors of estimates of the coefficients (i.e decreased reliability), thus the assessment of the role played by each macro-sector variable would be difficult to interpret.

– SERVICES: this variable (or group of variables) is (are) a specialisation index(es) (LQ as described in Section 4) based on services employment for each LLS. As in the case of manufacturing, we introduce this variable at two different levels of definition: in *ict*01 model we use an aggregate index, while in *ict*02 model the specialization refers to a specific class of services: business services (see Appendix).

In addition, in the empirical analysis we utilized some control variables:

– SME-M: this variable is a specialisation index (LQ as described in Section 4) based on small and medium-sized manufacturing firms (less than 250 employees);

– EU-Ob.1: this is a dummy variable equal to 1 if the LLS belongs to an Objective 1 region (see paragraph 4.1.2);

– UNIV99: this is a dummy variable equal 1 if the LLS houses university main or decentralised offices and faculties.

The equation corresponding to the *ict01* model has the following form:

$$LQ_{ICT}^{(\lambda)} = constant + a1 \cdot MANUF + a2 \cdot SERVICE + a3 \cdot EU\text{-}Ob1 + a4 \cdot UNIV99 + a5 \cdot SME\text{-}M + \varepsilon \qquad (3)$$

[4] Even though it is known that high multicollinearity (so long as it is not perfect) does not violate OLS assumptions, when high multicollinearity is present, confidence intervals for coefficients tend to be very wide and t-statistics tend to be very small. Coefficients will have to be larger in order to be statistically significant, i.e. it will be harder to reject the null when multicollinearity is present. We compute the so-called "condition index", as suggested by Belsley, Kuh and Welsch (1980), and the results of which suggest that the use of continuous LQ variables generates a value over 30. This result indicates excessive collinearity in the data.

As mentioned above, to investigate ICT local specialization at a more detailed level, we also present the results for the *ict02* model, in which macro-sector dummies and business service LQ index are employed:

$$LQ_{ICT}^{(\lambda)} = constant + a1 \cdot SP\text{-}MANUF\_1(TEXT) + \ldots + \\ + a10 \cdot SP\text{-}MANUF\_10(PAPER) + a11 \cdot SERV\_1(BUSINESS) + \\ + a12 \cdot EU\text{-}Ob1 + a13\ UNIV99 + a14 \cdot SME\text{-}M + \varepsilon \qquad (4)$$

Equation (3) and (4) are estimated applying OLS regression methodology to 686 LLS. Since diagnostic tests indicate problems of heteroskedasticity, we use robust standard errors using White's heteroskedasticity consistent method (White, 1980).

A further couple of variables are used (in place of SME-M) in *ict03-ict05* models, where equations (3) and (4) are estimated only for industrial districts. Industrial districts are, by definition, LLS of small and medium-sized manufacturing firms (Istat, 2006). Nevertheless, they are heterogeneous in terms of predominant employment size of firm. Thus, it is meaningful to verify if industrial districts dominated by medium-sized firms (with 50 to 249 employees) are more ICT-conducive environments than industrial districts dominated by small firms (with 1 to 49 employees).

The variables are:

– MEDIUM-M: this variable is a specialisation index (LQ as described in Section 4) based on medium-sized manufacturing firms (with 50 to 249 employees);

– SMALL-M: this variable is a specialisation index (LQ as described in Section 4) based on small manufacturing firms (with 1 to 49 employees).

5.3 The regression results

The estimates reported in Table 5.1 offer the first representation of our empirical investigation using data for all 686 Italian LLS.

The results for *ict01* model support a positive and significant relationship between LLS specialized in manufacturing or service activities and relatively high localization of ICT employment. Vice versa, LLS characterized by manufacturing SMEs or belonging to Southern Italy (EU Objective 1 regions) show a significant, but negative association with ICT specialization. The presence of university for the LLS is a positive and significant factor related to ICT specialization.

