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The Role of Services for Manufacturing Firms' Exports

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ABSTRACT

Manufacturing firms increasingly focus on services. This trend is evident in their composition of input, in-house production and seemingly also in total sale. Firms' services intensity may affect their productivity, and thereby competitiveness abroad. Services are also instrumental in connecting to the foreign market and can help firms to differentiate their offers. However, only bits and pieces of the relation between services and manufacturing's exports have been analysed in previous literature. This study contributes by discussing the role of services for the firm, arriving at some conjectures and testing them empirically. Export intensity is regressed on two services parameters, applying a fractional model to a rich panel of firms in Sweden in the period 2001-2007. The microeconometric results suggest that there is an effect of services inputs, while controlling for covariates and firm heterogeneity. Raising the proportion of services in in-house production, on average, yields higher export intensity. Buying-in more services is associated with higher export intensity for firms in selected industries. Overall, the study provides new firm-level evidence of the role of services as inputs in manufacturing.

Keywords: firm, export intensity, manufacturing, services, intangibles, innovation
JEL codes: F14, L24, L25, L60, 033

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1. Introduction

Manufacturing in industrialised countries uses services more intensively than before and there are indications that the share of services in total turnover is up. On the input side, the ratio of bought-in services to value-added has increased across all manufacturing industries (Nordås, 2010).[2] In-house services production has also expanded (Pilat and Wölfl, 2005; and Lodefalk, 2012). Manufacturing increasingly employs mathematicians, engineers, computing professionals and business professionals (Pilat and Wölfl, 2005). Services used or produced by manufacturing firms include research and development (R&D) but also extend to knowledge or intangible capital services more generally, as well as to services such as telecommunication and transport, see the typology of services in figure 1.[3] On the output side, the share of services in total turnover appears have grown too (Pilat and Wölfl, 2005). As regards export, Lodefalk (2012) finds that manufacturing's services export has more than doubled between 1998 and 2006, in real terms.

On the one hand, an increased focus on services could act as a drag on manufacturing's total exports, since services are less tradable. On the other hand, there are arguments why services in manufacturing may support exports. Services may help firms to overcome costly informal barriers such as asymmetric information in international trade. Changes on the demand side in industrialised countries are also likely to favour manufacturing firms that focus more on the services content of their offer (Schettkat and Yocarini, 2006).[4] Finally,

[2] It now accounts for about 20 per cent of total cost in manufacturing, whereas intermediate goods account for 30-55 per cent of total cost.

[3] The extensive use of services in manufacturing firms is illustrated in the Swedish multinational Sandvik (National Board of Trade, 2010). Its tooling company alone uses 40 types of services, of which less than 25 per cent are transport services. Generally, in manufacturing, the three largest services categories bought-in are: other business services; transport, storage and communication, excl. post and telecommunication; and wholesale and retail trade. R&D constitutes a minor share of services in manufacturing, see figure A1 in the appendix.

[4] One way in which manufacturing firms can develop their offer is by adding services over the manufacture's lifetime. In this way the contact with the customers can be extended far beyond the actual sales event (Potts, 1988; and Wise and Baumgartner, 1999). Especially if the installed-base-to-new ratio is high, the after-sales market can be substantial. An example of how to exploit the installed base is long-distance monitoring of products, such as an airplane engine sold by one firm and subsequently monitored by its own engineers in order to prevent unnecessary losses of airtime for the customer.

there might also be a link between services, through productivity, to exports, as will be explained. Empirically, knowledge is poor on exporters' buying-in, production and sales of services and only some pieces of the relation between services and exports have been studied.

This study adds to the empirical literature on export determinants by analysing the role of services for manufacturing firms' competitiveness abroad, using a rich panel of manufacturing firms in Sweden in the period 2001-2007. The specification is estimated using a fractional maximum-likelihood estimator, while controlling for the usual covariates that have been found to be associated with export performance and firm heterogeneity.

- Figure 1. A simple typology of services -

The results indicate that expanding the proportion of services in in-house activities of manufacturing, on average, yields higher export intensity for the firm, when controlling for initial labour productivity and human and physical capital intensities. The results are statistically significant and robust to different specifications and estimation strategies. Buying-in more services is also associated with higher export intensity but only for firms in selected industries. The overall conclusion is that manufacturing firms may become more competitive internationally by using more services.

The outline of the rest of the paper is as follows. In section two, the conceptual framework is developed and previous literature is briefly reviewed. Data and descriptive statistics are presented in section three. The specification and estimation strategy is discussed in section four. Section five analyses, econometrically, the relation between services and exports. Section six concludes. (Additional tables, figures, and information on data are found in the appendix.)

2. Conceptual framework and previous evidence

2.1 Conceptual framework

Firms who want to participate in exports need to cope with certain challenges, including trade costs and more intense competition on the world market. Firms have to find out what rules and regulations apply for export of their product to a specific market. They must research the market, possibly modify both their product and its marketing as well as establish a distribution network. Merely distribution costs may be corresponding to as much as half of the retail price (Burstein *et al*, 2003). These kinds of costs are sunk and therefore contribute to persistence in exporting (see e.g. Roberts and Tybout, 1997). As regards variable cost, each delivery by a firm involves costs for customs, insurance and transportation. Time lost in transport and at the border can add substantially to these costs (Hummels, 2001). Negotiating and maintaining business contracts and contacts with foreign authorities is also likely to be costly. In addition, monitoring of the foreign market and adjustment to changes in demand as well as rules and regulations are associated with costs. Transaction costs are substantially higher for more distant export markets (Egger, 2008; and Nordås, 2008). In sum, variable costs put a continuous pressure on exporters to keep on performing better than non-exporters.

Bearing the export barriers in mind, we would expect that firms that export are the better firms within their industry. Indeed, the empirical literature on firms' exports establishes that exporters are different from non-exporters in the same industry, in terms of size, productivity and capital intensity (Bernard and Jensen, 1995 and 1999; and Bernard *et al*, 2007).

The presence of trade costs and the fact that exporters are more productive than non-exporters, within their industry, has been incorporated in modern trade theory. In their important contributions, Melitz (2003) and Bernard *et al* (2003) develop general equilibrium models with heterogeneous firms, monopolistic competition and international trade.

Drawbacks with these models are that productivity is exogenous and the differentiation of products is not elaborated upon.

More recently, exporters' pre-entry productivity premiums have been made endogenous in trade models. The model by Costantini and Melitz (2008) is an example where expectations of trade liberalisation influence firms' decision to innovate. This implies that productivity may deliberately be raised by the firm before it starts to export. Another example is Lopéz' (2004) model of firms in a developing country. Firms consider whether to export or not. If the firm is productive enough it consciously self-selects to export. As a preparation, the firm buys and applies new technology so as to become more productive and produce a competitive good (price- and character-wise) for the foreign market.

Unfortunately, the literature on firms' export behaviour does neither consider services in general, nor the use and production of services in manufacturing. However, manufacturing firms in industrialised countries are likely to use services such as R&D in preparation for export-entry, and such as market monitoring and design for continued presence on the export market. This motivates an attempt to briefly provide a theoretical perspective on the role of services for firms' export.

To frame the discussion on these firm-level linkages a Cobb-Douglas production function is taken as a starting point: $Q_{it} = A_{it}\, SL_{it}^{\alpha}\, L_{it}^{\beta}\, K_{it}^{\gamma}\, MI_{it}^{\delta}\, SI_{it}^{\zeta}$, where *i* is the manufacturing firm in an industrialised country and *t* is time; Q is value added; A is total factor productivity, SL is labour engaged in services activities; L is labour in manufacturing activities; K is physical capital; MI is material input; and SI is services input. In this setting, services figure in two places, as shares of labour input and of intermediates. Services as well as other factors of production exhibit diminishing marginal returns. The firm is located in a small and open industrialised country and benefits from relative abundant access to services labour, R&D and advanced technology.

