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Manufacturing exports and the impact of business services.

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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 empirical focus of this paper is on the "dynamic efficiency gains" brought about by the interaction of manufacturing and BS industries and, in particular, on assessing the role of BS in supporting (in a Schumpeterian fashion) various types of non-price competitive factors, the most important being the capacity of developing and introducing new products, more effective organizational innovations and new business models. The empirical analysis is based on an original data set obtained by 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, innovation, industry level data

JEL codes: L80, O30

1. Introduction

The attention devoted to Business services (BS) by economic scholars and policy makers is rapidly growing. This is clearly due to the centrality assumed by this composite bunch of service activities in modern economic systems and to the rising policy concern regarding the need of giving more qualitative content to the on-going process of tertiarisation of our economies. In fact, along with being the high value added and innovative component of services, over the last two decades BS have also represented one of the most dynamic branches of the economy, outperforming most manufacturing industries and also showing a certain anti-cyclical behaviour. These traits and performances are visible also in the EU area where BS sectors nowadays account for more than 10% of total employment and value added. The direct contribution given by BS to aggregate EU economic growth (and especially to employment creation) is rather straightforward and well documented by official statistics and several empirical studies (Kox and Rubalcaba 2007a; Eurostat 2011; Mustilli and Pelkmans 2012; Bogliacino et al. 2013).

Along with directly contributing to aggregate macro-economic growth, BS are perhaps having an even more important role in changing the structure and functioning of production systems and business models, and in particular the ways in which goods and services are produced, delivered and traded both within and across countries. There is no doubt that information and communication technologies (ICT) have acted as a key driver and enabler of BS growth, favouring the emergence of a market for intangible inputs, facilitating the "splintering" away of service-type functions from manufacturing industries, reshaping the content and scale of the value-chains, in particular those between manufactures and service providers. As a result, the nexus between BS and the rest of the economy has progressively strengthened both in quantitative and qualitative terms and an increasing amount of literature has started to relate the economic performances of manufacturing industries to the strength and quality of their linkages with the BS sector (Antonelli 1999; Windrum and Tomlinson 1999; Greenhalgh and Gregory 2000; Baker 2007; Camacho and Rodriguez 2007a, 2007b; Evangelista et al. 2013; Mariotti et al. 2013)[1].

As far as the economic effects of BS on "down-stream industries", the latter can be conceptualised and studied taking into account two basic mechanisms. The first one relies upon

[1] 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.

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.

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 rise 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.

Over the last decade the economic impact of BS on downstream industries and firms has been empirically assessed by an increasing number of contributions. The evidence produced is nonetheless still far from having provided an exhaustive picture of the various areas of impact of BS as well as on the different possible mechanisms through which this sector is able to influence the economic performance of client industries. Looking at the state of the art of this new research field three major broad gaps seem to emerge: first, most of the literature focuses on "productivity" and "growth" as the two performance variables of downstream industries affected by BS, neglecting the potential contribution BS might provide to the international competitiveness of both manufacturing and service industries; second, the marked heterogeneity characterizing the supply and demand of BS inputs has been usually downplayed; third, the existence of different mechanisms and channels through which BS might affect the economic performance of client industries is not explicitly taken into account.

This paper aims at starting to fill these gaps by assessing the contribution provided by the Business service sector (BS) to the international competitiveness of manufacturing industries and by taking explicitly into account the "heterogeneity issue", i.e. the existence of different

type of BS inputs, user sectors and sources of competitiveness enhanced by BS. Our main empirical focus is on the "dynamic efficiency gains" brought about by the interaction of manufacturing and BS firms and, in particular, on assessing the role of BS in supporting various types of non-price competitive factors, the most important being the capacity of developing and introducing new products, more effective organizational innovations and new business models. However we also recognise that the demand of BS inputs can respond to a mere cost-cutting outsourcing strategy, carried out by manufacturing firms through the externalization of low value-added and non-strategic service activities. We assume that the relevance of these different potential sources of competitiveness affected by BS is likely to differ depending on the strength and the quality of the linkages between the manufacturing and the service sector and in particular on the type of BS input provided and user sector.