Table 5.1 – Regression results: OLS model for ICT specialization across Italy

	Model ict01		Model ict02	
Constant	1.262	*	2.314	***
	(0.652)		(0.247)	
MANUF	0.669	***		
	(0.161)			
SERVICES	1.703	***		
	(0.439)			
SP-MANUF_1(TEXT)			0.007	
			(0.055)	
SP-MANUF_2(LEATHER)			0.014	
			(0.082)	
SP-MANUF_3(FURNIT)			0.055	
			(0.058)	
SP-MANUF_4(JEWEL)			0.130	*
			(0.070)	
SP-MANUF_5(FOOD)			−0.038	
			(0.063)	
SP-MANUF_6(MECH)			0.293	***
			(0.069)	
SP-MANUF_7(METAL)			−0.008	
			(0.060)	
SP-MANUF_8(CHEMIC)			0.178	***
			(0.057)	
SP-MANUF_9(TRANSP)			0.207	***
			(0.069)	
SP-MANUF_10(PAPER)			0.187	***
			(0.058)	
SERV_1(BUSINESS)			0.888	***
			(0.142)	
EU-Ob.1	−0.434	***	−0.142	**
	(0.060)		(0.061)	
UNIV99	0.641	***	0.386	***
	(0.075)		(0.067)	
SME-M	−0.646	***	−0.371	**
	(0.202)		(0.178)	
Adj. R^2	0.26		0.34	
St. Error	0.66		0.63	
F-test	49.7		26.7	
Obs.	686		686	

Note: White robust standard errors in parenthesis. The dependent variable is a LQ index of ICT specialization, modified with Box-Cox formula (as described in paragraph 5.1). ***indicate that the coefficient is different from zero at the 1%; ** at the 5%; and * at the 10% level.

The findings for the *ict02* model reveal some additional elements of explanation. We found that LLS with high employment concentration in business services have the greatest probability of developing an ICT specialization. LLS with a university enjoyed the same favourable circumstance.

The significance of estimated coefficients indicates that LLS with high levels of employment concentration in machinery, equipment and instruments (SP-MANUF_6), petrochemicals, rubber and plastic products (SP-MANUF_8), transport equipment (SP-MANUF_9) and paper, publishing and printing (SP-MANUF_10) are significantly more ICT-specialized. The coefficient for jewellery (SP-MANUF_4) is positive too, but significant at only 10%.

In this detailed model the condition of LLS situated in Southern Italy (EU Objective 1 regions) is still negative. Finally, the *ict02* model indicates that for LLS characterized by manufacturing SMEs there is a low probability to attain a greater-than-the-national-average ICT employment specialization.

This final outcome requires further analysis. In the Italian debate, the relatively small size of manufacturing firms has been identified as the main factor for lower ICT adoption rates and, consequently, for the unsatisfactory performance of Italian economic system (for example, see Onida, 2004). Even though this point of view appears to not really recognize the variety characterizing the small business sector, it is traditionally argued that this obstacle can be associated with a sort of "Italian anomaly" in product specialization. The percentage of population occupied in light industries in Italy (textile, clothing, leather goods, etc.) is effectively larger than observed in other industrialized economies. This industry is chiefly organized to satisfy a highly variable demand for differentiated and personalised goods. So that the system of production is small scale and firms operate in a limited number of phases of a common production process. This "anomaly" is often summarized as the "industrial district" effect.

We consider that our econometric analysis (models *ict01* and *ict02*) is in line with the general opinion that SMEs are less likely to be involved in ICT diffusion to business. But this should not be interpreted as a confirmation that the high presence of industrial districts, where small and medium-sized manufacturing firms employment has the largest share, is at the origin of inadequate ICT diffusion to business in the Italian industrial sector.

In fact, we have to stress that not all LLS with a large concentration of SMEs are industrial districts. Much literature supports the idea that the nature of SMEs depends on the organization of production process in which they are placed in (see, for example, Becattini, 2004; Becattini *et al.*, 2003).

