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The increasing service intensity of European manufacturing

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In this study, using fixed-effects models based on the manufacturing sector for 18 European Union countries for the period 1995–2008, we find that the employment share of service occupations is significantly and positively related to the output share of producer services in manufacturing. In particular, the increase in the output share of services accounts for an average of 13% of the increase in the share of service occupations. When service occupations are disaggregated by different categories, we find that the output share of services is significantly and positively related to the share of managers, professionals, and technicians. In contrast, the remaining service occupations do not benefit from the increase in service revenues. Finally, professionals and technicians are complementary to purchased services (from either domestic or foreign suppliers).

Keywords: service occupations; servitization; intermediate service inputs; global sourcing; manufacturing sector

Introduction

The interaction between manufacturing and services has increased rapidly in recent decades (Bryson & Daniels, 2010; Francois & Woerz, 2008; Pilat & Woelfl, 2005). On the output side, manufacturing firms increasingly offer services in combination with their products (Neely, 2008) and/or services that are embedded in new physical products (Bryson & Daniels, 2010). Indeed, data based on European Union (EU) and OECD input–output (I–O) tables show that in the EU-15 countries, the share of producer services in total manufacturing output increased by about one percentage point between 1995 and 2007. On the input side, we observe an increase in the share of intermediate service inputs from abroad. This indicates that firms are increasingly active in global sourcing of producer services. Furthermore, there has been a strong increase in the share of service occupations in the manufacturing sector, showing a widespread shift in the production process towards service functions. Data based on the EU Labour Force Survey (EU-LFS) for the manufacturing sector in the EU-15 countries shows that the share of service occupations rose from 37% to 42% between 1993 and 2008. However, this increase was uneven across different categories of service occupations. While there was a strong increase in the employment share of supervisors, professionals, and technicians, the share of clerks and market shop sales workers was almost stable during the same time period. In addition, production-related occupations decreased rapidly during the same period.

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This paper investigates the impact of the increase in the output share of services on the demand for different categories of service occupations in the manufacturing sector. Another question researched herein deals with the categories of service occupations (e.g. professionals, technicians, and clerks) that benefit most from the increase in service revenues. Furthermore, we investigate whether purchased services (from either foreign or domestic suppliers) are complements or substitutes to in-house services.

This paper contributes to the literature on the increasing integration of manufacturing and services in a number of ways. To our knowledge, this is the first paper to investigate the link between the increase in manufacturing sector's service offerings and the demand for different in-house service functions, which are measured as occupations. In addition, we use different sources of I–O tables – namely from the OECD and EU – to construct different measures of the output share of producer services in manufacturing. We also construct several different measures of intermediate producer services, such as the ratio of domestically purchased services and those purchased abroad to total output. Since purchased services include activities that add varying amounts of value, we use both total producer services (transportation, financial, and business services) and the subgroup of business services only. The empirical analysis concentrates on the manufacturing sector because this is the only sector in which the trend towards service occupations can be observed (except for construction and mining with similar tendencies). The employment share equations are estimated using the standard two-way fixed-effects model with robust standard errors.

The structure of this paper is as follows: the second section summarizes the previous literature; the third section introduces the empirical model and the hypotheses; the fourth section presents the data used and some descriptive statistics, while the empirical results are discussed in the fifth section. Some concluding remarks are provided in the sixth section.

Literature review

Anecdotal and case study evidence suggests that manufacturing firms generate an increasing share of revenues from services (e.g. Antioco, Moenaert, Lindgreen, & Wetzels, 2008; Fang, Palmatier, & Steenkamp, 2008; Gebauer, 2007; Howells, 2004). This trend is commonly referred to as 'servitization', the servicing of manufacturing (Baines, Lightfoot, Benedettini, & Kay, 2009; Bryson & Daniels, 2010; Howells, 2004; Neely, 2008; Vandermerwe & Rada, 1988), product service solutions (Johnstone, Dainty, & Wilkinson, 2008), or the service infusion of manufacturing (see the special issue of the Journal of Service Management 2011). Manufacturing firms' service offerings typically include design and development services (ICT) systems and solutions, maintenance and support services, and installation and implementation services, but also financial services, property and real estate services, and consulting (Neely, 2008). However, Schmenner (2009) suggested that the integration of manufacturing and services is not a new concept, but one that arose 150 years ago.

Furthermore, not only there has been an increase in the share of service occupations combined with an increase in service offerings in manufacturing, but there has also been an increase in the demand for intermediate service inputs from both domestic and foreign suppliers. The increase in service revenues together with the rise of intermediate services is referred to as services duality (Bryson & Daniels, 2010). The rapid diffusion of ICT has made it possible to source services globally. In fact, the previous literature shows that the international trade in intermediate services is growing substantially faster than that in

intermediate goods (Jensen, 2008; Lejour & Smith, 2008; Miroudot, Lanz, & Ragoussis, 2009). However, the bulk of producer services is still sourced from domestic suppliers. Overall, it seems as though the growing share of service workers in manufacturing has been accompanied by a rise in intermediate service inputs and in the output share of services. However, intermediate producer services from abroad and the share of service occupations are growing faster than the share of service revenues in manufacturing. There are several underlying factors that contribute to the rising importance of services in manufacturing. These include increasing product complexity, product differentiation, and access to new and superior services that complement in-house services (Francois, 1990; MacPherson & Vanchan, 2010; Peneder, Kaniovski, & Dachs, 2003).

While the amount of literature on the extent, characteristics, and determinants of the servitization of manufacturing based on firm-level data (Bascavusoglu-Moreau & Tether, 2010; Fang et al., 2008; Howells, 2004; Lay, Copani, Jäger, & Biege, 2010; Leo & Philippe, 2001; Neely, 2008; Neely, Benedettini, & Visnjic, 2009) is growing at a rapid pace, relatively few studies have examined the consequences of the rising output of services in manufacturing for the occupational structure of the workforce in the manufacturing sector. There is also a large and quickly growing body of literature on the role of intermediate service inputs in manufacturing based on I–O tables (Francois & Woerz, 2008; Peneder et al., 2003) and on survey data (see, e.g. Juleff-Tranter, 1996). Furthermore, extensive literature is available on the impact of intermediate producer services on productivity, output, and manufacturing exports (Drejer, 2002; Fixler & Siegel, 1999; Francois & Woerz, 2008; Ten Raa & Wolff, 2001). These studies show that producer services play an increasing role as suppliers of intermediate inputs in the manufacturing sector (Francois & Woerz, 2008; Peneder et al., 2003) and in the total economy (O'Mahony & Timmer, 2009). Furthermore, intermediate service inputs have a positive effect on productivity growth in the manufacturing sector (see, e.g. Ten Raa & Wolff, 2001). More recently, Francois and Woerz (2008) showed that intermediate business services are significantly and positively related to manufacturing exports, value added, and employment based on data on 24 OECD countries for the period 1994–2004, but only in technology-intensive manufacturing industries. Furthermore, the effects depend on the type of service inputs and are not clear-cut with respect to how financial, insurance, and transportation services influence manufacturing exports and output.

