Innovation, employment and skills in services. Firm and sectoral evidence

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Abstract

In this article the employment impact of innovation in the heterogeneous universe of services is investigated, using data provided by the 1993-95 Italian innovation survey (CIS II). The empirical evidence presented shows that the impact of innovation on employment varies greatly according to the type of innovation strategy pursued by firms, across industries and according to the level of qualification of the labour force. Innovation activities tend to substitute low skilled jobs with jobs with a higher level of qualification. Among small firms and in less than half of the service sectors considered the net effect is positive, particularly in industries which have a strong scientific and technological base. The negative impact of innovation on employment is on the contrary concentrated among large firms, capital intensive industries and in all financial-related sectors (banking, insurance and other financial services). In these latter industries the labour-saving effect of innovation seems to be linked to the widespread use of Information and Communication Technologies (ICTs). In the case of Italy, an overall negative impact of innovation on employment has been found. It is argued that this result is affected by the specialisation of Italian economy in the most traditional service industries.

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1. Introduction

The service sector is nowadays a major component of advanced economies accounting for between 50% and 75% of jobs and value added in most OECD countries (OECD, 2000a). Within services, the bulk of activities is still concentrated in the most traditional and labour intensive branches such as trade, hotel and restaurants and social and personal services which account for between 60% and 80% of total employment in market services. Over the last 20 years, financial and business services, along with community, social and personal services have been the most dynamic components of the tertiary sector. These industries have contributed to alleviate, and in some countries even fully compensate, the severe job losses occurred in the manufacturing sector over the last two decades (Table 1).

The continuous proliferation of new services, and the processes of commodisation, industrialisation and reorganisation of services on a global scale, suggest that services are at the core of the current process of structural change in modern economies, opening up new opportunities for aggregate growth and creation of jobs. Nevertheless, OECD countries have shown different abilities to capture such opportunities, depending on their initial strength as well as their ability to move towards the most high value added and dynamic services. The speed at which service markets have been de-regulated and opened to competition is another key factor behind the different growth of services within the OECD area.

Over the period 1985-96, USA, Canada, UK and Japan have shown the best employment performances and experienced the highest rates of growth of services. In particular, UK has shown an extraordinary employment growth rate in the financial sector, while USA and Canada have combined high rates of growth in both financial related services and transport and telecommunications. On the contrary, Italy is an example of a much less successful story of structural change and shift to services. The poor overall employment performances experienced in Italy in the period 1985-96 can be explained, among other things, by its initial weakness in the most dynamic and technologically intensive services and the difficulty to reshape its pattern of specialisation. The result is that more than 80% of jobs in the Italian service sector is still located in traditional branches such as trade, hotel and restaurants and community and social services.

Technology and innovation are increasingly recognised as major forces behind the growth of services. Information and Communication Technologies (ICTs) are, in fact, playing a pivotal role in revolutionising the ways in which most of "traditional" services are produced, traded and delivered, as well as offering opportunities for the generation of new activities in

many service industries (Petit and Soete, 1996 and 2001; Antonelli, 1999; Andersen et al., 2000; OECD, 2000b)[1].

[Tables 1 around here]

An increasing amount of empirical evidence is in fact confirming that technology does play a role in services. Nowadays service industries perform in most countries up to one third of total business R&D (BERD) and account for more than 50% of the total R&D embodied in the intermediate inputs and capital equipment, with financial and communications services being the major technology adopters within services (OECD, 2000a). In particular, ICT-related investments are heavily concentrated within the service sector: in countries such as USA and UK, for which data are available, services account for 80% of total investment in ICTs.

Technological change is likely to play an important role also with respect to the overall dynamics of employment in services. In particular the emergence and widespread diffusion of ICTs has an impact on employment through three main mechanisms, that is by:

a) expanding final demand and/or shifting its composition from tangible goods to intangible, information and knowledge intensive services;

b) changing the composition of intermediate demand both in services and manufacturing towards information and knowledge based inputs and processes;

c) increasing labour productivity in some of the service activities traditionally affected by the so-called cost-disease or productivity-bias (Baumol, 1967).

The overall impact of technological change on employment in services is however very difficult to be empirically assessed because of the joint presence of positive and negative direct effects and the existence of a complex set of compensating mechanisms, operating both within the service sector, between the service and the manufacturing sectors, and increasingly at an international scale. In particular, mechanisms a) and b) above are likely to have a positive impact on employment, provided that they do not phase out pre-existing services, goods and intermediate inputs. On the other side, mechanism c) is likely to have a negative impact, although there might be positive compensating mechanisms on employment via the

[1] Petit and Soete point out that ICTs radically transform the basic context in which services are perceived and delivered, changing the tradability of services and expanding the potentiality for the creation of entire new markets. According to these authors, ICTs are able to launch a new cumulative mechanism of accumulation and growth somehow similar to the one experienced in the first two decades of post-war period (Petit and Soete, 2001).

reduction of prices, income increases and the consequent growth of demand brought by technological change in services[2].

