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IT OUTSOURCING IN FINNISH BUSINESS

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ABSTRACT: This paper reviews the characteristics and magnitude of information technology (IT) outsourcing as well as studies its labor productivity effects with a representative sample of Finnish businesses. Depending on the IT task in question, on average from one-third to two-thirds of IT has been outsourced; of the ten categories considered, the development of non-Internet business-to-business applications (e.g., EDI) is the leading activity in this respect. The various dimensions of IT outsourcing are all highly positively correlated. After controlling for industry and regional effects as well as characteristics of firms and their employees, it is found that an externally-supported computer user is about 20% more productive than an otherwise similar worker without a computer, which corresponds to about 5% output elasticity of outsourced IT; the effect of internally-supported computer use is not statistically significantly different for zero, and it is also several times smaller in magnitude. While the issues of causality, timing, self-selection, and unobserved firm heterogeneity are not fully addressed, the findings nevertheless suggest that IT outsourcing may have significant economic consequences.

JEL CODES: D23, D24, L14, L24.

KEYWORDS: Labor productivity; Information technology; Computers; Outsourcing; Finnish business.

1. Introduction

Despite of the fact that firms increasingly outsource some or all of their (routine) information technology (IT) tasks, its economic consequences remain ill-understood. In this paper we employ *Statistics Finland*'s IT and e-commerce survey to empirically study the firm-level productivity effects of IT outsourcing. We find that IT outsourcing enhances an organization's IT use and thus also boosts its labor productivity.

In the new millennium the dominant fad in management strategy has been to concentrate on one's core competences. Faced with intensifying global competition, firms are increasingly forced to cut production costs. With the prolonged economic upswing in Finland, firms feel that they are unable to attract sufficiently qualified employees. All of these observations have made IT outsourcing attractive to Finnish firms. Furthermore, changes in both domestic and international supply of IT services have made them more accessible and affordable. Thus, it is no wonder that in a survey by the leading Finnish IT trade journal *Tietokone* (January 2008 issue, page 9), more than half of the top management in Finnish firms – and more than one-third of IT management – agrees that it is their firms' priority to outsource as much IT as possible.

In their review Mahnke, Overby, and Vang (2005) come to the conclusion that three main theoretical perspectives underlie empirical work on IT outsourcing: (1) transaction cost economics as well as (2) capacity-based and (3) relational views. The literature suggests that the primary reasons for outsourcing are to lower cost, to gain flexibility, to optimize financial structure, to seek outside IT expertise, to gain strategic advantage (to focus on core competences, to facilitate mergers and acquisitions, to reduce time-to-market, to circumvent problems in attracting IT talent), and to respond to political pressures (dissatisfaction with internal IT, pressure from vendors, desire to imitate competitors etc.). The risks identified in the literature include the loss of absorptive capacity and/or control, declining innovativeness, deteriorating performance, increasing transaction or hidden costs, leaking out of business secrets, as well as immediate and/or subsequent dismotivation of the employees.[1]

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[1] Heshmati (2003) provides a survey of the more general literature on outsourcing and its relationship to efficiency and productivity. Siegel and Griliches (1992), Fixler and Siegel (1999), Görg and Hanley (2005) , as well Görg, Hanley, and Strobl (2008) are among the papers considering the relationship of productivity and services outsourcing in general. Abraham and Taylor (1996) suggest that a firm's decision to contract out business support