The methodology used to assess the impact of BS on export shares of manufacturing industries also presents some element of originality. The data-set used in the empirical analysis is the result of the merging of three industry level 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. In particular, the combination of CIS and input-output data allows us to measure both the economic and innovation contents of the BS inputs used by manufacturing industries. Due to data-constraints (and in particular to the merging process of different statistical 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 and type of manufacturing industries 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 and draws from them some policy implications.

2. Literature review

As already stressed in the previous section, in the last two decades business services have grown much faster than the rest of the economy. The interpretation of the rapid growth of BS

has somewhat changed over time. Originally, the growth of BS has been interpreted as the result of outsourcing strategies of manufacturing firms, with the latter externalizing to BS service tasks and functions previously located within their organizational boundaries[2]. In this perspective, outsourcing activities have been seen as strategies aiming at reducing production costs and increasing production efficiency and flexibility, with no - or only marginal - qualitative changes in the type of service input used. Transaction costs theory has often been used to interpret the motives behind the "make or buy" decision applied to service actitvies and inputs (Walker and Weber 1984, 1987; Lyons 1995), with two opposite forces coming into play in the outsourcing decision: on the one hand, the presence and relevance of market imperfections (asymmetric information and moral hazard) favoring the "in-house" production; on the other hand, the scope for production efficiency and cost reductions gains obtainable through outsourcing. The most recent literature seems however to acknowledge that "costs" and "static efficiency gains" might not be the only factors behind outsourcing strategies and the choice of taking advantage of the existence of specialized service providers. Several contributions, adopting the resource based view, have in fact started to recognize that relevant motivations behind firm's outsourcing decisions are related to creating dynamic competitive advantage and developing capabilities across organizational boundaries (Espino-Rodriguez and Padron-Robaina 2006).

What these later contributions suggest is that the growth of business services, and its associated impact, cannot be fully understood within the interpretive lenses of the traditional outsourcing literature. On the one hand, the rising service content of many production actitivites and products can be associated to more general phenomena such as the increasing organizational complexity of production and distribution models and the rise of coordination costs and problems (Francois and Woerz 2008)[3]; on the other hand, the emergence and rapid growth of the BS sector can be interpreted as a sign of a paradigmatic change in the processes and mechanisms responsible for the generation and diffusion of knowledge in modern and increasingly internationalized economic systems (Massini and Miozzo 2010). In fact, a consolidated body of literature sees BS as the modern providers and diffusers of knowledge, able to generate externalities and to positively affect aggregate labor productivity and

[2] Bhagwati (1984) has suggested that business services appear to be a growing sector in part because firms are externalising service activities that were formerly performed inside the firm.

[3] However, the extent to which the outsourcing of service tasks and activities by manufacturing firms represents a viable and effective strategy to reduce costs and coordination problems remains a debated issue, especially in the case of the most strategic and highly value added service functions (Bengtsson and Dabhilkar 2008; Windrum et al. 2009).

economic growth (Antonelli 1998; Tomlinson 2000; Guerrieri et al. 2005; Crespi 2007; Rubalcaba and Kox 2007; Maggi and Muro 2013; Desmarchelier et al. 2013). ICT have played an important role for the emergence of a "market for knowledge", increasing the stockability, transportability and tradability of information, releasing it from some time-spatial indivisibilities and constraints characterizing the production, storage and transmission of information and codified knowledge. In this perspective, the diffusion of ICTs and the growth of BS take place as parallel interdependent processes reshaping the structure of knowledge flows and the technological interdependences in the economy as a whole (Castellacci 2008). There is no doubt that the sub-set of BS named as Knowledge Intensive Business Sectors (KIBS) are the key players in this process of strutcural change.[4]

Also the literature on KIBS has progressively enlarged its original focus, with important implicatons also fo the analysis of the economic effects of the BS sector as a whole. In fact, 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. 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 (Corrocher et al. 2009; Miles 2012; Consoli and Elche 2013).[5] Furthermore, far from being constituted by pure market transactions of generic or abstract knowledge these linkages have been 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)[6].

