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The contribution of Business services to the export performances of manufacturing industries. An empirical study on 5 European countries

by

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Abstract

This paper investigates the contribution provided by the Business service sector (BS) to the international competitiveness of manufacturing industries that acquire and use intangible intermediate inputs (in particular those provided by two main BS sub-sectors: "Communication and computer related services" and "Other business activities"). The main valued added of this paper consists of having assessed the role played by BS on the export performances of manufacturing sectors integrating – for a selected number of EU countries - different industry level data sources, namely the OECD Input-Output Tables, the OECD Structural Analysis Database and data provided by the Community Innovation Survey. The results of the empirical analysis show that BS do exert a positive impact on the international competitiveness of manufacturing industries even though these effects vary according to the type of intermediate intangible input acquired and type of user sector.

Keywords: business services, international competitiveness, industry level data

JEL codes: L80, O30

1. Introduction[*]

Advanced economies are experiencing a process of transformation by which services account for an increasing share of value added, employment and international trade. Within the broad category of services, business services (BS) play a special role, since their growth has gone hand in hand with a process of reorganisation of the ways in which goods and services are produced, delivered and traded both within and across countries. The growth of BS has been favoured by the development and diffusion of Information and Communication Technologies (ICT) that have affected the linkages between manufacturing and service industries, on the one hand by increasing the service content of many manufacturing activities and, on the other, by facilitating the "splintering" away of activities previously performed inside manufacturing firms. This process of structural change, involving new interaction mechanisms between business services and other manufacturing and service industries, affects both the performance of the BS sector itself and of the "user sectors".

As far as the effect of BS on the aggregate performance of economies Kox and Rubalcaba (2007a; 2007b) distinguish between a direct effect, stemming from the BS's own rapid growth, and an indirect one connected to the positive effects that BS have on the rest of the economy via the diffusion of specialized and knowledge intensive inputs. Among the two mechanisms the latter is by far the most powerful one, and this especially taking into account the still relatively limited size of BS when compared to the size of both the other branches of services and the manufacturing business sector as a whole. The existence of an indirect macro-economic effect of BS is in turn based on two basic assumptions and namely: a) that BS represent a very dynamic and innovative component of modern economies; b) that both the innovation and economic performances of firms and industries depend on the quantity and quality of the intangible inputs produced and delivered by the BS sector. While point a) above has been explored by a large amount of evidence, empirical research on point b) is still scarce and this because of the difficulty of measuring the qualitative content of BS output and the numerous channels and mechanisms through which BS affect the performances of client industries.

This paper aims at starting to fill this gap by assessing the contribution provided by the Business service sector (BS) to the international competitiveness of manufacturing industries

[*] This paper has benefitted from comments given by the participants to the research seminar "The impact of Business services on the innovation and economic performances of client industries" held at the Birkbeck College (University of London) on June 17, 2013 and by some useful suggestions provided by Helen Lawton Smith to a previous draft.

that acquire and use intangible intermediate inputs, in particular those provided by two main BS sub-sectors: "Communication and Computer related services" and "Other business activities". More specifically, the economic impact of BS is investigated by taking into account the composite nature of this heterogeneous sector, the size and content of services delivered to client indutries, the extent to which these external intangible inputs are able to support the export performance of manufacturing industries. Such an impact is empirically assessed at industry level, combining three data sources: the OECD Input-Output Tables; data drawn from the EUROSTAT Community Innovation Survey (CIS) and a set of economic performance indicators drawn from the OECD Structural Analysis (STAN) database. Due to data-constraints (and in particular to the merging of the three different data-sources), the empirical analysis is restricted to a selected number of EU countries (Germany, France, Italy, Spain and the United Kingdom). The paper is structured as follows: in the next section the specific contribution of this paper is located within the context of the exiting literature on BS and their economic impact. Section 3 contains a description of the dataset used in the empirical analysis along with some preliminary descriptive statistics on main differences across countries in the use of BS inputs. Section 4 presents the results of the econometric estimates of the impact of BS on the international competitiveness of manufacturing industries. The concluding section summarizes the main results of this contribution.

2. Literature review

Despite there is no consensus in the literature on the precise definition of business services, the latter can be broadly defined as "a set of service activities that - through their use as intermediary inputs - affect the quality and efficiency of the production activities, by complementing or substituting the in-house service functions" (Kox and Rubalcaba, 2007a, p. 4).

The beneficial economic effects of BS on client industries can be conceptualised and studied taking into account two basic mechanisms. The first one relies upon the classical Smithian law, and more in particular on the scale economies and productivity gains obtainable through increased levels of specialization in the production and delivering of service inputs. At least part of these beneficial effects are captured by "downstream sectors" in terms of an increasing availability of intangible production inputs offered at (relatively) low prices. On the basis of this type of argument SMEs (being the major users and producers of these

services) are likely to be the ones which benefit the most from the emergence of a specialized market for BS.

The second mechanism has to do with the dynamic efficiency gains brought about by the emergenge of a BS sector. In fact, the Smithian mechanism has not only a quantitative dimension. When framed into a dynamic context, the twin process of market expansion and increased specialization paves the way to qualitative changes in all segments of the new vertically integrated sectors accelerating the introduction of new technologies and organizational models. This intertwined process of quantitative and qualitative changes has characterized also the emergence and growth of the BS sector. On the one hand, BS "...provide products to client firms that are different (higher quality, more specialized) from the in-house services that the client firms produced in-house beforehand, or that are even completely new" (Kox and Rubalcaba, 2007b, p. 8). On the other hand, BS are likely to stimulate the innovation capacity of client firms, supporting the introduction of new process technologies as well as enhancing their capability to design, develop, introduce, and effectively locate into the market, new or improved products. There are also authors who have interpreted the emergenge and rapid growth of the BS sector as the sign of a more general paradigmatic change of the key actors responsible for the generation and diffusion of knowledge in modern economic systems. According to Antonelli "...the knowledge-intensive business service industry is replacing the manufacturing industry as the engine of the accumulation of competencies and knowledge in a knowledge-based economy" (Antonelli, 1998, p. 192) [1]

This capacity of affecting the dynamic efficiency of client industries is of course highly differenciated within the heterogeneous universe of the BS sector, depending (among other factors) on the innovation potential of each specific BS industry and (as a consequence) on the qualitative and innovative content of the specific services provided to clients (Shearmur and Doloreux, 2013). This in turn justifies the great emphasis put by the most recent literature on a particular sub-set of BS and namely those referred to as Knowledge Intensive Business Sectors (KIBS), the non-KIBS being identified as the more routinary business services activities.