Labour productivity is a function of inputs and total factor productivity. The latter is assumed to be positively correlated with the level of technology used for combining inputs into the final product. Technology, in turn, is a positive function of the firm's stock of knowledge capital, where knowledge capital consists of the firm's: computerised information;[5] innovation capital, that is, scientific and creative property; and economic competences such as brand name, education and organisational capital (Corrado *et al*, 2004).[6] Services labour contributes to the knowledge capital through its activities in for example R&D, software design, market research, education and organisational development.[7] Moreover, the level of knowledge capital in combination with services labour determine the firm's ability to comprehend and exploit technology advances elsewhere, what is known as absorptive capacity (Cohen and Levinthal, 1990).

The firm sells manufactures, and potentially also services. Output is sold on the domestic market but may also be sold abroad. Export (EX_{it}) is a function of productivity and services: $EX_{it} = F\ (Q_{it}/L_{it}\ ,\ SL_{it},\ SI_{it})$. Selling abroad incurs additional destination-specific variable and fixed costs. Therefore, the firm only exports if its productivity is high enough to bear the extra costs involved. The higher its productivity, the more markets it will enter, and the larger is its exports.[8]

The firm can prepare for and sustain exports by raising its services content, since this may contribute to firm productivity. Services can assist the firm in lowering input

[5] Software may be considered a general purpose technology, which results in increasing returns-to-scale (Bresnahan and Trajtenberg, 1995; and Hall and Trajtenberg, 2004).
[6] Moving beyond R&D to capture firm-specific assets, Braunerhjelm (1996) suggests a measure that includes cumulated investment in R&D, software, marketing and education. As regards organisational capital, Bloom and Van Reenen (2010) find that management practices have an important and significant effect on firm performance, using cross-section firm-level data from different countries.
[7] In 2006, 31 percentage points of the 46 per cent employed in services-related occupations in Swedish manufacturing had post-secondary education (Lodefalk, 2012). For 13 OECD-countries, the corresponding mean was 27 percentage points out of 44 per cent in 2002 (Pilat and Wölfl, 2005). Services-related employees constituted less than 30 per cent of ordinary labour, which does not need to have any specific education.
[8] Empirically, the link between firm productivity and export propensity is well established and ISGEP (2008) verifies a positive and significant link between firm productivity and export intensity in 13 out of 14 OECD-countries covered.

requirements and in using labour more efficiently. This may be the result of engineering, supply chain management or other management services (Nordås, 2010; and Bloom and Van Reenen, 2010).[9] As discussed above, services labour also augments the firm's absorptive capacity, and thus its productivity. A rise in productivity is expected to cause exports to go up, in comparison with sales on the domestic market, that is, export intensity rises.

Adding services also differentiates the firm's offer from its competitors' and thereby increases foreign demand (Chamberlin, 1933). Using more services may increase costs and entail a price rise, but can nevertheless increase demand, if the modified offer appeals more to customers. The firm can gain a competitive advantage in this way because customers do not know exactly which product matches their wants and because customers' wants may be influenced. Firms' advantages in the industrialised country in this regard are its closeness to: customers demanding quality (Linder, 1961); customers concerned about environmental and social aspects of the product and its production; and to customers who increasingly demand services (Schettkat and Yocarini, 2006). Close contacts with its customers is also expected to contribute to innovation (Miroudot, 2006).[10]

As mentioned, informal barriers to export abound but they can be overcome through the use of services. Some services may assist in entering foreign markets, others in maintaining foreign relations, and yet others in expanding the volumes traded. Without these services, firms might still start to export and expand exports, but making use of them is likely to reduce trade costs. For example, intermediaries in foreign trade can facilitate for the firm to find

[9] R&D services are likely to account for an important but limited share of this effect. R&D constitutes about seven per cent of bought-in services in Swedish manufacturing according to Input-Output data, see figure A1 in the appendix. Moreover, just six per cent of those employed in manufacturing do R&D, according to the author's own calculations based on official data from Statistics Sweden.

[10] Case studies from the Swedish motor vehicle industry indicate that customers increasingly take services for granted when buying new vehicles, services which therefore are included in the price of the vehicles (Witell *et al*, 2009). Moreover, services contribute substantially to differentiating the firms' offers, making them more competitive vis-à-vis foreign competitors. For the environmental sector, a study by USITC (2005) reports that services – such as R&D and maintenance – often are integrated into the price of air pollution control equipment and may constitute 10-30 per cent of the purchase price.

basic information and to establish initial contacts in the foreign market. Translators and interpreters may be deployed to overcome language and cultural barriers. The firm may use legal and monitoring services in order to limit opportunistic behaviour of foreign business partners and customers. Marketing services are likely to be important in informing and appealing to customers abroad, which are unfamiliar with the firm's product. Government relation services may ease entry to the new market, assist in expanding exports there, and more generally reduce policy-induced uncertainty.

2.2 Previous evidence

To what extent firms use services, besides transport, to be successful in exports is less well-known. Most of the studies on the relation between services and export are limited to subsets of services that are bought-in by manufacturing firms and their effect on firms' propensity to export.

The link between in-house services and exports is touched upon in Bernard and Jensen (1995 and 1999) and Bernard *et al* (2007). Using micro-level data for US manufacturing, they verify an export premium in terms of non-production workers over total employment. However, the share of non-production workers has no statistically significant effect on the probability to start exporting (Bernard and Jensen, 1999). Braunerhjelm (1996) regresses export intensity on intangible capital and concludes that it has a positive and statistically significant effect, using micro-level data for Swedish manufacturing. At the macro-level, empirical studies show that investments in intangibles account for a relatively large share of economic growth in recent years (see e.g. Corrado *et al*, 2009; and Edquist, 2009).[11]

With respect to innovation and exports, Hirsch and Bijaou (1985) find a positive correlation between R&D and exports, and most subsequent studies find a link between

[11] It can be added that Hulten *et al* (2009) analyse the gap between book and market value in 12 R&D-intensive German firms and find that intangibles explain a big part of the gap.

innovation inputs or outputs, on the one hand, and exports, on the other (Cassiman and Martínez-Ros, 2007).[12] Cassiman *et al* (2010) contribute by analysing the innovation-productivity-export link, using Spanish firm-level data. Their results suggest that innovation contributes to the noted productivity of exporters-to-become.[13] This is in line with findings of Baldwin and Gu (2004), who show that exporters are more innovative and productive, and their productivity grows faster already before entering the export market.

A related empirical literature is the one on outsourcing of services and firm performance, where outsourcing is measured as the share of services in some other aggregate, such as total input or wages. Few studies analyse what happens to firms' in-house production of services. However, Görzig and Stephan (2002) do, and they find that firms that outsource services (while cutting in-house labour costs) perform better in terms of return per employee, but worse in terms of gross operating surplus. As regards productivity and outsourcing or offshoring of services, the results are not clear-cut (Bjerring Olsen, 2006). However, there are firm-level studies showing that services trade liberalisation boosts productivity in manufacturing (Arnold *et al*, 2006 and 2010).