Also 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. In fact, BS include a rather heterogeneous set of service activities which nonetheless should have one common feature, namely the potentiality of "affecting the quality

[4] 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 2012).

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

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

and efficiency of the production activities by complementing or substituting the in-house service functions" (Kox and Rubalcaba 2007a, p. 4).

This capacity of affecting the performance of client industries remains however higly differenciated, 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), the ways in which these services match and complement internal firms' competencies and assets (Miles 2012).

Taking empirically into account this heterogeneity and its economic impact 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 by BS to the rest of the economy as well as to disentangle the different mecchanisms through which BS affect the performance of user industries.

Most of the empirical literature on BS and its economic impact has looked at the effects of this sector on the productivity and growth performances of the client industries or at a macroeconomic level.[7] An area that has remained largely univestigated is the contribution of BS to international competitiveness, and this at any possible level of aggergation (country, sector and firm). This is somewhat surprising, especially taking into account the existence of a very large and consolidated body of literature investigating the linkages between innovation and international trade performances of firms, sectors and economies at large[8]. As well known, 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 the introduction of technologically new products and processes, along with price and cost competitive factors, is the key factor allowing firms to maintain and increase market shares, especially in science based sectors. One characterizing feature of this line of research has been its main focus on the role played by internal (to the sector) innovation variables as sources of international competitiveness. An exception is represented by the studies looking at the inter-sectoral technological linkages and at their potential role for explaining the competitive performance of the industries benefitting from knowledge flows across industries (Fagerberg

[7] For a review of this stream of literature see Evangelista et al. (2013).

[8] 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 and has been further developed using a wider range of technological indicators, taking into account the dynamic nature of the 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).

1997; Laursen and Meliciani 2000, 2002)[9]. 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. It is worthwhile to note however that the bulk of this literature maintains a clear manufacturing focus and adopts a strict technological perspective of these linkages and their effects.[10]

It is possible to synthesise this review section by stating that the literature investigating the economic impact of BS is characterized by the following traits and caveats: it has overlooked the potential role of BS in supporting a very relevant performance variable of client industries that is their international competitiveness; it has explored these effects in a rather basic and aggregate fashion, taking into account the acquisition and use of BS inputs in purely quantitative terms and without distinguishing these effects according to the type of BS input delivered and type of client industry.

This paper aims at moving a step ahead in this research area by shedding new light on the contribution of BS to the international competitiveness of manufacturing industry taking explicitly into account the heterogeneous nature of BS industries, type of user sectors and sources of competitiveness affected by BS. As it will be discussed in the following section this heterogeneity of linkages and effects will be empirically addressed taking into account two distinct groups of BS industries and two different branches of client industries on the basis of a unique industry-level data-set.

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

[9] Laursen and Meliciani (2010) have analysed the role of ICTs knowledge flows on international competitiveness using bibliometric data.

[10] As far as we know, there are only a couple of studies that have examined the impact of services in general and BS in particular on the international competitiveness of the sectors purchasing and using intermediate intangible inputs. 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 for 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. Wolfmayr (2008) estimates (for 16 OECD countries over 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.

taking into account two important sub-sectors: "Communication and computer related services" (64 and 72 Nace-Rev1 classification) and "Other business activities" (74 Nace-Rev1). 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).

As already indicated we are mainly interested in capturing the dynamic efficiency gains manufacturing firms can obtain purchasing intangible inputs from BS. One important assumption of this study is that these gains are likely to be positively correlated to both the size and qualitative (innovation) content of BS inputs. 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).[11] In particular we 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 provides 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[12]. The table shows that the most innovative BS sector is found in Germany and the least innovative in Spain, mirroring the technological ranking of the manufacturing industries of the 5 countries taken into account in this study.

[11] 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 (Pianta et al. 2011). In this study we use only CIS3 and CIS4 data, that is those covering the periods 1998-2000 and 2002-2004.