Some SMEs act as key firms *à la* Perroux. Others move as sub-contractors for large establishments. But they are often isolated and located in rural LLS. And, finally, SMEs can operate as specialized firms *à la* Marshall constituting an industrial district (Brusco, 1996; Bellandi and Sforzi, 2003).

We therefore think that it is logical to verify whether our results are different when we focus on the role of industrial district SMEs. In other words, is firm size also negatively correlated with local ICT specialization when equations (3) and (4) are estimated with data for 156 LLS identified as industrial districts (IDs)? Table 5.2 reports the results of this test. The reduction of sample size (from 686 to 155 observations[5]) does not reduce the significance of main effects.

[5] In these regressions we excluded one LLS-district (Apice), because it always proved as outlier, with an extremely high value for Cook's distance test.

Table 5.2 – Regression results: OLS model for ICT specialization across industrial districts in Italy

	Model ict03		Model ict04		Model ict05	
Constant	2.118	***	2.111	***	2.346	***
	(0.316)		(0.334)		(0.462)	
SP-MANUF_1(TEXT)	0.164	*	0.164	*	0.157	*
	(0.091)		(0.092)		(0.092)	
SP-MANUF_2(LEATHER)	0.025		0.026		0.033	
	(0.099)		(0.099)		(0.100)	
SP-MANUF_3(FURNIT)	0.047		0.048		0.049	
	(0.095)		(0.093)		(0.094)	
SP-MANUF_4(JEWEL)	0.257	*	0.257	*	0.250	*
	(0.150)		(0.150)		(0.151)	
SP-MANUF_5(FOOD)	−0.236	**	−0.237	**	−0.246	**
	(0.099)		(0.100)		(0.100)	
SP-MANUF_6(MECH)	0.469	***	0.468	***	0.448	***
	(0.113)		(0.111)		(0.114)	
SP-MANUF_7(METAL)	−0.205	*	−0.207	*	−0.221	*
	(0.117)		(0.121)		(0.122)	
SP-MANUF_8(CHEMIC)	0.140		0.139		0.128	
	(0.119)		(0.118)		(0.116)	
SP-MANUF_9(TRANSP)	−0.172		−0.173		−0.181	
	(0.151)		(0.152)		(0.154)	
SP-MANUF_10(PAPER)	−0.009		−0.011		−0.023	
	(0.116)		(0.119)		(0.121)	
SERV_1(BUSINESS)	0.632	**	0.632	**	0.601	**
	(0.290)		(0.291)		(0.293)	
EU-Ob.1	−0.352	**	−0.351	**	−0.339	**
	(0.160)		(0.165)		(0.166)	
UNIV99	0.295	***	0.295	***	0.293	***
	(0.089)		(0.089)		(0.089)	
MEDIUM-M			0.008			
			(0.107)			
SMALL-M					−0.157	
					(0.232)	
Adj. R^2	0.25		0.24		0.24	
St. Error	0.55		0.55		0.55	
F-test	4.9		4.5		4.5	
Obs.	155		155		155	

Note: White robust standard errors in parenthesis. The dependent variable is a LQ index of ICT specialization, modified with Box-Cox formula (as described in paragraph 5.1). ***indicate that the coefficient is different from zero at the 1%; ** at the 5%; and * at the 10% level. In these regressions we excluded one LLS-district (Apice), because it always proved as outlier, with an extremely high value for Cook's distance test.

Some conclusions can be drawn looking at the three models *ict03-ict05*:

– the positive and significant relationship between high employment business services concentration and ICT specialization is robust also when we look at IDs,

– IDs specialized in machinery, equipment and instruments (SP-MANUF_6) are significantly more likely to experience ICT employment concentration; also the estimated coefficient for textile and clothing (SP-MANUF_1) is positive, but significant at only 10%;

– IDs with relatively high employment concentration in food industries (SP-MANUF_5) and metal production (SP-MANUF_7) show a negative association with ICT, even though these effects are only significant at 5 and 10% level;
– the confirmed statistical significance for coefficients for EU-Ob.1 and UNIV99 suggests that the environmental determinants of ICT localization for IDs are fairly similar to those for all LLS;
– the alternative use of MEDIUM_M or SMALL_M, in order to capture some possible heterogeneity impact due to firm size in the case of IDs does not produce significant coefficients. This can be interpreted as a confirmation that analysing the relationship between firm size and ICT specialization without considering the organization of production process in LLS can generate misleading results.