The theoretical debate on the relative importance of positive and negative effects of technological change on employment has a long tradition in economics (see Freeman and Soete, 1987, Petit, 1995, Vivarelli, 1995 and Spiezia and Vivarelli, 2002 for a review), although with an almost exclusive focus on the manufacturing sector. In the case of manufacturing activities, the difficulty of empirically addressing such a complex issue has pushed scholars to identifying a first set of "stylised facts". It has been shown that over the last two decades the most innovative firms and industries have experienced better employment performance than the traditional and least innovative ones (OECD, 1996). Also, most of the new jobs have been generated by small firms (Davis et al., 1996), although the role of innovation in the growth of small firms remains to be clarified as well as the "quality" of the new jobs generated. It has also been shown that the creation of new jobs is more likely to be linked to product-oriented innovation strategies. Process innovations are instead associated to strategies of rationalisation of production with the substitution of labour with technologies embodied in fixed capital (Vivarelli and Pianta, 2000; Pianta, 2001). Further, there is ample evidence that technological change has not been "neutral" vis à vis the different components of the work force (OECD, 1996). The introduction of new technologies, and especially the diffusion of ICTs, tends in fact to privilege the use of a more qualified labour and make obsolescent previous professions and skills (see OECD, 1996 for a review of the empirical literature).

As far as the service sector is concerned, we are still a long way from having a satisfactory picture of the extent, role and nature of innovative activities[3]. In the last two decades most of the theoretical and empirical literature on technology and innovation has in fact focused on the manufacturing sector, which has traditionally been seen as the major producer and user of technology. As far as the relationship between technological change and employment is concerned, the lack of data and systematic analyses referring to the service sector is even more severe. This point is clearly stressed in the OECD volume "Technology, Productivity and Job Creation" which states that "At the firm level, examining the dynamics of technology and employment *(in the service sector)* is complicated by the lack of studies based on micro-level data... At the sectoral level, the lack of appropriately detailed data hampers cross-sectoral

[2] As already mentioned, the issue is made even more complex by the increasingly close integration between services and manufacturing. Most service industries heavily rely upon (largely process) technologies generated within the manufacturing sector and more and more manufacturing firms are becoming dependent on a wide range of high value added and knowledge intensive services (service innovations).

[3] Among the works which have attempted to establish some theoretical foundations of innovation in services can be mentioned Barras, 1986 and Gallouj and Weinstein, 1997. See also Hauknes, 1996, for a review of the most relevant literature.

empirical work and makes case studies of specific sectors more attractive" (OECD, 1996, p. 73).

In absence of robust statistical evidence, the literature has been taken over by optimistic scenarios on the employment perspectives linked to the emergence of the new technological paradigm. Most of the contributions have tended to emphasise the positive employment effects of ICTs, both at the firm level and in the service sector as a whole (OECD, 2000b). The traditional view, which portrayed services as "sheltered" sectors, characterised by low productivity and poor technological performance, has been superseded by one emphasising the high technological performance of sectors such as ICT-related services, telecommunications, or high value added business services (the so called KIBS - Knowledge Intensive Based Services). However, as already mentioned above, the fact that ICTs might also be used to cut-down costs, rationalise production and delivery processes, save jobs and skills has often been overlooked. In other words, only the positive effects associated to the mechanisms a) and b) mentioned above have been taken into account. The debate on the skill-bias nature of technological change shows a similar bias. There is in fact much more emphasis on the jobs' opportunities offered by the ICTs than on the jobs and skills made redundant by the adoption of new technologies.

The purpose of this article is to establish a more balanced and empirically grounded picture of the variegated nature of innovation activities in the service sector and their impact on employment. The empirical evidence is based on data provided by the innovation survey carried out in Italy by the National Statistical Office (ISTAT) in collaboration with the Institute for Studies on Scientific Research and Documentation of the National Research Council. This survey represents one of the first large-scale statistical attempt to collect systematic information on innovation activities in the service sector on the basis of the guidelines indicated in the revised version of the OECD "Oslo Manual" (OECD-EUROSTAT, 1997)[4]. The Istat survey has provided, for a sample of more then 6,000 service firms drawn from an universe of 19,300 market service companies with more than 20 employees, a wide range of quantitative and qualitative firm level data on innovation activities introduced in the period 1993-95. Unlike the other countries involved in the Community Innovation Survey (CIS), Italian firms have also been asked about the impact that innovation has had on total employment of the firms, and on the personnel with different levels of qualification (high, medium and low skilled employees). This unique data-set allows therefore us to explore in depth and on the basis of representative sample the complex relationship between innovation and employment in services.

[4] The methodology of Italian innovation survey in services is described in Evangelista, 2000.

This article is structured as follows: next section provides an overview of the heterogeneous and sector specific nature of innovation within services. Section 3 contains an empirical assessment of the employment impact of innovation associated to different types of firms' strategies, while section 4 explores the diversified impact of innovation on employment across main service industries, firm size classes and in the service sector as a whole. The final section summarises the main results presented in the paper and briefly discusses the extent to which these results can be generalised beyond the Italian case.

2. Sectoral patterns of innovation in services

An overall picture of the diffusion of innovation in services and in the manufacturing sector across European countries has been recently provided by the results of the second European Community Innovation Survey (CIS2) (EUROSTAT, 2001). Table 2 shows the percentages of firms which have introduced at least a product (service) and/or a process innovation in the period 1995-97 in the different European countries in the two main branches of the economy[5]. These figures can be used as a proxy of the average propensity of firms to innovate in the different countries and sectors. More than one third of the service firms in Europe (40.3%) have introduced a technological innovation in the period covered by the survey, while the corresponding figure for the manufacturing sector is more than 50%. Compared to manufacturing firms, service firms show a lower propensity to innovate in all countries, the exceptions being Luxembourg and Portugal. According to this indicator the most innovative countries in services are Ireland (58%), Austria (55%) and Luxembourg (48%), followed by Germany (46%) and UK (40%). Italy shows a share of innovating firms in services (31%) below the European average. The Italian figure reflects first and foremost the already mentioned specialisation of Italian economy in the most traditional service industries but might also reveal a less active attitude of Italian firms towards innovation.