Meanwhile, related literature has investigated the determinants of the use of internal and external producer services (Abramovsky & Griffith, 2006; Broersma & Van Ark, 2007; Pardos, Gómez-Loscos, & Rubiera-Morollón, 2007). For instance, based on UK firm-level data, Abramovsky and Griffith (2006) found that the use of ICTs has a positive effect on both the incidence of business service imports and the share of purchased services. Using industry-level data for the Netherlands, Broersma and van Ark (2007) found that industries with a high share of intermediate service inputs also exhibit a high share of IT investment.

In summarizing the empirical literature, one can conclude that the growing importance of both internal and external services and the rise of service revenues in manufacturing are well documented. However, a striking feature of the empirical literature is that the phenomenon of service differentiation on the output side and the increased use of internal and external services in the manufacturing sector on the input side have been studied in isolation from each other. As such, the studies neglect the impact of the rising output share of services on the change in the occupational structure of the workforce towards service-related occupations – in particular, towards professionals and technicians at the expense of clerks, administrative support, and other office-related occupations. It is

obvious that the increase in the manufacturing sector's service offerings is leading to a shift in the demand for service occupations. One open question in this context concerns the type of service occupations that benefit most from the rise of service revenues in the manufacturing sector. The relation between service inputs and the service output of manufacturing firms is also relevant from a policy standpoint. For instance, the Monti (2010) report stresses the importance of service revenues for European manufacturers, stating 'European industry must move further into the provision of services'.

Empirical model and theoretical background

The importance and characteristics of intermediate services and service offerings in the production process in manufacturing are well documented in the literature. The concept of service duality introduced by Bryson and Daniels (2010) highlights the dual role of services in the production process. First, services are incorporated into manufacturing as intermediate inputs. These are referred to as production-related services. Second, services are developed to support products, which are referred to as product-related services. This often leads to a bundling of goods and services. Examples include new software that is directly embedded in new physical products. Other examples include training and maintenance support for new products. These product-related services not only are provided within the company but can also be offered to external customers (Bryson, 2010). An example is a company that provides training courses for in-house individuals as well as training courses to external clients. Bryson and Daniels (2010) suggested that I–O tables can be used to investigate the patterns and implications of service duality.

Figure 1 illustrates the linkages between the output of producer services, external services, and in-house services in the manufacturing sector. It is assumed that a typical

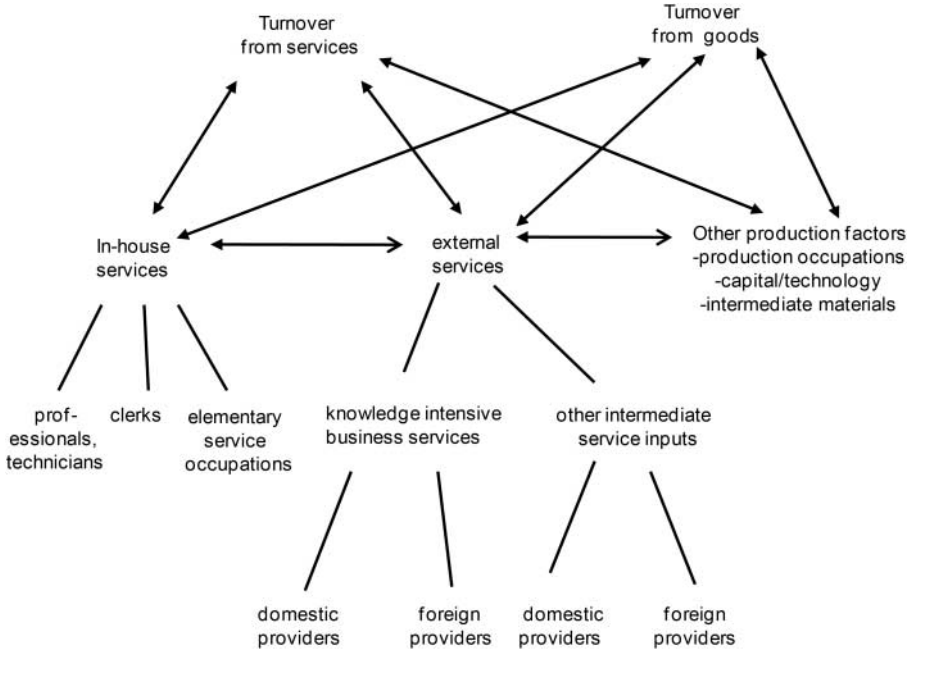

Figure 1. Inputs and outputs of manufacturing firms offering services related to their products.

manufacturing firm offers services in combination with its physical products. In general, both service occupations and intermediate service inputs are important production factors in modern manufacturing. Greenfield (1966) and Francois (1990) suggested that producer services also play an important role in the coordination and control of operations within the manufacturing production process. Other production factors include production occupations, capital and material inputs, and the technological level of the firms.

An increase in the output of services will directly increase the demand for specific service occupations involved in preparing and delivering these services. Manufacturing firms increasing their service offerings are also likely to use more external services. The increase in service revenues also has an indirect effect on in-house service occupations when internal and external services complement each other. In this case, an increase in external services due to an increase in service output will lead to an increase in the demand for service occupations. The complementary relationship between internal and external service inputs is consistent with the resource-based theory of the firm (Barney, 1991; Yasuda, 2005). Barney (1991) suggested that external services are often used as an instrument to access knowledge and skills. Beyers (2005) suggested that external service suppliers often deliver superior knowledge because of their high levels of specialization and new types of business solutions that are unlikely to be found or generated in-house. Similarly, Bryson and Daniels (2010) came to the conclusion that intermediate business services support services produced in-house. Using survey data on 50 manufacturing firms in the USA, MacPherson and Vanchan (2010) found that the purchase of industrial design services is complementary to in-house core competencies. The outsourcing of industrial design services is often related to the acquisition of superior services or totally new services, which is unlikely to reduce in-house services (MacPherson, 2008). Francois (1990) also found that producer services and in-house service functions are complementary to each other based on a theoretical model.

However, intermediate services and in-house services can be substitutes. It can be the case that firms outsource service activities they previously performed in-house; the gains from contracting depend on the transaction costs. This is often related to a strategy in which firms focus on their core competencies by outsourcing their non-core service activities (Hamel & Prahalad, 1990). Such activities can then be sourced from external suppliers. An increase in intermediate service inputs can, therefore, be regarded as an indicator of service outsourcing. The degree of substitutability between external and internal service functions is likely to depend on the type of service activity at hand. Blinder (2009) suggested that service tasks are quite heterogeneous and differ with respect to their potential offshorability, whereas jobs that require face-to-face contact with customers are less vulnerable. Similarly, Moncarz, Wolf, and Wright (2008) suggested that administrative support occupations, such as clerks and data entry positions that require relatively little training, are most likely to be outsourced.

An increase in intermediate service inputs may change the structure of service occupations. Increased use of external services may lead to a rise in in-house activities, particularly in coordinating, monitoring, and controlling of the quality and performance of external suppliers (Williamson, 1975). This will likely raise the demand for professional occupations rather than for elementary or intermediate service qualifications, such as clerks and administrative support personnel.