The comparison between these results and those obtained for Italy (Table 5.1) shows that the localization of ICT production is affected by local sectorial specialization and the model of production (e.g. textile-clothing across industrial districts vs. transport equipment across Italy). Nevertheless, there are local sectorial specializations which seem to be indifferent to the model of production (e.g. machinery, equipment and instruments) because they are localized across both industrial districts and Italy. Policy makers should consider this when they have to design industrial policies to boost ICT production. In fact, industrial policies sometimes have to be place-based and sometimes sector-based.

6. Conclusions

One of the most debated issues in recent economics literature is the impressive growth of ICT activities in recent decades and their impact on productivity. The prevailing opinion is that ICT and its active use is inextricably linked to economic competitiveness and growth.

Studies on ICT spatial dimension have investigated dispersion and agglomeration of ICT activities, but they have tended to underestimate the importance of “places” in determining ICT employment increase.

This paper contributes to this debate through empirical research focusing on locational determinants of ICT specialization across Italy. To date, only a limited number of studies have investigated localization patterns by using appropriate units of analysis as Local Labour Systems (LLS). There is no point in opening a discussion on the modifiable areal unit problem (MAUP) (Openshaw, 1984), but researchers that use territorial units of analysis should be aware of this problem and, therefore, to choose with care the “places” to be used in their empirical studies.

The regression results, as they relate to each manufacturing macro-sectors, tend to support the thesis that specific industries need to be investigated with reference to specific places. In other words, econometric models applied to all LLS of a country are not able to capture the diversity of its industrialization model.

Again, the regression results indicate that LLS with high specialization in business services are more likely to develop ICT activities. In addition, the presence of academic institutions positively affects the probability of being a ICT-specialized LLS. On the contrary, the results confirmed a significant and negative relationship between the location of LLS in Italian southern regions (Objective 1) and ICT diffusion to business.

Above all, the results demonstrate that industrial districts are places which can have a positive role in developing ICT activities.

What are the policy implications of these empirical findings? In Italy, national government's policies have identified technology districts as the appropriate device to promote the development of ICT sectors and to change the product specialization of Italian industry (Fondazione Cotec, 2005; Ministero dello Sviluppo Economico, 2006). This policy approach is designed to avoid the obstacle to the diffusion of ICTs to business caused by the "Italian anomaly" (see the above quotation in par. 5.3). The strategy to support technology districts initiatives is based on the conviction that industrial districts are not conducive local environments to ICT development. But our pattern of results proved this conviction is mistaken.

It is realistic to think that policy-makers are more interested to know *how* to form and develop a technology district than to know *what* it is. However, if policy-makers knew that what they call "technology districts" draw from ideas advanced in Marshallian industrial districts (St. John and Pouder, 2006) perhaps they would change opinion on industrial districts capacity to act as incubators of ICT industries. St. John and Pouder (2006, p. 162), however, propose a distinction between industrial and technology districts: the first, being industry focused, "evolve over time in line with the industry life cycle"; while technology districts, being technology focused, are districts "in which new technologies give rise to new product classes and whole new industries". If we credit this distinction, it follows that many of Italian industrial districts are actually technology districts. In particular, industrial districts specialised in mechanical industries which are those more apt to develop ICT products, as it has been showed before. Therefore, with regard to policies intended to change the product specialization of Italian industry, the neglect of industrial districts needs to be reconsidered.

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Appendix

A.1 Information and Communication Technology (ICT) definition

As indicated in OECD (2002), since 1998 the principles underlying the definition of ICT have been the following:
– for *manufacturing industries*, the products of a candidate industry: i) must be intended to fulfill the function of information processing and communication including transmission and display, ii) must use electronic processing to detect, measure and/or record physical phenomena or control a physical process;
– for *services industries*, the products of a candidate industry: must be intended to enable the function of information processing and communication by electronic means.