[Table 2 around here]

Technological opportunities differ greatly within services and marked sectoral differences in the average propensity of firms to introduce innovations occur. In the case of Italy the percentage of innovating firms is around or over 60% in sectors such as R&D services, banking, insurance and other financial services; in more traditional and least innovative services such as retail trade, hotels and restaurants, cleaning and security the percentage of innovating firms ranges between one tenth and one fifth of the total. Service industries differ from each other even more in the amount of resources devoted to innovation and type and ways in which new knowledge is generated or adopted. The multiform nature of innovative

[5] Data for Italy refer to the period 1993-95.

activities and their sectoral specificity have been in fact underlined by a vast literature, although almost exclusively with reference to the manufacturing industry. Besides activities generating new technological knowledge such as R&D, an increasing attention has also been put on less formalised technological activities linked to design, as well as processes of technology adoption and diffusion (OECD, 1996; Evangelista, 1999). This wider perspective on the nature and locus of innovation activities is even more needed in services where formalized R&D, and "hard" technological activities are expected to play only a marginal role (Evangelista and Sirilli, 1995, Evangelista 2000). The OECD "Oslo Manual" adopts this more comprehensive perspective of innovation identifying for the service sector various innovative activities including R&D, design activities, the acquisition of know-how, the acquisition and development of new software, training, the purchasing of new equipment and machinery and marketing activities linked to innovation. The relative importance of these different innovation sources in services can be assessed using CIS data. Table 3, reporting a sectoral break-down of Italian CIS data on innovation expenditures, confirms the presence of a rich variety of innovative patterns in services. R&D represent an important source of innovation only in the case of very few service industries, namely those specialized in the provision of R&D and engineering services. Industries which devote substantial shares of their innovation expenditure to software are advertising, all the financial services as well as trade and repair of motor vehicles. Industries innovating mainly through the acquisition of new machinery and equipment include capital intensive services such as transport and waste and disposal, although investments represent by far the largest chunk of innovation expenditure across most industries. An indicator of innovation intensity, i.e. the total innovation expenditure per employee, is also included in Table 3. These data provide additional support to the presence of very different levels of technological opportunities within services and lead to discourage any easy generalization on the supposed innovative backwardness of services.

[Table 3 around here]

Along with data on innovation expenditures, CIS data provide a wide range of qualitative information on firms' innovation behaviours, such as the type of innovation introduced (service/process), the objectives pursued by firms and the main channels through which firms acquire the relevant technological knowledge. These data allow to provide a detailed picture of the variegated nature of innovation activities in services. Using a large set of indicators drawn by CIS the authors of this article have in fact identified in a previous contribution a few distinct sectoral patterns of innovation which can be synthesised as follows (see Evangelista and Savona, 1998; Evangelista, 2000)[6]:

[6] For a detailed description of the methodology and data used to build the sectoral taxonomy recalled in this article, see Evangelista, 2000.

Technology users

This cluster includes the most traditional branches of services (retail trade, security, cleaning, hotel & restaurants, repair and trade of motorvehicles) all transport activities (air, land and sea transport, travel and transport agencies) as well as waste and disposal. The common features of this group of sectors are the low resources devoted to innovation and their being "technological dependent" from external (mainly manufacturing) suppliers. Therefore technological interactions between firms located in these sectors and the external environment reflect traditional user-producer links confined to the acquisition of capital equipment from manufacturing suppliers. Waste, land, sea and air transports are the most innovative and capital intensive sector in this cluster, while retail, security, cleaning and hotels and restaurants are the least innovative ones.

S&T-based

This group includes R&D, engineering, technical consultancy services along with computing and software. These are the most innovative industries in services, the largest part of their innovative efforts aiming at the generation and development of new technological knowledge. The largest share of innovation costs is devoted to R&D and design activities (90% in the case of the R&D services and 60% in the case of engineering). The innovative pattern of these sectors is also characterised by the close interactions between firms and universities and research institutes. It might be argued that these industries are located very up-stream in the knowledge-generating chain. Computing and software and technical consultancy are characterised by close interactions with both final customers and consultancy firms as well as with private research institutes. What these sectors do is providing appropriate answers to a variety of technical needs and requirements of clients, exploiting the available technologies.

ICT users

These sectors are heavy users of software, hardware and information networks. The most representative sectors in this group are all the financial services (banks, insurance and other financial), wholesale trade and advertising. Frequent exchanges of information and know how with final users is also a characterising feature of the innovative profile of these industries. Accordingly, innovative activities in these sectors do not rely upon R&D and design, nor on the acquisition of technologies embodied in traditional machinery and equipment. The largest share of innovation expenditures is devoted to the development and acquisition of software. Firms also attach great importance to technical information drawn from consultancy firms and

competitors. Advertising is by far the most innovative sector among this cluster of service industries, although banks and insurance services are major users of ICTs[7].

