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Offshoring and ICT – Evidence for German Manufacturing and Service Firms

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Non-Technical Summary

Final goods and some services are nowadays often not only produced at one location but their value creation is organised within global value chains: Many firms source inputs, either intermediate goods or services, from abroad. The process of relocating parts of the production and value creation activities abroad is called offshoring. Modern information and communication technologies (ICT) are recognised to be a central driver behind the recent rise in firms' offshoring activities because ICT have the potential to reduce the costs associated with offshoring, e.g. communication costs with suppliers. In particular, the Internet has made previously mostly non-tradeable services tradeable, even across international borders. Moreover, ICT facilitate the splitting up of production processes. Existing empirical evidence suggests that more ICT-intensive firms are more likely to offshore inputs than less ICT-intensive firms.

In this paper, I analyse the relationship between sourcing inputs from abroad, i.e. offshoring, and a firm's ICT use. Using firm-level data from Germany with detailed information on ICT use, I distinguish between manufacturing and service sector firms. The studied ICT measures cover complex enterprise resource software, e-commerce for ordering products or services from suppliers, investment in software, hardware and telecommunication as well as the share of employees working predominantly at the computer (PC) as a proxy for a firm's ICT intensity.

The results show that firms using software to coordinate and to manage the supply chain are more likely to offshore than firms which do not use such software, particularly in manufacturing. For manufacturing firms, the share of employees working mainly at the PC is positively related to offshoring, too. For service firms, also the use of general enterprise resource planning software and of e-commerce over the Internet for ordering at suppliers make offshoring more likely. Moreover, offshoring firms from both sectors tend to perform better than non-offshoring firms: Firms with a higher labour productivity and firms which have realised a product innovation are significantly more likely to offshore. Overall, the findings reveal a positive link between ICT and offshoring as well as a performance advantage of offshoring firms in comparison to non-offshoring firms which is stated in the literature.

Das Wichtigste in Kürze

Die Herstellung von Endprodukten und einiger Dienstleistungen findet heutzutage oft nicht mehr nur an einem Standort statt, sondern ist in globalen Wertschöpfungsketten organisiert. Diese Entwicklung zeigt sich darin, dass immer mehr Unternehmen Vorleistungen, entweder Zwischenprodukte oder Dienstleistungen, von Zulieferern aus dem Ausland beziehen. Der Auslagerungsprozess von Teilen der Produktions- und Wertschöpfungsaktivitäten ins Ausland wird als „Offshoring“ bezeichnet. Ein zentraler Treiber für Offshoring sind moderne Informations- und Kommunikationstechnologien (IKT). IKT haben das Potenzial die mit dem Import von Vorleistungen verbundenen Kosten, wie z.B. Kosten für die Kommunikation mit Zulieferern oder Logistikkosten, zu reduzieren. Insbesondere einige Dienstleistungen, die einst als nicht handelbar galten, sind über das Internet international handelbar geworden. Zudem vereinfachen IKT die Aufspaltung von Wertschöpfungsketten. Bisherige empirische Analysen kommen mehrheitlich zu dem Ergebnis, dass IKT-intensivere Unternehmen eher Vorleistungen importieren als Unternehmen, die IKT weniger nutzen.

In dem vorliegenden Papier untersuche ich den Zusammenhang zwischen dem Import von Vorleistungen und der Nutzung von IKT auf Firmenebene. Dazu werden Unternehmensdaten mit detaillierten Informationen zu IKT verwendet und bei der Analyse zwischen dem verarbeitenden Gewerbe und Dienstleistungssektoren in Deutschland unterschieden. Die betrachteten IKT-Anwendungen beinhalten komplexe Unternehmenssoftware, die Nutzung des Internets zur Bestellung bei Zulieferern, Investitionen in Hardware, Software und Telekommunikation sowie den Anteil der Beschäftigten, die überwiegend am Computer arbeiten, als ein Maß für die IKT-Intensität eines Unternehmens.

Die Ergebnisse zeigen, dass Unternehmen, die Software zum Management von Lieferanten-Beziehungen nutzen, eher Vorleistungen importieren als Unternehmen, die eine solche Software nicht nutzen. Im verarbeitenden Gewerbe besteht zudem ein positiver Zusammenhang zwischen Offshoring und dem Anteil der Beschäftigten, die überwiegend am Computer arbeiten. Dienstleistungsunternehmen importieren Vorleistungen eher, wenn sie Software zur Ressourcenplanung des Unternehmens nutzen sowie Produkte oder Dienstleistungen bei Zulieferern über das Internet bestellen. Außerdem erweisen sich die Offshoring betreibenden Unternehmen aus beiden Sektoren als produktiver und innovativer als Unternehmen, die keine Vorleistungen importieren: Eine höhere Arbeitsproduktivität sowie realisierte Produktinnovationen stehen in einem positiven Zusammenhang zum Bezug von Vorleistungen aus dem Ausland. Allgemein weisen die Ergebnisse auf eine positive Beziehung zwischen IKT und Offshoring hin sowie auf den in der Literatur genannten Produktivitätsvorteil von Firmen, die Vorleistungen importieren, im Vergleich zu denen, die keine Vorleistungen von Auslandsmärkten beziehen.

Offshoring and ICT - Evidence for German manufacturing and service firms *

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Abstract

In this paper, I analyse the relationship between offshoring and ICT at the firm level differentiating between manufacturing and services. Using firm-level data from the manufacturing and service sector in Germany and a broad range of ICT measures, overall, the results reveal a positive relationship between offshoring and ICT. Thus, they support the argument that ICT might be relevant for offshoring. Controlling for other firm characteristics, software to coordinate and to manage the supply chain increases the offshoring probability, in particular for manufacturing firms. For service firms, also general enterprise software and e-commerce purchases from suppliers make offshoring more likely. Labour productivity and the realisation of a product innovation are significantly and positively linked to offshoring for firms from both sectors. This finding confirms the productivity advantage of offshoring in comparison to non-offshoring firms that is stated in the literature.

keywords: offshoring, information and communication technologies, firm-level analysis

JEL codes: D22, L23, F14

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1 Introduction

Recent advances in information and communication technologies (ICT) are recognised to be an important driver behind the rise in offshoring intermediate inputs, i.e. sourcing inputs from abroad, from the mid-1990 onwards, which has led to an increased importance of global value chains. For instance, Grossman and Rossi-Hansberg (2007, p.59) state: "Revolutionary progress in communication and information technologies has enabled an historic (and ongoing) break-up of the production process." ICT may particularly be an enabler for trade in services because many services, like for instance accounting services or technical support, have been seen as non-tradable before. Generally, ICT can reduce communication, information and transaction costs, which in an international context, can be interpreted as trade costs. Moreover, ICT may also indirectly affect the offshoring decision through increased firm performance given the productivity-enhancing impact of ICT and the argument put forward by Antrás and Helpman (2004) that due to fixed costs of starting to offshore, firms need a certain productivity level to be able to engage in offshoring (Benfratello et al., 2009). These arguments suggest that offshoring firms might differ in their ICT use from non-offshoring firms.

The purpose of this paper is to shed more light on the link between ICT and offshoring of inputs, comprising materials and services, at the firm level.[1] I investigate if the use of specific ICT applications significantly increases the offshoring probability taking account of other firm characteristics, such as labour productivity, that might also be relevant for the decision to offshore. As such, the analysis provides characteristics of offshoring firms. The data set used for the empirical analysis comprises information on ICT use and offshoring activities of firms from the manufacturing and service sector in Germany. Firms' ICT use is measured by enterprise software systems, firms' e-commerce purchases from suppliers, the level of ICT investment and the share of employees working mainly at the computer (PC).

The empirical study contributes to the literature in two respects. First, I analyse various ICT measures in their relationship to offshoring in contrast to existing empirical evidence which mostly considers one or two measures for a firm's ICT use, mostly the level of ICT investment or e-commerce. In particular, to the best of my knowledge, the analysis provides first firm-level evidence on the relationship between ICT-based software systems use and offshoring. In addition, the data includes information on the use of e-commerce purchasing, the level of ICT investment in hardware, software and telecommunication and the share of employees working mainly with the computer as a measure for the firm's hardware infrastructure and dependence on the computer for her value creation. The different measures account for the heterogeneity of ICT and allow to distinguish which kind of ICT might be relevant for a firm's offshoring

[1] I do not focus neither on services offshoring nor on information technology (IT) outsourcing, two issues widely discussed in the literature.

activity. Second, the analysis presents evidence on characteristics of offshoring service firms in addition to manufacturing firms for which most of the empirical evidence on offshoring is based on till so far. As such, it allows to investigate potential differences between the two sectors in the link between offshoring and ICT use and other firm characteristics, respectively.

The results show that for manufacturers, ICT-based supply chain management and the share of employees working mainly at the PC increase the probability to offshore. For service firms, besides software to manage the supply chain, also general enterprise software as well as e-commerce purchases increase the offshoring probability. In both sectors offshoring is significantly positively related to labour productivity and realised product innovations.

The remaining paper is structured as follows: Section 2 discusses the relevant literature for the empirical analysis. Section 3 explains the econometric implementation and section 4 describes the data. In section 5 the empirical results are presented, and section 6 concludes.

2 Background Discussion

Offshoring[2] describes the sourcing of intermediate inputs from a foreign located firm.[3] Hence, offshoring implies that the production process of a final good is split into several stages in a number of locations where each location contributes to the value of the final good or service (Krugman, 1995). From a macroeconomic perspective, offshoring is measured as trade in intermediate goods or trade in intermediate services, which based on the World Trade Organization definition capture commercial services excluding travel and transportation (Cheung and Rossiter, 2008). Offshoring is also defined as "the relocation of jobs and processes to any foreign country without distinguishing whether the provider is external or affiliated with the firm" (Olsen, 2006, p.6). Thus, the term offshoring does not specify the ownership structure between the sourcing firm and the firm from which she sources the inputs. On the one hand, offshoring includes the sourcing from a foreign external supplier. This option is also called international or foreign outsourcing or arm's-length trade. On the other hand, offshoring encompasses intra-firm trade across borders, which is also referred to as international insourcing. If the sourcing firm decides to open an affiliate abroad, which produces the intermediate inputs, this is usually called (vertical) foreign direct investment (FDI). Since offshoring inputs implies that the input crosses a national border, it can also be interpreted as importing inputs from abroad.[4]

[2] Other expressions mentioned in the literature for offshoring are "slicing up the value chain" (Krugman, 1995), (international) fragmentation of production (Deardorff, 2001) or disintegration of production (Feenstra, 1998).
[3] See e.g. Olsen (2006) for an overview of the conceptual framework of offshoring.
[4] See section 3 for an explanation of how offshoring is measured in this paper.