Using more business services seems to be positively correlated with exports, according to analysis of cross-country data, at the industry level. Buying-in more business services in a manufacturing industry is associated with a higher value-to-weight ratio in exports (Nordås, 2010). The intensity of using knowledge-intensive business services has been found to be positively correlated with comparative advantage at the industry level, when the thickness of the market is taken into account (Bottini and Tajoli, 2010). Importing more business services is also associated with improved exports, value-added and employment, for skill and technology intensive manufacturing (Francois and Woerz, 2008).

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[12] Cassiman and Martínez-Ros (2007) provide a survey, and Girma *et al* (2008) as well as Aw *et al* (2011) more recent evidence.

[13] A largely affirmative empirical study of the innovation-productivity link is done by Griffith *et al* (2006), who use micro-level data for four countries.

3. Data and description

3.1 Data

The unbalanced panel data set used in this study contains core financial, employment and foreign trade information for all Swedish manufacturing firms (ISIC 10-37) that were active during the years 2001-2007. However, only firms with at least 20 full-time employees are included in the study, since reliable information on services is limited to those firms. In total, the sample consists of some 6,000 firms and 27,900 observations.[14] The level of detail of the data enables us to distinguish between different services components in manufacturing firms: firms' purchases of services; their in-house services activities; and services sales. All data come from Statistics Sweden.[15]

Key variables used in this study are exports and services inputs. Export is measured as the share of merchandise exports in total sales, that is, export intensity. Preferably, the numerator would also include services exports. Unfortunately, panel data on service exports is only available for a small subset of Swedish firms.[16] It should be recognised that this does not imply that no services are captured by the export variable. Firstly, services may be integrated into the merchandise itself, for example, software. Secondly, an item that is recorded as a merchandise export may actually be a bundle of manufactures and related services, such as financial solutions, installation, training, maintenance and repair, and only case-studies would enable us to separate such a bundle into its components.

With respect to services, a measure is constructed on the relative importance of services in the firm's total activities, and another one on the relative importance of services in the

[14] For about 2,500 of the 6,000 firms, there are annual observations over the entire period.
[15] Data is not deflated. Firstly, deflation of firm-level data is not a clear-cut issue. Deflators are at best approximations at the industry level, e.g. the producer price index, which still does not take input price developments into account. Moreover, to consider price changes by deflating with producer price index at the industry level does not change the results when industry heterogeneity already is controlled for, as in this study.
[16] Having data on cross-border services export would be valuable but still non-comprehensive in terms of total services export. For example, a firm may provide services to foreign customers via commercial presence or through foreign partners. The sale of those services is at best indirectly captured in the firm's own cross-border services exports.

firm's overall sourcing of input. The first measure is based on an OECD-classification of occupations as services-related or not (Pilat and Wölfl, 2005). The classification is based on the International Standard Classification of Occupations (ISCO). We define services-related occupations to include the following occupations, with ISCO codes within parenthesis: legislators, senior officials and managers (100); professionals (200); technicians and associated professionals (300); clerks (400); services workers and shop and market sales workers (500); and selected occupations in the remaining categories.[17] Firm's expenses for wages to services employees are then divided by total wages.

The second services measure is based on data about the firm's costs for externally sourced input. The measure is calculated as the proportion of costs for services bought-in by the firm in sales, where sales represent the total value of output used by the firm. The numerator, costs for purchased services, encompasses services ranging from real estate services to R&D services. (For more details on data and definitions of other variables as well as data sources, see the appendix and table A1.)

3.2 Description

Descriptive statistics for a snapshot of the Swedish panel are provided in table 1. In 2007, the sample covers about 4 000 manufacturing firms. Most of the firms are small or medium-sized companies with a median value of 44 employees. The majority of firms trade internationally but their median export intensity is a low 10 per cent. However, the presence of large firms leads to substantially larger means for parameters such as export intensity and number of employees. 46 per cent of the firms are part of a multinational enterprise.

With respect to services, most manufacturing firms have a substantial share of services in in-house production – an average of 45 per cent – but a limited share of services in total

[17] The other occupations included are: drivers and mobile plant workers (830) among plant and machine operators and assemblers; sales and services elementary occupations (910) as well as transport labourers and freight handlers (933) among elementary occupations. The group of services-related employees is dominated by occupations with educational requirements equivalent to upper secondary education or higher.

sales.[18] Between 2001 and 2007, the mean share of in-house services has risen, the mean share of purchased services has declined somewhat, while mean export intensity has been roughly constant (figure A2). These simple statistics do not by themselves indicate a positive association between in-house services and exports. However, the correlation coefficient between in-house services and export intensity is positive and new exporters seem to increase their use of in-house services before and briefly after export entry (table A3).

- Table 1. Snapshot of Swedish manufacturing firms -

How different are more services-intense firms in terms of exports and other key economic variables compared to other firms? To describe this, and in analogy with the concept of premia in the heterogeneous firm literature on trade, the "premia" for services-intense manufacturing firms are estimated by running six pooled ordinary least squares (OLS) regressions. The regression model, with variables in logs, is:

$$X_{it} = \beta_0 + \beta_1 S_{it} + \beta_2 IND_{it} + \beta_3 EMP_{it} + \varepsilon_{it}, \qquad (1)$$

where X is a particular characteristic of firm *i* (export intensity, labour productivity or human capital intensity) at time *t*; S is the firm's share of services in in-house production or the share of bought-in services in total output; IND is the firm's industry classification, at the three-digit level; EMP measures size in terms of the number of full-time employees; and ε is an idiosyncratic error term. The "premia" are reported in table 2. They measure the elasticity of variables of interest with respect to services.

- Table 2. Services premia, in terms of elasticities -

The in-house services premium is positive and strongly significant in terms of export intensity. A 10 per cent higher proportion of services in in-house production is associated with

[18] As for the negative minimum value of the share of bought-in services in sales, it is explained by repurchases of services suppliers, according to Statistics Sweden. The maximum value of the share of in-house services is one and this is recorded for less than 300 firms, which nevertheless are classified as manufacturing firms by Statistics Sweden. Descriptive statistics for the whole period can be found in table A2.

almost 5 per cent higher export intensity. Likewise, there is a premium in terms of human capital intensity, where a 10 per cent larger share of in-house services is associated with more than 10 per cent higher human capital intensity. This indicates that labour hired in manufacturing for performing services tasks is more skilled than other labour. The premium in terms of productivity is smaller, but non-trivial and statistically significant. In contrast, a higher share of bought-in services is mostly associated with premia that are non-significant and of little practical importance.[19]

4. Empirical specification and estimation strategy

The conceptual framework suggests that services may be instrumental to manufacturing firms' exports. Therefore, our empirical specification models a firm's expected conditional export intensity as a function of: services-intensities; other supply side factors of the firm that are known to be associated with export performance (firm size, labour productivity, multinational status, and previous export experience); human and physical capital intensities; and firm heterogeneity. General factors, such as tariffs and non-tariff barriers, are excluded from the analysis since focus is on export determinants at the micro rather than the macro level. More formally, we have:

$$E(y_{it} \mid \mathbf{X}_{it-n}, \mathbf{Z}_{it-n}, c_i) = \mathbf{X}_{it-n}\boldsymbol{\beta}_X + \mathbf{Z}_{it-n}\boldsymbol{\beta}_Z + \mathbf{A}_{it-n}\boldsymbol{\beta}_A + \mathbf{T}\boldsymbol{\beta}_T + c_i, \qquad (2)$$

where i is the firm; t is the year; n is the lag, which is one for services-intensity variables and two for control variables; y is the export intensity scalar; $\mathbf{X}$ is a 1 x K_1 vector of services-intensity variables that includes the shares of services in in-house production and of bought-in services in total output; $\mathbf{Z}$ is a 1 x K_2 vector of covariates and industry classification at the

[19] Results on export are robust to the inclusion of capital intensities and productivity. Results on productivity and human capital are also robust to the inclusion of capital intensities and physical capital intensity, respectively.

three-digit level; **A** is a 1 x K_3 vector of interaction terms; **T** is a 1 x K_4 vector of year dummies; and *c* is an unobserved firm-specific effect.[20]

Conditional on the covariates in equation (2), the average effect of services on those who use them more intensively is assumed not to be biased by sample selection. By viewing treatment as randomly assigned, conditioned on the covariates, estimation results can be interpreted as indications of average "causal" effects (Angrist and Pischke, 2009).