The OECD definition provides the ISIC Rev. 3 classes to be included and the table of correspondence between ISIC Rev. 3 and the national classifications (for Italy ISTAT-ATECO is usually very similar to European Union NACE Rev.1).

Table A.1 reports the codes and description of classes included. As Iuzzolino (2003) and others, we decided to exclude commercial activities.

Table A.1 The ISTAT-ATECO 4-digit codes included in ICT definition

ICT Group	ATECO codes	Description
ICT manufacturing	30.01	Manufacture of office machinery
ICT manufacturing	30.02	Manufacture of computers and other information processing equipment (excluding repairing)
ICT manufacturing	31.30	Manufacture of insulated wire and cable
ICT manufacturing	32.10	Manufacture of electronic valves and tubes and other electronic components
ICT manufacturing	32.20	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy
ICT manufacturing	32.30	Television and radio receivers, sound or video recording or reproducing apparatus and associated goods
ICT manufacturing	33.20	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment
ICT manufacturing	33.30	Manufacture of industrial process control equipment
ICT services	72.10	Hardware consultancy
ICT services	72.2	Software consultancy and supply
ICT services	72.30	Data processing
ICT services	72.40	Database activities
ICT services	72.50	Maintenance and repair of office, accounting and computing machinery
ICT services	72.60	Other computer related activities
ICT services	64.20	Telecommunications

Source: OECD (2002).

A.2 Definition of macro-sectors adopted for the analysis of manufacturing and services specialization indexes (LQ).

Table A.2 – The ISTAT-ATECO 3-digit codes included in macro-sectors definition

Macro-sectors	ATECO codes and description
SP-MANUF_1(TEXT)	17 (Manufacture of textiles), 18 (Manufacture of wearing apparel, except footwear)
SP-MANUF_2(LEATHER)	19 (Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear)
SP-MANUF_3(FURNIT)	20 (Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials), 26 (Manufacture of other non-metallic mineral products) and 361 (Manufacture of furniture)
SP-MANUF_4(JEWEL)	362 (Manufacture of jewellery and related articles), 363 (Manufacture of musical instruments), 364 (Manufacture of sports goods) and 365 (Manufacture of games and toys)
SP-MANUF_5(FOOD)	15-16 (Manufacture of food products and beverages)
SP-MANUF_6(MECH)	2231 (Reproduction of sound recording), 275 (Casting of metals), 28 (Manufacture of fabricated metal products, except machinery and equipment) 29 (Manufacture of machinery and equipment n.e.c.) 30 (Manufacture of office machinery and computers) 31 (Manufacture of electrical machinery and apparatus n.e.c.)
SP-MANUF_7(METAL)	27 (Manufacture of basic metals)
SP-MANUF_8(CHEMIC)	24 (Manufacture of industrial chemicals and other chemical products)
SP-MANUF_9(TRANSP)	34 (Manufacture of motor vehicles, trailers and semi-trailers), 35 (Manufacture of other transport equipment),
SP-MANUF_10(PAPER)	21 (Manufacture of pulp, paper and paper products), 221 (Publishing), 222 (Printing and service activities related to printing)
SERV_1 (BUSINESS)	511 (Wholesale on a fee or contract basis) 631 (Cargo handling and storage), 634 (Activities of other transport agencies), 651 (Monetary intermediation), 652 (Other financial intermediation), 671 (Activities auxiliary to financial intermediation, except insurance and pension funding), 672 (Activities auxiliary to insurance and pension funding), 712 (Renting of other transport equipment), 713 (Renting of other machinery and equipment), 72 (Computer services and related activities), 731 (Research and experimental development on natural sciences and engineering), 732 (Research and experimental development on social sciences and humanities), 741, 742, 743, 744, 745, 746, 747, 911, 924,

Source: Istat (2006).