Arguments and empirical evidence from various literature strands are relevant for the analysis of this paper. First, there is the literature on the benefits of ICT for offshoring and outsourcing of any kind of intermediate input.[5] ICT help reducing the costs of outsourcing of business services as they have the potential to lower search and transaction costs directly and as they can decrease the degree of specificity of the transaction since ICT are compatible with general skills, which are easily transferrable across firms (Abramovsky and Griffith, 2006): Therefore, firms with a higher ICT investment level are expected to outsource and offshore more services. Moreover, ICT may improve the matching of buyers and suppliers of specialized inputs and business services, which may increase outsourcing activities (Grossman and Helpman, 2002). ICT also enable a change in the task composition of jobs (Autor et. al, 2003), thereby facilitating the fragmentation of production processes across borders and leading to so-called "trade in tasks", a term suggested by Grossman and Rossi-Hansberg (2008) to highlight the labour content of offshoring manufacturing tasks and business functions.

Besides the ICT-enabled direct cost reduction and the ICT-facilitated change in job task composition as drivers for outsourcing inputs, ICT may also indirectly affect a firm's offshoring decision through ICT-improved firm performance (Benfratello et al., 2009). The argumentation for the indirect effect of ICT on the offshoring decision is based on two strands of the literature: On the one hand, by now it is undisputed that ICT may be productivity-enhancing. There is a large literature on productivity effects of ICT investment at the enterprise level and also at the macroeconomic level.[6] On the other hand, firm heterogeneity in productivity is suggested to be an important determinant for a firm's global sourcing decision: More productive firms are more likely to engage in offshoring as they have the resources to overcome the fixed costs of offshoring (Antrás and Helpman, 2004). The fixed (sunk) costs of offshoring include, for instance, searching for foreign suppliers or making contracts. This theoretical consideration suggests a causal self-selection of already more productive firms into offshoring prior to starting to offshore. There is also a literature strand investigating possible feedback effects from offshoring on productivity, i.e. the other direction of causality.

Empirical evidence on the relationship between ICT use at the firm-level and the decision to engage in offshoring, though scarce, mainly suggests a positive link: For Japanese manufacturers, a higher computer intensity, measured as the number of computers per firm sales, is linked with a higher foreign outsourcing intensity (Tomiura, 2005). Using firm-level data from the United Kingdom, Abramovsky and Griffith (2006) find that firms with higher investment in ICT and using the Internet to order goods or services outsource more business services and are more likely to offshore them, too. For Korean manufacturers, an ICT level of at least using

[5] There is a large literature strand, mainly from the management and information technology literature, focusing on the determinants and impacts of information technology (IT) outsourcing. However, the focus of this paper is the role of ICT for offshoring any kind of production process inputs, and not only IT services. Therefore, the IT outsourcing literature is not discussed explicitly in this paper.

[6] For an overview see e.g. Draca, Sadun, and Van Reenen (2007) and Kretschmer (2012).

the Internet for e-commerce is positively related with the offshoring decision, in particular for offshoring from the own foreign affiliate (Hyun, 2010). However, the relationship is not significant if only international outsourcing, i.e. cross-border arm's length transactions, is considered as the international sourcing decision or if an instrumental variable approach is used to control for potential endogeneity between ICT and the offshoring decision. The only evidence for a negative relationship is found by Benfratello et al. (2009) for Italian manufacturing firms whose ICT investment is significantly and negatively related to the offshoring decision, once controlling for the endogeneity of ICT.[7]

With respect to the role of productivity for offshoring, the few existing firm-level evidence generally supports the positive link. For instance, German manufacturers have already a higher labour productivity than non-offshoring firms prior to and also after offshoring (Wagner, 2011). For Japanese manufacturers, a higher foreign outsourcing intensity is associated with higher productivity (Tomiura, 2005). However, Hyun (2010) finds for Korean manufacturers that labour productivity does not seem to be an important determinant for a firm's decision to engage in offshoring. Empirical evidence for positive productivity effects from offshoring are rather mixed and suggest that for manufacturers materials or services offshoring often have no significanr productivity effect in contrast to a positive effect of services offshoring for service firms.[8]

Further findings from the firm-level studies of determinants of offshoring are that offshoring manufacturers are larger in terms of the number of employees (e.g. Wagner, 2011) or in terms of sales (e.g. Tomiura, 2005 for foreign outsourcing) and they are more R&D intensive (e.g. Tomiura, 2005 or Hyun, 2010). The positive relationship between offshoring and R&D is theoretically motivated by Glass and Saggi (2001) who derive that international outsourcing increases innovation incentives. The economic mechanism behind the positive link is that international outsourcing reduces production costs through lower prices for the inputs sourced from abroad than domestically available and thereby raises a firm's profits so that the higher profits can be used to increase the innovation rate through increased R&D spending. Empirically, Görg and Hanley (2011) find a positive effect of international outsourcing of services on innovative activity using plant-level data from the Republic of Ireland. Moreover, Criscuolo et al. (2005) find that globally engaged firms, exporters or being part of a multinational, innovate more than purely domestic firms. The innovation advantage can be contributed to a higher number of researchers but also to a more diversified set of inputs, which provides a larger information pool, and is available to globally engaged firms through their contacts to suppliers, customers or foreign affiliates.

[7] Not controlling for endogeneity of ICT to offshoring, they also find a positive and significant coefficient for ICT investment with respect to offshoring.

[8] See for a review of productivity effects of offshoring at the macroeconomic and microeconomic level e.g. Olsen (2006) and as an example Wagner (2009) for an investigation of German manufacturers.

Generally, empirical evidence reveals significant differences between importing and non-importing firms.[9] For instance, Bernard et al. (2007) find that U.S. importing manufacturers have mainly very similar characteristics to exporting firms: They are larger, more productive, more capital- and skill-intensive, pay higher wages prior to international market entry than non-exporting and non-importing firms. The similarity between exporting and importing firms comes mainly from the fact that importing firms are mostly also exporters.

Firm-level evidence for internationally active service firms is still scarce. Though not studying explicitly service firms only, Breinlich and Criscuolo (2011) provide characteristics of exporters and importers that trade services. They find that only very few firms trade services and, similar to previous evidence for firms trading goods, that service importers are larger in terms of employment and sales, more labour productive, more capital intensive, they pay higher wages and are more likely to be foreign-owned or part of a multinational.

Finally, some findings from the literature on ICT adoption and its impact on productivity are relevant. Empirical evidence often finds a positive relationship between ICT adoption and firm size as well as human capital.[10] Firm size is often interpreted as a measure for a firm's financial capacity to afford complex and often expensive ICT systems, where larger firms are likely to have better access to financial resources than smaller firms. Moreover, exporters are found to be more likely to use ICT. However, there is large firm-level heterogeneity with respect to productivity and investment patterns even within the same industries that might be induced due to differing characteristics in management orientation, organisational structures and skills.[11] Moreover, ICT are said to be an enabler for innovation (Brynjolfsson and Saunders, 2010).

Within the literature on ICT and productivity, enterprise software systems as a particular type of ICT are shown to have positive productivity impacts. Typical examples for such systems are Enterprise Resource Planning (ERP), ICT-based Supply Chain Management (SCM) or Customer Relationship Management (CRM).[12] These are all highly complex systems. ERP is a general purpose software that integrates enterprise functions such as sales and distribution, materials management, production planning, financial accounting, cost control, and human resource management (Aral et al., 2007). While CRM focuses on the interaction with customers, SCM may refer to ICT-based processing of up to all steps of the value chain. The principal role of such software solutions is to assist the firm to gather information from various business processes, analyse this information and then to execute on it to increase the performance of the supply chain (Chopra and Meindl, 2007). The benefits of such systems might be especially

[9] The literature on importing firms does usually not distinguish if the imports are final goods or intermediate inputs.

[10] For a recent review of the evidence on ICT adoption and firm characteristics see e.g. Haller and Siedschlag (2011).

[11] See e.g. Draca, Sadun, and Van Reenen (2007).

[12] For more information on these ICT applications, see e.g. Engelstätter (2012).

useful for firms with external suppliers. Therefore, software systems might be possibly positively related to a firm's offshoring behaviour. In particular, SCM might be helpful for offshoring firms to manage their global value chain. To the best of my knowledge, there does not exist any study yet that investigates explicitly the role of enterprise software systems for offshoring.

The goal of this paper is to provide new empirical evidence on the role of ICT and other relevant firm characteristics for the probability to engage in offshoring. I analyse the link of distinct ICT variables to offshoring distinguishing between manufacturing and service firms. Based on the arguments for the impact of ICT for the offshoring decision derived in the literature, I expect a positive link between offshoring and ICT.

3 Econometric implementation

In order to investigate how ICT applications are related to the probability of sourcing inputs from abroad a univariate probit model is chosen

$$P(Y_i = 1|X_i) = \Phi(\alpha + \beta'_{ICT} ICT_i + \gamma' X_i) \tag{1}$$

where the dependent variable offshoring activity Y_i is a dummy variable being equal to one if firm i offshores, and equal to 0 if not. $\Phi(.)$ represents the cumulative standard normal distribution, ICT_i is a vector of ICT applications and X_i a vector of control variables. The ICT vector covers distinct types of enterprise software systems, e-commerce usage for ordering products or services, and the level of ICT investment. The share of employees working mainly with the PC is included in all regressions as a proxy for a firm's ICT intensity.[13] Moreover, to check if more ICT-intensive firms are more likely to offshore, an ICT index is constructed by counting the number of ICT applications used in a firm.[14]

X_i is a vector of controls comprising variables that might have an impact on the decision to offshore inputs as well as on adopting a certain ICT application, as identified in the literature on determinants of offshoring and on ICT adoption. It takes account of firm size and human capital. If offshoring leads especially to a relocation of low-skilled jobs abroad as discussed in the literature, offshoring engagement and more skilled human capital are expected to be positively related. The skill intensity is also relevant for ICT adoption as the literature on ICT and productivity has provided empirical evidence for the complementarity between skills and

[13] See e.g. Engelstätter (2012) for a use of this measure.