The model is dynamic in the sense that is has a lagged structure.[21] An increased focus on services in a firm could arguably be viewed as an investment, which entails structural adjustments and future pay-offs. Of course, this applies to activities such as R&D but it is also reasonable to assume that it applies to many other services activities. Moreover, there might be a lag between an increased services focus of the firm and pay-offs in terms of customer recognition. Lastly, endogeneity of covariates, such as productivity, to services could bias the coefficient estimates of interest. The dynamic model fixes the values of the covariates before the services variables are established.

To estimate the model in equation (2) we would ideally use fractional and partially censored regression with firm heterogeneity. By definition, the response variable is a limited dependent variable, $0 \leq y \leq 1$, with many observations in the low-end corner.[22] Therefore, the effect of predictor variables should not be constant, but rather diminish at high levels of those variables. This suggests that a non-linear model is appropriate (Papke and Wooldridge, 1996). Wagner (2001) surveys potential models for estimating effects on fractional response

[20] For an overview of firm characteristics associated with export performance, see for example Bernard *et al* (2007); Greenaway and Kneller (2005 and 2007); and Hiep and Nishijima (2009). As regards size, the effect on export performance is not entirely clear. Fryges and Wagner (2010) as well as Sterlacchini (2001) find a positive effect, but there is also a level effect, which might be the result of larger exporters moving on to serve foreign markets mainly through foreign direct investments rather than exports. In the sensitivity analysis, we therefore include the square of size. However, the coefficient is insignificant and does not change results. It can be added that the share of services sales in total sales is included in the services intensity vector to control for any potential influence of services output on merchandise export.

[21] As a consequence, two years of the seven year panel are lost and we end up with 16 429 observations.

[22] 17 per cent of the 27 871 observations have zero export values.

variables. He concludes that newly developed fractional models are to prefer over previously used approaches. Relevant models include the fractional logit and probit models proposed by Papke and Wooldridge (1996 and 2008). However, in our application, the numerator of the response variable is partially truncated. Firms' exports to the rest of the EU below a threshold are not reported, while there is no threshold for exports to the rest of the world. The consequence is even more zeros in the response variable. For 5,900 (21 per cent) of the 27,900 observations there is no registered export to the EU.

We accommodate for the partial truncation of the response variable, by using censored maximum likelihood estimation that also takes the fractional nature of the variable into account. Additionally, firms' heterogeneity is considered by including an unobserved firm-specific random effect. In essence, this results in a constrained and two-limit Tobit regression, henceforth, fractional Tobit. The model is well suited for the particular response variable of the study and exploits both within and between variation in the unbalanced seven year panel.

The latent variable is:

$$y_{1it}^{*} = \rho\, y_{2it} + \mathbf{X}_{it-n}\boldsymbol{\beta}_{X} + \mathbf{Z}_{it-n}\boldsymbol{\beta}_{Z} + \mathbf{A}_{it-n}\boldsymbol{\beta}_{A} + \mathbf{T}\,\boldsymbol{\beta}_{T} + c_i + u_{it}$$

$$y_{1it} = \begin{cases} d_{it}^{\#} / s_{it} & \text{if } d_{it} \leq d_{it}^{\#} \\ y_{1it}^{*} & \text{if } d_{it}^{\#} / s_{it} < y_{1it}^{*} < 1 \\ 1 & \text{if } y_{1it}^{*} \geq 1 \end{cases} \qquad (3)$$

where the unobservable variable y_{1it}^{*} is the intensity of exports to the EU, and y_{2it} is the intensity of exports to the rest of the world; $c_i \sim N(0,\sigma_c^2)$ is a firm-specific random effect; $u_{it} \sim N(0,\sigma_u^2)$ is an idiosyncratic error term; and d_{it} is the value of exports to the EU. The lower corner of the response variable varies, since it is the ratio of the threshold for exports to the EU ($d_{it}^{\#}$) and the firm's total sales (s_{it}). Finally, the *partial* truncation of a firm's export is considered by separating the response variable y_{it} into intensity of EU exports y_{1it} and of

exports to the rest of the world y_{2it}, and moving the latter to the right-hand side of the equation, while constraining the coefficient ρ to - 1.

To get marginal effects, which are comparable to OLS coefficients, coefficients from the maximum likelihood estimation are multiplied with a scalar: the predicted probability of the latent variable being within the restricted range, evaluated at the mean of the regressor (Wooldridge, 2002). In this application, this means that the more firms with truncated EU exports, the lower is the scalar and, hence, the marginal effect.

5. Results

5.1 Benchmark estimates

The role of conventional export predictors is estimated in the first column of table 3. All variables have the expected sign. Export intensity is positively related to the firm's productivity, size, multinational status and its previous export experience, according to a pooled OLS estimation. In column two, the generic model is augmented with two services-intensity variables: the proportion of services in in-house production; and the share of bought-in services in total output. Both variables have positive and statistically significant coefficients. The elasticity of export intensity with respect to in-house services is 0.2, that is, a one per cent rise in in-house services is associated with roughly 0.2 per cent higher export intensity, on average. The export elasticity with respect to purchased services is smaller (0.07 per cent).

- Table 3. The role of services for exports -

To consider that the relation between services and exports may be non-linear, quadratic terms of the services variables are included in the specification of column three.[23] Services are now more strongly associated with firms' export intensity, compared to when non-linearity is

[23] Descriptive statistics in tables A4-A5 suggest a non-linear relation.

disregarded. The diminishing marginal return to services is confirmed by the coefficients of the quadratic terms, which are negative and significant.

The role of services in manufacturing is likely to differ across heterogeneous firms. For example, new exporters and firms without multinational associations are the ones that we would primarily expect to benefit from services that assist in overcoming informal barriers to trade entry. Established exporters might instead find monitoring and government relation services important for exports. Furthermore, multinational firms might benefit more from services added to differentiate products, since multinationals are known to export to larger and thicker foreign markets. To control for such non-uniform relations between services and exports across firms, a number of interactions are included. In column four in table 3, interactions are added between in-house services and export experience, multinational status and firm size, as well as between services variables. This improves the adjusted explanatory value of the regression and confirms heterogeneous associations between services and export intensity.

Estimates on the role of services presented so far, may be biased due to the partly truncated and fractional nature of the response variable. To accommodate for this, the specification with non-linearity and interactions is rerun, using constrained and censored maximum likelihood estimation. The results of this preferred estimation are presented in the fifth column of table 3. The estimation confirms a positive and statistically significant association between in-house services and export intensity, while the one between bought-in services and export intensity vanishes. The magnitude of the link between in-house services and export intensity is lower when we account for particularities of the response variable, but it is still economically substantial. On average, a ten per cent increase in the share of services in in-house production is associated with 0.6 per cent higher export intensity, taking non-

linearity and interactions into account.[24] Among interactions, the most substantial and significant one is between in-house services and previous export experience. The coefficient is positive, which means that in-house services are more strongly associated with export intensity for established exporters than for new ones.