Thouin, Hoffman, and Ford (2008) study the effects of IT budget, outsourcing, and (internal) personnel on financial performance of integrated health care delivery systems. They find that higher IT expenditures and outsourcing intensity are associated with better profitability. Florin, Bradford, and Pagach (2005) study investors' reactions to IT outsourcing. IT outsourcing announcements are positively associated with short-term abnormal returns but long-term returns become negative due to organizational restructuring efforts. Domberger, Fernandez, and Fiebig (2000) suggest that there might be learning in IT outsourcing: first-term contracts tend to be more expensive than subsequent contracts. The also find that competitive bidding – as opposed to directly negotiated contracts – does not lead to lower prices but it is associated with better performance, which they attribute to the clients better-defined expectations and requirements. Mahnke, Özcan, and Overby (2006) suggest that timing might be important for IT outsourcing also from an other perspective: the governance choices with respect to IT are influenced by firms' attempts to position themselves as early- or late-movers in varying technological regimes. Bertschek and Müller (2006) use a semi-parametric endogenous switching model to study IT outsourcing. While IT outsourcing does not seem to make firms too different in observed dimensions (partial production elasticities of key inputs), firms without IT outsourcing produce more efficiently than those with IT outsourcing, which they attribute to coordination costs.[2] Knittel and Stango (2008) examine the effect of IT outsourcing with a panel of US credit unions. They find that IT outsourcing has significant productivity benefits primarily towards the end of their 1992–2005 observation period. The effect is present only when studied within-firm and switching to outsourcing is endogenous. In cross-section they find that less productive firms are more likely to outsource. Clayton (2005), along with eight associated researchers, touch upon the issue of IT outsourcing. Findings suggest that IT outsourcing is complementary to IT capital. They do

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is influenced by the associated savings, the volatility of output demand, and skill availability of the outside contractor. In the model by Grossman and Helpman (2002) the equilibrium level of outsourcing is determined by firms' trade-off between the relatively high governance costs of integrated firms as opposed to the search costs for partners by outsourcing firms. Domberger et al. (1995) study competitive tendering of service provision with data on cleaning contracts: they find that competition reduced prices while the quality was maintained or even enhanced.

[2] Abramovsky and Griffith (2006) suggest that information and communication technology (ICT) in itself has consequences on a firm's choice to outsource (regardless of type): they find that more ICT-intensive firms outsource more and that they are also more likely to off-shore. Bardhan et al. (2006) come to a similar conclusion; they also find that outsourcing of production processes is associated with lower cost and higher quality. Bartel, Lach, and Sicherman (2005) present a model formalizing these observations.

not, however, find that IT outsourcing would be a significant determinant of productivity when included in a regression with IT investment.[3]

[3] In what follows, we do not measure IT investment *per se* but rather IT use directly, which is a function of prior and current IT investment as well as rented, leased, or similarly acquired equipment (as a part of the outsourcing contract the provider typically exploits its own IT capital for which the customer is not billed separately). Furthermore, in our regression setting we do not consider outsourced IT services that are best characterized as investment as opposed to purchases for immediate consumption.

2. DATA

Our data on IT originates from Statistics Finland's *Information technology use and electronic commerce in enterprises 2005* -survey[4] conducted in the spring of 2005 with some questions referring to the time of the survey and some to the statistical year of 2004. The survey's question 7.1 is: *To what extent are the following information technology functions performed by your firm's own (hired) labor / outside labor?* [5] Answers are requested in the following ten categories:

(a) Design/development of Internet homepages,[6]
(b) Maintenance of Internet homepages,[7]
(c) Internet marketplace for private/retail customers,[8]
(d) Internet or extranet marketplace for businesses,[9]
(e) Other business to business commerce application (for example EDI),[10]
(f) Development and maintenance of applications,[11]
(g) Development of other information technology systems,[12]
(h) Operation/maintenance of servers,[13]
(i) Operation/maintenance of a PC environment,[14] and
(j) User support,[15]

with the following six mutually exclusive answering alternatives given for each: *Completely performed by external labor*,[16] *Mostly performed by external labor*,[17] *Equally performed by external and own labor*,[18] *Mostly performed by own labor*,[19] *Completely performed by own labor*,[20] and *I am unable to say / Irrelevant*.[21]

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[4] In Finnish: *Tietotekniikka ja sähköinen kauppa yrityksissä 2005*.

[5] In Finnish: *Missä määrin seuraavat tietotekniikkatoiminnot tehdään yrityksenne omalla työvoimalla / ulkopuolisella työvoimalla?*

[6] In Finnish: *Internet-kotisivujen suunnittelu/kehittäminen*.

[7] In Finnish: *Internet-kotisivujen ylläpito*.