[14] A more standardised ICT index at the industry level is not necessary since all industry variation is captured by industry dummy variables. See below for more information.

ICT.[15]

A firm's international participation, captured by export status and if she has a foreign affiliate, is included since it is suggested that firms with other foreign contacts have potentially lower offshoring costs and thus might be more likely to offshore. Labour productivity is considered to account for the potential role of firm productivity for the offshoring decision as well as for the potential link between ICT and productivity. Moreover, more productive firms might have better financial capacities to afford expensive ICT systems. To account for the link between offshoring and innovation, a firm's innovative capabilities are captured by either a firm's R&D intensity, as a measure of innovation input, or product and process innovation, as two measures for realised innovations. The innovation variables may also be correlated with the ICT variables given that ICT may enable to innovate as well as the installation of software systems represents a realised process innovation.

Finally, industry dummy variables based on the industry affiliation according to the NACE two-digit industry level[16] are included to capture industry-specific effects as well as a dummy indicating if the firm is located in East Germany to account for possible regional effects. The next section gives a more detailed description of the data used for the analysis.

The probit regressions allow for heteroskedastic error terms by using the robust standard errors estimation. Since offshoring as the dependent variable and the ICT and control variables as explanatory variables are from the same year, possible endogeneity of the variables do not allow to make causal interpretations and therefore the econometric results are interpreted as correlations between the variables.[17]

4 Data and Descriptive Analysis

The data used in the empirical analysis are from the ZEW ICT survey 2010 conducted by the Centre for European Economic Research (ZEW) and were collected by computer-aided telephone interviews.[18] The survey has a focus on the diffusion and use of ICT. Besides the questions related to ICT, the survey provides information about general firm characteristics and performance measures such as the number of employees, the qualification structure of the labour force, total turnover and innovation activity. The survey comprises firms from

[15] See e.g. Draca, Sadun, and Van Reenen (2007) for a summary of the skill-ICT complementarity hypothesis.
[16] WZ 2008 classification.
[17] Since the data set used for the empirical analysis provides cross-sectional data, it cannot be accounted of the endogeneity. See the next section for more details on the data set and the used variables.
[18] The ZEW ICT survey was also conducted in 2002, 2004 and 2007. Most questions are asked in every wave and the rotating Panel format allows to build a Panel data set. However, the offshoring variable was newly introduced in 2010 so that no Panel analysis can be conducted for the purpose of this paper.

the manufacturing and from the service sector with at least five employees. Around 4,400 firms located in Germany, stratified on a sectoral, size class and locational basis (East/West Germany) were interviewed.[19]

A firm's offshoring behaviour is captured by a dummy variable indicating if the firm offshored any inputs, goods or services, in 2009. This binary variable is constructed from the question "Based on all inputs: What is the share that was sourced from abroad in 2009?", which was only asked to firms if they imported any goods or services at all and provides a measure for a firm's offshoring share. The dummy variable is equal to one if a firm has a strictly nonzero offshoring share, and equal to zero if it does not import any goods or services. The information that the firm sources inputs from abroad allows to conclude that the firm has business contacts with foreign suppliers and makes use of inputs produced abroad for the own value creation process. Therefore, the variable captures that offshoring firms participate in the international fragmentation of production and hence, also in the international division of labour.[20]

If the firm indicates to have a foreign affiliate the information on offshoring activities does not allow to distinguish if the input is sourced from a foreign affiliate, which would be intra-firm trade, or from a foreign external supplier, which would refer to international outsourcing.[21] Hence, the exact ownership of the foreign firm, from which a firm sources, remains unspecific. However, for all firms without a foreign affiliate it can be concluded that if they source inputs from abroad, they engage in international outsourcing. To check if there is a difference in the relationship between offshoring and ICT use for purely internationally outsourcing firms and the whole sample of firms comprising also those with a foreign affiliate, I run the regressions for both samples of firms.

The firm's ICT use is captured by various ICT applications. First, four types of information-based entreprise software systems are considered: Enterprise Resource Planning (ERP) and software solutions for Supply Chain Management (SCM), for Customer Relationship Management (CRM) and for Content or Document Management systems (CDMS). Second, e-commerce use over the Internet for ordering products or services from suppliers is analysed as a direct application of the Internet. The use of enterprise software systems and e-commerce is represented by a dummy variable equal to one if the firm uses the mentioned ICT applications. Third, the level of investment in hardware, software and telecommunication equipment (ICT investment)

[19]The data set used for this analysis is accessible at the ZEW Research Data Centre: http://kooperationen.zew.de/en/zew-fdz/home.html

[20]In the literature as well as in the media the term offshoring is sometimes associated with job relocations of previously domestic jobs to foreign countries when the offshored inputs were previously produced within the firm domestically or sourced from domestic suppliers and then the business function that had produced this input is relocated. The offshoring measure used in this empirical analysis does not allow to make any conclusions about such possible relocations of business processes abroad and resulting domestic job losses since the question in the survey only asks if the firm sourced inputs from abroad.

[21]See section 2 for a discussion of the terminology of offshoring.

is analysed, which has been also taken in previous empirical studies to measure a firm's ICT use. Finally, the share of employees predominantly working with the computer is considered, which can be interpreted as a measure for a firm's ICT intensity. Another measure for a firm's ICT intensity is a constructed ICT index which counts the number of a firm's used ICT applications. For this index, only the software systems and e-commerce purchases are considered. Hence, by this construction a firm can have an ICT index value equal to at maximum five and at minimum equal to zero if she indicates not to use any of the considered ICT-based technologies. For robustness checks, an ICT index is built that counts only the number of used enterprise software systems and excludes the information on e-commerce for ordering from suppliers. This modified index purely reflects the extent of a firm's software systems adoption and can have a maximum value of four.

Further firm characteristics included in the control vector are measured as follows: Firm size is captured by the logarithmic number of employees and skilled human capital by the share of highly skilled workers (degree from university, university of applied sciences or university of cooperative education). A firm's further international participation is captured by the export status and if the firm has a foreign affiliate. Finally, the logarithmic labour productivity is included where labour productivity is measured as total sales per employee. Innovation input activity is reflected by the R&D intensity measured as R&D expenditures as a share of total sales. Innovation outcomes are considered by including a dummy variable equal to one if the firm has realised a product or process innovation in the period from 2006-2009, respectively.

The estimation sample contains firms with at least 5 employees. To exclude extreme outliers, observations with a labour productivity below the 1st and above the 99th percentile are dropped.[22] Moreover, the sample is constructed using the specification with CRM as the variable of interest controlling for other firm characteristics because the number of observations in the regression with CRM is lowest.[23] The resulting sample comprises 1253 firms from the manufacturing sector and 1174 from the service sector.[24]

Table 1 shows the distribution of firms across industries for the sample that is used in the empirical analysis as well as for the complete data set that includes all firms that were interviewed in the 2010 wave. Since the distribution of the estimation sample is not significantly different from the complete data set it can be assumed that the used sample is representative with respect to the industries.

[22] In total, 51 observations are dropped, 25 which are below the 1st and 26 which are above the 99th percentile.
[23] The specification with innovation outcomes is used for the sample creation.
[24] The reason why for the regression with other ICT applications the number of observations differs (see the tables in the appendix) is due to the fact that not for all observations with information on CRM use, information for other ICT applications is available. That is why the regression with CRM has the highest number of observations while the regressions of all other ICT applications are conducted with slightly less observations but still they are based on the same sample. The lowest number of observations is used when analysing the role of ICT investment because this variable is often not reported.

Table 2 shows offshoring participation in percent across industries. Around 59 percent of manufacturers offshore, while offshoring is still less frequent for service firms with only 27 percent. Across sectors in the manufacturing industry, offshoring participation is for all except for the metal industry above 50 percent indicating that many manufacturers participate in global value chains. For the service sector, the offshoring participation distribution looks quite different. Offshoring activities are highest for the retail (39 percent) and wholesale trade (63 percent). Potentially, these high values might not only reflect the sourcing of inputs from abroad but merely importing final goods for domestic resale if the interviewee misunderstood the question when asked how large the share of imported inputs based on all inputs was. Since this possibility cannot be ruled out, for robustness checks the empirical analysis is conducted excluding these two sectors. Besides the retail industry, the sectors media services (31 percent) and IT and other information services (32 percent) reveal fairly high offshoring participation, whereas in the real estate activities sector only 6 percent offshore.

Table 3 shows the percental ICT use and the average level of ICT investment in millions of Euro by offshoring and non-offshoring firms separately for the manufacturing and service sector. It becomes evident that the percentage of offshoring manufacturers using any kind of ICT application is always higher than the percentage of non-offshoring manufacturers. The difference in the usage frequency is highest for SCM and lowest for Internet ordering. Similarly, offshoring service firms use on average any kind of ICT application more often than non-offshoring service firms, again with the largest difference for SCM use and lowest for CDMS and Internet ordering. However, non-offshoring service firms have a slightly higher mean share of employees working mainly with the computer than offshoring firms. For both sectors, the average ICT intensity as measured by the constructed ICT index is higher for offshoring than non-offshoring firms.

Table 4 presents means of the other firm characteristics. The differences between offshoring and non-offshoring firms found in the literature are generally reflected. Offshoring firms in the manufacturing and service sector are on average larger, have a higher labour productivity, more innovative and are more often exporters as well as more of them have a foreign affiliate than non-offshoring firms. In the manufacturing sector, offshoring firms have a higher average share of high-skilled workers, while this average share is roughly the same for offshoring and non-offshoring firms in the service sector.

The descriptive analysis suggests that offshoring firms differ in their ICT adoption as well as in other important firm characteristics from non-offshoring firms suggesting that ICT matter for offshoring. As expected by theoretical considerations, on average the diffusion of ICT is larger for offshoring than for non-offshoring firms. However, since a pure mean comparison does not control for firm characteristics that might be deterministic for the offshoring decision as well as the ICT adoption, the results of a univariate probit model, controlling for such firm

characteristics, are presented in the next section to investigate whether or not the relationship between offshoring and ICT is significant.