[12] 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.

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 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 sector.

Table 2 shows the values of this index, computed - with reference to the acquisition of total BS inputs - by several types of down-stream industries and namely by the total manufacturing sector, the four Pavitt's industry categories (Pavitt 1984), the total service sector, the business service industry and the other (non-BS) service sectors.. Germany and France show the highest values of the index in the majority of manufacturing sectors. The rather low levels of the index in the case of UK are somewhat surprising. However, the table shows that UK service sectors are indeed high users of BS, and in particular UK business service firms are the most intensive buyers of BS inputs. 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.

It is worth noticing that service sectors are more heavy users of BS inputs than manufacturing industries and this reflects the greater importance that intangible inputs play in the tertiary sector. It is also interesting to highlight the high stability over time of these indicators (2000-2005), with the only partial exception of science based and Business service industries. This stability signals the structural nature of the sectoral interdependencies between BS and the other sectoral branches of the economy.

Tables 3 and 4 show our BS indexes computed separately for the two main sub-sectors, i.e. the more technology intensive and innovative BS services (Table 3), such as information and communication services (Communication and computer related services), and the heterogeneous "Other business services" sector (Table 4). 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 Communication and computer related 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 Communication and computer related services is around 1% in all countries. In the case of UK we find once again low levels in the use of Other BS services inputs by manufacturing sectors as opposed to an intensive use of these inputs by the service sectors while this asymmetry is not found in the case ICT related related inputs. Somewhat surprising are also the figures for Italy where the share of Communication and computer related 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. More generally, Table 4 shows an implicit correlation between the technological intensity of downstream sectors (proxied by Pavitt categories) and the intensity in the use of Communication and computer related services. This might signal the existence of a broad complementary relationship between the acquisition of ICT related service inputs and the internal technological efforts of manufacturing firms. In fact, in all countries, the highest users of Communication and computer related services are – within manufacturing - "science based", and "specialised supplier" sectors while "scale intensive" and "supplier dominated" sectors make a relatively a lower use of these service inputs.[13]

Finally, it is interesting to point out that, with the only exception of Germany, in all other countries traditional manufacturing sectors and high technology industrial sectors do not significantly differ from each other in the use of the least technological business services industries (i.e. "other BS inputs"), and 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.

[13] More generally, the complementary and/or supporting role of ICT service inputs play with respect to the internal innovation efforts of manufacturing firms emerges from the analysis of the correlation coefficients (not reported but available on request) between the use of these inputs and various innovation indicators, and in particular those measuring the R&D intensity of down-stream industries and the importance attached to strategies aiming at improving product quality or extending/entering into new markets. These correlation coefficients remain positive and significant also controlling for the presence of industry (Pavitt) and country fixed effects.

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

The main research hypothesis that is empirically tested in this study is that BS are able to enhance the international competitiveness of manufacturing industries. In particular we assume that the contribution provided by BS is twofold. BS can have an impact on the performances of user industries through two different channels and namely by: a) sustaining and enhancing the innovative capability of user industries with a possible impact on international competitiveness through a higher ability to introduce new products; b) introducing new organizational and business models as well as more effective marketing strategies to penetrating international markets. In both cases we expect that BS contribute to develop capabilities across organizational boundaries and to strengthen firms' position in the global value-chain. Both channels may, therefore, impact on the so called "non price" factors of international competitiveness of manufacturing industries, in particular those based on the quality upgrading of products, organizational structures and business models. However, we do not rule out the possibility that the acquisition of BS input might also respond to the outsourcing of low value added activities, that is a competitive strategy merely based on lowering production costs and prices.