[1] This perspective is also conveyed by Castellacci in its new sectoral taxonomy of innovation integrating service and manufacturing industries (Castellacci, 2008). Also in this contribution the idea is that the emergence of a new set of general purpose technologies (namely those connected to the emergence of the ICTs) has deeply changed the structure of the sectoral linkages fuelling the process of technological accumulation and economic growth.

Originally, the literature on KIBS has been largely focussed on a rather restricted number of service activities, namely on R&D and ICT related services.[2] The more recent literature on KIBS has progressively enlarged the boundaries and features of this peculiar market, adopting a broader view on the type of actors involved, on the innovative services exchanged, on the type of interactions taking place between KIBS and client industries (Miles, 2012).[3] Furthermore, far from being constituted by pure market transactions of generic or abstract knowledge in many cases these linkages can be best represented as a "cooperative mode of innovation" in which both KIBS and client industries play an active role (Tether and Tajar, 2008; Freel, 2010; Doloreux and Shearmur, 2012)[4].

The literature on "service innovation" and "innovation in services" (Gallouj, 2002; Miles, 2005; Tether, 2005; Evangelista, 2006; Gallouj and Savona, 2009; Abreu et al., 2010) has significantly contributed to such a shift of perspective, emphasing the important role played by "non-technological" types of skills, competencies and learning processes broadly relating to areas of firms' organization, market characteristics, consumer habits and tastes, financial and legal matters. These developments of the literature bear important implications also for the analysis of the economic impact of an heterogenous set of industres such as BS. In the light of what said above, such an impact should be assessed going beyond the restricted area of KIBS, taking into account the composite nature of BS, the size and content of the services provided to client industries, the ways in which these services match and complement internal firms' competencies and assets (Miles, 2012). The empirical assessment of these quantitative effects is of course not an easy task due to the difficulty of identifying effective and appropriate measures of (and data on) the qualitative and innovative content of the services delivered to client firms/industries as well as to isolate their specific effect at firm, sectoral or macro level. Thus, it does not come as a surprise that the economic impact of BS has been so far empirically explored in a rather basic and straightforward fashion.

The empirical literature on the economic impact of BS has been largely focussed on assessing the contribution provided by these sectors on the performance of downstream industries. These effects have often been estimated by including BS inputs in a typical production

[2] KIBS are usually identified in a sub section of the NACE 74 Business service branch and include the following services activities: Legal, accounting, tax consultancy, market research, auditing, opinion polling, management consultancy, architectural, engineering and technical consultancy, technical testing and analyses, advertising, other business activities n.e.c. (Muller and Doloreux, 2009; Miles, 2102).

[3] See also Muller and Doloreux, 2009, for a review of the literature on KIBS.

[4] For a detailed study on the extent and the modalities of knowledge exchange between KIBS and their clients see also Landry et al., 2012.

function setting(Antonelli, 1998; Katsoulacos and Tsounis, 2000; Crespi, 2007), finding a positive role of BS on countries' productivity and growth .

Tomlinson (2000) and Windrum and Tomlinson (1999) investigate the role of services for output and productivity using a different approach. Rather than applying a production function approach they consider the interaction of labour with two types of intermediate goods, namely material inputs and communication and business services. They find a positive effect of intangible inputs on output and productivity even though in presence of marked differences across countries. The converging message stemming from these empirical exercises is that what is important is not the quantity of services in the domestic economy, but the degree of connectivity between services and other economic activities.

Another stream of empirical literature looks at possible spillover effects from BS to the rest of the economy (Antonelli, 1999; Greenhalgh and Gregory, 2000; Baker, 2007; and Camacho and Rodriguez, 2007a and 2007b among others). These studies find significant externalities connected to the presence and size of BS industries[5]. In particular Antonelli (1999) finds important effects of business services use on value added of client industries. Greenhalgh and Gregory (2000) show that business services have played a key role in sustaining productivity growth during the 1980s, causing large labour savings in other industries, and contributing to rise product quality in downstream sectors. Baker (2007), using Input-Output Tables for a sample of 13 OECD countries and introducing BS as an additional input in a production function, finds that in most countries the contribution of BS (including renting of machinery; computer and related activities; R&D and other business services) to production is higher than their cost (however this is the case also for other services). Finally, Camacho and Rodriguez (2007a, 2007b) look at the effects of Knowledge Intensive Services (KIS) (Communication; Computer and related services; R&D services) on productivity of their client industries for a sample of 11 EU15 countries in 1995 and 2000. They find that KIS have in general a positive impact on productivity, although there are important differences across countries and over time. More relevant to our paper, they also investigate how KIS contribute to diffuse technology across industries combining data on the R&D intensity of

[5] Similar results are found also by more detailed studies at the firm level. In particular Martinez-Fernandez (2010) illustrates the strategic role of knowledge intensive services for the success of the Australian mining industry while Mas-Verdu et al. (2011) show that KIBS are a key sector to both the creation and the diffusion of knowledge in the Spanish innovation system through input output linkages.

each KIS industry and input output tables.[6] They find that KIS industries occupy a relevant position in terms of diffusion of product embodied R&D through intermediate sales.

While the effects of BS on the growth and productivity performance of downstream industries have been investigated by a relatively large number of studies, the extent to which BS are able to influence the international competitiveness of their client firms and sectors has not been explored. This is somewhat surprising, especially taking into account the presence of a very large and consolidated body of literature investigating the linkages between innovation and international competitiveness of firms, sectors and economies at large. This stream of literature follows the so-called "technology gap approach to trade" opened up by the pioneering contribution of Luc Soete (1981) in which market shares (absolute competitive advantage) and trade specialization (relative competitive advantage) of countries were associated to patent based indexes of technological competitiveness of the different economies. Following contributions have investigated the link between technology and international competitiveness more in depth using a wider range of technological indicators, taking into account the dynamic nature of this relationship and the importance played by sector and country specific factors (Fagerberg, 1988; Amendola et al., 1993; Magnier and Toujas-Bernate, 1994; Amable and Verspagen, 1995; Verspagen and Wakelin, 1997; Anderton, 1999; Carlin et al., 2001; Montobbio, 2003).