Another explanation for the expansion of in-house services relates to the rise of multinational enterprise activities in industrialized countries. When firms relocate parts of their services abroad, headquarter service activities expand and the parent companies in question begin importing and exporting more services than before (Lodefalk, 2010).

Finally, it is important to distinguish between knowledge-intensive business services (KIBS) and other intermediate service inputs, such as transportation and financial services. KIBS consist of computer services, research and development, legal activities, accountancy services, market research, management consultancy, architectural activities, technical consulting, and advertising. The importance of KIBS as sources of innovation, output, and productivity is widely acknowledged (Boden & Miles, 2000; Miles, 2005).

Given the theoretical and empirical literature discussed, we derive the following hypotheses:

H1: A rising output share of services is significantly and positively related to the share of service occupations.

H2: The magnitude of the employment effects of the output share of services is likely to be different across different types of service occupations and is expected to increase with the skill level of the service occupations.

H3: The degree of substitutability between intermediate service inputs and service occupations is heterogeneous between different categories of service occupations and also differs with respect to the origin of the service provider (domestic or foreign).

The regression equation can be derived from a flexible cost function in which total costs depend on two types of labour, namely service occupations and non-service occupations. The resulting factor share equation relates the wage bill share of service occupations to output, relative wages, capital, and measures of external services. However, a consistent time series for occupational wages are not available and can, therefore, not be controlled for.[1] Following the related literature, the wage bill share is approximated by the employment share. The determinants of the employment share of service occupations in the manufacturing sector can be described as

$$\frac{\mathrm{LSCVS}_{it}}{L_{it}} = \beta_{1j}\frac{\mathrm{MSCVS}_{ijt}^{\mathrm{DOM}}}{Y_{it}} + \beta_{2j}\frac{\mathrm{MSCVS}_{ijt}^{\mathrm{FOR}}}{Y_{it}} + \beta_{3j}\frac{\mathrm{YSCVS}_{ijt}}{Y_{it}} + \theta_t + \mu_i + \varepsilon_{it},$$

where t denotes time, i denotes country, and $j = 1$ denotes total producer services and $j = 2$ represents KIBS. LSCVS_{it} is the number of service occupations and L_{it} is the total number of occupations (service and production occupations). $\mathrm{MSCVS}_{ijt}^{\mathrm{DOM}}$ denotes services purchased from domestic providers by the manufacturing sector and $\mathrm{MSCVS}_{ijt}^{\mathrm{FOR}}$ denotes services purchased from abroad by the manufacturing sector; both input factors are measured in relation to manufacturing output in basic prices, Y_{it}. YSCVS_{ijt} denotes the output of producer services. m_i is the country effect, q_i denotes a set of time dummy variables, and e_{it} is the error term. A positive sign of b_3 indicates that an increase in the output share of services will lead to an increase in the demand for service occupations relative to total occupations. Positive signs of b_1 and b_2 indicate that in-house services and external sources from either domestic or foreign providers are complementary to each other. Services purchased from abroad are indicators of the extent of global sourcing, while services purchased from domestic suppliers are indicators of domestic outsourcing. As the share of service output and purchased services may have different effects on different service occupations, we also investigated the demand for three different categories of service occupations: (i) supervisors, professionals, and technicians; (ii) clerks; and (iii) other elementary service occupations. The equations will be estimated by the fixed-effects model with cluster-robust standard errors. In addition, we used standard errors that are robust to serial correlation and cross-sectional correlation – as well as arbitrary

heteroscedasticity – as demonstrated by Driscoll and Kraay (1998). Since all variables are I–O ratios or shares, stationarity of the time series is a plausible assumption.

Alternatively, we replaced external services with the ratio of economy-wide service imports to output, $IMSCVS_{it}/Y_{it}$, which led to the following regression equation:

$$\frac{LSCVS_{it}}{L_{it}} = \tilde{\beta}_1 \frac{IMSCVS_{it}}{Y_{it}} + \tilde{\beta}_2 \frac{YSCVS_{it}}{Y_{it}} + \tilde{\theta}_t + \tilde{\mu}_i + \tilde{\varepsilon}_{it}.$$

Note that the ratio of service imports to GDP includes both intermediate and final service imports. The coefficient $\tilde{\beta}_1$ indicates the change in the share of service occupations due a one percentage change in the ratio of service imports.

Data and descriptive statistics

In order to investigate the determinants of service occupations, we used manufacturing industry data for several EU countries by matching aggregate data from the EU-LFS with manufacturing industry data based on I–O tables. We used product-by-product I–O tables for the EU countries that contain information on the use of intermediate services as inputs in the manufacturing sector. In particular, we used the symmetric I–O table (SIOT) at basic prices (including both domestic and imported use) and the SIOT for imports that are available at 5-year intervals for most of the EU countries. For some EU countries, annual SIOTs are available. The EU SIOTs are supplemented with national I–O tables for which data are available (i.e. DE, DK, IT, and UK). The share of purchased (producer) services measures the output of the service industry that is used as an input in manufacturing. We distinguished between total purchased producer services (NACE rev 1.1 55–74) and purchased business-service inputs, which are also referred to as KIBS. The KIBS comprise computer services, management and consulting services, research and development, accounting, and architectural services, as well as a number of low-skilled services, such as cleaning, security services, and call centres (NACE rev.1.1 72–74). However, the low-skilled services only represent a tiny proportion.

One problem in measuring services purchased from abroad is that in some countries (e.g. UK and USA), the tables of imports used are generally compiled using the import proportionality assumption. This assumes that the import share of a product is the same for both intermediate and final users (Feenstra et al., 2010). For most EU countries, however, the assumption is not imposed and direct information is available.

Furthermore, in order to measure the output share of producer services, we used supply tables that include information on the supply of goods and services by product and type of supplier. Again, we distinguished between producer services and KIBS. Note that EU supply tables are not internationally comparable across countries. For Denmark and France, for instance, these tables only contain information on the output of business services. Therefore, we also employed the OECD industry-by-industry I–O tables, which by their nature are more comparable across countries than product-by-product tables.

Service occupations were calculated using the anonymized EU-LFS and population weights. In addition, we used the tabulated data provided by EUROSTAT. The service occupations include self-employed individuals and employees, and we applied the definition used by Pilat and Woelfl (2005). Service occupations are classified into three broad groups: (i) legislators, senior officials and managers, professionals and technicians, and associate professionals (ISCO-88 100–348); (ii) clerks, administrative service personnel, and other office-related staff (ISCO-88 400–522); and (iii) other service occupations

(ISCO-88 830–916+933). Non-service occupations include occupations related to production (such as skilled agricultural and fishery workers, workers in crafts and related trades, plant and machine operators, and those in assembly and basic employment).

Descriptive statistics on the change in the output share of services, intermediate service inputs, and the different service occupations for the manufacturing sector by country are presented in Tables 1–5 and Figures 2–4. We found that the share of service occupations has increased in all EU-15 countries at the expense of production occupations (Table 1). In particular, the share of service occupations has increased rapidly since the year 2000 (Figure 2). Note that the shift in the occupational structure towards service occupations is not a new phenomenon: In the USA, for instance, the increase in service occupations began back in the 1910s (Diamond, 1962) or from the 1950s onwards (Francois, 1990; Kenessey, 1987). However, in the EU-10 countries (i.e. central and eastern EU countries) for which data are available, the share of service occupations is stable over time.