As anticipated in the previous section and stressed in the literature (Shearmur and Doloreux 2013), it is likely that the relevance of mechanism a) and b) is somewhat sector-specific, that is it could vary according to the type of BS inputs and type of manufacturing industry. Although it is difficult to formulate clear-cut research hypotheses regarding the possible complementary relationships between the use of the two groups of BS inputs taken into account in this study and the technological profile of the user sector, we might expect that:

a) the acquisition of Communication and computer related services is likely to complement "internal" innovation efforts and competencies of client industries, enhancing their innovation capability and, in particular, their capacity to develop and introduce new products; we also expect that these effects will be more relevant and significant for the most innovative and technologically intensive manufacturing industries;

b) the acquisition of inputs provided by the "Other business activities" sector is likely to respond to the need to enhance the internal organizational and marketing competencies of manufacturing firms; however, due to the high heterogeneity of this sector, the use of this type of inputs may also be associated to less innovative strategies, and in particular to outsourcing practices aiming at increasing internal production efficiency and reducing

costs. Both types of strategies might therefore enhance the international competitiveness of user industries (especially in the case of low and medium technology sectors) although supporting different type of strategies and sources of competitiveness. In particular, the acquisition of service inputs such as consultancy, legal services and marketing, may contribute to enhance the innovation and organizational capabilities of a good section of the so-called traditional industries; on the other hand, the outsourcing of labour intensive and low-value added service function might represent a viable and effective strategy in order to tackle the competitive pressure in markets and industries where price/cost competitiveness is dominant[14].

Relevant indications on the hypotheses discussed above 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 services and others BS) and using as additional regressors a set of CIS variables identifying different types of innovation strategies and competitive factors. In synthesis, the three research questions empirically addressed in this section 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:

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

[14] In the empirical analysis this effect will be partly captured by cost variables.

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 labor cost; *BS* is the intensity in the use of BS inputs (see equation 2); country (μ_i), sectoral/Pavitt groups (λ_k) and a time dummy (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 labor cost as important or very important objectives of their innovation activities) (Crespi and Pianta 2007). Among the variables listed above those capturing the relevance of non-price related competitive strategies include the R&D indicator and the CIS variable indicating the importance of improving products; the relevance of cost-price based competitive strategies is proxied by the *ULC* variable and the CIS indicator measuring the importance of reducing costs as well as the expenditures on new machinery and equipment). Table 5 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.[15] The first term varies from sector to sector and captures the degree of connectivity between BS 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.[16] Due to availability of data, the second term is calculated only for 2004 (the final period) and extended to both periods.[17]

4.3 Data and descriptive statistics

Table 6 shows the main descriptive statistics for each variable used in the econometric regressions. 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 (Eurostat 2004).

[15] 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).

[16] The basic idea behind our "innovation-weighted BS intensity indicator" is similar to that adopted by Papaconstantinou et al. (1998) in order to measure embodied technology diffusion across sectors. In this study the technology embodied in a product of an industry is computed 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.

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

Changes in export shares correspond to changes in the level of international (export) competitiveness of each country in each manufacturing sector.[18] 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 related service inputs can be detected from the data. Unit labour costs appear as stable.

4.4 Regression results

Table 7 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 new machinery and equipment per employee). Column 2 reports the results of a richer specification and namely one including as regressors two additional CIS variables reflecting the dominant innovation strategy pursued in the sector (the share of firms aiming at increasing product quality and the share of firms aiming at reducing labour costs). Moreover, the unit labour costs indicator is decomposed into two variables: labour compensation per employee (the cost component of *ULC*) and the value added per employee (the productivity component).

The table provides us with several interesting insights. First, the use of BS seems 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

[18] 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.

quality positively affect export market shares, the mere acquisition of new machinery and equipment as well as strategies aiming at reducing labour costs are associated with losses in export shares. This suggests that – especially in the case of advanced economies - relying upon the introduction of process innovations (with the 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 R&D activities. Finally, price competitiveness (unit labour costs) is important – with the usual ceteris paribus clause - for gaining export shares[19]. However, when decomposed, it appears that what really matters for gaining market shares is labour productivity.