All in all, this stream of literature provides general and converging evidence that technology plays a very relevant role in explaining the capability of penetrating international markets, and that, along with price and cost competitive factors, the introduction of technologically new products and processes might be the key factor allowing firms to maintain and increase market shares, especially in science based sectors. Among the most recent developments of this literature it is important to mention the contributions emphasizing the role played by intersectoral linkages as a relevant source of international competitiveness (Fagerberg, 1997; Laursen and Meliciani, 2000; 2002). These studies provide us with a rather variegated picture of both the inter-industry technological interdependencies and of the role played by technology as a source of international competitiveness across industries. Furthermore these studies show that inter-industry flows of technology taking place within countries seem to be more important, as factor enhancing international competitiveness, than cross border technological flows.

[6] Camacho and Rodriguez apply a methodology similar to that used by Papaconstantinou et al. (1998) - and applied to service activities by Amable and Palombarini, (1998) - assessing which industries incorporate in their products, through the acquisition of intermediate inputs, more embodied R&D.

It is worthwhile to note that the bulk of the literature exploring the relevance and the economic effects of inter-industry knowledge flows has a clear manufacturing focus and adopts a strict technological perspective of these linkages. Furthermore, as far as we know, there are only a couple of studies that have examined the impact of BS on the international competitiveness of the sectors purchasing and using intermediate intangible inputs[7]. Francois and Woerz (2008) examine for a selection of OECD countries (during the 1994-2004 period) the impact of services' imports on manufacturing exports. Distinguishing between different types of services and importing industries the study finds a strong positive association between the level of business service openness and export performances of the most skill-and-technology-intensive industries, a negative correlation in the case of labour intensive industries and no relationship in the case of resource intensive sectors. Similarly, the level of imports of financial, insurance and communication services does not seem to have any effect on the export performances of importing industries. Wolfmayr (2008) estimates – for 16 OECD countries and the 1995-2000 period, the impact of the acquisition of services in general (and KIBS in particular) on the export performances of downstream industries. The study finds that the interconnectivity between the manufacturing sectors and the service sector has a positive and highly significant impact on export market shares only in the case of high-skilled, technology-driven industries.

This paper aims at providing additional evidences on the role played by BS in sustaining the international competitiveness of manufacturing industries. As pointed out above this represents an under-investigated research area. More specifically we aim at providing fresh empirical evidence on the importance played by BS in supporting two distinct competitive strategies of firms and industries: a) strategies aiming at reducing production costs; b) strategies pursuing a qualitative and technological improvement of products. Within the wide macro-sector of BS we will focus on the importance played by two main BS aggregate sectors: "Communication and Computer related services" and the broad category "Other business activities. The focus on these two BS sub-sectors is broadly consistent with previous categorizations of KIBS and in particular with the distinction commonly made between T-KIBS ("Technology related KIBS) and the P-KIBS (professional KIBS) (Miles, 2012).

[7] Laursen and Meliciani (2010) have analysed the role of ICTs on international competitiveness using bibliometric data. Guerrieri and Meliciani (2005) have explored the role of demand of BS by manufacturing industries as factor stimulating the international competitiveness of Business services.

Alongside the use of these intangible inputs we will take into account the role played by more traditionally technological and cost-related competitive factors (R&D expenditures, investment in technologically new machinery, labour costs). Although it is difficult to formulate clear-cut ex-ante research hypotheses regarding the possible complementary relationships between the use of the two BS inputs and the different competitive strategies of firms and industries, we might expect that: a) the acquisition of Communication and Computer related services are likely to complement "internal" innovation efforts and competencies of client industries, enhancing the innovation capability of user sectors and, in particular, their capacity to develop and introduce new products; b) the acquisition of inputs from the "Other business activities" sector is more likely to be associated to less innovative strategies consisting in pursuing outsourcing practices, increasing internal production efficiency and reducing costs. Given the existence of very different sector specific technological regimes we also expect that low and high-tech sectors pursue different types of innovation strategies and use different types of BS inputs. In addition, we assume that both the economic size and the innovation content of BS inputs play a relevant role.

3. The use of business service inputs by manufacturing industries. Descriptive evidences

As already pointed out in the previous section BS is a rather heterogeneous sector. A wide definition of this sector includes all industries providing intangible intermediate inputs to the rest of the economy. In this paper we adopt a more restricted definition of Business services focussing on two important sub-sectors: "Communication and computer related services" (64 and 72 Nace-Rev1 classification) and "Other business activities" (74 Nace-Rev1). We rely on two sets of information to assess the potential role of business services on the export performance of manufacturing industries: their own innovativeness and the degree of connectivity between these sectors and the rest of the economy. In order to measure both the economic size and innovation content of *BS flows,* we combine the EUROSTAT Community Innovation Surveys (CIS) data with the OECD Input-Output Tables (2010).[8] In particular we

[8] CIS data are those elaborated by the University of Urbino for the SIEPI/SI database.Compared to the CIS data made available by EUROSTAT, the SIEPI/SI data set provides a wider set of CIS indicators at industry 2digit level and for three different CIS waves (in this study we use only CIS3 and CIS4 data, that is those covering the periods 1998-2000 and 2002-2004). This was made possible by integrating and elaborating data directly from national data providers through special cooperation agreements. In order to investigate the link between innovation and several dimensions of the innovative activity, the SIEPI/SI database includes measures of economic performances, demand and composition by professions and education levels on the six largest

use CIS data to measure the innovative (or more broadly the qualitative) content of BS sector output (and other industries) and Input-Output data to measure the economic linkages between business services sectors and client industries. Data on trade performances and labour cost compensation are drawn from the OECD STAN (Structural Analysis Database). Due to data constraints, the dataset covers only 5 European countries - Germany, France, Italy, Spain, and the United Kingdom. It is an industry-level database (two digit Nace Rev. 1 classification) covering 20 manufacturing and 17 services sectors. The detail of sectors is provided in the Appendix.