3. The impact of innovation on employment: firm level evidence

The relationship between innovation and employment has not been usually investigated by the innovation surveys which have adopted the OECD Oslo Manual approach. The revised version of such a manual does not provide in fact any specific guideline on how to tackle this complex issue (OECD-EUROSTAT, 1997). Yet, in the questionnaire used for the Italian innovation survey a specific question on the impact of technological change on employment was included. Service firms have been asked whether the introduction of innovation has led to: i) an increase, ii) a decrease iii) or had no effects on the use of labour. Firms have also been asked to distinguish between the impact of innovation on total employment and on high, medium and low skilled personnel. These data capture the direct impact of firms' innovation activities on the employment through three main mechanisms:

a) the creation of new services (service innovations);

b) the quality enhancement of pre-existing services (incremental service innovations);

c) the introduction of new processes and delivery systems (process innovations).

In the case of a) and b) a positive impact of innovation activities on employment at the firm level is expected, in all cases in which the new services do not phase-out pre-existing services. In the case of the introduction of process innovation (c), the impact of innovation on employment depends on whether the technologies introduced have a labour-saving effect or, vice versa, are introduced to improve the quality of the delivery processes. In this latter case the introduction of process and product innovations are complements and their effects difficult to be disentangled. It is expected that individual enterprises have provided an answer which corresponds to the "net outcome" of these different effects of innovation.

The net outcome of innovation on employment, at the firm level, could in turn be the result of a variety of interdependent factors, such as the specific innovation strategy followed by firms, their organisational structure (firm size), the technological opportunities and the demand conditions which characterize the different service industries.

[7] Post and telecommunications are located at the crossroad of the three main patterns described above. Firms in this sectors perform both R&D and design activities, they innovate also through investments in capital equipment and draw technological information from different actors (universities, research institutes, consultancy firms and competitors).

We have tried to disentangle the relevance of all these factors by estimating a binary logit model, using a selection of variables contained in the data set at our disposal. The information on the impact of innovation on employment have been transformed in a dycotomic variable which takes value "1" in case of a positive impact and "0" in the case of a negative or a nil impact. As explanatory variables we have included the type of innovation introduced by firms (product or process), the resources devoted to innovation (total innovation expenditures per employee) and the type of innovative activities performed (percentage of different innovation inputs out of the total innovation expenditures). We have also included among the regressors the number of employees (used as a proxy of firm size) and a series of sectoral dummies capturing the presence of fixed sectoral effects. Three different binary logit models have been carried out to assess the impact of innovation respectively on total employment and on high and low skilled personnel.[8] The results of the logit estimates are reported in Table 4.

[Table 4 around here]

All three regressions show a rather good capacity to explain the phenomenon investigated. The probability of having a positive impact of innovation on employment is predicted by the regressions in 78% of cases in the case of equation 1 and 72% and 94% of cases respectively in the case of equations 2 and 3.

Most innovative firms (that is, those spending more on innovation per employee), and those introducing service innovation are more likely to have indicated a positive impact of innovation on total employment. Such a positive impact is however limited to the case of high skilled personnel. The same variables loose their statistical significance in equation 3.

The probability of finding a positive impact of innovation on total employment (equation 1) is also found in the case of innovative strategies aiming at generating or acquiring new knowledge (R&D, design and acquisition of know-how) and pushing the new services into the market (marketing). The only innovative variable showing a negative sign (though statistically not significant) is the one related to the relevance of software expenditure in total innovation costs. In equation 2 all the innovative variables show positive and statistically significant coefficients, including the share of innovation costs devoted to the acquisition and internal development of software and training. The percentage of total innovation costs devoted to the acquisition of new equipment has not been included among the explanatory variables, the latter variable being a complement to 100% of the other cost items included in the equation.

[8] The analysis has been carried out using a sub sample of 943 innovative firms. Among the 1244 innovative firms 301 had to be excluded either because of missing values or because belonging to sectors containing a too low number of firms.

Given the positive sign of the cost items included in the regression, the share of total innovation costs linked to investment (if included as a regressor) would have shown a negative sign.

All the explanatory innovative variables taken into account in our analysis do not show any explicative power in equation 3, that is in relation to the impact on low skilled personnel. This might suggest that the negative impact of innovation on low skilled employment is rather generalised and largely independent from the specific strategies pursued by firms.

The probability of finding a positive impact of innovation on employment decreases monotonically with firm size and this relationship is found statistically significant with respect to both high skilled and low skilled employment. This result suggest that innovation activities in large firms are associated to organisational changes and rationalisation processes which lead to job losses also among the most qualified personnel.

Fixed sectoral effects are also important in explaining the different impact of innovation strategies on employment. It is likely that the sectoral dummies included in the equation capture on the one hand the sector specific nature of technological regimes in services (those not captured by the innovative variables included in the equations) and, on the other, the presence of marked differences in demand conditions across service industries. As far as sector specific technological regimes in service are concerned, it should be stressed that the type of variable at our disposal does not allow us to capture the diversified effect of ICTs on employment. ICTs are likely to have a positive impact on employment in all cases in which such technologies are used to introduce new or improved services while they are likely to have a negative impact when they are used to reduce the labour content of highly repetitive or labour intensive activities. We try to disentangle these diversified effects of ICTs on employment across industries in the next section.