5.2 Results across industries, firm size and services occupations

The value added of using more services, for example to differentiate offers, is likely to be higher for firms in certain industries and lower for firms in other industries. Therefore, in table 4, estimated elasticities are presented for three broad groups of industries. The first group mostly consists of manufacturing firms in the consumption goods industry (ISIC 1), the second group consists mostly of firms in the basic industry (ISIC 2), and the third mainly of firms in the engineering industry (ISIC 3).

- Table 4. The role of services across industries, in terms of elasticities -

According to the fractional Tobit estimation, the share of in-house services is positively and significantly associated with export intensity in the "basic industry", but not in the other two industries. The share of bought-in services has no statistically or practically significant link with export intensity in the main estimation, as said. However, results at the industry level suggest that the share of bought-in services is positively associated with export intensity for the "consumption goods industry".

The elasticity between services and export intensity may also differ across firms of different size, why separate regressions have been run. For this purpose, firms are divided into three groups: small firms are considered as those having fewer than 50 employees; medium-sized firms as those with at least 50 but fewer than 250 employees; and large firms as those with at least 250 employees. The results in table 5 indicate that there is a positive link

[24] A simple calculation shows that the turning point for the concave services-export intensity relation is 75 per cent for in-house services and 29 per cent for bought-in services

between in-house services and export intensity for medium-sized firms, but not for small and large firms. Purchased services are also positively associated with exports for medium-sized and large firms, but the links are practically less important.

- Table 5. The role of services across firm size, in terms of elasticities -

Services used by manufacturing firms range from manager services to shop sales services. Based on the conceptual framework, we would expect that positive effect on exports rests on services that raise productivity, differentiate offers, and help to connect to the foreign market. To analyse this, the association between in-house services and export intensity is decomposed. Services-related occupations are categorised into five groups: managers; professionals; technicians and associate professionals; clerks; and service workers and shop and market sales workers. The results are displayed in table 6. Manager services are most strongly associated with export intensity. Professional services and technicians are also substantially and positively linked to exports. However, the link between hiring of clerks and export intensity is smaller and there is no statistically significant link for service workers and shop and market sales workers.

- Table 6. The role of in-house services across occupations, in terms of elasticities -

5.3 Robustness analysis

The robustness of the main findings are analysed by performing five additional estimations and the results are presented in table 7. In column one, manufacturing firms' merchandise *and* services export is considered, while keeping the aforementioned limitations to services trade statistics in mind. The elasticity of manufacturing firms' export intensity with respect to the proportion of in-house services rises to about 0.09, when services exports are included. This indicates that the elasticity of the main estimation, with respect to in-house services, is downward biased.

Another robustness check is to control for productivity changes before and after a rise in services usage, as well as in the same period as the actual export takes place. Therefore current productivity as well as its first and second lags are added to the main specification. The results in column two would seem to suggest that the link between in-house services and exports primarily operates through other channels than productivity.

- Table 7. Robustness tests -

Next, the relation between in-house services and R&D is considered, in column three. It is conceivable that the share of services in in-house production to an extent captures R&D, which previously has been linked to exports in the literature. R&D is not controlled for in equation (3) due to a lack of data. However, a proxy is the share of services provided by employees with doctor's degree. We therefore disaggregate human capital intensity into medium-skill and high-skill human capital intensity, where the latter represents employees with a doctor's degree. Furthermore, high-skill human capital intensity is controlled for in the same period as the in-house services variable. Thus, a significant coefficient for the share of services in in-house production would be capturing something else than the link between R&D and export. The elasticity of export intensity with respect to in-house services is about one third lower, when attempting to control for R&D, and statistically significant at the 5 per cent level. This suggests that the link between export intensity and in-house services also captures services other than R&D.[25] Meanwhile, and as expected, the R&D proxy shows to be important for export intensity.

An alternative estimation model is adopted in column four, to take the selection of firms into exports explicitly into account, while disregarding the fractional nature of the response variable. Export is considered as a two step decision: whether to export or not; and how much

[25] Moreover, only seven per cent of bought-in services in manufacturing are R&D services, see fig. A1 in the appendix, and an even smaller share of employees do R&D, according to own calculations based on official data from Statistics Sweden.

to export. These estimation results also establish a positive and significant link between export intensity and services.

Additionally, we have analysed how partial truncation of the numerator of the response variable affects results. Firstly, the main specification is estimated with the preferred estimation model while treating export intensity as a non-truncated response variable. The results diverge substantially from those of the main model. This could be expected. A large fraction of the observations are zeros and among the other observations with EU exports the median export EU value is only 17,700 million SEK, in 2007, which is not very far from the export threshold of 4,500 million. Thus, ignoring truncation would risk to severely bias results. Secondly, we would like to see if the message from the main estimation holds when limiting the analysis to exports to the rest of the world. Such an analysis cannot provide the full picture, since export to the rest of the world is only a fraction of total exports from Sweden (34 per cent in 2007). However, export to the rest of the world is not truncated, making it useful for an additional reality check. The results from this extra estimation confirm the main findings.[26] Thus, the results hold also when looking at non-truncated exports.

Checks for misspecification of the preferred model and for its numerical accuracy have also been done. For example, higher powers of some variables are added. Adding the squared value of size increases the coefficient for size itself, while the magnitude of the squared size's coefficient is practically negligible and other results are unaffected. Higher powers of the services variables are also be added to consider further non-linearity. However, the coefficients of these powers are not statistically significant. Moreover, the number of lags in the model has been experimented with, without it altering the main results. The numerical accuracy of the estimation might be another issue. The preferred model is a maximum likelihood model that computes the log likelihood using adaptive Gauss-Hermite quadrature,

[26] Generally, the effects of most explanatory variables are smaller. The diminishing return to in-house services is now both statistically and practically much less important.

where the results can be sensitive to the number of quadrature points used. Therefore the estimation has been rerun using different number of quadrature points. The results change only marginally and consequently the estimation does a good job.

5. Conclusions and final remarks

Manufacturing firms increasingly focus on services and they may do so in preparing for export entry and export expansion. Services can help to bear extra costs associated with exports; overcome informal trade barriers; manage more intense foreign competition; and accommodate for changes in demand. It is therefore expected that firms' use of services is positively associated with exports. However, so far, only bits and pieces of the relation between the services and exports have been studied. Effects of the wide range of services that firms use on firms' export intensity have not been analysed.

This study contributes by discussing the role of services for the manufacturing firm, arriving at some conjectures and testing them empirically. After an initial descriptive analysis, export intensity is regressed on two services parameters and covariates, using a rich unbalanced panel of manufacturing firms in Sweden in the period 2001-2007.

The descriptive analysis shows that firms with a larger proportion of services in in-house production are different. They also perform substantially better in terms of exports. The microeconometric results suggest that there is an effect of services inputs, when controlling for the usual covariates and firm heterogeneity. A 10 per cent rise in the ratio of services in in-house production is expected to yield about 0.6 per cent higher export intensity next year, on average and taking second order effects into account. The result is statistically significant and robust to different specifications and estimation methods. Using more manager services, professional services and technical services are most strongly associated with export intensity. Buying-in more services seems to affect export intensity positively in some industries.