Table 1 provide us with rough indications on the innovation performances of the two Business service industries taken into account in this study (in 2004) across the five countries considered in our data set. The data contained in the table highlight the main differences between the innovation intensity of the two BS sub-sectors and that characterizing the total manufacturing industry and total services. The innovation intensity indicator is computed as the industry level ratio between the total expenditure on innovation activities carried out in 2004 and the total turnover in the same reference year[9]. The table shows that the most innovative BS sector is found in Germany and the least innovative in Spain. One important message emerging from Table 1 is that BS contribute to determine the overall innovation potential of countries and this is because of both the different innovation performance of the BS sectors on their own and (perhaps more importantly) because of the contribution they provide to the innovation performances of the other sectors.

Input-Output tables make it possible to measure the intensity of the linkages between BS and other industries. The strength of these linkages - or put in other words, the BS intensity of the user sectors - can be assessed looking at the share of BS inputs purchased by each client industry either on total production or on total inputs. In a previous contribution we have shown that the use of the two indicators provides very similar indications (Evangelista et al. 2013). In this study the second type of indicator on BS intensity is used and it is computed as the sum of the expenditure devoted by each manufacturing industry to the acquisition of services from Post and Telecommunications, Computer and related activities and Other business activities, all divided by the total production output of each user (manufacturing)

countries that were part of the EU before the new accessions (Germany, France, Italy, the Netherlands, Spain and the United Kingdom) from 1995 to 2007 (Pianta et al., 2011).

[9] Total innovation expenditure includes the total expenditure for four categories: intramural In-House R&D (includes capital expenditures on buildings and equipment specifically for R&D), acquisition of R&D (extramural R&D), acquisition of machinery, equipment and software (excludes expenditures on equipment for R&D) and acquisition of other external knowledge.

sector.

Table 2a shows the values of this index computed respectively for the total manufacturing sector and for the four Pavitt's industry categories (Pavitt, 1984), and also distinguishing for the different types of BS input. Germany and France show the highest values of the index in the great majority of manufacturing sectors. The rather low levels of the index in the case of UK is somewhat surprising. However, in a previous study (Evangelista et al. 2013) we have shown that UK service sectors are indeed high users of BS. The asymmetry in the use of BS between manufacturing and service sectors in the UK seems therefore to reflect the high share of services in this economy and, in particular, the relevance of high value added services (such as financial services) that are notoriously strong users of BS.

Table 2a also shows an implicit correlation between the technological intensity of downstream sectors (proxied by Pavitt categories) and the intensity in the use of BS. This might signal some complementarity between the use of BS and the internal technological efforts of manufacturing user firms. In fact, in all countries, the highest users of BS are "science based" and "specialised supplier" sectors while "scale intensive" and "supplier dominated" sectors make a relatively low use of BS. It is also interesting to highlight the high stability over time of these indicators (2000-2005), with the only exception of science based industries. This stability signals the structural nature of the sectoral interdependencies between BS and the manufacturing sectors, also in the case of a particularly dynamic sector such as Business services.

Tables 2b and 2c show the same BS indexes computed separately for the two main sub-sectors, i.e. the more technology intensive and innovative BS services, such as information and communication services (Communication and computer related services), and the heterogeneous "other business services" sector. The tables provide information on the relevance of these two different typologies of services for the whole manufacturing industry and for sectors with different levels of technological intensity and types of innovation strategies.

In all countries and sectors "other business services" have a much higher quantitative relevance than information and communication services. The weight of other business services in total industrial production value ranges between 6.3% in Germany to 2.4% in the UK, while the weight of information and communication services is around 1% in all

countries.

Once again in the case of UK we find low levels in the use of both BS services inputs by manufacturing sectors. Somewhat surprising are also the figures for Italy where the share of information and communication services on industrial output is above the 5 countries' average in all manufacturing sectors. This may depend on the low average firms' size characterising the Italian industry and on the difficulty for Italian small and medium enterprises to develop internally their information systems.

Finally, it is interesting to point out that, while for information and communication BS there is a positive correlation between their use and the technological intensity of downstream sectors, this is not the case for the "other business services". In fact, with the only exception of Germany, in all other countries traditional manufacturing sectors and high technology industrial sectors make do not significantly differ from each other in the use of this typology of intangible inputs (sometimes traditional industries make an even more intensive use of these inputs). It is, therefore, reasonable to assume that for traditional manufacturing industries the acquisition of intangible inputs from the "other business services" sector may be a way to overcome the limited capability to develop internally knowledge intensive and high value added activities.

4. The effects of BS on international competitiveness of manufacturing industries

Our basic research hypothesis is that BS may contribute to enhance the international competitiveness of manufacturing industries. The use of BS inputs is likely to impact positively on the performances of user industries through two different channels and namely by: a) sustaining and enhancing the innovative capability of user industries, especially their ability to introduce new products; b) contributing to improve the organizational models and the production efficiency of firms.

As anticipated in the previous section, and stressed in the literature (Shearmur and Doloreux, 2013) it is likely the two BS industries taken into account in this study have a different relevance and influence on the two types of strategies and area of impact indicated above. Furthermore, mechanisms a) and b) might have a different relevance according to the type of

client industry. With the data at our disposal we will not be able to shed full light on these specific points. Nonetheless, some indications will be drawn by running separate econometric estimates for different groups of industries (high and low technology sectors), different type of BS inputs (communication and computer related and others BS) and using as additional regressors CIS variables identifying different types of innovation strategies and competitive factors.

Three research questions addressed are the following:

1. Do BS industries affect the manufacturing industry's export performances?

2. Are these effects different according to the type of BS input used? Have the most technologically intensive BS inputs (Communication and Computer related services) a different impact when compared to the less innovative service inputs (provided by the "other business service" sector)?

3. Are these effects different according to the type of user sector and the dominant competitive strategy characterizing the different manufacturing industries?

4.1 The model

The contribution of BS to the international competitiveness of manufacturing industries is empirically assessed estimating the following equation:

$$\Delta Qexp_{i,k,,t} = \beta_0 + \beta_1 Qexp_{i,k,,t-1} + \beta_2 Inn_{i,k,,t-1} + \beta_3 ULC_{i,k,t-1} + \beta_4 BS_{i,k,,t-1} + \mu_i + \lambda_k + \Lambda_t + \varepsilon_{i,k,t} \quad (1)$$

where $Qexp_{i,k,,t}$ is the export market share for the country *i*, in the sector *k* at time *t*; *Inn* is the innovative intensity of sectors measured through CIS variables; *ULC* is the unit labour cost; *BS* is the intensity in the use of BS inputs (see equation 2); country (μ_i), sectoral/Pavitt groups (λ_k) and time dummies (Λ_t) are also included.