5 Empirical Results

Table 5 to Table 7 show the raw effects of the relationship between offshoring and the specific ICT measures, where the average marginal effects of the probit regressions are reported. As suggested by the descriptive analysis, for manufacturing and service firms all ICT measures are positively related to offshoring. Only Internet ordering in the manufacturing sector is not significantly related to the offshoring decision.

However, once controlling for other firm characteristics, many of the ICT coefficients become insignificant as Table 8 to Table 13 reveal. The only difference between the specifications in Tables 8 to 10 and Tables 11 to 13 are that in the former a firm's R&D intensity is taken as a proxy for innovation input, while in the latter a firm's innovation outcomes are captured by the information on realised product and process innovations. Among the ICT variables, in the manufacturing sector, only SCM and the share of employees working predominantly at the PC are robustly significantly related to offshoring across distinct specifications. Hence, SCM using manufacturers are significantly more likely to offshore than manufacturers without SCM. For service firms, using ERP, SCM and Internet ordering significantly increase the offshoring propensity. For instance, using ERP increases the probability of offshoring by roughly 6 percentage points, while Internet ordering raises the offshoring probability by nearly 7.5 percentage points (see specification (6) in Table 13). Though the results of Abramovsky and Griffith (2006) are not completely comparable to those in this paper since they only consider business services offshoring, they also find that using the Internet to order goods significantly increases the offshoring probability for British firms.

It seems plausible that SCM use makes offshoring more likely given that the purpose of SCM is exactly to coordinate and manage integrated value chains and to support the contact with suppliers. Likewise, it does not seem surprising that CRM does not significantly increase the probability of offshoring since CRM is a software used to support the relationship with final customers of the product or service. Therefore, CRM helps to manage relationships at the end of the value chain, which is relevant for all firms, regardless of whether or not they offshore. The significant relationship between Internet ordering and offshoring for service firms underlines the role of the Internet for transactions with suppliers. The share of employees working mainly with the computer as a measure of ICT intensity is only significantly positively related to offshoring in the manufacturing sector but not for service firms. This suggests that more ICT-intensive manufacturers are more probable to offshore than less ICT-intensive firms. In contrast,

offshoring service firms do not differ significantly with respect to this ICT intensity measure from non-offshoring firms, which seems plausible given that the computer is a standard work tool for many jobs in the service sector, in particular for the sectors IT and other information services or business consultancy and advertising.

The central findings from the previous regression results, which investigate the ICT variables separately, are reflected in the relationship between offshoring and the ICT index, too (see Table 14 and 15). Though, controlling for realised innovation outcomes, the ICT index is only significantly and positively related to offshoring for service firms but not for manufacturers, the relationship is significant for firms from both sectors when controlling for R&D intensity (see Table 14).[25] Thus, the results from the ICT index suggest that a larger number of ICT applications is associated with a higher offshoring probability indicating that offshoring firms are more ICT-intensive in terms of the number of installed software systems than non-offshoring firms.

With respect to the other firm characteristics, for both sectors exporting significantly increases the offshoring probability with a magnitude of around 23 percentage points for both sectors (see e.g. Table 13). On the one hand, this supports the evidence that offshoring firms are often exporters, too. On the other hand, the fairly large coefficient estimates confirm the hypothesis proposed in the literature that firms with already some contact to foreign business partners are more likely to offshore than firms without any further international contacts. Moreover, having a foreign location increases the probability to offshore for service firms at the 1-percent level and sometimes also for manufacturing firms at the 5- or 10-percent level. Across the various specifications, firm size is only significantly positively related to offshoring for manufacturers, while the share of highly skilled employees as a measure for skill intensity is neither significantly linked to offshoring for the manufacturing nor the service sector.

The relationship between labour productivity and offshoring is significantly positive for both sectors, which confirms the findings from the literature that on average, offshoring firms are more productive than non-offshoring firms. As suggested by the descriptive statistics, having realised a product or process innovation respectively increases the probability to be an offshoring firm for manufacturers and service firms (see e.g. Table 13). Hence, offshoring firms tend to perform better than non-offshoring firms. In contrast to empirical evidence from other data sets, the R&D intensity is not significantly related to offshoring for manufacturers but only for service firms (see e.g. Table 10).

[25] A possible reason for the insignificance of the ICT index estimated coefficient for manufacturing with innovation outcomes might be a collinearity problem between the ICT index regressor and the product and process innovation dummy variables since they have a relatively high correlation (0.29 and 0.28, respectively). Not controlling for innovation outcomes, the ICT index is significantly and positively related to the offshoring probability.

Given that the descriptive analysis reveals a high offshoring participation in the retail and wholesale industry, that might not necessarily reflect trade in inputs but of final goods if the interviewee misunderstood the question, the regression analysis is conducted excluding these two sectors to see if the results remain robust (see Table 16 and Table 17). It turns out that the coefficient estimates of ERP decrease and slightly loose in significance, while the positive relationship between SCM and offshoring becomes insignificant. This suggests that offshoring retail and wholesale trading firms are particularly more likely to use ERP and SCM and thus drive the significantly positive relationship between offshoring and ERP or SCM. Contrarily, the estimate for Internet ordering increases in size from roughly 0.08 (see sepcification (6) in Table 13) with the full service sample to 0.15 (see specification (3) in Table 17) when the retail and wholesale sectors are excluded. Moreover, the positive relationship between process innovation and offshoring is no longer significant. Otherwise, the results remain robust.

ICT are said to facilitate particularly moving activities outside the firm and doing them at a greater geographic distance because they reduce transaction and adjustment costs (Abramovsky and Griffith, 2006). Therefore, all the previous regressions are done including in the sample only firms that source inputs from abroad but do not have any foreign affiliate, i.e. in terms of definitions, they engage in international outsourcing, and firms that do not offshore at all. Firms that indicate to source inputs from abroad and have a foreign affiliate are excluded from the sample and it is assured that the remaining offshoring firms source them from an external foreign supplier. The purpose of this sample reduction is to analyse if the results for the relationship between the probability to engage in international outsourcing and ICT use change in comparison to the estimates from the full sample.[26] For manufacturing firms, 1082 observations are left with 52.77 percent international outsouring firms, while for service firms 1112 remain in the sample, among which 22.48 percent source internationally. These shares are slightly lower than for the sample which includes offshoring firms with a foreign location (see section 4).

With respect to the raw effects (see Table 18 to 20), the estimation results are qualitatively the same as for the whole sample, which includes the firms with a foreign affiliate. Quantitatively, all coefficient estimates are slightly smaller than with the full sample and the coefficient estimates for CRM and ICT investment in the service sector become less significant. Controlling for other firm characteristics, in the manufacturing sector SCM remains significantly related to the international outsourcing decision (see Table 21 and specification (1) in Table 22), while as with the full sample, the other ICT variables do not make internationally outsourcing more likely. Moreover, the positive relationship between the share of employees working mainly at the PC and international outsourcing now becomes insignificant, too. However, exporting, labour productivity, product and process innovation remain significantly positively related to

[26] In the vector of control variables, the dummy variable for foreign location is left out since none of the international outsourcing firms in that reduced sample has a foreign affiliate.

international outsourcing.

For service firms, the results (see Tables 21 and 22) remain qualitatively similar in comparison to the full sample (see Tables 10 and 13) when controlling for other firm characteristics, too: ERP and Internet ordering increase the probability of international outsourcing but no longer SCM. Exporting, higher labour productivity, product innovation and a higher R&D intensity significantly increase the probability to internationally outsource also for the remaining service firms. Once the retail and wholesale industries are taken out (see Tables 23 and 24) the relationship between ERP and international outsourcing becomes insignificant. This result suggests that mainly international outsourcing retailers and wholesale traders drive the positive relationship between international outsourcing and ERP. Internet ordering remains positively related to the international outsourcing decision at the 1-percent level.

The conclusion for the relationship between international outsourcing and the ICT index is the same as for the offshoring decision (see Table 25 and 26): The higher the number of used ICT applications, the higher is the probability of international outsourcing, though again not in manufacturing when controlling for innovation outcomes. The comparison of the results when distinguishing between offshoring and international outsourcing reveal that there are generally no significant differences in their relationship to ICT and other firm characteristics. The only relevant differences are that in the service sector, the link between international outsourcing and SCM and a realised process innovation respectively is not significant in comparison to offshoring and SCM or a process realisation. This results suggests that mainly offshoring service firms with a foreign location drive the significantly positive relationship between SCM and offshoring but not internationally outsourcing service firms without a foreign location.

6 Conclusion

This paper provides new findings on the relationship between various measures of ICT and offshoring. Overall, the findings show a positive link between ICT and offshoring. Thus, they support the argument that ICT are relevant for offshoring. The results reveal that offshoring firms differ from non-offshoring firms with respect to the use of specific ICT applications and labour productivity as postulated by anecdotal evidence and found by previous empirical studies. Moreover, the results reflect differences between the manufacturing and service sectors. In both sectors, using SCM makes offshoring more likely, particularly in manufacturing. This positive relationship underlines the importance of software to manage the value chain to coordinate firms' relationship with their suppliers, which might be especially relevant for offshoring firms with foreign suppliers. In addition, in manufacturing, a higher share of employees working mainly at the PC is associated with a higher offshoring probability. Contrarily, for service firms,

also having installed ERP as well as doing e-commerce purchases make offshoring more likely. In both sectors, the offshoring probability also raises with the number of implemented software systems indicating that more ICT-intensive are more likely to offshore than less ICT-intensive firms.

The cross-sectional analysis leaves open the question of the causal link between ICT and offshoring. One possible causal direction is that ICT enable the firm to offshore through their cost reduction effect or improved productivity performance, while from the other direction, offshoring firms are more likely to adopt ICT because for them it is particularly worthwhile to install complex ICT solutions to reduce their communication and transaction costs. A causal analysis helps identifying determinants and implications of the international fragmentation of production. However, to study the causal relationship, panel data with information on the timing of the offshoring decision and the ICT adoption would be necessary.

A robust finding from the empirical analysis is that for manufacturers and service firms, labour productivity and product innovations are positively linked with offshoring. Since ICT are shown to be productivity-enhancing as well as enablers for innovation, future research could analyse the impact of ICT on productivity and innovation taking the offshoring activities and a firm's further international activities into account. A precise understanding of the relationship between firms' international activities, their input choices, with ICT as one particular type of input, and their productivity and innovation outcomes is essential for policymakers to understand why purely domestically active firms often lag behind in their performance and to design productivity and innovation capabilities enhancing policies.