The increased focus on services in manufacturing firms may partly be seen as a response to the growing competition from emerging economies. Manufacturing in industrialised countries focuses on activities in the value-chain where it has comparative advantages. The advantages of relative abundant highly skilled labour, research and development as well as previous agglomeration patterns favour specialisation in high-value added manufacturing and services activities. Another reason for the more intense use of services is likely to be changes on the firms' demand side. Customers increasingly demand quality and services and they are more and more concerned about environmental and social aspects of products and their production.

Overall, the results underline the importance of services as inputs in manufacturing. By using more services, manufacturing firms in industrialised countries may become more competitive internationally. From a policy-making perspective, efforts to enhance access to services – for example, through liberalisation of the movement of services and services suppliers – would seem worthwhile.

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Tables and figures

Figure 1. A simple typology of services

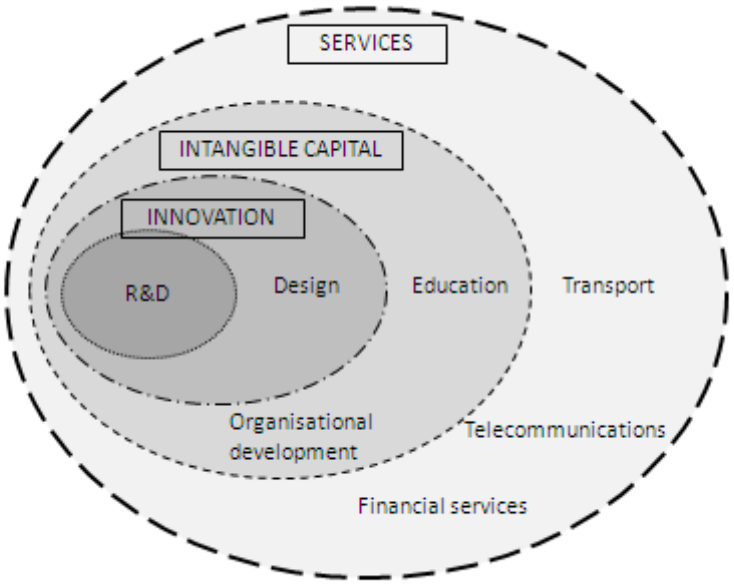


Table 1. Snapshot of Swedish manufacturing firms

	Mean	Median	Std. Dev.	Min.	Max.
Export intensity	0.24	0.10	0.29	0.00	1.00
Services in-house share	0.45	0.40	0.22	0.01	1.00
Services input share	0.17	0.15	0.10	-0.24	0.93
Employment	139	44	657	20	na
Labour productivity	667	581	390	13	7,701
Human capital intensity	0.19	0.14	0.15	0.00	1.00
Physical capital intensity	324	188	548	0	11,681
Services sales share	0.10	0.01	0.19	0.00	1.00
Multinational status	0.46	0.00	0.50	0.00	1.00
Exporter	0.81	1.00	0.39	0.00	1.00

Notes: Descriptives for the year 2007. Number of firms is 4,027. Number of observations in the 2001-2007 period is 27,871. Monetary values are in 1,000 SEK (approximately 148 USD) and employment in number of employees. Only merchandise trade is considered. One maximum value is not disclosed for confidentiality reasons.

Table 2. Services premia, in terms of elasticities

Premia \ Shares	In-house services	Services input
Export intensity	0.463***	0.012
Labour productivity	0.113***	-0.024***
Human capital intensity	1.066***	0.013

*Notes: Estimates of elasticities from six pooled OLS regressions, all with variables in logs and robust and clustered standard errors. * p < 0.10, ** p < 0.05, *** p < 0.01*

Table 3. The role of services for export

	Pooled OLS				Fractional Tobit
	(1)	(2)	(3)	(4)	(5)
ey/ex w.r.t. services in-house share		***0.191******	***0.261******	***0.299******	***0.0615****
ey/ex w.r.t. services input share		***0.0664****	***0.173******	***0.183******	***0.00405***
Services in-house share (sh_{t-1})		0.110***	0.384***	0.773***	0.325**
		(0.024)	(0.068)	(0.090)	(0.140)
Services input share (si_{t-1})		0.0902**	0.506***	0.593***	0.143
		(0.044)	(0.107)	(0.114)	(0.0942)
Log of employment (emp_{t-2})	0.0341***	0.0353***	0.0339***	0.0849***	0.107***
	(0.005)	(0.005)	(0.005)	(0.010)	(0.0119)
Log of labour productivity (lp_{t-2})	0.0382***	0.0376***	0.0375***	0.0377**	0.0189***
	(0.014)	(0.014)	(0.014)	(0.015)	(0.00570)
Log of human capital intensity ($hcap_{t-2}$)	0.00882***	0.00750***	0.00715***	0.00606***	0.00386**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.00152)
Log of physical capital intensity ($pcap_{t-2}$)	0.00332***	0.00328***	0.00280**	0.00170	0.00638***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.00155)
Multinational status (mne_{t-2})	0.101***	0.0934***	0.0949***	0.0264	0.0521***
	(0.008)	(0.008)	(0.008)	(0.018)	(0.0160)
Exporter (exp_{t-2})	0.127***	0.120***	0.114***	0.101***	0.117***
	(0.006)	(0.007)	(0.007)	(0.012)	(0.0345)
Services sales share (ss_{t-1})				-0.00198	0.0625
				(0.052)	(0.0451)
Services in-house share squared (shs_{t-1})			-0.272***	-0.272***	-0.143
			(0.070)	(0.072)	(0.0878)
Services input share squared (sis_{t-1})			-0.753***	-0.671***	-0.0680
			(0.177)	(0.178)	(0.107)
Services sales share squared (sss_{t-1})				0.136***	-0.0278
				(0.048)	(0.0511)
shxsi				-0.200	-0.208
				(0.145)	(0.132)
shxss				-0.348***	-0.0591
				(0.082)	(0.0611)
sixss				-0.213	-0.176*
				(0.135)	(0.105)
shxemp				-0.0964***	-0.0656***
				(0.019)	(0.0185)
shxexp				0.0212	0.243***
				(0.027)	(0.0897)
shxmne				0.153***	-0.00395
				(0.036)	(0.0369)
No. of Obs.	16,659	16,429	16,429	16,429	27,871
R^2-adj.	0.405	0.41	0.415	0.428	
Scale factor					0.388
Wald χ^2 (22)					964.170
Log-likelihood					2,195.925

*Notes: Pooled OLS regression results are displayed in columns 1-4, with robust and clustered standard error in parenthesis. Fractional Tobit results are in column 5, with robust and clustered standard errors based on 50 block bootstrap replications. ey/ex denote elasticities at means. * p < 0.10, ** p < 0.05, *** p < 0.01*

Table 4. The role of services across industries, in terms of elasticities

	(1)	(2)
	Pooled OLS	Fractional Tobit
Services in-house share (sh_{t-1})		
Consumption goods	-0.0172	-0.0986
Basic industry	0.349***	0.0695***
Engineering industry	0.265***	0.0758
Services input share (si_{t-1})		
Consumption goods	0.273***	0.145**
Basic industry	0.183***	0.00166
Engineering industry	0.155***	0.00678

*Notes: Displayed are elasticities at means, in column 1 from a pooled OLS regression with robust and clustered standard errors, and in column 2 from three fractional Tobit estimations with standard errors from 50 block bootstrap replications. * p < 0.10, ** p < 0.05, *** p < 0.01*

Table 5. The role of services across firm size, in terms of elasticities

	(1)	(2)
	Pooled OLS	Fractional Tobit
Services in-house share (sh_{t-1})		
Small	0.533***	0.449
Medium	0.232***	0.397**
Large	-0.0711	-0.201
Services input share (si_{t-1})		
Small	0.286***	0.0533
Medium	0.153***	0.0140*
Large	0.0971***	0.00813**