As already pointed out, the business service sector provides a heterogeneous array of intermediate inputs each 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 sectors, such as "Computer and related activities" and "communication services", providing inputs with a high technological content; other BS sectors are characterized by delivering input to client industries that are not strictly technological in nature. A high degree of heterogeneity characterizes in particular 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 on the international competitiveness of downstream industries of both the Communication and computer related services and Other business services 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: Communication and computer related services and "Other business services". Results of the two regression estimates are shown in Table 8.

[19] The different results of the unit labour cost variable (lower unit labour costs help increasing export shares) and the variable capturing the strategies aiming at reducing labour costs (these strategies are either ineffective or counter-productive) can be explained considering that lower unit labour costs might depend not only on lower employees' remuneration but also on higher labour productivity. Moreover, strategies devoted to reduce labour costs might signal the difficulty to compete in domestic and international markets.

Regression results show that while Communication and computer related services contribute to enhance export market shares of downstream sectors in both medium-high-tech and medium-low-tech sectors, Other business services contribute to the international competitiveness of the most innovative manufacturing industries only. There are two possible (complementary) 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 strategy has not proved to be successful.

As far as the other technological inputs, 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 to exert any positive effect on international competitiveness. In the same sectors both the level of labour productivity (with a positive sign) and labour costs (with a negative sign) do affect market shares. Differently from common wisdom, it appears that in low-technology sectors traditional inputs (expenditures in new machinery and equipment), and strategies devoted to reduce production costs, have a negative impact on export shares, while the labour costs coefficient is negative (as expected) but not statistically significant[20]. Innovation strategies devoted to improve product quality and a higher labour productivity have on the contrary a clear positive and significant impact on the international competitiveness of low technology 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.

[20] The lack of statistical significance of the labour cost (wage) coefficient in low-tech industries might be explained by the fact that this variable might capture in these industries not only a cost-related competitive factor but also the quality/skill content of the labour factor.

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. Secondly, the role of BS has been examined distinguishing between different types of service inputs (ICT and Other business services) and different types of user sectors (high and low-tech manufacturing industries). 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 the manufacturing industry and on the economic impact (in terms of international competitiveness) of the use of BS inputs.

The first message emerging from the descriptive analysis (Section 2) is that the intensity in the use of BS depends first of all on the technological profile of the user sectors. The most innovative manufacturing sectors demand a high quantity of business services. A straightforward implication of this finding is that the aggregate 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) activating virtuous (and vicious in the opposite case) circles that are likely to increase divergence across EU 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. Despite these are inputs with a much lower technological and innovation content (when compared respect to Computer and communication services) they can play a very important role in sustain the innovation and economic performances of manufacturing industries. In fact, these services include also knowledge intensive activities (legal and accounting, management, architectural and engineering activities, advertising and market research, etc.) and their important role for both innovation and international

competitiveness is somewhat proven by the large use that high technology manufacturing sectors make of these inputs.

The preliminary indications emerging from the descriptive analysis are largely 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 the amount (and innovation content) of BS inputs delivered to the manufacturing industries play a role in sustaining the international competitiveness of downstream industries, contributing to increase their export market shares. 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.

These results support our hypothesis that BS impact on the so called "non-price" factors of international competitiveness, in particular those based on quality upgrading of products, organizational structures and business models.

The evidence emerging from 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 our econometric estimations show a different impact of the various typologies of service inputs depending on the technological content of downstream sectors. While the use of ICT related 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. In order to interpret these results we have to consider that the acquisition of BS inputs might respond, especially in traditional industries, to the outsourcing of low value added activities with a very limited scope for the improvement of internal organizational models, innovation performances and product quality. This type of defensive strategy appears to be ineffective in sustaining international competitiveness, as also shown by the negative impact of strategies aimed at reducing production costs on the export market share of traditional manufacturing industries.