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A Appendix

Table 1: Industry distribution in full sample and the complete data set from 2010

Industry	**obs.**	**% of sample**	**obs.**	**% of data set**
Consumer goods	328	13.51	544	13.04
Chemical and pharmaceutical industry	106	4.37	175	4.19
Other raw materials	183	7.54	295	7.07
Metal industry	166	6.84	273	6.54
Electrical engineering	195	8.03	322	7.72
Machine construction	183	7.54	291	6.98
Vehicle construction	92	3.79	172	4.12
Retail trade	151	6.22	258	6.18
Wholesale trade	115	4.74	187	4.00
Transportation	138	5.69	254	6.09
Media services	101	4.16	186	4.46
IT and other information services	174	7.17	281	6.74
Financial and insurance activities	99	4.08	229	5.49
Real estate activities	83	3.42	134	3.21
Business consultancy and advertising	76	3.13	151	3.62
Technical services	142	5.85	252	6.04
Other business services	95	3.91	168	4.03
obs.	2427	100	4172	100

Data source: ZEW ICT survey 2010.

Table 2: Average offshoring participation across industries

Manufacturing sector	**Offshoring participation in %**	**Service sector**	**Offshoring participation in %**
Consumer goods	53.35	Retail trade	39.07
Chemical and pharmaceutical industry	70.75	Wholesale trade	63.47
Other raw materials	61.74	Transportation	19.56
Metal industry	46.99	Media services	30.69
Electrical engineering	71.28	IT and other information services	31.61
Machine construction	55.19	Financial and insurance activities	7.07
Vehicle construction	66.30	Real estate activities	6.02
		Business consultancy and advertising	15.79
		Technical services	21.83
		Other business services	12.63
Total	59.23	Total	26.57

Data source: ZEW ICT survey 2010.

Table 3: Average ICT characteristics by offshoring and non-offshoring firms

ICT variable	**offshoring firms**		**non-offshoring firms**	
Manufacturing sector	obs.	Mean	obs.	Mean
ERP	741	0.85	511	0.70
SCM	741	0.50	511	0.30
CRM	742	0.45	511	0.28
CDMS	741	0.53	509	0.37
Internet ordering	742	0.79	510	0.76
% empl. working with PC	742	0.38	511	0.28
ICT investment in million Euro	699	0.27	474	0.07
ICT index	740	3.11	509	2.41
Service sector	obs.	Mean	obs.	Mean
ERP	310	0.81	861	0.69
SCM	311	0.45	858	0.23
CRM	312	0.55	862	0.42
CDMS	311	0.62	861	0.53
Internet ordering	311	0.88	862	0.79
% empl. working with PC	312	0.60	862	0.63
ICT investment in million Euro	291	0.44	791	0.34
ICT index	307	3.31	856	2.66

Data source: ZEW ICT survey 2010.

Table 4: Average firm characteristics by offshoring and non-offshoring firms

ICT variable	**offshoring firms**	**non-offshoring firms**
Manufacturing sector		
no. employees	251	90
% highly skilled employees	0.16	0.12
% exporters	0.84	0.47
% with foreign affiliate	0.23	0.08
labour productivity in million Euro	0.20	0.14
sales in million Euro	59.41	20.52
% R&D intensity	0.06	0.05
% of firms with product innovation	0.70	0.52
% of firms with process innovation	0.68	0.53
Service sector		
no. employees	247	203
% highly skilled employees	0.27	0.27
% exporters	0.55	0.20
% with foreign affiliate	0.20	0.07
labour productivity in million Euro	0.25	0.17
sales in million Euro	87.06	54.09
% R&D intensity	0.07	0.04
% of firms with product innovation	0.62	0.42
% of firms with process innovation	0.71	0.59

Data source: ZEW ICT survey 2010.

Table 5: Probability of offshoring and ICT (1) - Raw average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
ERP	0.187***			0.144***		
	(0.024)			(0.034)		
SCM		0.180***			0.214***	
		(0.021)			(0.030)	
CRM			0.157***			0.108***
			(0.022)			(0.029)
sector and location dummies	no	no	no	no	no	no
number of observations	1252	1252	1253	1171	1169	1174
$Pseudo - R^2$	0.0231	0.0306	0.0214	0.0144	0.0366	0.0111

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses.

Table 6: Probability of offshoring and ICT (2) - Raw average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
CDMS	0.140***			0.082***		
	(0.023)			(0.029)		
Internet ordering		0.031			0.129***	
		(0.032)			(0.041)	
ln(ICT investment)			0.071***			0.025***
			(0.006)			(0.005)
sector and location dummies	no	no	no	no	no	no
number of observations	1250	1252	1047	1172	1173	1011
$Pseudo - R^2$	0.0175	0.0005	0.0592	0.0064	0.0085	0.0104

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses.

Table 7: Probability of offshoring and ICT intensity - Raw average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
ICT index (5 app.)		0.079***			0.062***	
		(0.008)			(0.008)	
ICT index (4 app.)			0.089***			0.064***
			(0.009)			(0.009)
% empl. working with PC	0.392***			-0.036		
	(0.057)			(0.034)		
sector and location dummies	no	no	no	no	no	no
number of observations	1253	1249	1249	1174	1163	1164
$Pseudo - R^2$	0.0296	0.0425	0.0463	0.0008	0.0358	0.0326

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses.

Table 8: Probability of offshoring and ICT (1) with R&D intensity
- Average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
ERP	0.041*			0.079***		
	(0.024)			(0.021)		
SCM		0.057***			0.054***	
		(0.020)			(0.019)	
CRM			0.009			0.035*
			(0.021)			(0.018)
% empl. working with PC	0.148***	0.149***	0.157***	0.007	0.008	0.005
	(0.051)	(0.050)	(0.050)	(0.029)	(0.029)	(0.029)
ln(employment)	0.033***	0.031***	0.036***	0.009	0.010*	0.012**
	(0.008)	(0.008)	(0.008)	(0.006)	(0.006)	(0.005)
% highly skilled empl.	0.064	0.057	0.061	-0.019	0.000	-0.008
	(0.074)	(0.074)	(0.073)	(0.036)	(0.036)	(0.036)
export activity	0.228***	0.227***	0.229***	0.240***	0.232***	0.237***
	(0.014)	(0.014)	(0.013)	(0.019)	(0.019)	(0.019)
foreign location	0.029	0.027	0.028	0.101***	0.107***	0.102***
	(0.029)	(0.029)	(0.029)	(0.028)	(0.028)	(0.028)
ln(labour productivity)	0.055***	0.052***	0.054***	0.040***	0.039***	0.041***
	(0.015)	(0.015)	(0.015)	(0.010)	(0.010)	(0.010)
R&D intensity	-0.160	-0.160	-0.164	0.256***	0.242***	0.237***
	(0.110)	(0.110)	(0.110)	(0.054)	(0.054)	(0.055)
sector and location dummies	yes	yes	yes	yes	yes	yes
number of observations	1169	1169	1170	1130	1129	1133
$Pseudo - R^2$	0.1616	0.1633	0.1607	0.2189	0.2158	0.2147

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses. Reference category: metal and machine constructing for the manufacturing sector, transportation and postal services for the service sector.

Table 9: Probability of offshoring and ICT (2) with R&D intensity
- Average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
CDMS	0.038**			0.027		
	(0.020)			(0.018)		
Internet ordering		0.026			0.092***	
		(0.022)			(0.023)	
ln(ICT investment)			0.018**			0.006
			(0.008)			(0.006)
% empl. working with PC	0.144***	0.160***	0.131***	0.009	0.016	0.006
	(0.050)	(0.050)	(0.046)	(0.030)	(0.030)	(0.028)
ln(employment)	0.033***	0.037***	0.014	0.013**	0.014***	0.008
	(0.008)	(0.007)	(0.010)	(0.006)	(0.005)	(0.007)
% highly skilled empl.	0.060	0.057	0.025	-0.008	-0.007	-0.031
	(0.073)	(0.074)	(0.069)	(0.036)	(0.036)	(0.033)
export activity	0.229***	0.230***	0.223***	0.236***	0.232***	0.222***
	(0.013)	(0.013)	(0.012)	(0.019)	(0.019)	(0.017)
foreign location	0.030	0.028	0.030	0.103***	0.107***	0.126***
	(0.029)	(0.029)	(0.025)	(0.029)	(0.028)	(0.027)
ln(labour productivity)	0.054***	0.054***	0.051***	0.042***	0.042***	0.050***
	(0.015)	(0.015)	(0.014)	(0.010)	(0.010)	(0.010)
R&D intensity	-0.173	-0.168	-0.194*	0.240***	0.241***	0.257***
	(0.109)	(0.111)	(0.099)	(0.055)	(0.055)	(0.050)
sector and location dummies	yes	yes	yes	yes	yes	yes
number of observations	1168	1170	996	1131	1133	983
$Pseudo - R^2$	0.1621	0.1611	0.1523	0.2123	0.2190	0.2184

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses. Reference category: metal and machine constructing for the manufacturing sector, transportation and postal services for the service sector.