Furthermore, there has been an increase in the share of producer services in total manufacturing output in almost all of the EU-15 countries (see Table 2 and Figure 3). Similar findings can be observed for the OECD I–O tables. Not surprisingly, we found that the output share of producer services is considerably higher when based on OECD industry-by-industry I–O tables (Table 2).

Table 1. Change in the share of service occupations in manufacturing (total and by different categories) (in percent).

	Share of service occupations			Share of supervisors, professionals, and technicians			Share of clerks and office and administrative service occupations			Share of elementary service occupations		
	1995	2000	2008	1995	2000	2008	1995	2000	2008	1995	2000	2008
AT	45	44	47	27	27	28	13	12	11	7	6	7
BE	49	58	55	26	28	34	13	12	12	10	8	9
CY	n.a.	33	39	n.a.	14	15	n.a.	9	14	n.a.	10	10
CZ	n.a.	36	38	n.a.	22	26	n.a.	7	6	n.a.	7	5
DE	n.a.	47	50	n.a.	28	30	n.a.	14	14	n.a.	5	6
DK	45	48	56	24	30	36	13	9	11	8	9	9
EE	n.a.	39	39	n.a.	23	26	n.a.	4	4	n.a.	13	9
ES	30	33	41	16	19	27	8	8	8	6	5	6
FI	n.a.	46	48	n.a.	33	39	n.a.	5	4	n.a.	7	5
FR	44	44	50	27	27	35	12	11	10	6	6	5
GR	29	31	39	13	15	21	10	10	11	6	6	7
HU	n.a.	31	35	n.a.	17	21	n.a.	8	7	n.a.	6	6
IE	41	42	48	22	26	32	12	11	10	6	5	6
IT	31	35	41	18	21	26	10	11	12	3	3	4
LT	n.a.	37	42	n.a.	20	25	n.a.	8	5	n.a.	9	11
NL	55	58	60	31	32	32	16	12	15	8	13	13
PL	n.a.	36	33	n.a.	22	20	n.a.	8	6	n.a.	7	6
PT	31	27	29	15	13	14	11	10	10	5	4	5
RO	n.a.	29	28	n.a.	16	17	n.a.	4	5	n.a.	8	7
SE	n.a.	44	44	n.a.	31	31	n.a.	8	9	n.a.	5	5
SI	n.a.	37	39	n.a.	23	27	n.a.	10	9	n.a.	4	4
SK	n.a.	35	32	n.a.	20	21	n.a.	6	5	n.a.	8	6
UK	48	50	58	30	33	39	12	12	10	5	5	8

Source: EU-LFS, weighted percentages.

Table 2. Change in the output share of services in manufacturing by data source and by type of service (in percent).

	Output share of producer services			Output share of KIBS			Output share of producer services			Output share of KIBS		
	EU I–O tables			EU I–O tables			OECD I–O tables			OECD I–O tables		
	1995	2000	2005	1995	2000	2005	1995	2000	2005	1995	2000	2005
AT	1.9	1.5	2.4	0.9	0.9	2.0	6.0	7.2	7.6	1.0	1.3	2.1
BE	0.9	0.7	1.6	0.7	0.5	1.4	6.9	7.4	6.8	2.1	2.6	1.7
CY	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
CZ	n.a.	1.4	0.9	n.a.	0.5	0.4	n.a.	6.3	5.7	n.a.	1.4	1.3
DE	1.6	1.8	2.0	0.7	0.9	1.0	3.9	3.9	3.8	0.9	1.0	0.9
DK	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	6.9	9.6	11.3	2.6	3.1	2.9
EE	n.a.	1.5	1.3	n.a.	0.2	0.2	n.a.	9.6	10.1	n.a.	1.6	1.8
ES	1.5	1.6	1.7	1.2	1.5	1.6	8.5	10.5	11.1	1.1	2.5	2.5
FI	4.0	7.2	8.4	3.2	6.3	7.9	5.8	5.8	6.9	1.5	1.8	1.7
FR	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	6.6	7.3	8.0	2.6	2.8	3.1
GR	n.a.	0.7	1.1	n.a.	n.a.	n.a.	9.5	14.4	14.4	0.4	1.0	1.2
HU	n.a.	1.3	1.4	n.a.	0.5	0.8	n.a.	6.1	6.1	n.a.	1.5	1.6
IE	n.a.	2.0	2.4	n.a.	1.8	2.2	n.a.	3.9	7.0	n.a.	0.6	1.3
IT	1.3	1.5	1.7	0.8	0.8	1.0	6.8	7.1	8.2	1.5	1.2	1.7
LT	n.a.	1.7	1.6	n.a.	0.5	0.5	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NL	3.1	3.5	3.9	2.7	3.2	3.6	6.1	7.4	7.3	1.8	2.3	1.8
PL	n.a.	1.2	1.5	n.a.	0.4	0.6	7.0	7.6	8.3	n.a.	2.0	2.1
PT	0.7	0.6	0.6	0.7	0.5	0.6	7.0	7.8	8.7	1.5	1.4	1.6
RO	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
SE	2.4	3.6	4.8	1.9	3.1	4.2	8.6	9.1	9.2	3.0	3.8	3.5
SI	n.a.	0.7	1.3	n.a.	0.3	0.7	6.8	6.3	5.9	2.4	2.3	1.8
SK	1.3	1.2	1.5	0.5	0.3	0.7	5.4	5.1	5.5	1.6	1.5	1.7
UK	3.6	4.6	4.7	2.2	3.0	3.3	8.7	10.9	9.5	2.2	2.0	1.7

Source: EU and OECD supply tables.

Note that it is difficult to compare the results for the output share of services based on I–O tables with the findings based on firm-level data. Using Compustat data on large US manufacturing firms, Fang et al. (2008) found a share of service sales in manufacturing of about 42%. Using data from Sweden's statistical office, Lodefalk (2010) found that manufacturers' revenues from services increased from 13.6% to 20.3% between 1997 and 2006. Neely (2008) analysed the business descriptions of large manufacturing firms and found that 30% of those with manufacturing SIC codes – some 10,000 firms in 25 countries – are offering services based on the OSIRIS database. However, the sample is restricted to firms with at least 100 employees, which may lead to overestimation of the share of manufacturing firms offering services. After updating the survey to include about 50,000 firms, Neely et al. (2009) found that the USA has the largest share of manufacturing firms offering services. Among the EU countries, Finland has the highest share of service revenues, followed by the Netherlands, Belgium, Germany, Sweden, Spain, and the UK. Based on survey data for eight European countries, Lay et al. (2010) found that 87.5% of the manufacturing firms are offering services, with a corresponding mean share of turnover of about 15%. Using the UK's Business Structure Database, Bascavusoglu-Moreau and Tether (2010) found that the share of manufacturing firms offering services is about 3.5%, with a share of 4% for the microfirms with nine or fewer employees and 90% for the very large firms with 10,000 or more employees.

Table 3. Change in the ratio of purchased producer services to output in manufacturing (distinguished between domestic and foreign suppliers based on EU I–O tables) (in percent).