As regressors we also include some CIS indicators measuring the innovative efforts of each industry (R&D expenditure per employee and the expenditure per employee due to acquisition of machinery and equipment linked to innovation) and the relevance of technological strategies finalized to improve products or to reduce costs (i.e. the share of firms in each sector considering the qualitative improvements of products and/or the

reduction of labour cost as important or very important objectives of their innovation activities). Table 3 contains a description of the variables used in the econometric estimates and the time span covered by the data.

Equation (1) is estimated with the OLS, checking for heteroschedasticity and intra-sectoral heterogeneity. The possibility of multicollinearity is checked through the VIF analysis (Variance Inflation Factors). The structure of the model somewhat reduces the presence of possible problems of endogeneity; independent variables refer to the first year (respectively, 2000 and 2004/2005) of the two periods for which the dependent variable has been computed (2000-2003; 2004-2007): an implicit (though rather short) time lag between the regressors and the dependent variable is thus introduced.

4.2 An innovation-weighted indicator of the BS intensity in client manufacturing industries

In this work the impact of BS is assumed to be dependent on the "economic size" and "innovation content" of BS inputs: in order to take into account both the "quantitative" and "qualitative" dimension of BS, the BS indicator in equation (1) incorporates both the amount of BS inputs purchased and used by client (manufacturing) industries and the innovation intensity of the BS provider sector. The BS (innovation weighted) indicator is computed as follows:

$$BS_{ikt} = \frac{\sum_{j=1}^{3} bs_{jikt}}{Y_{ikt}} \frac{\sum_{j=1}^{3} inn_{ji}}{\sum_{j=1}^{3} turn_{ji}} \qquad (2)$$

where *i* is the country, *k* is the destination (manufacturing) sector, *t* is the time period, *j* is the business services industry (Post and Communication, Computer and related services, Other business services), *bs* is the expenditure for each BS input in sector *k*, for country *i* at time *t*; *Y* is the downstream industry production, *inn* the total innovative expenditure and *turn* the total turnover of each BS industry.[10]

The first term varies from sector to sector and captures the degree of connectivity between BS

[10] Innovative expenditures are more reliable than innovative output data (i.e. the share of turnover due to innovative products), especially in services sector (Evangelista and Sirilli, 1995).

and manufacturing industries for each country (and for two periods); it is built using Input-Output tables, that is the economic inter-dependencies across industries. The second term is derived from the CIS database: it is country specific and constant across sectors (see Table 1); for less innovative BS inputs (Other business services), the "innovation weight" can be considered as a proxy of the qualitative content of these inputs.[11] Due to availability of data, the second term is calculated only for 2004 (the final period) and extended to both periods.[12]

4.3 Data and descriptive statistics

Table 4 shows the main descriptive statistics for each variable used in the econometric regressions (data sources are provided in Table 3). All monetary variables are expressed in euro; nominal variables have been changed at constant prices (2000) using sectoral (from STAN) and OECD GDP deflators. For the United Kingdom, the original figures provided are transformed using the exchange rate expressed in PPP (drawn from Eurostat, Prices and purchasing power parities, Statistics in Focus 53, 2004).

Changes in export shares correspond to changes in the level of international (export) competitiveness of each country in each manufacturing sector.[13] Country and industry level data of the export share variable (not reported in the table) shows as expected, the good performances of Germany in both periods, mainly in specialized suppliers and scale intensive industries; Spain also increases its export shares in the first period, especially in scale intensive sectors. On the contrary, export shares decrease in Italy, in particular in low-technology sectors. A comparison of the descriptive statistics of innovation variables in the first and second period shows an increase of R&D expenditures and a decline of innovative investment in new machinery and equipment. The all set of innovation variables shows in both periods a high inter-industry variability confirming the presence of rather distinct sector-specific technological regimes. Finally, from 2000 to 2005, a slight increase in the use of Other business services and a similar fall in the use of Communication and Computer and

[11] The basic idea behind our "innovation-weighted BS intensity indicator" is similar to that adopted by Papaconstantinou et al. (1996) in order to measure embodied technology diffusion across sectors. Papaconstantinou et al. (1996) compute the technology embodied in a product of an industry as the sum of its own R&D and that which is embodied in its purchases from other industries (as direct and indirect purchases of intermediate inputs and domestic investments). In our paper, rather than focusing on R&D we consider direct flows of innovation-weighted BS inputs to client industries.

[12] This is due to data constraints and in particular to the fact that CIS data for Germany (CIS 3, 2000) on total turnover and the market share changes for the country i total innovative costs are not available at 2 digit level in SIEPI/SI database (and, as already pointed out, not provided by EUROSTAT).

[13] Export shares are built by dividing export values in each sector and country by the sum of exports of countries in each sector; the sum of export shares for each sector is thus one.

related services inputs can be detected from the data. Unit labour costs appear as stable.

4.4 Regression results

Table 5 reports the results of the estimation of the impact of BS on countries' ability to gain market shares in international markets. Column one reports the results of the estimates which include CIS variables referring to amount of resources devoted to innovation (R&D expenditures per employee and expenditures for machinery per employee); column 2 reports the results of the estimates that include (as regressors) CIS variables reflecting the dominant innovation strategy in the sector (the share of firms aiming at increasing product quality and the share of firms aiming at reducing labour costs).

The table shows some interesting results. First, the use of BS appears to positively affect the capability of countries and sectors to gain market shares in international markets. This result is particularly relevant since it adds to the role played by traditional technological variables already documented in the literature. Second, the results show that not all types of technological inputs, nor all innovation strategies, are effective in enhancing international competitiveness. In fact, while R&D expenditures and strategies aiming at increasing product quality positively affect export market shares, the mere acquisition of new machinery and equipment as well as reducing labour costs is associated with losses in export shares. This suggests that – especially in the case of advanced economies - relying upon the introduction of process innovations (with aim of reducing production costs) does not represent an effective and viable strategy in order to improve international competitiveness. Our estimates show that, in order to increase export shares, it is necessary to invest in new products and in innovative inputs. Finally, price competitiveness (unit labour costs) is important for gaining export shares.