Table 10: Probability of offshoring and ICT with R&D intensity
- Average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
ERP	0.032	0.029	0.027	0.071***	0.068***	0.064***
	(0.023)	(0.024)	(0.024)	(0.020)	(0.021)	(0.021)
SCM	0.064***	0.054**	0.052**	0.039**	0.041**	0.037**
	(0.019)	(0.021)	(0.021)	(0.017)	(0.019)	(0.019)
CRM	-0.037*	-0.017	-0.017	0.013	0.019	0.016
	(0.021)	(0.023)	(0.023)	(0.016)	(0.018)	(0.018)
CDMS	0.018	0.028	0.027	0.004	0.003	-0.002
	(0.019)	(0.021)	(0.021)	(0.017)	(0.018)	(0.018)
Internet ordering	0.010		0.019	0.090***		0.078***
	(0.021)		(0.022)	(0.021)		(0.023)
ln(ICT investment)	0.013*			0.000		
	(0.008)			(0.006)		
% empl. working with PC	0.113**	0.135***	0.137***	0.000	-0.003	0.001
	(0.046)	(0.050)	(0.050)	(0.028)	(0.030)	(0.030)
ln(employment)	0.008	0.026***	0.027***	0.000	0.003	0.004
	(0.010)	(0.008)	(0.008)	(0.008)	(0.006)	(0.006)
% highly skilled empl.	0.023	0.057	0.054	-0.029	-0.012	-0.012
	(0.069)	(0.073)	(0.073)	(0.032)	(0.035)	(0.035)
export activity	0.220***	0.227***	0.227***	0.214***	0.234***	0.230***
	(0.012)	(0.013)	(0.013)	(0.017)	(0.019)	(0.018)
foreign location	0.032	0.029	0.029	0.123***	0.103***	0.106***
	(0.025)	(0.029)	(0.029)	(0.026)	(0.028)	(0.028)
ln(labour productivity)	0.053***	0.054***	0.054***	0.047***	0.037***	0.038***
	(0.014)	(0.015)	(0.015)	(0.010)	(0.010)	(0.010)
R&D intensity	-0.187*	-0.164	-0.168	0.260***	0.250***	0.250***
	(0.097)	(0.108)	(0.107)	(0.049)	(0.053)	(0.053)
sector and location dummies	yes	yes	yes	yes	yes	yes
number of observations	993	1167	1167	980	1124	1124
$Pseudo - R^2$	0.1572	0.1647	0.1649	0.2303	0.2191	0.2232

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses. Reference category: metal and machine constructing for the manufacturing sector, transportation and postal services for the service sector.

Table 11: Probability of offshoring and ICT (1) with innovation outcomes
- Average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
ERP	0.024			0.070***		
	(0.025)			(0.021)		
SCM		0.036*			0.048**	
		(0.021)			(0.019)	
CRM			-0.012			0.020
			(0.023)			(0.018)
% empl. working with PC	0.121**	0.121**	0.128**	-0.009	-0.007	-0.007
	(0.052)	(0.052)	(0.052)	(0.029)	(0.029)	(0.029)
ln(employment)	0.019**	0.018**	0.023***	0.005	0.006	0.009
	(0.008)	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
% highly skilled empl.	-0.020	-0.022	-0.021	-0.023	-0.004	-0.013
	(0.073)	(0.073)	(0.073)	(0.035)	(0.035)	(0.035)
export activity	0.230***	0.229***	0.232***	0.235***	0.230***	0.233***
	(0.014)	(0.014)	(0.014)	(0.019)	(0.019)	(0.019)
foreign location	0.058**	0.057**	0.057**	0.069**	0.076***	0.072***
	(0.029)	(0.029)	(0.029)	(0.027)	(0.027)	(0.027)
ln(labour productivity)	0.054***	0.052***	0.054***	0.042***	0.040***	0.043***
	(0.015)	(0.015)	(0.015)	(0.010)	(0.010)	(0.010)
product innovation	0.062***	0.062***	0.064***	0.104***	0.094***	0.099***
	(0.020)	(0.020)	(0.019)	(0.019)	(0.019)	(0.019)
process innovation	0.053***	0.051***	0.057***	0.042**	0.040**	0.045**
	(0.019)	(0.019)	(0.019)	(0.018)	(0.018)	(0.018)
sector and location dummies	yes	yes	yes	yes	yes	yes
number of observations	1252	1252	1253	1171	1169	1174
$Pseudo - R^2$	0.1617	0.1624	0.1614	0.2248	0.2218	0.2203

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses. Reference category: metal and machine constructing for the manufacturing sector, transportation and postal services for the service sector.

Table 12: Probability of offshoring and ICT (2) with innovation outcomes
- Average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
CDMS	0.013			0.009		
	(0.021)			(0.018)		
Internet ordering		0.019			0.087***	
		(0.023)			(0.024)	
% empl. working with PC	0.116**	0.125**	0.093**	-0.003	-0.000	-0.002
	(0.052)	(0.052)	(0.047)	(0.030)	(0.029)	(0.027)
ln(ICT investment)			0.013			0.001
			(0.008)			(0.006)
ln(employment)	0.021***	0.023***	0.010	0.010*	0.009*	0.010
	(0.008)	(0.008)	(0.010)	(0.006)	(0.005)	(0.007)
% highly skilled empl.	-0.021	-0.024	-0.060	-0.013	-0.014	-0.022
	(0.073)	(0.073)	(0.066)	(0.035)	(0.036)	(0.032)
export activity	0.231***	0.231***	0.222***	0.233***	0.227***	0.218***
	(0.014)	(0.014)	(0.012)	(0.019)	(0.019)	(0.017)
foreign location	0.055*	0.053*	0.041	0.072***	0.077***	0.099***
	(0.029)	(0.029)	(0.025)	(0.027)	(0.027)	(0.026)
ln(labour productivity)	0.054***	0.055***	0.060***	0.043***	0.044***	0.051***
	(0.015)	(0.015)	(0.014)	(0.010)	(0.010)	(0.010)
product innovation	0.062***	0.063***	0.061***	0.100***	0.098***	0.115***
	(0.020)	(0.019)	(0.018)	(0.020)	(0.019)	(0.018)
process innovation	0.056***	0.056***	0.060***	0.046**	0.046**	0.041**
	(0.019)	(0.019)	(0.017)	(0.019)	(0.018)	(0.017)
sector and location dummies	yes	yes	yes	yes	yes	yes
number of observations	1250	1252	1047	1172	1173	1011
$Pseudo - R^2$	0.1630	0.1629	0.1603	0.2182	0.2246	0.2280

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses. Reference category: metal and machine constructing for the manufacturing sector, transportation and postal services for the service sector.

Table 13: Probability of offshoring and ICT with innovation outcomes
- Average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
ERP	0.015	0.019	0.018	0.068***	0.064***	0.059***
	(0.024)	(0.026)	(0.026)	(0.020)	(0.022)	(0.021)
SCM	0.056***	0.041*	0.040*	0.036**	0.042**	0.036*
	(0.019)	(0.022)	(0.022)	(0.017)	(0.019)	(0.019)
CRM	-0.056**	-0.027	-0.027	0.002	0.008	0.005
	(0.022)	(0.024)	(0.024)	(0.016)	(0.018)	(0.018)
CDMS	0.009	0.008	0.007	-0.008	-0.011	-0.014
	(0.019)	(0.022)	(0.022)	(0.017)	(0.018)	(0.018)
Internet ordering	0.013		0.016	0.088***		0.075***
	(0.021)		(0.023)	(0.022)		(0.023)
ln(ICT investment)	0.010			-0.002		
	(0.008)			(0.006)		
% empl. working with PC	0.088*	0.114**	0.115**	-0.002	-0.012	-0.008
	(0.047)	(0.052)	(0.052)	(0.028)	(0.029)	(0.030)
ln(employment)	0.008	0.017**	0.018**	0.003	0.002	0.002
	(0.010)	(0.009)	(0.009)	(0.008)	(0.006)	(0.006)
% highly skilled empl.	-0.057	-0.020	-0.022	-0.022	-0.015	-0.018
	(0.066)	(0.073)	(0.073)	(0.032)	(0.035)	(0.035)
export activity	0.222***	0.230***	0.230***	0.211***	0.233***	0.228***
	(0.012)	(0.014)	(0.014)	(0.017)	(0.019)	(0.018)
foreign location	0.044*	0.056*	0.055*	0.100***	0.072***	0.077***
	(0.025)	(0.029)	(0.028)	(0.025)	(0.027)	(0.027)
ln(labour productivity)	0.062***	0.054***	0.055***	0.049***	0.040***	0.040***
	(0.014)	(0.015)	(0.015)	(0.010)	(0.010)	(0.010)
product innovation	0.062***	0.062***	0.062***	0.106***	0.098***	0.096***
	(0.018)	(0.020)	(0.020)	(0.018)	(0.019)	(0.019)
process innovation	0.060***	0.052***	0.052***	0.027	0.037**	0.038**
	(0.017)	(0.019)	(0.019)	(0.017)	(0.018)	(0.018)
sector and location dummies	yes	yes	yes	yes	yes	yes
number of observations	1044	1249	1249	1008	1164	1163
$Pseudo - R^2$	0.1645	0.1646	0.1648	0.2369	0.2243	0.2274

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses. Reference category: metal and machine constructing for the manufacturing sector, transportation and postal services for the service sector.

Table 14: Probability of offshoring and ICT intensity with R&D intensity
- Average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
ICT index (5 app.)		0.023***			0.032***	
		(0.008)			(0.006)	
ICT index (4 app.)			0.024***			0.030***
			(0.008)			(0.007)
% empl. working with PC	0.159***	0.135***	0.133***	0.015	-0.011	-0.010
	(0.050)	(0.050)	(0.050)	(0.029)	(0.029)	(0.029)
ln(employment)	0.037***	0.027***	0.027***	0.016***	0.002	0.003
	(0.007)	(0.008)	(0.008)	(0.005)	(0.006)	(0.006)
% highly skilled empl.	0.061	0.054	0.058	-0.008	-0.010	-0.011
	(0.074)	(0.072)	(0.072)	(0.036)	(0.035)	(0.035)
export activity	0.230***	0.226***	0.225***	0.237***	0.230***	0.232***
	(0.013)	(0.014)	(0.014)	(0.019)	(0.019)	(0.019)
foreign location	0.028	0.029	0.029	0.104***	0.104***	0.103***
	(0.029)	(0.029)	(0.029)	(0.029)	(0.028)	(0.028)
ln(labour productivity)	0.054***	0.054***	0.053***	0.042***	0.038***	0.038***
	(0.015)	(0.015)	(0.015)	(0.010)	(0.010)	(0.010)
R&D intensity	-0.162	-0.175	-0.170	0.243***	0.241***	0.242***
	(0.111)	(0.107)	(0.107)	(0.055)	(0.054)	(0.054)
sector and location dummies	yes	yes	yes	yes	yes	yes
number of observations	1170	1167	1167	1133	1124	1124
$Pseudo - R^2$	0.1607	0.1636	0.1633	0.2134	0.2200	0.2173

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses. Reference category: metal and machine constructing for the manufacturing sector, transportation and postal services for the service sector.