	Share of producer services from domestic providers			Share of KIBS from domestic providers			Share of producer services from abroad			Share of KIBS from abroad		
	1995	2000	2005	1995	2000	2005	1995	2000	2005	1995	2000	2005
AT	14.5	14.7	16.4	3.2	3.5	3.1	0.9	1.4	2.4	0.3	0.4	0.9
BE	13.3	16.6	16.2	3.2	4.4	4.0	2.2	2.6	2.6	0.5	0.9	1.0
CY	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
CZ	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
DE	16.8	19.1	18.3	6.2	7.0	6.9	0.6	1.1	1.1	0.2	0.5	0.5
DK	13.6	13.5	14.6	2.5	3.2	4.0	0.5	1.9	2.9	0.4	0.6	1.2
EE	n.a.	11.9	12.4	n.a.	1.5	1.9	n.a.	1.2	1.5	n.a.	0.6	1.0
ES	14.0	14.4	16.4	3.6	4.2	4.8	1.1	2.2	2.1	0.7	1.3	1.3
FI	10.5	15.1	14.9	3.6	3.4	3.6	2.6	3.0	3.6	1.5	2.7	3.2
FR	18.2	19.5	21.7	7.4	8.4	9.1	0.8	0.9	1.1	0.3	0.4	0.5
GR	n.a.	14.6	18.5	n.a.	3.4	3.7	n.a.	0.5	0.6	n.a.	0.2	0.2
HU	n.a.	8.6	11.7	n.a.	1.9	3.3	n.a.	2.6	3.2	n.a.	2.3	2.5
IE	n.a.	6.9	8.6	n.a.	1.4	2.6	n.a.	23.3	30.6	n.a.	15.3	23.9
IT	17.0	19.2	20.1	3.5	4.2	4.3	1.4	1.7	1.9	0.4	0.5	0.7
LT	n.a.	15.5	14.5	n.a.	0.5	0.6	n.a.	1.5	0.6	n.a.	0.1	0.1
NL	11.7	12.5	15.5	4.1	5.5	5.1	1.7	2.1	3.2	0.7	1.4	2.0
PL	n.a.	20.0	18.9	n.a.	3.4	4.0	n.a.	0.5	0.5	n.a.	0.2	0.3
PT	13.5	14.7	13.7	3.9	4.5	3.5	0.5	0.5	0.6	0.2	0.2	0.2
RO	n.a.	13.1	13.9	n.a.	0.3	0.5	n.a.	1.1	0.6	n.a.	0.1	0.1
SE	17.4	19.7	19.0	5.2	7.4	6.7	1.9	3.7	4.1	0.8	2.5	2.6
SI	12.6	12.1	13.7	1.8	2.4	2.9	1.3	1.7	1.4	0.2	0.4	0.7
SK	n.a.	9.9	9.4	n.a.	1.0	1.6	n.a.	2.8	2.3	n.a.	1.3	1.2
UK	15.2	18.1	18.5	3.4	3.9	4.0	0.7	0.8	0.9	0.3	0.4	0.4

Source: EU I–O tables.

Table 3 presents the change in the ratio of purchased producer services to gross output for the manufacturing sector based on the EU I–O tables, distinguishing between services purchased from domestic and foreign suppliers. Table 4 presents the change in the ratio of purchased producer services to gross output from abroad for the manufacturing sector based on the OECD I–O tables.

In addition, in both tables, we included the share of KIBS purchased. As expected, there has been an increase in purchased services in almost all countries (Table 3 and Figure 4).

The purchase of producer services from domestic suppliers has risen faster than that of services purchased from abroad (Table 3). Table 5 presents the change in the ratio of imported (economy-wide) services to GDP. In most EU countries, there is an increase in the ratio of imported services to GDP.

Empirical results

Table 6 presents the results of the fixed-effects model of the impact of the service output share on the employment share of service occupations and of three groups of service occupations. All regressions include a set of time dummy variables that are not reported. *t*-Values are based on standard errors according to Driscoll and Kraay's (1998) method,

Table 4. Change in the ratio of purchased producer services from abroad to output in manufacturing based on OECD I–O tables (in percent).

	Share of producer services from abroad			Share of KIBS from abroad		
	1995	2000	2005	1995	2000	2005
AT	1.0	1.5	2.5	0.3	0.4	1.0
BE	2.3	2.6	2.8	0.5	0.9	1.1
CY	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
CZ	n.a.	4.5	3.2	n.a.	3.0	1.3
DE	0.6	1.2	1.3	0.2	0.5	0.5
DK	0.5	1.9	2.9	0.4	0.6	1.2
EE	n.a.	1.3	1.6	n.a.	0.6	1.0
ES	1.1	2.2	2.1	0.7	1.3	1.3
FI	2.6	2.2	3.6	1.6	1.6	3.2
FR	0.8	0.9	1.1	0.5	0.4	0.5
GR	0.4	0.5	0.6	0.3	0.2	0.2
HU	n.a.	2.6	3.7	n.a.	2.3	2.2
IE	n.a.	23.1	29.6	n.a.	15.3	23.1
IT	1.4	2.3	2.8	0.4	0.6	0.9
LT	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NL	1.7	2.1	3.2	0.7	1.4	2.0
PL	0.5	0.6	0.6	0.2	0.2	0.3
PT	0.6	0.8	0.6	0.3	0.2	0.2
RO	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
SE	2.7	3.0	4.1	1.2	2.2	2.7
SI	1.0	0.9	1.5	0.2	0.5	0.7
SK	1.9	2.8	2.3	0.8	1.3	1.2
UK	0.8	0.9	1.0	0.3	0.4	0.4

Source: OECD I–O tables.

which usually produce higher *t*-values in absolute terms. In addition, we display standard *t*-values based on cluster-robust standard errors.

The first column presents the results for the employment share of all service occupations. The second column includes the results for the employment of supervisors, professionals, and technicians (also referred to as highly skilled, white-collar workers). The third and fourth columns contain the results for the employment share of clerks, administrative service personnel, and other office-related workers, as well as other service occupations. We used both the output share of producer services and the output share of knowledge-intensive industries (NACE rev. 1.1 72–74). In addition, the share of service output is based on two data sources: EU I–O tables and OECD I–O tables; of which, the latter are based on data collected every 5 years.

We found that the output share of producer services has a positive and significant impact on the employment share of service occupations. The coefficient is 0.8, indicating that an increase in the output share of producer services by one percentage point will lead to an increase in the share of service occupations by 0.8 percentage points. However, the coefficient is only weakly significant, exhibiting a *t*-value of 1.91 (indicating significance at the 7% level). Based on Driscoll–Kraay standard errors, the output share of services is significant at the 1% level. In order to provide an indication of the magnitude of the relation between the output share of services and service occupations, one can calculate the contribution of the change in the service output share to the change in the share of

Table 5. Change in the ratio of imported (economy-wide) services to GDP (in percent).