4. The impact of innovation on employment: sectoral evidence

The firm level evidence presented above, though interesting in many respects, is not able to provide any hint or rough estimate of the net impact of innovation on employment at a more aggregate level, that is at the industry level and for the service sector as a whole. In fact, the overall impact of firms' innovation activities on employment does not depend only on the individual innovative behaviours of firms. Rather, it is the outcome of the competitive game taking place among firms in each industry and even across different industries. The existence of a positive relationship between innovation and employment at the firm level could in fact be compatible with an overall loss of jobs at a more aggregate level. This is likely to occur in

the cases of weak aggregate demand, which makes the competition between firms particularly harsh. In such cases the introduction of new services and especially new processes by the most innovative firms might displace production capacity and jobs in other (less innovative) firms (Pianta, 2001). All this justifies a more in depth exploration of the different effects of technological change on employment at the industry level. Accordingly, firm level responses on the impact of innovation on employment have been aggregated at the sectoral level and then used to build "weighted normalised indexes". Such indexes are computed as the difference between the number of firms indicating that innovation had a positive effect on employment and the number of those which have indicated a negative effect, all divided by the total number of innovating firms. All individual data have been weighted by firm size (number of employees) so to get in due account the different relevance of large firms across industries. The index proposed here can thus be read as a synthetic indicator of the extent of job creating (in case of a positive sign) or labour-saving (in case of a negative sign) effects of innovation activities on total employment and on personnel with different levels of qualification.

[Table 5 around here]

Table 5 shows for the main service sectors the "weighted normalised indexes" of the effects of innovation respectively on total employment and on high and low qualified jobs. The last column synthesises the overall skill-bias effect, as measured by the difference between column 2 and 3. Service industries have been grouped according to the sectoral taxonomy presented in section 2 and ranked, within each group, according to the impact of innovation on total employment.

In more than a half of service sectors listed in table 5 the innovations introduced have had a negative impact on employment, though the labour displacing effects have been particularly severe among less qualified jobs. The table shows the presence of very diverse patterns. Differences across service industries can be analysed looking at:

i) the sign and strength of the impact of innovation on total employment, which can be distinguished respectively in: strong-positive, moderate-positive and negative (see column 1 of Table 5);

ii) the extent to which innovation activities have a skill-biased effect, that is the extent to which new jobs displace low skilled jobs (see column 4 of the table 5). In this case we have labelled the different sectoral cluster between those where technological change has a strong or a moderate skill-biased impact on labour.

The results reported in Table 5 can be synthesized as follows.

S&T-based sectors:
(positive impact/strong skill-bias)

In the *S&T-based* industries, namely R&D, technical consultancy, computing and software, the introduction of both new services and new processes has had a positive impact on employment, the only exception being represented by engineering services where a negative impact seems to prevail. The negative index found in the case of the latter sector suggests that, compared to the other S&T based services, engineering services might have benefited to a lesser extent by the "demand-pull effect" associated to the emergence of the ICT paradigm. The demand for these services has in fact grown to a much less extent than the demand for the other S&T related services. All the S&T based services are characterised by the presence of a clear process of substitution of high skilled labour with low skilled labour. The skill-biased nature of technological change is particularly strong among firms providing R&D services.

ICT Users:
(negative impact/strong skill bias)

In these sectors the technological opportunities offered by the use of ICTs has been more substantial, compared with the rest of the economy. Our data seem to suggest that, at least in the case of Italy, the use of such technologies has had a negative impact on employment. Particularly in banks, insurance advertising and post and telecommunications the labour saving effects linked to the introduction of ICTs have been more severe. In all these industries the creation of high skilled jobs linked to the introduction of new services has not been strong enough to offset the destruction of low qualified jobs linked to the introduction of labour saving technologies. These data suggest that the employment dynamics experienced by these industries in the last two decades has little to do with the opportunities offered by technological change, while it is more likely to be linked to the long term growth of the final and intermediate demand for this kind of services.

Technology users:
(moderate negative impact/moderate skill-bias)

The overall impact of innovation activities in these sectors is negative, though with rather mixed patterns. The strongest labour displacing effects of technological change are found in all transport industries including travel services. These industries are heavy users of technologies embodied in new means of transport and ICT-based equipment. In both cases the use of such technologies has been associated to processes of reorganisation of production and

distributive structures which have led to large labour redundancies. On the contrary, less innovative industries such as security and cleaning, wholesale, and hotel and restaurants, have not experienced the same extent of technological and organisational changes. This is in turn due to the fact that in these labour intensive sectors the opportunities offered by ICTs to increase the overall efficiency of production and delivery activities are not particularly high. Most of these sectors are in fact those traditionally affected by the so-called "cost disease". This suggests that the dynamic of employment in these sectors is primarily linked to the growth of demand, while the role played by technological change is much less important. *Technology user* services are also characterised by the presence of a moderate *skill bias* are also concentrated. On average, firms in these industries have in fact only marginally reduced low qualified jobs or in some cases even increased employment with a low qualification. This is the case of security, hotels, trade and repair of motor vehicles and other business services.

5. The impact of innovation on employment in services: an aggregate picture

What is the aggregate employment outcome of the various innovation firm's strategies and sector specific patterns of innovation analysed in the previous sections? Following the methodology used in the previous section we can provide an answer to this question by summing-up and weighting by size all firms' responses on the employment impact of their innovation activities. Accordingly, normalized weighted indexes for the Italian service sector as a whole and for the main firm size classes have been computed. Table 6 shows the values of such indexes which once again refer to total employment and to personnel with different levels of qualification.