Table 15: Probability of offshoring and ICT intensity with innovation outcomes
- Average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
ICT index (5 app.)		0.011			0.026***	
		(0.008)			(0.007)	
ICT index (4 app.)			0.010			0.023***
			(0.009)			(0.007)
% empl. working with PC	0.126**	0.112**	0.112**	-0.001	-0.020	-0.019
	(0.052)	(0.052)	(0.052)	(0.029)	(0.029)	(0.029)
ln(employment)	0.022***	0.018**	0.018**	0.010*	0.001	0.002
	(0.008)	(0.008)	(0.008)	(0.005)	(0.006)	(0.006)
% highly skilled empl.	-0.022	-0.022	-0.021	-0.012	-0.017	-0.014
	(0.073)	(0.072)	(0.072)	(0.036)	(0.035)	(0.035)
export activity	0.231***	0.229***	0.229***	0.233***	0.228***	0.231***
	(0.014)	(0.014)	(0.014)	(0.019)	(0.018)	(0.019)
foreign location	0.057**	0.055*	0.055*	0.073***	0.075***	0.072***
	(0.029)	(0.029)	(0.029)	(0.027)	(0.027)	(0.027)
ln(labour productivity)	0.053***	0.054***	0.054***	0.043***	0.041***	0.041***
	(0.015)	(0.015)	(0.015)	(0.010)	(0.010)	(0.010)
product innovation	0.063***	0.060***	0.061***	0.102***	0.091***	0.094***
	(0.020)	(0.020)	(0.020)	(0.019)	(0.019)	(0.019)
process innovation	0.056***	0.052***	0.052***	0.047***	0.036**	0.037**
	(0.019)	(0.019)	(0.019)	(0.018)	(0.018)	(0.018)
sector and location dummies	yes	yes	yes	yes	yes	yes
number of observations	1253	1249	1249	1174	1163	1164
$Pseudo - R^2$	0.1613	0.1636	0.1634	0.2199	0.2232	0.2216

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses. Reference category: metal and machine constructing for the manufacturing sector, transportation and postal services for the service sector.

Table 16: Probability of offshoring and ICT with R&D intensity
- Average marginal effects - Without retail and wholesale industry

	Service sector				
	(1)	(2)	(3)	(4)	(5)
ERP	0.044**	0.037*	0.033		
	(0.021)	(0.022)	(0.022)		
SCM	0.010	0.021	0.010		
	(0.018)	(0.020)	(0.019)		
CRM	0.023	0.033*	0.025		
	(0.018)	(0.020)	(0.020)		
CDMS	0.011	0.008	0.002		
	(0.018)	(0.019)	(0.018)		
Internet ordering	0.183***		0.155***		
	(0.029)		(0.031)		
ln(ICT investment)	-0.005				
	(0.006)				
ICT index (5 app.)				0.032***	
				(0.007)	
ICT index (4 app.)					0.024***
					(0.007)
% empl. working with PC	-0.005	-0.016	-0.005	-0.023	-0.019
	(0.030)	(0.032)	(0.032)	(0.032)	(0.032)
ln(employment)	0.008	0.004	0.006	0.000	0.004
	(0.008)	(0.006)	(0.006)	(0.006)	(0.006)
% highly skilled empl.	-0.058*	-0.062*	-0.058*	-0.059*	-0.060*
	(0.032)	(0.035)	(0.035)	(0.034)	(0.035)
export activity	0.202***	0.220***	0.218***	0.216***	0.220***
	(0.020)	(0.022)	(0.022)	(0.022)	(0.022)
foreign location	0.100***	0.079***	0.076***	0.076***	0.079***
	(0.028)	(0.029)	(0.029)	(0.029)	(0.029)
ln(labour productivity)	0.063***	0.052***	0.053***	0.052***	0.052***
	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)
R&D intensity	0.280***	0.267***	0.267***	0.264***	0.266***
	(0.046)	(0.048)	(0.049)	(0.048)	(0.048)
sector and location dummies	yes	yes	yes	yes	yes
number of observations	767	868	868	868	868
$Pseudo - R^2$	0.2051	0.1785	0.1942	0.1839	0.1779

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses.
Reference category: transportation and postal services.

Table 17: Probability of offshoring and ICT with innovation outcomes
- Average marginal effects - Without retail and wholesale industry

	Service sector				
	(1)	(2)	(3)	(4)	(5)
ERP	0.049**	0.040*	0.034		
	(0.021)	(0.023)	(0.022)		
SCM	0.014	0.029	0.017		
	(0.019)	(0.021)	(0.020)		
CRM	0.019	0.027	0.020		
	(0.018)	(0.021)	(0.020)		
CDMS	0.002	-0.000	-0.005		
	(0.018)	(0.019)	(0.019)		
Internet ordering	0.173***		0.147***		
	(0.030)		(0.032)		
ln(ICT investment)	-0.004				
	(0.006)				
ICT index (5 app.)				0.030***	
				(0.007)	
ICT index (4 app.)					0.022***
					(0.008)
% empl. working with PC	0.007	-0.009	0.001	-0.016	-0.013
	(0.030)	(0.032)	(0.032)	(0.032)	(0.032)
ln(employment)	0.010	0.003	0.004	0.000	0.003
	(0.008)	(0.006)	(0.006)	(0.006)	(0.006)
% highly skilled empl.	-0.052	-0.055	-0.055	-0.056	-0.054
	(0.032)	(0.034)	(0.035)	(0.034)	(0.034)
export activity	0.201***	0.224***	0.220***	0.219***	0.224***
	(0.020)	(0.022)	(0.022)	(0.022)	(0.022)
foreign location	0.088***	0.061**	0.061**	0.062**	0.060**
	(0.028)	(0.029)	(0.028)	(0.028)	(0.029)
ln(labour productivity)	0.062***	0.051***	0.053***	0.052***	0.052***
	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)
product innovation	0.085***	0.079***	0.072***	0.069***	0.077***
	(0.021)	(0.022)	(0.022)	(0.022)	(0.022)
process innovation	-0.012	0.001	0.002	-0.002	0.001
	(0.016)	(0.018)	(0.018)	(0.018)	(0.018)
sector and location dummies	yes	yes	yes	yes	yes
number of observations	790	901	900	900	901
$Pseudo - R^2$	0.1990	0.1723	0.1847	0.1751	0.1714

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses. Reference category: transportation and postal services.

International outsourcing

Table 18: Probability of international outsourcing and ICT (1)
- Raw average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
ERP	0.159***			0.098***		
	(0.031)			(0.034)		
SCM		0.150***			0.167***	
		(0.027)			(0.032)	
CRM			0.131***			0.063**
			(0.028)			(0.028)
sector and location dummies	no	no	no	no	no	no
number of observations	1081	1081	1082	1109	1107	1112
$Pseudo - R^2$	0.0146	0.0169	0.0121	0.0084	0.0250	0.0047

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses.

Table 19: Probability of international outsourcing and ICT (2)
- Raw average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
CDMS	0.118***			0.048*		
	(0.028)			(0.028)		
Internet ordering		0.026			0.113***	
		(0.036)			(0.041)	
ln(ICT investment)			0.052***			0.012**
			(0.007)			(0.005)
sector and location dummies	no	no	no	no	no	no
number of observations	1079	1081	890	1111	1111	959
$Pseudo - R^2$	0.0105	0.0003	0.0245	0.0028	0.0077	0.0027

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses.

Table 20: Probability of international outsourcing and ICT intensity
- Raw average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
ICT index (5 app.)		0.064***			0.045***	
		(0.010)			(0.008)	
ICT index (4 app.)			0.072***			0.045***
			(0.010)			(0.009)
% empl. working with PC	0.323***			-0.063*		
	(0.061)			(0.032)		
sector and location dummies	no	no	no	no	no	no
number of observations	1082	1078	1078	1112	1102	1103
$Pseudo - R^2$	0.0186	0.0251	0.0274	0.0029	0.0218	0.0184

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses.

Table 21: Probability of international outsourcing and ICT with R&D intensity
- Average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
ERP	0.042*	0.039	0.037	0.066***	0.064***	0.061***
	(0.025)	(0.027)	(0.027)	(0.020)	(0.021)	(0.021)
SCM	0.069***	0.054**	0.053**	0.025	0.030	0.027
	(0.022)	(0.025)	(0.025)	(0.017)	(0.019)	(0.019)
CRM	-0.043*	-0.021	-0.021	0.014	0.021	0.018
	(0.024)	(0.027)	(0.027)	(0.017)	(0.018)	(0.018)
CDMS	0.026	0.034	0.033	0.007	0.005	0.001
	(0.021)	(0.023)	(0.023)	(0.017)	(0.018)	(0.018)
Internet ordering	0.008		0.017	0.086***		0.069***
	(0.024)		(0.025)	(0.022)		(0.023)
ln(ICT investment)	0.005			-0.002		
	(0.009)			(0.006)		
% empl. working with PC	0.095*	0.116**	0.117**	-0.002	-0.006	-0.002
	(0.053)	(0.057)	(0.058)	(0.028)	(0.029)	(0.029)
ln(employment)	-0.003	0.010	0.010	-0.003	-0.002	-0.001
	(0.011)	(0.010)	(0.010)	(0.008)	(0.006)	(0.006)
% highly skilled empl.	0.035	0.061	0.059	-0.028	-0.016	-0.016
	(0.077)	(0.082)	(0.082)	(0.032)	(0.036)	(0.035)
export activity	0.236***	0.240***	0.240***	0.191***	0.209***	0.205***
	(0.015)	(0.017)	(0.017)	(0.018)	(0.020)	(0.020)
ln(labour productivity)	0.057***	0.053***	0.054***	0.044***	0.031***	0.032***
	(0.016)	(0.017)	(0.017)	(0.010)	(0.010)	(0.010)
R&D intensity	-0.191*	-0.177	-0.181	0.240***	0.232***	0.233***
	(0.104)	(0.117)	(0.117)	(0.050)	(0.054)	(0.054)
sector and location dummies	yes	yes	yes	yes	yes	yes
number of observations	851	1015	1015	931	1068	1068
$Pseudo - R^2$	0.1155	0.1234	0.1236	0.1956	0.1823	0.1859

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses. Reference category: metal and machine constructing for the manufacturing sector, transportation and postal services for the service sector.