	1995	2000	2007
Q6 AT	8.2	8.8	10.3
BE	11.0	14.5	14.4
CY	14.3	17.4	17.7
CZ	9.9	9.7	8.4
DE	5.2	7.2	7.6
DK	9.3	13.3	17.7
EE	13.2	16.1	14.1
ES	3.7	5.9	6.7
FI	7.4	7.9	9.2
FR	4.4	4.9	5.0
GR	n.a.	8.5	5.6
HU	9.4	10.1	11.5
IE	16.1	34.2	37.5
IT	4.5	5.1	5.8
LT	7.5	5.9	8.7
NL	12.1	14.6	13.7
PL	2.7	5.4	5.7
PT	5.2	5.0	5.5
RO	5.0	5.4	5.2
SE	7.5	10.5	11.5
SI	7.2	7.3	9.1
SK	9.3	8.7	8.8
UK	5.8	6.8	7.6

Source: Eurostat, New Cronos.

service occupations. The calculations suggest that the rising service output share explains 13% of the increase in the share of service occupations between 1995 and 2006 based on the countries for which data are available for the entire sample period.[2] This indicates that while the servitization of manufacturing does shift the structure of employment towards service occupations, the magnitude of the effect is quite modest.

Furthermore, we found that the output share of services has a positive and significant impact on the employment share of professionals and technicians. Here, the coefficient is highly significant at the 1% level based on both robust standard errors and Driscoll–Kraay standard errors that are robust to heteroscedasticity, serial correlation, and cross-sectional correlation. However, for the employment share of clerks, administrative support, and other office-related occupations, the coefficient is not significantly different from zero, indicating that this category of service occupations does not benefit from the servitization of manufacturing. For the remaining group of service occupations, the results are not clear-cut depending on how the output share of services is measured and which data source is used. However, the group of other service occupations – including drivers of trucks and other vehicles, as well as sales service occupations – represents only a tiny part of the service occupations as a whole. Furthermore, we found that the impact is robust to the measurement of service outputs (based on EU I–O tables or OECD I–O tables). When the output share of knowledge-intensive services is considered, we found that the impact on total service occupations decreases slightly in size and significance. As expected, we found that the impact of the share of service revenues on the employment share of supervisors, professionals, and technicians increases in magnitude and significance when only knowledge-intensive services are considered. This is not surprising

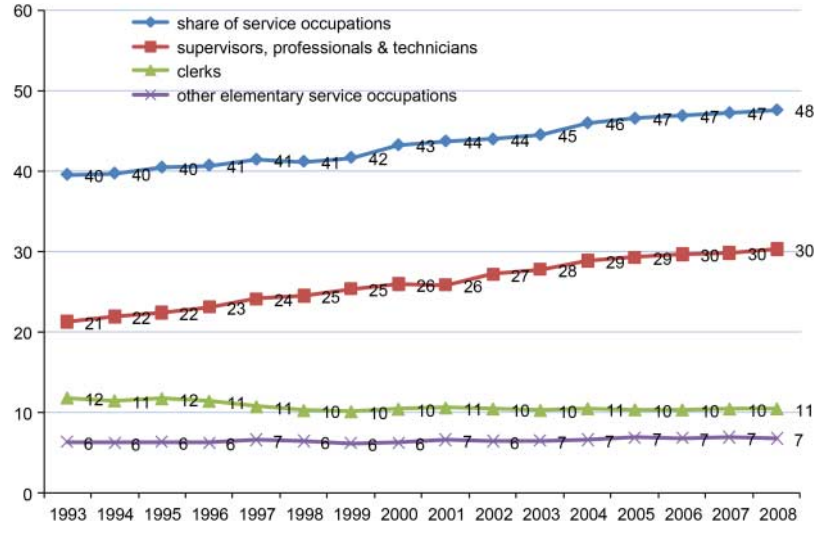

Figure 2. Change in the share of service occupations and by different categories in the EU-15 countries (unweighted means across countries in percent).
Source: EU-LFS, weighted percentages. This figure includes EU countries for which data are continuously available since 1993.

Colour online, B/W in print

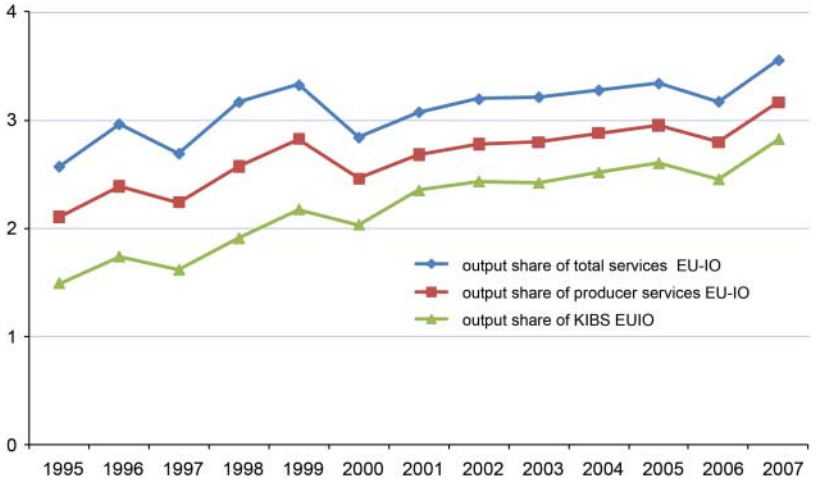

Figure 3. Change in the output share of producer services in the EU-15 countries for which data are continuously available (unweighted means across countries in percent).
Source: EU I–O tables.

Colour online, B/W in print

because an increase in the revenues of knowledge-intensive service activities raises the demand for in-house services in related tasks and functions.

In order to test the robustness of the basic regression results, we conducted a number of sensitivity and robustness checks. First, we included interaction terms for the service output share multiplied by country dummy variables in order to investigate whether the coefficient varies across the countries. However, the coefficients on the interaction terms are not significantly different from zero. Second, we experimented with interaction

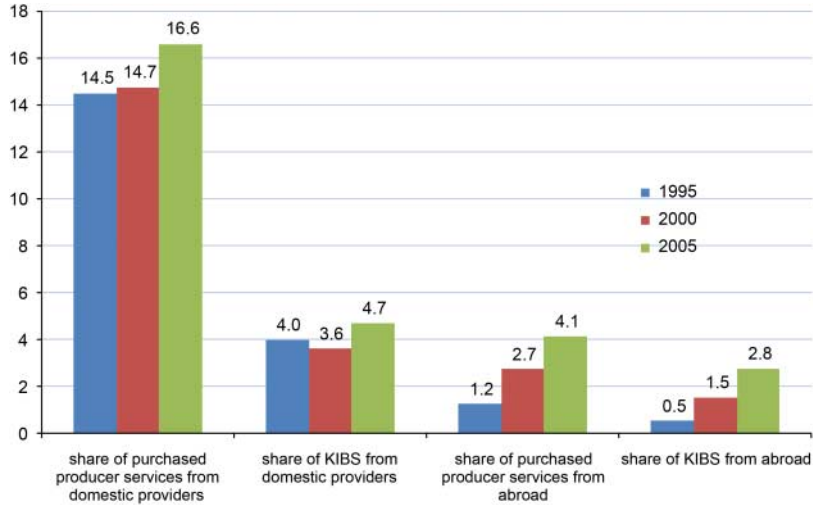

Figure 4. Change in the output share of producer services in the EU-15 countries for which data are continuously available (unweighted means across countries in percent).
Source: EU I–O tables.

terms between time dummy variables and the output share of services. Here, the coefficients of the interaction terms are once again not significantly different from zero.