As already pointed out, the business service sector provides an heterogeneous array of intermediate inputs characterised by very different qualitative and innovative contents. The result of this heterogeneity is that the impact of BS on the international competitiveness of downstream sectors may vary to a great extent. Within BS there are some activities with a high technological content such as "computer and related activities" and "communication services" but also inputs that are not strictly technological in nature. A high degree of

heterogeneity characterizes also the "other business services" group, the latter including both sectors with a high level of human capital (such as consultancies, technical services, etc.) and more traditional services such as cleaning and security services. Furthermore, the impact of ICT services and other business services on the international competitiveness of downstream industries may also differ according to the technological content of the user sectors. These differences have been examined running two separate regressions, each of these taking into account a different sub-group of downstream manufacturing sectors (a "medium high tech" sectoral group including the Pavitt "science based" and "specialised suppliers" industries and a "medium low tech" group including "scale intensive" and "supplier dominated" sectors). In both regressions the impact of BS on the export performances of downstream industries is estimated looking at the specific role played by two different types of BS inputs: ICT services and "other business services".

Regression results show that while ICT services contribute to enhance export market shares of downstream sectors in both medium-high-tech and medium-low-tech sectors, "other business services" only contribute to the international competitiveness of the most innovative manufacturing industries. There are two possible interpretations of this result. First, due to the already mentioned heterogeneity of "other business services" it is likely that low-tech manufacturing sectors acquire from this BS sub-sector mainly low innovative inputs that do not support their international competitiveness. Secondly, the use of "other business services" inputs by traditional manufacturing sectors might consist of a process of mere outsourcing, in particular the externalization of low value added activities. This strategy could signal the difficulty of advanced countries in facing international competition in traditional sectors. Our results show that, if this is the case, this type of more defensive strategy has not proved to be successful.

As far as the other technological inputs are concerned, it is interesting to observe that in high-tech sectors only the R&D expenditure variable has a role to play while other inputs/strategies do not seem do exert any positive effect on international competitiveness. More surprising is the result that in low-tech sectors traditional inputs (expenditures in new machinery and equipment), and strategies devoted to reduce production costs, have a negative impact on export shares while R&D expenditures and innovation strategies devoted to improve product quality have a positive and significant impact on the international competitiveness of downstream sectors. These results suggest that advanced countries, need

to adopt more complex and active innovation strategies also in traditional sectors if they want to be competitive in international markets.

5. Conclusions

The evidence presented in this paper provides strong empirical support to the positive impact exerted by BS on downstream sectors. Compared to previous research, this contribution contains some elements of originality in its empirical focus, methodology used and results. First, differently from previous studies, this paper has examined the effects of BS on a performance variable previously neglected in the literature, i.e. on the international competitiveness of user industries. The ability of downstream sectors to gain export market shares is enhanced by their linkages with the BS sector. Secondly, the role of BS has been examined distinguishing between the different type of service inputs (ICT and other business services) and the typology of manufacturing user sectors (high and low-tech). Finally, we have looked at the impact of BS sector on manufacturing industries considering both the quantity and the quality of service inputs provided by the former to the latter.

The descriptive analysis and the econometric estimations have provided interesting and complementary indications on the linkages between BS and manufacturing user sectors and on the economic impact (in terms of international competitiveness) of the use of BS inputs.

The first message emerging from the descriptive analysis (reported in Section 2) is that the intensity in the use of BS depends first of all on the technological profile of using sectors. The most innovative manufacturing sectors demand a high quantity of business services. As a consequence the total demand of BS depends first of all on structural factors linked to countries' productive and technological specialisation. Considering the dynamic and two ways relationship between BS and manufacturing downstream industries, this means that a high and qualified demand for these inputs improves the overall quality of the BS supply (and their innovation content) leading to virtuous and vicious circles that are likely to increase divergence across countries in innovation and international competitiveness. This is somewhat confirmed by the fact that among the five countries considered in this study, Germany and France are by far the countries with the highest level of interdependence between BS and manufacturing sectors, while countries characterized by a less innovative industry, and specialized in medium and low technology sectors, such as Italy and Spain, show weaker linkages between BS and downstream manufacturing sectors.

The second message emerging from the descriptive analysis is that, among the two typologies

of BS considered in this study, "other business services" are by far the most used inputs in all industrial sectors and countries. These are inputs with a much lower technological content with respect to computer and communication services. However, it should be highlighted that high technology manufacturing sectors make a large use of these inputs and that these services include also knowledge intensive activities (legal and accounting, management, architectural and engineering activities, advertising and market research, etc.). This implies that also these (less strictly technological) services may contribute to enhance the technological capabilities of user sectors and their international competitiveness.

The hypotheses and expectations emerging from the descriptive analysis are partly confirmed by the results of the econometric estimations. Considering the BS sector as a whole (i.e. computer and related services, communication services and other business services) estimation results show that BS inputs have a positive impact on the international competitiveness of downstream manufacturing industries contributing to increase export market shares of industries. The strong and highly significant impact of BS is complementary to the positive role played by more traditional technological variables, namely R&D expenditures and other types of innovation strategies devoted to increase product quality.

This simple analysis does not allow disentangling the transmission mechanisms through which BS affect the performance of downstream sectors. However, as argued in the literature, it is likely that the BS sector plays an important role in facilitating the diffusion and adoption of knowledge in downstream sectors with modalities and mechanisms different from the more traditional channels consisting in the acquisition of R&D services, new machinery and equipment.