[Table 6 around here]

Looking at the Italian service sector as a whole, innovation activities seem to have had a negative impact on total employment, although such a negative impact is concentrated among the least qualified personnel. These figures are the joint result of the different patterns of innovation analysed in the previous sections and the specific service sector's specialisation of Italian economy. Unlike other countries, in Italy 3/4 of total employment in services are concentrated in the most traditional and least innovative branches, that is the groups of sectors defined in our taxonomy as *Technology users* and *ICT users* sectors. In particular, the *Technology user* category alone accounts for more than 80% of total firms in services and more than 60% of employment. The S&T based service sectors, where we found a positive impact of innovation on employment, account for less then 5% of total employment in the Italian service sector. Therefore, it is not a surprise that the presence of a positive impact of technological change on employment in the most innovative service industries has not been

able to offset the labour-saving nature of technological change which instead has dominated most of the other sectors.

Table 6 also reveals the presence of a strong "size factor" in the relationship between innovation and employment, a result which had already emerged by our logit estimates in section 3. In particular, in large firms innovative activities have shown a strong labour-saving effect (which is particularly marked on the least qualified personnel) whereas innovative activities in small firms have had a positive impact on employment. Also, the results emerged looking at the size factor are consistent with the sectoral evidence presented in the previous section. Large firms are in fact concentrated in industries such as banking, transports, wholesale trade, post and telecommunication, that is in sectors where scale economies are relevant and in markets which have recently being liberalized and increasingly opened to international competition. Both factors have pushed large firms to use ICTs not only to provide new services but also to cut-down labour costs and to rationalize their production and distributive structures.

6. Concluding remarks

This paper has provided original empirical evidence on the multi-faced nature of innovation in services and its impact on employment and skills. Our analysis has in fact highlighted the presence of a large variety of innovative patterns, which tends to discourage any simple generalisation about innovation in services. Service industries differ in terms of the amount of resources put by firms into the innovation process, the nature of the activities carried out, the different knowledge bases underlying the innovation processes and the different interactive patterns through which service firms innovate. The acknowledgement of such diversified patterns of innovation is an important starting point also for the analysis of the impact of innovation on employment.

At the micro level, the impact of innovation on employment is affected by the specific strategy followed by firms. The logit estimates presented in section 3 have shown that a positive impact is more likely to be found in the case of firms' innovative strategies focussed on the introduction of new services, the internal generation of knowledge (R&D and design), the external absorption of relevant competencies (acquisition of know-how) and marketing. On the contrary, the skill-biased nature of innovation activities emerges as a much more generalized outcome of firms strategies.

Firms' behaviours are important for determining the employment outcome of innovation but even more important are the specific industries, markets and technological regimes in which

firms operate. The sectoral evidence presented in section 4 has shown that the employment opportunities offered by ICTs are very diverse across service industries. Again, what is common to all service industries is a general tendency to substitute unskilled labour with employment with higher level of qualification. The net employment outcome is however very diverse across sectors. A positive impact has been found in the most innovative and knowledge-intensive sectors, while a negative one was found in the case of all financial-related sectors, in the typical capital intensive service industries (transport-related services) and in some of the most traditional branches of services (trade, waste and disposal).

The most worrying and somehow unexpected finding of this paper is that at an aggregate level, that is taking the service sector as a whole, innovation activities in the period covered by the survey (1993-95) seem to have had a negative impact on employment. We have argued that such a result partly reflects the peculiarities of the Italian service sector both in terms of its sectoral composition and in the attitude of firms toward innovation. More in particular, it is likely that the strong specialisation of the Italian service sector in the most traditional branches has affected the pessimistic picture emerging from our empirical evidence. Further work is needed to clear such doubts and some answers will be provided once the data by the Community Innovation Surveys will be available and comparable across countries.

While the aggregate results presented in this article reflect a national specificity, the sectoral picture presented in section 4 should hold beyond the Italian case. Compared to much of the current literature emphasising the positive impact of ICTs on employment, the evidence provided in this paper draw a more variegated picture, emphasising the diversified impact of ICTs across industries and firm size classes. A crucial distinction which emerge from our empirical evidence and deserve to be stressed is the one between sectors producing, adopting and disseminating new ICTs services (and more broadly, knowledge based inputs) and sectors in which such technologies are used as process innovations to cut-down costs and rationalise the production and distributive structures. While in the first group of sectors (*S&T based*) innovation activities are associated to the introduction of new services and the emergence of new markets, in the second group of sectors (*Technology and ICTs users*) the labour saving nature of ICTs usually prevails. Such evidence seems strong enough to downplay over-optimistic scenarios which foresee in the widespread use of ICTs a major panacea against unemployment both in services and in the economy as a whole. As it is well known among scholars of technological change, product and process innovation as well as producers and user of technology are, to a large extent, two sides of the same coin and can not exist independently from each other (Simonetti et al, 1995). This point applies also to a pervasive technological cluster such as ICTs and has important implications for the assessment of the long term employment perspectives associated to the new technological paradigm.