Table 7 presents the results of the fixed-effects model when both measures of external services (services purchased domestically and from abroad) are also included in the basic specification.

Again, we provide results for service occupations overall and for the three subgroups: (i) supervisors, professionals, and technicians; (ii) clerks and shop sales personnel; and (iii) other basic service occupations. In addition, results are available for two types of external services: one broad measure including total services purchased and one narrow measure including only KIBS.

The results show that services purchased from both domestic and foreign sources are significantly and positively related to the employment share of service occupations. This indicates that intermediate service inputs and service occupations are complements independent from the location of the service provider. The coefficient of the ratio of services purchased from abroad to total manufacturing output is 0.55, indicating that an increase in the output share of services by one percentage point will cause the share of service occupations to increase by 0.55 percentage points. For the ratio of services purchased from domestic suppliers, we found an even higher coefficient of 0.72. Turning to the three subgroups of service occupations, we found that the most highly skilled group of service occupations is complementary to services purchased from abroad, while the other groups of service occupations do not benefit from the use of external services from abroad.

Concerning the impact of KIBS, we found that the group of professionals, technicians, and supervisors is complementary to business services purchased from domestic providers, while clerks do not benefit. Furthermore, we again found that professionals, technicians, and supervisors benefit from the rising output share of services, while clerks do not benefit from the servitization of manufacturing even when controlling for external services.

Overall, the results are consistent with earlier studies. Van Welsum and Reif (2009) found that the share of clerical occupations potentially affected by offshoring is the

Table 6. Fixed-effects model of the impact of the service output share on the share of service occupations (by different categories).

	Share of total service occupations		Share of supervisors, professionals, and technicians		Share of clerks and sales workers		Share of other service occupations		No. of observations	No. of countries
	Coefficient (*t*)	R^2	Coefficient (*t*)	R^2	Coefficient (*t*)	R^2	Coefficient (*t*)	R^2		
Output share of services (NACE 55–95) based on EU supply I–O table (in %)	0.81* (1.91) [4.82]	0.39	0.64*** (2.98) [3.30]	0.60	−0.08 (−0.61) [−1.32]	0.60	0.31 (0.89) [2.29]	0.08	197	19
Output share of producer services (NACE 55–74), EU supply I–O table (%)	0.80* (1.86) [4.69]	0.40	0.60*** (2.73) [2.88]	0.60	−0.07 (−0.49) [−0.95]	0.60	0.33 (0.92) [2.47]	0.07	197	19
Output share of knowledge-intensive services (NACE 72–74), based on EU supply I–O table	0.70 (1.49) [4.07]	0.40	0.66*** (3.26) [3.99]	0.59	−0.12 (−0.82) [−1.44]	0.59	0.21 (0.61) [1.89]	0.08	189	18
Output share of producer services (NACE 55–74) (OECD SIOT) (in %)	0.44* (1.77) [3.51]	0.70	0.44 (1.26) [6.28]	0.70	0.17 (0.69) [3.34]	0.19	−0.15 (−0.59) [−1.32]	0.12	46	18
Output share of knowledge-intensive services (NACE 72–74), OCED SIOT (%)	1.47* (1.66) [2.87]	0.71	0.15 (−0.16) [0.48]	0.71	0.22 (0.42) [1.20]	0.18	−0.24 (−0.37) [−2.24]	0.11	46	18

Notes: *t*-Values are based on robust standard errors (in parentheses) and based on Driscoll and Kraay's (1998) standard errors (in brackets). The dependent variables are the employment share of service occupations (following the definition of Pilat and Woelfl (2005) and the employment share of three subgroups: (i): supervisors, professionals, and technicians (ISCO 88 100–348); (ii) clerks and sales shop workers (ISCO 88 400–523); and (iii) other service workers (basic employment, drivers, etc.) (ISCO 88 830–916, 933). Time dummies are jointly significant at the 1% level, but not reported. The sample includes data for the following countries and time periods: AT and BE: 1995, 1997, 1999–2007; CZ: 1997–2007; DE, EE, IE, and LT: 2000–2007; ES, IT, and NL: 1995–2007; GR: 2000–2008; HU and SK: 1998–2007; PL: 2000–2006; PT: 1995–2006; SE: 1997–2007; SI: 1996, 2000–2007; and UK: 2000–2008).

*Significant at the 10% level.

***Significant at the 1% level.

Table 7. Fixed-effects estimates of the impact of external services and service output on the employment share of service occupations (by different categories).

	Share of total service occupations Coefficient (*t*)	Share of supervisors, professionals, and technicians Coefficient (*t*)	Share of clerks and sales workers Coefficient (*t*)	Share of other service occupations Coefficient (*t*)
Specifications with total purchased services				
Output share of producer services (excluding wholesale and retail trade and public and personnel services) (%)	−0.23 (−0.56) [−1.06]	1.14*** (3.52) [11.79]	−0.65*** (−2.81) [−1.65]	−0.29 (−0.66) [−1.39]
Ratio of producer services purchased from abroad to output (%)	0.55 (2.35)*** [5.46]	0.32*** (2.82) [4.06]	0.11 (0.77) [3.19]	0.08 (0.53) [0.94]
Ratio of domestic producer services to output (%)	0.72 (2.32)*** [4.60]	0.03 (0.10) [5.05]	0.23 (1.62) [0.22]	0.16 (1.05) [1.35]
No. of observations	69	69	69	69
No. of countries	18	18	18	18
R^2 within	0.67	0.73	0.30	0.16
Specifications with KIBS				
Output share of producer services (excluding wholesale and retail trade and public and personnel services)	1.12 (1.50) [1.85]	1.23** (2.24) [2.91]	−0.19 (−0.71) [−1.42]	0.74 (0.93) [1.78]
Ratio of KIBS services from abroad to output (%)	0.40 (2.37)** [5.76]	0.22** (2.40) [2.92]	0.12* (1.69) [3.74]	0.05 (0.57) [1.65]
Ratio of domestic KIBS to output (%)	0.35 (0.38) [0.56]	0.82 (1.51) [2.08]	−0.75 (−1.53) [−4.00]	−0.41 (−0.74) [−1.19]
No. of observations	66	66	66	66
No. of countries	18	18	18	18
R^2 within	0.58	0.70	0.30	0.20

Note: See Table 1.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

highest of all service occupations, ranging between 27% in Finland and 63% in Portugal. For service occupations as a whole, however, the positive impact of the output share of services disappears when controlling for external services.

We again conducted a number of robustness checks, including interaction terms between groups of countries (eastern, high-income, and low-income countries). We found that the interaction terms are not significant. However, the results become slightly more significant when the four eastern European countries (i.e. CZ, SK, SI, and PL) are excluded or interaction terms are included. Second, we used an instrumental variable method in which imported intermediate services are instrumented with lagged

Table 8. Fixed-effects estimates of the impact of service imports on the share of service occupations in manufacturing (by different categories).