The results of the aggregate estimates (when differences in the type of research inputs and downstream sectors are not taken into account) need to be qualified. In fact, the results of the econometric estimations reported in Table 6 show a different impact of the various typologies of service inputs depending on the technological content of downstream sectors. While the use of ICT inputs contributes to increase export market shares in both low and high-tech manufacturing sectors, the use of "other business services" (consultancy, legal services, marketing, cleaning, security, etc.) is positive and significant only for high-tech manufacturing industries. This result is somewhat surprising, especially taking into account the potential positive impact of non technological inputs (as those supplied by "other business services") on the competitiveness of traditional sectors. It is however important to take into consideration the large heterogeneity of the services included in the "other BS" category and

the possibility that the demand for these services may respond to very different motivations and strategies. We can, therefore, propose two different (and complementary) explanations of the asymmetry found in this study in the impact of the use of "other BS inputs" on high and low-tech manufacturing downstream sectors. First, it is possible that traditional manufacturing industries tend to demand less knowledge intensive BS inputs which have in turn a limited capability to enhance the international competitiveness of these sectors. Secondly, the use of non-technological BS inputs, especially in low innovative manufacturing sectors, may consist of mere outsourcing processes with a very limited scope for the improvement of internal organizational models, innovation performances and product quality. Both these explanations are supported by the other regression results. In fact, in traditional manufacturing sectors, innovative strategies aimed at reducing production costs have detrimental effects on international competitiveness resulting in lower export market shares.

Overall, the results of this study suggest that international competitiveness is more and more based on technological advantages and innovation capabilities, and this is true not only in the context of high technology sectors but also in the more traditional manufacturing industries. In this framework business services may play an important supporting role, especially for the innovative activity of small and medium enterprises. Our regression results suggest that this role cannot given for granted since it depends both on the quality of the supply of these services and on the quality of the demand from downstream sectors. Although the supply and demand of knowledge intensive intangible inputs depends on structural factors, a move towards a new innovation and industrial policy aiming at enhancing the quality and quantity of sectoral interdependencies between business services and the rest of the economy is highly needed.

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Table 1. Innovation intensity of BS industries and other main sectors

Total innovation expenditure as a share of total turnover (percentage values) - 2004.

Sectors	*Germany*	*UK*	*France*	*Italy*	*Spain*
Total Business services**	3.15	2.35	2.39	2.08	1.70
- Information and communication BS	4.78	5.16	3.70	3.11	2.26
- Other BS	1.63	1.22	1.57	0.75	1.13
Total service industires	1.31 *	0.91	1.21	1.13	0.54
Total manufacturing industry	5.15	3.96	3.58	2.24	1.55

**: includes sectors (NACE rev. 1) 64, 72 e 74

*: exluding sectors 52, 55, 70 e 71;

Source: CIS

Table 2. Intensity in the use of BS by manufacturing indstries (2005).
Expenditures for the acquisition of BS as % of production output

Industry groups	*Germany*	*UK*	*France*	*Italy*	*Spain*	*5 country average*	*% Var. 2000-2005*
				2a - Business services (total)			
Science based	10.3%	3.8%	7.6%	5.9%	6.6%	6.8%	-0.6%
Specialized suppliers	8.3%	4.6%	6.9%	6.2%	5.4%	6.3%	0.3%
Scale intensive	6.9%	3.0%	7.3%	5.0%	4.9%	5.4%	0.3%
Supplier dominated	5.6%	3.3%	7.5%	4.1%	5.2%	5.1%	0.3%
Total manufact. Ind.	7.5%	3.5%	7.3%	5.2%	5.5%	5.8%	0.1%
				2b - ICT related BS			
Science based	2.1%	1.3%	1.5%	2.7%	1.3%	1.8%	0.0%
Specialized suppliers	1.2%	1.4%	1.1%	1.9%	0.6%	1.3%	0.1%
Scale intensive	1.0%	0.9%	1.0%	1.2%	0.7%	1.0%	0.0%
Supplier dominated	0.7%	1.0%	1.0%	1.0%	0.9%	0.9%	0.1%
Total manufact. Ind.	1.2%	1.1%	1.1%	1.6%	0.9%	1.2%	0.0%
				2c - Other BS			
Science based	8.2%	2.5%	6.0%	3.2%	5.3%	5.1%	-0.5%
Specialized suppliers	7.2%	3.3%	5.8%	4.3%	4.7%	5.0%	0.2%
Scale intensive	5.8%	2.0%	6.3%	3.8%	4.2%	4.4%	0.3%
Supplier dominated	4.9%	2.3%	6.5%	3.1%	4.3%	4.3%	0.3%
Total manufact. Ind.	6.3%	2.4%	6.2%	3.6%	4.6%	4.6%	0.1%

Source: OECD input/output data

Table 3. Variables and data sources of the panel

Variables	*Source*	*Period 1*	*Period 2*
Intensity in the use of BS (innovation weighted index)	I/O (OCSE) and CIS 2004 (EUROSTAT)	2000	2005
R&D (intra-muros) expenditure (th. of euro per empl.)	CIS (EUROSTAT)	2000	2004
Expenditure for technologically new machinery & equip. (th. of euro per empl.)	CIS (EUROSTAT)	2000	2004
% of firms indicating the technological improvement of product as a very relevant objective	CIS (EUROSTAT)	2000	2004
% of firms indicating "lowering labour costs" as a very relevant objective of their innovation strategies	CIS (EUROSTAT)	2000	2004
Export market shares variation	STAN (OCSE)	2000-2003	2004-2007
Labour cost per unit of product	STAN (OCSE)	2000	2004

Table 4. Descriptive Statistics

Period 1 (2000-2003)	*Average*	*st. dev.*	*Min*	*Max*
Export market share variation	0.00	0.03	-0.08	0.09
Intensity in the use of BS (innovation weighted index)	11.01	7.97	2.56	39.27
Intensity in the use of BS_ICT (innov. weighetd index)	3.97	3.77	0.66	26.26
Intensity in the use of Other BS (innov. weighetd index)	4.46	3.61	0.64	18.26
R&D expenditure (Intra-muros) (th. of euro per empl.)	2.58	4.64	0.04	25.19
Expenditure for technologically new machinery & equip. (th. of euro per empl.)	3.25	4.30	0.03	30.18
% of firms indicating the technological improvement of product as a very relevant objective of innovation	36.71	13.91	7.85	78.65
% of firms indicating "lowering labour costs" as a very relevant objective of innovation strategies	24.30	8.29	7.83	54.78
Labour cost per unit of product	0.65	0.12	0.31	0.92
Period 2 (2004-2007)	*Mean*	*S.d.*	*Min*	*Max*
Export market share variation	0.00	0.03	-0.11	0.18
Intensity in the use of BS (innovation weighted index)	12.07	7.43	2.92	38.53
Intensity in the use of BS_ICT (innov. weighetd index)	3.89	3.20	0.79	22.65
Intensity in the use of Other BS (innov. weighetd index)	5.36	3.78	0.91	17.83
R&D expenditure (Intra-muros) (th. of euro per empl.)	3.74	5.93	0.06	26.11
Expenditure for technologically new machinery & equip. (th. of euro per empl.)	1.69	1.80	0.06	12.59
% of firms indicating the technological improvement of product as a very relevant objective of innovation	27.97	18.75	4.62	76.46
% of firms indicating "lowering labour costs" as a very relevant objective of innovation strategies	18.61	17.98	1.27	68.68
Labour cost per unit of product	0.65	0.12	0.15	0.94