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Table 1 - Employment growth in manufacturing and service industries in the G7
(Compound annual growth rates for the period 1985-1996)

Country	Total Economy	Total Manufact.	Total Services	Trade H&R	Transport & Commun.	Finance & Business	Social & Personal
Italy	0.2	-1.1	0.7	1.0	0.7	1.4	3.9
USA	1.6	-0.2	2.1	1.5	1.9	3.2	3.7
Canada	1.5	-0.2	1.9	1.4	1.2	3.5	2.7
Japan	1.3	0.2	1.8	0.1	1.1	1.5	3.1
France	0.6	-1.6	1.5	0.4	0.5	2.6	2.6
Germany	0.6	-1.1	1.6	2.0	0.7	2.1	4.4
UK	0.7	-0.6	1.7	0.5	0.6	5.0	4.7

Source: Oecd: Science, Technology and Industry Outlook 1998

Table 2 - Percentage of innovating Firms in service and manufacturing sectors in Europe
(1996-1998)

Country	**Service Sector** (%)	**Manufacturing Sector** (%)
Belgium	13.2	34.3
Germany	45.8	68.7
Spain	n.a	29.0
France	30.6	42.8
Italy*	31.3	48.3
Ireland	57.8	73.4
Louxembourg	48.5	41.8
Netherlands	36.0	62.1
Portugal	28.0	25.3
Austria	54.9	67.3
Finland	23.8	36.4
Sweden	32.0	54.2
UK	39.9	59.0
Norway	21.9	48.0
Europe	**40.3**	**51.4**

Source: EUROSTAT, Community Innovation Survey 199
* Italian data for services refer to the period 1993-1995

Table 3 - Breakdown of innovation costs and innovative intensity by industry in services (Italy, 1995)

Service sectors	Distribution of innovation costs (% values)					Innovation costs per employee (Euro, 1995)
	R&D	Design and Know-how	Software	Training and Marketing	Investment	
R&D	83.9	7.4	1.0	1.2	6.5	49632
Engineering	70.6	8.5	5.8	2.8	12.3	10003
Technical consultancy	53.8	2.0	6.1	11.6	26.5	7398
Computing and software	18.3	42.0	12.8	6.2	20.6	5201
Other financial services	0.6	11.0	39.2	2.5	46.7	4740
Advertising	5.4	10.1	62.5	8.7	13.3	3577
Wholesale trade	4.5	5.7	18.4	5.6	65.8	3026
Insurance	9.1	24.9	29.0	6.4	30.7	2630
Waste disposal	0.0	5.8	1.5	3.6	89.0	2576
Legal and accounting	10.1	27.2	18.6	15.7	28.3	2340
Land transportation	1.5	1.6	2.1	1.0	93.8	2244
Other business services	0.0	9.3	15.7	2.0	73.0	1823
Post and telecommunication	25.4	2.0	5.4	4.2	63.0	1808
Banking	3.3	19.2	36.5	7.4	33.6	1658
Trade and repair of motorv.	2.1	11.4	39.1	6.6	40.9	1571
Air transport	1.8	29.9	27.1	3.6	37.6	1415
Travel and transport services	4.3	11.0	19.6	3.9	61.2	1211
Shipping and sea transp.	0.8	4.0	5.0	1.1	89.2	1111
Hotel and restaurants	2.1	6.3	25.3	14.7	51.6	575
Retail trade	1.0	9.1	22.0	6.8	61.1	494
Cleaning	3.5	4.3	21.2	10.6	60.4	328
Security	0.3	1.2	19.9	4.8	73.8	241
Total	23.7	11.6	14.1	4.5	46.0	2315

Source: Italian Innovation Survey of Service Firms

Table 4 - The employment impact of innovation in services - Logit estimates (Italy, 1993-95)

Dependent variables	***Model 1*** *Positive impact on total employment*			***Model 2*** *Positive impact on high skilled employment*			***Model 3*** *Positive impact on low skilled employment*		
Number of observations	943			943			943		
-2Log L	913.1			1047.5			414.2		
Overall	78.15%			72.11%			93.64%		
	Coefficients	**S.E.**	**Sig.**	**Coefficients**	**S.E.**	**Sig.**	**Coefficients**	**S.E.**	**Sig.**
Intercept	-2.08	(0.58)	**	-2.28	(0.43)	**	-2.17	(-0.7)	**
Firm size	-0.46	(0.09)	**	0.18	(0.08)	**	-0.54	(0.17)	**
Introduction of service innovation	0.39	(0.17)	**	0.44	(0.16)	**	0.12	(0.28)	
Introduction of process innovation	-0.06	(0.17)		0.09	(0.16)		0.11		
Total innovation expend. per employe	0.008	(0.00)	**	0.02	(0.00)	**	0.003	(0.00)	
% of R&D, design and know-how exp	0.71	(0.34)	**	0.56	(0.31)	*	0.74	(0.56)	
% of software expenditures	-0.10	(0.28)		0.47	(0.26)	*	-0.22	(0.46)	
% of training expenditures	0.84	(0.57)		0.99	(0.52)	**	0.78	(0.89)	
% of marketing expenditures	2.24	(0.67)	**	1.65	(0.64)	**	2.06	(0.88)	**
Trade and repair of motorvehicles	1.46	(0.65)	**	-0.25	(0.57)		0.80	(0.77)	
Wholesale trade	1.44	(0.57)	**	0.28	(0.42)		0.10	(0.68)	
Retail trade	1.40	(0.64)	**	-0.08	(0.51)		0.13	(0.87)	
Hotel and restaurants	reference			reference			reference		
Transport services	1.40	(0.59)	**	0.06	(0.43)		-0.34	(0.75)	
Post and telecommunication	2.25	(1.11)	**	1.13	(1.01)		-6.07	(43.78)	
Financial services	0.58	(0.60)		0.12	(0.43)		-0.08	(0.73)	
Computing and software	1.63	(0.62)	**	0.82	(0.47)	*	0.12	(0.79)	
R&D	0.38	(0.86)		-1.13	(0.83)		-0.73	(1.33)	
Legal and accounting	1.17	(0.80)		0.60	(0.62)		0.66	(0.99)	
Engineering	1.21	(0.74)	*	0.65	(0.60)		-6.54	(19.69)	
Technical consultancy	2.05	(0.10)	**	-0.06	(0.99)		-6.66	(36.56)	
Advertising	0.05	(1.20)		-1.19	(1.15)		-6.68	(32.85)	
Security	1.23	(0.85)		-1.77	(1.10)		0.44	(1.22)	
Cleaning	1.90	(0.72)	**	0.52	(0.58)		1.51	(0.85)	*
Other business services	1.70	(0.74)	**	1.05	(0.60)	*	1.06	(0.89)	
Waste and disposal	2.50	(0.83)	**	0.37	(0.74)		1.45	(1.04)	