Table 22: Probability of international outsourcing and ICT with innovation outcomes
- Average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
ERP	0.026	0.029	0.028	0.065***	0.060***	0.057***
	(0.027)	(0.029)	(0.029)	(0.020)	(0.022)	(0.021)
SCM	0.062***	0.041	0.041	0.028	0.033*	0.028
	(0.022)	(0.026)	(0.026)	(0.017)	(0.019)	(0.019)
CRM	-0.063***	-0.029	-0.029	0.004	0.009	0.006
	(0.024)	(0.027)	(0.027)	(0.017)	(0.018)	(0.018)
CDMS	0.017	0.014	0.014	-0.002	-0.007	-0.010
	(0.022)	(0.024)	(0.024)	(0.017)	(0.018)	(0.018)
Internet ordering	0.006		0.010	0.082***		0.065***
	(0.024)		(0.026)	(0.023)		(0.024)
ln(ICT investment)	0.003			-0.002		
	(0.009)			(0.006)		
% empl. working with PC	0.065	0.090	0.091	-0.008	-0.017	-0.013
	(0.054)	(0.059)	(0.059)	(0.027)	(0.029)	(0.029)
ln(employment)	-0.006	-0.001	-0.001	-0.001	-0.003	-0.002
	(0.011)	(0.010)	(0.010)	(0.008)	(0.006)	(0.006)
% highly skilled empl.	-0.048	-0.025	-0.026	-0.025	-0.020	-0.024
	(0.074)	(0.082)	(0.082)	(0.032)	(0.035)	(0.035)
export activity	0.244***	0.248***	0.248***	0.183***	0.200***	0.195***
	(0.015)	(0.017)	(0.017)	(0.018)	(0.020)	(0.020)
ln(labour productivity)	0.064***	0.054***	0.054***	0.045***	0.033***	0.034***
	(0.016)	(0.017)	(0.017)	(0.010)	(0.010)	(0.010)
product innovation	0.061***	0.066***	0.066***	0.103***	0.094***	0.093***
	(0.020)	(0.023)	(0.023)	(0.019)	(0.020)	(0.020)
process innovation	0.066***	0.058***	0.058***	0.015	0.026	0.027
	(0.020)	(0.022)	(0.022)	(0.016)	(0.018)	(0.018)
sector and location dummies	yes	yes	yes	yes	yes	yes
number of observations	887	1078	1078	956	1103	1102
$Pseudo - R^2$	0.1195	0.1221	0.1222	0.2012	0.1861	0.1887

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses. Reference category: metal and machine constructing for the manufacturing sector, transportation and postal services for the service sector.

Table 23: Probability of international outsourcing and ICT with R&D intensity
- Average marginal effects - Without retail and wholesale industry

	Service sector				
	(1)	(2)	(3)	(4)	(5)
ERP	0.038*	0.030	0.027		
	(0.020)	(0.021)	(0.021)		
SCM	-0.005	0.006	-0.001		
	(0.018)	(0.020)	(0.019)		
CRM	0.027	0.039*	0.030		
	(0.018)	(0.021)	(0.020)		
CDMS	0.007	0.004	-0.001		
	(0.017)	(0.018)	(0.017)		
Internet ordering	0.169***		0.128***		
	(0.030)		(0.030)		
ln(ICT investment)	-0.009				
	(0.006)				
ICT index (5 app.)				0.026***	
				(0.007)	
ICT index (4 app.)					0.019**
					(0.007)
% empl. working with PC	-0.005	-0.016	-0.007	-0.021	-0.017
	(0.028)	(0.031)	(0.031)	(0.030)	(0.030)
ln(employment)	0.005	-0.002	-0.001	-0.005	-0.003
	(0.008)	(0.006)	(0.006)	(0.006)	(0.006)
% highly skilled empl.	-0.052*	-0.060*	-0.056*	-0.056*	-0.057*
	(0.031)	(0.034)	(0.034)	(0.034)	(0.034)
export activity	0.170***	0.184***	0.182***	0.180***	0.183***
	(0.021)	(0.024)	(0.023)	(0.023)	(0.024)
ln(labour productivity)	0.054***	0.042***	0.043***	0.041***	0.042***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
R&D intensity	0.258***	0.245***	0.246***	0.245***	0.246***
	(0.046)	(0.047)	(0.048)	(0.047)	(0.047)
sector and location dummies	yes	yes	yes	yes	yes
number of observations	733	831	831	831	831
$Pseudo - R^2$	0.1554	0.1308	0.1441	0.1347	0.1297

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses.
Reference category: transportation and postal services.

Table 24: Probability of international outsourcing and ICT with innovation outcomes - Average marginal effects - Without retail and wholesale industry

	Service sector				
	(1)	(2)	(3)	(4)	(5)
ERP	0.045**	0.034	0.030		
	(0.021)	(0.022)	(0.021)		
SCM	0.003	0.016	0.007		
	(0.018)	(0.020)	(0.020)		
CRM	0.024	0.032	0.025		
	(0.019)	(0.021)	(0.020)		
CDMS	0.002	-0.001	-0.006		
	(0.018)	(0.019)	(0.018)		
Internet ordering	0.155***		0.118***		
	(0.031)		(0.031)		
ln(ICT investment)	-0.006				
	(0.006)				
ICT index (5 app.)				0.025***	
				(0.007)	
ICT index (4 app.)					0.019**
					(0.008)
% empl. working with PC	0.002	-0.013	-0.005	-0.019	-0.016
	(0.029)	(0.031)	(0.031)	(0.031)	(0.031)
ln(employment)	0.006	-0.003	-0.001	-0.005	-0.003
	(0.008)	(0.006)	(0.006)	(0.006)	(0.006)
% highly skilled empl.	-0.048	-0.052	-0.053	-0.052	-0.049
	(0.031)	(0.034)	(0.034)	(0.034)	(0.034)
export activity	0.160***	0.177***	0.174***	0.172***	0.176***
	(0.021)	(0.024)	(0.023)	(0.023)	(0.024)
ln(labour productivity)	0.052***	0.040***	0.041***	0.040***	0.040***
	(0.010)	(0.011)	(0.011)	(0.010)	(0.010)
product innovation	0.085***	0.078***	0.072***	0.070***	0.076***
	(0.021)	(0.023)	(0.023)	(0.022)	(0.023)
process innovation	-0.021	-0.008	-0.007	-0.010	-0.008
	(0.015)	(0.017)	(0.017)	(0.016)	(0.017)
sector and location dummies	yes	yes	yes	yes	yes
number of observations	754	861	860	860	861
$Pseudo - R^2$	0.1492	0.1240	0.1333	0.1255	0.1229

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses. Reference category: transportation and postal services.

Table 25: Probability of international outsourcing and ICT intensity with R&D intensity - Average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
ICT index (5 app.)		0.025***			0.029***	
		(0.009)			(0.006)	
ICT index (4 app.)			0.027***			0.027***
			(0.009)			(0.007)
% empl. working with PC	0.144**	0.117**	0.115**	0.013	-0.012	-0.011
	(0.057)	(0.057)	(0.057)	(0.029)	(0.029)	(0.029)
ln(employment)	0.022**	0.011	0.010	0.009*	-0.003	-0.002
	(0.009)	(0.009)	(0.009)	(0.005)	(0.006)	(0.006)
% highly skilled empl.	0.062	0.056	0.058	-0.009	-0.013	-0.013
	(0.083)	(0.082)	(0.082)	(0.037)	(0.035)	(0.035)
export activity	0.244***	0.238***	0.238***	0.213***	0.205***	0.207***
	(0.017)	(0.017)	(0.017)	(0.020)	(0.020)	(0.020)
ln(labour productivity)	0.053***	0.053***	0.052***	0.035***	0.032***	0.032***
	(0.017)	(0.017)	(0.017)	(0.010)	(0.010)	(0.010)
R&D intensity	-0.176	-0.187	-0.181	0.228***	0.227***	0.228***
	(0.120)	(0.116)	(0.116)	(0.056)	(0.055)	(0.055)
sector and location dummies	yes	yes	yes	yes	yes	yes
number of observations	1018	1015	1015	1076	1068	1068
$Pseudo - R^2$	0.1191	0.1222	0.1220	0.1760	0.1830	0.1807

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses. Reference category: metal and machine constructing for the manufacturing sector, transportation and postal services for the service sector.

Table 26: Probability of international outsourcing and ICT intensity with innovation outcomes - Average marginal effects

	Manufacturing sector			Service sector		
	(1)	(2)	(3)	(4)	(5)	(6)
ICT index (5 app.)		0.013			0.023***	
		(0.009)			(0.007)	
ICT index (4 app.)			0.013			0.021***
			(0.010)			(0.007)
% empl. working with PC	0.108*	0.090	0.090	-0.006	-0.024	-0.023
	(0.059)	(0.059)	(0.059)	(0.029)	(0.029)	(0.029)
ln(employment)	0.005	-0.000	-0.000	0.005	-0.004	-0.003
	(0.009)	(0.010)	(0.010)	(0.005)	(0.006)	(0.006)
% highly skilled empl.	-0.030	-0.031	-0.029	-0.015	-0.021	-0.018
	(0.082)	(0.081)	(0.081)	(0.036)	(0.035)	(0.035)
export activity	0.250***	0.247***	0.247***	0.200***	0.195***	0.198***
	(0.017)	(0.017)	(0.017)	(0.020)	(0.020)	(0.020)
ln(labour productivity)	0.052***	0.054***	0.053***	0.036***	0.034***	0.034***
	(0.017)	(0.017)	(0.017)	(0.010)	(0.010)	(0.010)
product innovation	0.068***	0.065***	0.065***	0.097***	0.088***	0.091***
	(0.023)	(0.023)	(0.023)	(0.020)	(0.020)	(0.020)
process innovation	0.062***	0.058***	0.058***	0.036**	0.025	0.026
	(0.022)	(0.022)	(0.022)	(0.018)	(0.018)	(0.018)
sector and location dummies	yes	yes	yes	yes	yes	yes
number of observations	1082	1078	1078	1112	1102	1103
$Pseudo - R^2$	0.1188	0.1209	0.1208	0.1812	0.1851	0.1838

Significance levels: $*$: 10% $**$: 5% $***$: 1%. Standard errors in parentheses. Reference category: metal and machine constructing for the manufacturing sector, transportation and postal services for the service sector.