Table 5. The impact of BS on the international competitiveness of manufacturing Industires - OLS estimates

Dependent variable: Export market share variation (t, t-1)	*Coeff.*	*t value*	*Sig.*	*Coeff.*	*t value*	*Sig.*
Export market share (t-1)	-0.096	-4.68	***	-0.077	-3.87	***
R&D expenditure	0.001	2.79	***			
Exp. for tech. new machinery & equip.	-0.002	-2.54	**			
% of firms improving product quality				0.001	2.06	**
% of firms reducing labour costs				-0.001	-3.31	***
BS innovation weighted index	0.002	2.10	**	0.001	1.96	*
Labour cost per unit of product	-0.064	-2.69	***	-0.042	-1.71	*
Germany	0.032	3.30	***	0.016	1.70	*
France	-0.021	-2.27	**	-0.010	-1.24	
Italy	-0.011	-1.66	*	-0.019	-2.61	***
Spain	-0.008	-1.42		-0.017	-3.28	***
Science Based	-0.021	-2.32	**	-0.016	-1.95	**
Specialized Suppliers	-0.008	-1.10		-0.006	-1.02	
Scale Intensive	0.000	-0.08		-0.002	-0.53	
Dummy t2 (second period)	0.001	0.31		0.000	-0.19	
Constant	0.048	2.63	***	0.042	2.31	**
Adjusted R2	0.404			0.397		
Number of observations	180			203		
Prob > F	0.000		***	0.000		***

Note: *, **, *** denote statistical significance at respectively 10, 5 and 1 per cent

Table 6. The impact of BS on the international competitiveness of hitech and low-tech. manufacturing industires OLS estimates

Dependent variable:	HI_TECH manuf. ind.						LOW_TECH manuf. ind.					
Export market share variation (t, t-1)	*Coeff.*	*t value*	*Sig.*	*Coeff.*	*t value*	*Sig.*	*Coeff.*	*t value*	*Sig.*	*Coeff.*	*t value*	*Sig.*
market share (t-1)	-0.064	-1.01		-0.076	-1.37		-0.083	-4.10	***	-0.066	-3.05	***
R&D (intra-muros) expenditure (a)	0.001	1.75	*				0.002	1.70	*			
Exp. for tech. new machinery & equip. (a)	-0.002	-1.34					-0.002	-3.31	***			
% of firms improving product quality				0.000	0.27					0.001	1.99	**
% of firms reducing labour costs				-0.001	-1.13					-0.001	-2.84	***
BS_ICT	0.002	2.48	**	0.002	2.04	**	0.004	2.98	***	0.003	2.00	**
BS_OTHER	0.008	2.14	**	0.007	1.97	*	-0.001	-1.57		-0.001	-0.64	
Labour cost per unit of product	-0.061	-1.71	*	-0.066	-2.14	**	-0.066	-2.68	***	-0.032	-1.11	
Germany	0.003	0.09		0.002	0.06		0.042	5.29	***	0.024	3.12	***
France	-0.034	-1.37		-0.020	-0.90		-0.008	-0.89		-0.001	-0.14	
Italy	0.020	1.25		0.002	0.15		-0.015	-1.87	*	-0.015	-1.97	**
Spain	0.002	0.11		-0.011	-0.65		-0.003	-0.45		-0.010	-1.58	
Science Based	-0.017	-1.97	*	-			-			-		
Specialized Suppliers	-			0.014	1.77	*	-			-		
Scale Intensive	-			-			0.001	0.23		-0.002	-0.37	
Dummy t2 (second period)	0.001	0.08		0.000	0.07		0.002	0.63		-0.001	-0.45	
Constant	-0.007	-0.20		0.008	0.24		0.050	2.53	**	0.032	1.50	
Adjusted R2	0.597			0.557			0.438			0.376		
Number of observations	60			69			120			134		
Prob > F	0.004		***	0.001		***	0.000		***	0.000		***

Note: *, **, *** denote statistical significance at respectively 10, 5 and 1 per cent
a: thousands of euro per employee

Appendix: Sectors (with Nace code) and Pavitt's industry groups

Nace Rev.1 *Isic Rev.3*	*Sectors name*	**Pavitt's group**
15-16	FOOD PRODUCTS, BEVERAGES AND TOBACCO	SD
17	TEXTILES	SD
18	WEARING APPAREL, DRESSING AND DYEING OF FUR	SD
19	LEATHER AND LEATHER PRODUCTS AND FOOTWEAR	SD
20	WOOD AND PRODUCTS OF WOOD AND CORK	SD
21	PULP, PAPER AND PAPER PRODUCTS	SII
22	PRINTING AND PUBLISHING	SII
23	MANUFACTURE OF COKE, REFINED PETROL AND NUCLEAR FUEL	SII
24	CHEMICALS AND CHEMICAL PRODUCTS	SB
25	RUBBER AND PLASTICS PRODUCTS	SII
26	OTHER NON-METALLIC MINERAL PRODUCTS	SII
27	BASIC METALS	SII
28	FABRICATED METAL PRODUCTS, except machinery and equipment	SD
29	MACHINERY AND EQUIPMENT, N.E.C.	SS
30	OFFICE, ACCOUNTING AND COMPUTING MACHINERY	SB
31	ELECTRICAL MACHINERY AND APPARATUS, NEC	SS
32	RADIO, TELEVISION AND COMMUNICATION EQUIPMENT	SB
33	MEDICAL, PRECISION AND OPTICAL INSTRUMENTS	SB
34	MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	SII
35	OTHER TRANSPORT EQUIPMENT	SS
36-37	MANUFACTURING NC AND RECYCLING	SD