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. Moreover they can help firms to develop capabilities across organizational boundaries thus strengthening their position in the global value-chain. 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
- Communication and computer 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 total BS inputs* by manufacturing and service indstries (2005)
Expenditures for the acquisition of BS inputs as % of total production output

	Total manufact. ind.	*Science based ind.*	*Special. suppliers ind.*	*Scale intensive ind.*	*Supplier dominated ind.*	Total service sectors	*Business services*	*Other service sectors*
Germany	7.5%	10.3%	8.4%	6.5%	6.7%	11.2%	22.4%	7.3%
UK	4.0%	4.6%	4.6%	3.4%	4.1%	14.9%	23.4%	11.6%
France	7.5%	8.7%	7.2%	7.0%	7.7%	14.1%	22.9%	10.6%
Italy	4.9%	4.7%	5.8%	5.0%	4.4%	11.2%	19.2%	9.0%
Spain	5.7%	8.5%	5.4%	4.8%	6.0%	8.1%	16.9%	5.8%
Total**	5.9%	7.4%	6.3%	5.3%	5.8%	11.9%	21.0%	8.9%
Var. 2000-05**	0.3%	1.4%	1.0%	-0.5%	0.2%	0.2%	1.3%	-0.7%

Source: OECD input/output data. *: includes inputs purchased from sectors 64, 72 and 74 (Nace-Rev1); **: 5 country average

Table 3 - Intensity in the use of ICT-BS inputs* by manufacturing and service indstries (2005)
Expenditures for the acquisition of BS inputs as % of total production output

	Total manufact. ind.	*Science based ind.*	*Special. suppliers ind.*	*Scale intensive ind.*	*Supplier dominated ind.*	Total service sectors	*Business services*	*Other service sectors*
Germany	1.0%	1.3%	1.2%	1.0%	0.7%	3.4%	8.5%	1.7%
UK	1.2%	1.5%	1.4%	1.0%	1.1%	4.9%	5.7%	4.6%
France	1.1%	1.4%	1.2%	0.9%	1.0%	4.0%	7.0%	2.8%
Italy	1.2%	1.4%	1.5%	1.2%	1.0%	4.0%	7.7%	3.0%
Spain	0.9%	1.6%	0.7%	0.7%	1.0%	3.4%	10.4%	1.6%
Total**	1.1%	1.4%	1.2%	1.0%	1.0%	3.9%	7.9%	2.7%
Var. 2000-05**	0.2%	1.0%	0.7%	-0.3%	0.3%	0.3%	-1.0%	0.3%

Source: OECD input/output data. *: includes inputs purchased from sectors 64 and 72 (Nace-Rev1); **: 5 country average

Table 4 - Intensity in the use of Other BS inputs* by manufacturing and service indstries (2005)
Expenditures for the acquisition of BS inputs as % of total production output

	Total manufact. ind.	*Science based ind.*	*Special. suppliers ind.*	*Scale intensive ind.*	*Supplier dominated ind.*	Total service sectors	*Business services*	*Other service sectors*
Germany	6.5%	9.0%	7.2%	5.5%	5.9%	7.7%	14.0%	5.6%
UK	2.8%	3.2%	3.2%	2.4%	3.0%	10.0%	17.6%	7.1%
France	6.5%	7.3%	6.0%	6.1%	6.7%	10.1%	15.9%	7.8%
Italy	3.7%	3.4%	4.3%	3.8%	3.4%	7.2%	11.5%	6.0%
Spain	4.8%	6.9%	4.7%	4.1%	5.1%	4.7%	6.5%	4.2%
Total**	4.9%	5.9%	5.1%	4.4%	4.8%	7.9%	13.1%	6.1%
Var. 2000-05**	0.0%	0.4%	0.3%	-0.2%	0.0%	-0.1%	2.3%	-1.0%

Source: OECD input/output data. *: inputs purchased from sector 74 (Nace-Rev1); **: 5 country average

Table 5 - 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 6 - 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 Communication and computer BS (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
Labour compensation per employee at constant prices (th. of euros base year 2000)	33.66	13.09	13.07	94.21
Value added per employee at constant prices (th. of euros base year 2000)	54.00	28.36	19.53	229.56
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 Communication and computer BS (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
Labour compensation per employee at constant prices (th. of euros base year 2000)	33.66	13.09	13.07	94.21
Value added per employee at constant prices (th. of euros base year 2000)	54.00	28.36	19.53	229.56