*Notes: Displayed are elasticities at means, in column 1 from a pooled OLS regression with robust and clustered standard errors, and in column 2 from three fractional Tobit estimations with standard errors from 50 block bootstrap replications. * p < 0.10, ** p < 0.05, *** p < 0.01*

Table 6. The role of in-house services across occupations, in terms of elasticities

Managers $_{(t-1)}$	0.0482***
Professionals $_{(t-1)}$	0.0247***
Technicians and associate professionals $_{(t-1)}$	0.0321**
Clerks $_{(t-1)}$	0.0204**
Service workers and shop and market sales workers $_{(t-1)}$	-0.00672
No. of Obs.	27 871
Wald χ^2 (37)	21 915.24
Log-likelihood	2 312.802

*Notes: Displayed are elasticities at means from a fractional Tobit estimation, with standard errors from 50 block bootstrap replications. Occupational classification of services jobs is done at the 1-digit level of the International Standard Classification of Occupations (ISCO). To the fifth category of service, shop and market sales workers are three additional 3-digit occupations added, as mentioned in section three . * p < 0.10, ** p < 0.05, *** p < 0.01*

Table 7. Robustness tests

	Including services export	Controlling for labour productivity	Including proxy for R&D	Selection model
	(1)	(2)	(3)	(4)
ey/ex w.r.t. services in-house share	***0.0871******	***0.0619****	***0.0394****	***0.258*****
ey/ex w.r.t. services input share	***-0.0117***	***0.0108***	***0.00361****	***0.204*****
Services in-house share (sh_{t-1})	0.492***	0.324**	0.360**	0.604***
	(0.087)	(0.130)	(0.150)	(0.110)
Services in-house share squared (shs_{t-1})	-0.228***	-0.150*	-0.207**	-0.162*
	(0.069)	(0.078)	(0.0930)	(0.087)
Services input share (si_{t-1})	0.100	0.153	0.156*	0.612***
	(0.096)	(0.095)	(0.0917)	(0.131)
Services input share squared (sis_{t-1})	-0.0883	-0.0520	-0.0785	-0.678***
	(0.114)	(0.103)	(0.105)	(0.195)
No. of Obs.	19,688	27,871	27,871	16,429
Scale factor	.383	.388	.388	
Wald χ^2 (22)	952.480	1,476.650	1,098.130	
Rho				-0.440 (0.0373)
Log-likelihood	2,761.165	2,210.001	2,222.322	-2,802.712

Notes: Fractional Tobit regression results are displayed in columns 1-3, with standard errors from 50 block bootstrap replications, and Heckman regression results in column 4, with robust and clustered standard errors. In column 1, the response variable of the estimation includes services export in the numerator and the period is limited to 2003-2007 period. In this period, services trade is survey-based, but covers the overall majority of all services trade for Sweden. In column 2, current and the first and second lag of labour productivity is added to the main specification. In column 3, the share of employees with a doctor's degree is controlled for, as a proxy for R&D. For brevity, control

Appendix

Tables and figures

Table A1. Data description and sources

Variable	Definition	Data sources
Export intensity (eint)	Share of merchandise export over total sales	Statistics Sweden, SBS and FTS
Services in-house share (sh)	Share of wages to services-related labour in total wages	Statistics Sweden, SBS and RAMS
Services input share (si)	Share of bought-in services in total input	Statistics Sweden, SBS
Employment (emp)	Number of employees (full-time equivalents)	Statistics Sweden, SBS
Labour productivity (lp)	Value-added per full-time employee	Statistics Sweden, SBS
Human capital intensity (hcap)	Share of employees with post-secondary education	Statistics Sweden, RAMS
Physical capital intensity (pcap)	Capital stock per full-time employee	Statistics Sweden, SBS
Services sales share (ss)	Share of services in total sales	Statistics Sweden, SBS
Multinational (mne)	Multinational status dummy (1 if part of an enterprise with firms abroad, 0 otherwise)	Statistics Sweden, EGR
Exporter (exp)	Exporter dummy (1 if exporting, 0 otherwise)	Statistics Sweden, FTS

Note: Sources from Statistics Sweden are Structural business statistics (SBS); Register based labour market statistics (RAMS); Foreign Trade Statistics

Table A2. Descriptive statistics, 2001-2007

	Mean	Median	Std. Dev.	Min.	Max.
Export intensity	0.25	0.11	0.29	0.00	1.00
Services in-house share	0.43	0.38	0.22	0.00	1.00
Services input share	0.18	0.16	0.11	-0.34	1.00
Employment	143	44	642	20	na
Labour productivity	567	498	479	0	41,490
Human capital intensity	0.17	0.13	0.14	0.00	1.00
Physical capital intensity	323	192	1,348	0	194,577
Services sales share	0.08	0.00	0.17	0.00	1.00
Multinational status	0.49	0.00	0.50	0.00	1.00
Exporter	0.83	1.00	0.38	0.00	1.00

Notes: The number observations i the 2001-2007 period is 27,871. Monetary values are in 1,000 SEK (approximately 148 USD) and employment in number of employees. Only merchandise trade is considered. One maximum value is not disclosed for confidentiality reasons.

Table A3. Pairwise correlation

	eint	sh	si	emp	lp	pcap	hcap	ss	mne	exp
eint	1.000									
sh	0.151	1.000								
si	0.016	0.241	1.000							
emp	0.315	0.117	0.098	1.000						
lp	0.169	0.167	-0.115	0.157	1.000					
pcap	0.121	-0.075	-0.021	0.119	0.119	1.000				
hcap	0.185	0.322	0.097	0.215	0.122	0.013	1.000			
ss	-0.013	0.256	0.072	0.143	0.081	-0.100	0.078	1.000		
mne	0.384	0.253	0.077	0.450	0.156	0.072	0.211	0.140	1.000	
exp	0.386	0.075	-0.029	0.242	0.098	0.169	0.164	0.021	0.289	1.000

Notes: Number of observations in the 2001-2007 period is 27,871. Values are in 1,000 SEK (approximately 148 USD).

eint: *Export intensity (merchandise export / total net sales)*

sh: *Services share in in-house production (services wages / total wages)*

si: *Services share in costs for externally sourced input*

emp: *Log of employment (measured as the number of full-time equivalents)*

lp: *Log of labour productivity (value-added / employment)*

pcap: *Log of capital intensity (capital stock / employment)*

hcap: *Log of human capital intensity (employment with post-secondary education or higher / total employment)*