Standard errors are reported in brackets

** = significant at 95% level

* = significant at 90% level

Table 5 - The employment impact of innovation in services by sector (Italy, 19

Sectors	Weighted normalised differences*			
	Total employm.	High skilled employm.	Low skilled employm.	Skill-Bias effect
	1	2	3	(2-3)
S&T Based	**0.08**	**0.52**	**-0.38**	**0.90**
Technical consultancy	0.17	0.41	-0.25	0.66
Computing and software	0.15	0.49	-0.26	0.75
R&D	0.08	0.55	-0.43	0.98
Engineering	-0.15	0.65	-0.52	1.18
ICT Users	**-0.36**	**0.35**	**-0.53**	**0.88**
Advertising	-0.14	0.13	-0.33	0.46
Other financial services	-0.19	0.47	-0.08	0.55
Banks	-0.33	0.29	-0.64	0.93
Post and telecommunication	-0.40	0.41	-0.40	0.81
Insurance	-0.45	0.39	-0.60	1.00
Technology Users	**-0.22**	**0.44**	**-0.44**	**0.87**
Trade and repair of motorv.	0.29	0.19	0.03	0.16
Other business services	0.13	0.42	0.01	0.41
Wholesale trade	0.11	0.33	-0.12	0.44
Cleaning	0.06	0.40	-0.34	0.74
Security	0.05	0.21	0.07	0.15
Hotel and restaurants	0.02	0.11	0.02	0.09
Retail trade	-0.01	0.40	-0.42	0.82
Legal services	-0.02	0.40	-0.26	0.66
Waste and disposal	-0.07	0.28	-0.51	0.80
Sea transport	-0.14	0.26	-0.24	0.50
Travel and transport service	-0.33	0.21	-0.48	0.69
Land transport	-0.61	0.77	-0.77	1.53
Air transport	-0.91	0.94	-0.91	1.85

* Number of firms with a positive impact minus the number of firms with a negative impact/ total nu
of innovative firms (all individual data have been weighted by the number of employees)

Table 5 - The employment impact of innovation in services by sector (Italy, 19

Sectors	Weighted normalised differences*			
	Total employm.	High skilled employm.	Low skilled employm.	Skill-Bias effect
	1	2	3	(2-3)
S&T Based	**0.08**	**0.52**	**-0.38**	**0.90**
Technical consultancy	0.17	0.41	-0.25	0.66
Computing and software	0.15	0.49	-0.26	0.75
R&D	0.08	0.55	-0.43	0.98
Engineering	-0.15	0.65	-0.52	1.18
ICT Users	**-0.36**	**0.35**	**-0.53**	**0.88**
Advertising	-0.14	0.13	-0.33	0.46
Other financial services	-0.19	0.47	-0.08	0.55
Banks	-0.33	0.29	-0.64	0.93
Post and telecommunication	-0.40	0.41	-0.40	0.81
Insurance	-0.45	0.39	-0.60	1.00
Technology Users	**-0.22**	**0.44**	**-0.44**	**0.87**
Trade and repair of motorv.	0.29	0.19	0.03	0.16
Other business services	0.13	0.42	0.01	0.41
Wholesale trade	0.11	0.33	-0.12	0.44
Cleaning	0.06	0.40	-0.34	0.74
Security	0.05	0.21	0.07	0.15
Hotel and restaurants	0.02	0.11	0.02	0.09
Retail trade	-0.01	0.40	-0.42	0.82
Legal services	-0.02	0.40	-0.26	0.66
Waste and disposal	-0.07	0.28	-0.51	0.80
Sea transport	-0.14	0.26	-0.24	0.50
Travel and transport service	-0.33	0.21	-0.48	0.69
Land transport	-0.61	0.77	-0.77	1.53
Air transport	-0.91	0.94	-0.91	1.85

* Number of firms with a positive impact minus the number of firms with a negative impact/ total nu
of innovative firms (all individual data have been weighted by the number of employees)

Table 6 - The employment impact of innovation in services by firm size (Italy, 1993-95)

	Weighted normalised differences*			
Size classes (No. of employees)	Total employm.	High skilled employm.	Low skilled employm.	Skill-Bias effect
	1	2	3	(2-3)
20 - 49	0.23	0.27	-0.02	0.29
50 - 199	0.16	0.29	-0.09	0.39
200 - 999	-0.10	0.29	-0.28	0.57
1000 and over	-0.44	0.47	-0.63	1.10
Totale	**-0.27**	**0.41**	**-0.48**	**0.89**

* Number of Firms with a positive impact minus the number of firms with a negative impact / total number of innovative firms (all individual data have been weighted by the number of