Table 7 - The impact of BS on the export performances of manufacturing industries
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	***	-0.088	-4.42	***
R&D expenditure per employee	0.001	2.79	***	0.001	2.91	***
Expenditure for new machinery and equipment per employee	-0.002	-2.54	**	-0.002	-2.38	**
% of firms aiming at improving product quality				0.001	2.15	**
% of firms aiming at reducing labour cost				-0.001	-3.10	***
BS innovation weighted index	0.002	2.10	**	0.001	2.10	**
Labour cost per unit of product	-0.064	-2.69	***			
Labour compensation per employee				0.000	-0.79	
Value added per employee				0.000	2.82	***
Germany	0.032	3.30	***	0.021	2.14	**
France	-0.021	-2.27	**	-0.023	-2.41	**
Italy	-0.011	-1.66	*	-0.013	-1.79	*
Spain	-0.008	-1.42		-0.013	-2.06	**
Science based	-0.021	-2.32	**	-0.028	-2.55	**
Specialised suppliers	-0.008	-1.10		-0.015	-1.72	*
Scale intensive	0.000	-0.08		-0.004	-0.62	
Dummy t2 (second period)	0.001	0.31		-0.002	-0.76	
Constant	0.048	2.63	***	0.008	0.63	
R-Squared	0.404			0.480		
Numero di osservazioni	180			178		
Prob > F	0.000		***	0.000		***

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

Table 8 - The impact of BS on the export performances of hi-tech and low-tech manufacturing industries (OLS estimates)

Dependent variable	**High-tech manufact.**			**Low-tech manufact.**		
Export market share variation (t, t-1)	*Coeff.*	*t value*	*Sig*	*Coeff.*	*t value*	*Sig.*
Export market share (t-1)	-0.067	-1.00		-0.072	-3.43	***
R&D expenditure per employee	0.001	1.70	*	0.001	0.97	
Expenditure for new machinery and equipment per employee	-0.001	-0.46		-0.003	-2.46	**
% of firms aiming at improving product quality	0.000	-0.18		0.001	1.75	*
% of firms aiming at reducing labour cost	-0.001	-0.67		-0.001	-2.66	***
Communication and computer BS (innovation weighted index)	0.002	1.76	*	0.003	2.44	**
Other BS (innovation weighted index)	0.008	2.13	**	0.000	-0.55	
Labour compensation per employee	-0.001	-2.82	***	0.000	-0.84	
Value added per employee	0.001	2.43	**	0.000	2.53	**
Germany	-0.003	-0.07		0.031	3.51	***
France	-0.034	-1.34		-0.015	-2.04	**
Italy	0.008	0.46		-0.015	-1.79	*
Spain	-0.009	-0.51		-0.010	-1.20	
Science based	-0.018	-1.68	*	-		
Specialised suppliers	-			-		
Scale intensive	-			0.000	-0.03	
Dummy t2 (second period)	0.000	-0.02		-0.001	-0.37	
Constant	-0.026	-0.69		0.011	0.80	
R-Squared	0.623			0.494		
Number of observations	60			118		
Prob > F	0.004		***	0.000		***

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

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

Nace Rev.1 Isic Rev.3	*Sectors name*	**Pavitt's group***
15	FOOD PRODUCTS, BEVERAGES	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	SI
22	PRINTING AND PUBLISHING	SI
23	MANUFACTURE OF COKE, REFINED PETROL AND NUCLEAR FUEL	SI
24	CHEMICALS AND CHEMICAL PRODUCTS	SB
25	RUBBER AND PLASTICS PRODUCTS	SI
26	OTHER NON-METALLIC MINERAL PRODUCTS	SI
27	BASIC METALS	SI
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	SI
35	OTHER TRANSPORT EQUIPMENT	SS
36-37	MANUFACTURING NC AND RECYCLING	SD

*: SD: Supplier dominated; SI: Scale intensive; SS: Specialised suppliers; SB: Science based