ss: *Services share in total net sales*

mne: *Multinational enterprise dummy*

exp: *Exporter dummy*

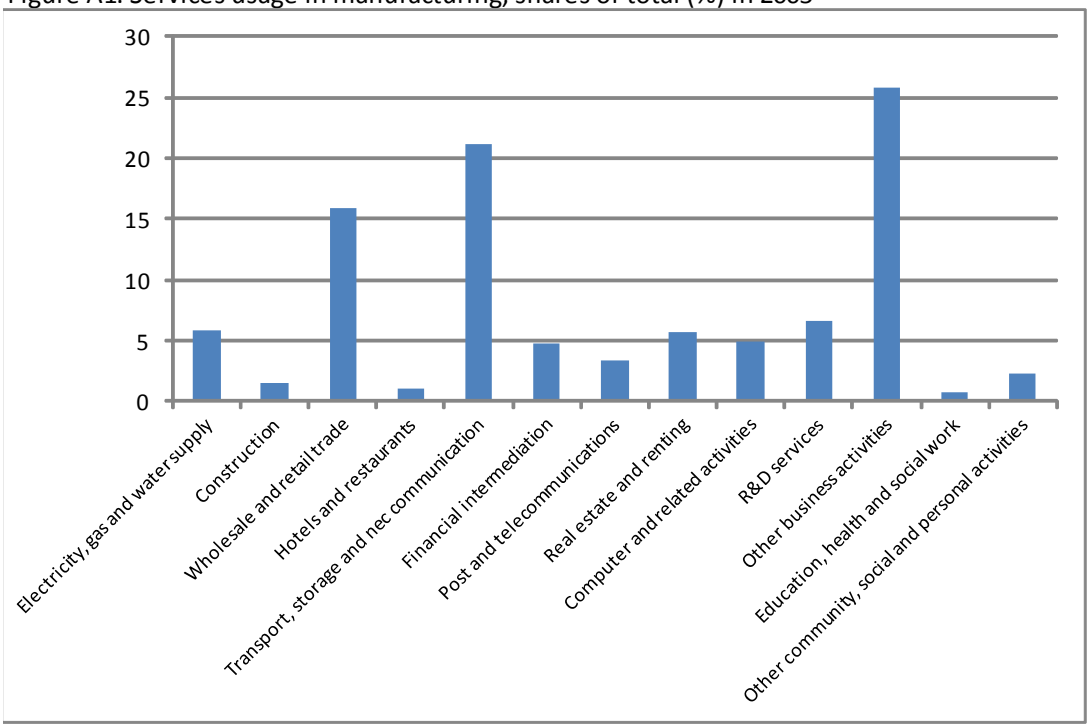
Table A4. Export intensity of firms with various levels of services share in in-house production, 2007

	No. of Obs.	Mean	Std. Dev.	Median
≤ 20%	385	0.094	0.189	0.002
> 20% and ≤ 40%	1,606	0.205	0.267	0.069
> 40% and ≤ 60%	1,153	0.291	0.300	0.184
> 60% and ≤ 80%	491	0.376	0.325	0.313
> 80%	392	0.213	0.315	0.009

Table A5. Export intensity of firms with various levels of services input share in total output, 2007

	No. of Obs.	Mean	Std. Dev.	Median
≤ 10%	766	0.226	0.287	0.088
> 10% and ≤ 30%	2903	0.250	0.292	0.115
> 30% and ≤ 50%	303	0.206	0.317	0.009
> 50% and ≤ 70%	45	0.097	0.220	0.000
> 70%	10	0.162	0.276	0.005

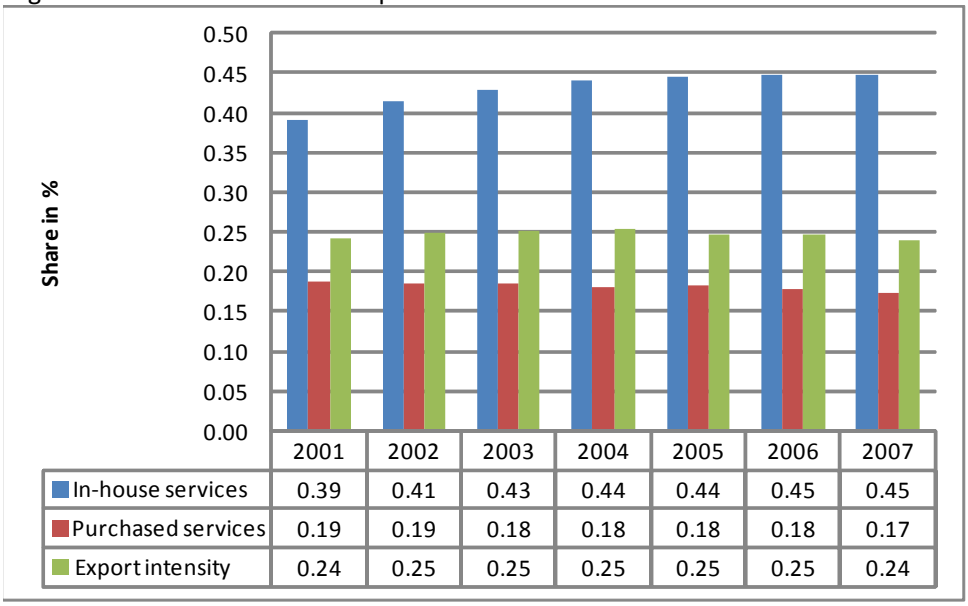
Figure A1. Services usage in manufacturing, shares of total (%) in 2005



Source: Input-output table 2005, Statistics Sweden, own calculations.

Notes: Due to confidentiality, R&D and Other business services are reported together in the I-O table. However, by using publicly available information from Statistics Sweden, this post has been disaggregated into its constitutent parts, while keeping in mind that these figures are approximations. Use of public administration and compulsory social security services (NACE 75) is not included.

Figure A2. Mean services and export shares 2001-2007



	2001	2002	2003	2004	2005	2006	2007
In-house services	0.39	0.41	0.43	0.44	0.44	0.45	0.45
Purchased services	0.19	0.19	0.18	0.18	0.18	0.18	0.17
Export intensity	0.24	0.25	0.25	0.25	0.25	0.25	0.24

Data

Data for the study comes from Statistics Sweden and covers 2001-2007. The resulting unbalanced micro panel database encompasses all manufacturing firms in Sweden (ISIC 10-37).

Financial information comes from the Swedish Structural Business Statistics (SBS). The SBS is based on data of the Swedish Tax Authority but is supplemented by survey data for some variables as well as for the largest firms. A firm is generally defined as the smallest legal entity. However, there are some 50 "composite firms" who report for more than one legal entity within the same enterprise group.[27] Industry affiliation of firms and entities is from the Business Register and is done using the Swedish standard industrial classification (SNI 2002). SNI 2002 corresponds to NACE (rev. 1.1) up to 4-digit level and to ISIC (rev. 3) up to the 2-digit level.

Information on enterprise affiliation comes from the Swedish Enterprise Group Register (EGR). Data has been collected by Statistics Sweden and PAR AB. An enterprise group is

[27] For 2006, 55 "composite firms" enclosed 1071 other legal entities.

defined as a group consisting of a mother firm and at least one more firm, where the mother holds the absolute and therefore controlling majority (>50%) of the stocks.[28]

Statistics on highest education attained for each resident aged 16-74 comes from the register based labour market statistics (RAMS). Since 2001 RAMS also contains information on number of employees, their occupation and remuneration.

Foreign trade data is from the Swedish Foreign Trade Statistics (FTS). It includes value (SEK) and country of origin or destination. With respect to merchandise trade with non-EU countries, data comes from compulsory registration information of the Swedish Customs. Regarding intra-EU merchandise trade, data covers the trade of all firms with an annual import or export of 2.2 and 4.5 million SEK, respectively.[29] For services trade, all collated bank transactions larger than 150 000 SEK crossing the Swedish border is included before 2003. Since 2003 data is based on a quarterly survey. A representative sample of some 5 000 services traders is included in the survey – 10 per cent of the population – and a third of the sample is replaced each year.[30]

[28] In 2006 about 70 per cent of firms in the EGR were in Swedish-only groups, 17 per cent in foreign ones and 13 per cent in Swedish multinationals.
[29] The earlier limit for exports and imports being covered was 1.5 mn SEK (1998-2004). For trade via another EU member, information on the actual sender or receiver is unavailable.
[30] Data for travel funds and some government authorities are reported separately by the Central Bank to Statistics Sweden.