	Share of total service occupations Coefficient (*t*)	Share of supervisors, professionals, and technicians Coefficient (*t*)	Share of clerks and sales workers Coefficient (*t*)	Share of other service occupations Coefficient (*t*)
Output share of producer services (excluding wholesale and retail trade and public and personnel services) (%)	0.63 (1.64) [4.04]	0.52** (2.38) [3.37]	−0.05 (−0.39) [−0.62]	0.28 (0.81) [1.80]
Ratio of economy-wide service imports to GDP (%)	0.76* (1.75) [3.23]	0.36 (1.63) [2.18]	−0.09 (−0.73) [−1.43]	0.23 (1.66) [4.15]
No. of observations	198	198	198	198
No. of countries	19	19	19	19
R^2 within	0.44	0.62	0.15	0.11

Note: See Table 1.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

changes and the US price index of information and communication technologies is converted to euros. However, the results are almost similar and are available upon request.

Table 8 presents the results of the fixed-effects model with the ratio of service imports to GDP as an alternative measure of external services purchased from abroad. Here, service imports include both final and intermediate imports and also refer to imports into the economy at large rather than to those into manufacturing alone. We found that both service occupations as a whole and highly skilled service occupations benefit from imports of services. However, the effect is only marginally significant when *t*-values are based on clustered standard errors. The coefficient of service imports becomes more significant based on the Driscoll–Kraay standard errors. In contrast, we found a negative impact of service imports on clerks and shop sales personnel, but the coefficient is not significant at the 10% level. Furthermore, there is a positive and marginally significant relationship between the share of basic service occupations and the ratio of service imports. This is not surprising, as basic service occupations include truck drivers and cleaning and shop sales personnel, who cannot be traded.

Conclusions

This paper provides new empirical evidence of the extent of linkages between services and manufacturing. In particular, we investigated the extent to which changes in the employment share of service occupations can be explained by the increase in the output share of services in manufacturing. In addition, we analysed whether service occupations are a complement of or a substitute for services purchased from either domestic or foreign suppliers. Furthermore, we placed special emphasis on the role of KIBS either as output or externally sourced input. Finally, we distinguished between different types of service occupations, such as

professionals, technicians, clerks, and basic service occupations. The data were drawn from the EU-LFS and EU and OECD I–O tables for the period 1995–2008.

The results show that the EU manufacturing sector's service offerings are increasing. Between 1995 and 2005, the output share of producer services rose from 7% to 8.5% (unweighted across the EU-15 countries). In addition, manufacturing is relying increasingly on external and internal services, particularly business services from external providers and skilled service occupations such as professionals and technicians. Overall, these trends show that the boundaries between manufacturing and services are becoming increasingly indistinct.

The results clearly show that labour demand is shifting away from production occupations to skilled service occupations. Service occupations have generally been growing faster than both external services from domestic suppliers and the output share of services in manufacturing, indicating that other factors – such as (information) technology and research and development activities – are also important in the shift towards services in the occupational structure towards service occupations.

The empirical results based on fixed-effects models for manufacturing industries in several EU countries show that part of the shift away from production towards service occupations can be attributed to the shift from goods production to service production. Based on 18 EU countries for the period 1997–2007, an average of 13% of the increase in the employment share of service occupations in the manufacturing sector can be attributed to the increase in the output share of services.

Furthermore, we found that external services and highly skilled service occupations are complements, which support the resource-based theory of external linkages with suppliers. However, we did not find clerical occupations to be negatively affected by the global sourcing of producer services. If anything, one can conclude that clerical occupations are rather affected by intermediate services purchased from domestic providers. Furthermore, service imports tend to have a positive impact on professionals, technicians, and supervisors, but not on clerks and other basic service occupations.

However, some limitations of the study should be noted. First, activities of manufacturing enterprises can shift towards services over time, which may lead to reclassifications of an individual enterprise from services to manufacturing (Fixler & Siegel, 1999). These reclassifications can be caused by domestic outsourcing, offshoring, restructuring, and/or technological change and can lead to an under-representation of the manufacturing sector in the national economy (Hellebrandt & Davies, 2008). For the UK, Hellebrandt and Davies (2008) found that the switches from manufacturing to services are quite common, but also reclassifications from services to manufacturing. In particular, switches between manufacturing to services and between services to manufacturing are the most important type of reclassifications among the three industry groups: manufacturing, services, and non-manufacturing. However, it is not clear what the implications of these reclassifications would be for the link between service occupations, intermediate services, and service sales. More research based on Business Register data is needed to shed light on the implications of industry reclassifications. Business Register data make it possible to investigate whether or not manufacturing firms are reclassified as services firms. Second, the rising demand for temporary agency workers in EU manufacturing may have implications for both the occupational structure of the workforce and the share of intermediate services. The rise of temporary agency workers is associated with an increase in intermediate services and probably to a change in the occupational structure of the workforce to the disadvantage of unskilled and semi-skilled manual and white-collar workers. Again, this problem is difficult to address with the available data at the aggregate

level and requires linker employer–employee data as well as detailed data on occupations of temporary agency workers. Third, the occupational approach that separates service occupations from production occupations can be criticized because not all professional and service occupations perform service activities and some production occupations also perform service activities. Diamond (1962) and Alic (1994) suggested that it is difficult to separate service occupations from manufacturing occupations. In order to define service work in different industries such as manufacturing, there is a clear need to combine occupational data with data on service activities or service functions (Marshall, Damesick, & Wood, 1987).

There are several directions for future research in this area. We have estimated the empirical model based on aggregate data for the manufacturing sector pooled across EU countries. One possibility for extending the work is to use two-digit industry data for service occupations, intermediate services, and the output share of services. Nordas (2010) showed that the service intensity of manufacturing (measured as purchased services) differs widely across two-digit industries, finding a higher service intensity in the computer and office machinery, chemical, and food industries. Similarly, there is a higher output share of services in skill-intensive manufacturing industries. This requires additional unpublished data based on the EU-LFS that can be tabulated by EUROSTAT. Doing so would make it possible to investigate the link between service occupations, intermediate services, and service sales for each country. Another direction for future research is to use an additional data source, namely the structural business statistics. The structural business statistics include information on the turnover from service activities for manufacturing firms which is available at the two-digit level industry level. In addition, there is information on turnover by wholesale and retail trade and goods production. The turnover share from service activities can be used as an alternative measure to the share of service sales based on I–O tables. The most interesting direction of future work, in our view, is to investigate the impact of the increasing share of turnover from services at the firm level. For instance, it is possible to investigate the impact of the increasing share of turnover from service firms on the demand for white-collar workers at the firm level but also on other outcome variables such as productivity growth.

Acknowledgement

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Notes

1. In principle, one can include wages for the different occupations. However, occupational wages from the European Community Household Panel are only available for the period 1994–2001 and data from the EU SILC are only available from 2004 onwards.
2. The output share of services increased from 2.1% to 3.1% in the period 1995–2006 based on 10 EU countries that remain in the sample for the entire period. The corresponding increase in the share of service occupations is 6% points (from 41% to 47%), resulting in a contribution of 0.8 percentage points, or 13.4%.

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