[8] In Finnish: *Internet-kauppapaikka yksityis/vähittäisasiakkaille*.

[9] In Finnish: *Internet tai extranet kauppapaikka yrityksille*.

[10] In Finnish: *Muu yritystenvälisen liiketoiminnan sovellus (esim. EDI)*.

[11] In Finnish: *Sovellusten kehittäminen ja ylläpito*.

[12] In Finnish: *Muu tietotekniikkasysteemien kehittäminen*.

[13] In Finnish: *Palvelinten käyttö/ylläpito*.

[14] In Finnish: *PC-ympäristön käyttö/ylläpito*.

[15] In Finnish: *Käyttäjätuki*.

[16] In Finnish: *Kokonaan ulkopuolisella työvoimalla*.

[17] In Finnish: *Pääosin ulkopuolisella työvoimalla*.

[18] In Finnish: *Yhtä paljon ulkopuolisella ja omalla työvoimalla*.

[19] In Finnish: *Pääosin omalla työvoimalla*.

We will discuss IT outsourcing in light of the answers provided to these questions. It should be noted that some categories refer to the external purchases of investment inputs – expected to deliver a flow of service used internally and/or contribute to goods and/or services sold externally in the future – while some refer to the external purchases of services for immediate consumption. Of the above categories (a) and (g) as well as to a lesser extent (c), (d), and (e) may be considered investment; categories (b), (h), (i), and (j) may be considered consumption; category (f) involves both. The usefulness of (f) is hindered by the fact that it is unclear, what are the respective roles of packaged software and firm-specific solutions.

The structure of the IT outsourcing section suggests a continuous coding of the relevant questions: outsourcing goes from 0 (*completely internal*) to 100% (*completely external*) with a clearly identified mid-point of 50% (*equally*). While the *mostly internal* and *external* alternatives are less clear cut, it is not unreasonable to code these respectively as 25% and 75% outsourcing. The analysis below is based on this choice of coding.

For the non-IT variables we use values referring to the statistical year of 2005.[22] We include firms with at least ten employees in manufacturing (D, Nace 2002 industry codes 15–37); electricity, gas and water supply (E, code 40); construction (F, code 45); and private services (F–K, codes 50–74) in which at least some employees use computers at their work. Furthermore, the firm's capital stock, labor input, and value added must be observed. As also "importance" (employment) weighted figures are considered, we exclude 18 firms with over 2,000 employees. After these restrictions we are left with a usable cross-section of 1,839 firms.

IT outsourcing is widespread (see Table 1): depending on the category (and conditional on considering the question relevant and being able to answer), on average the sample firms have outsourced 40–66% (weighted: 37–64%) of the IT activity in question; most firms (56–74%; weighted: 50–83%) bi-source (Du, Lu, and Tao, 2006), i.e., both purchase externally and provide internally the service in question; 6–29% (weighted: 6–36%) of the sample firms perform the IT activity in question completely internally and 14–31% (weighted: 10–28%) completely externally. On average 17–93% of the sample firms consider the various IT outsourcing questions relevant (depends on the employed IT system) and are able to answer.

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[20] In Finnish: *Kokonaan omalla työvoimalla*.

[21] In Finnish: *En osaa sanoa / Ei relevantti*.

[22] The details on firm-level employment (educational structure etc.) refer to the end of year 2004.

Table 1. Unweighted and weighted distributions of the IT outsourcing responses.

Unweighted	Sh. of those answering / considing relevant (%)	Conditional of being able to answer and considering relevant, the extent of outsourcing (Mean and X% outsourced): Mean	0%	25%	50%	75%	100%
(a) Design/development of Internet homepages	86	56	15	17	18	32	18
(b) Maintenance of Internet homepages	86	46	25	26	10	19	19
(c) Internet marketplace for retail customers	17	52	19	22	13	24	22
(d) Internet marketplace for business customers	22	52	18	19	16	29	18
(e) Other business to business commerce appl.	28	66	8	13	14	34	31
(f) Development and maintenance of applications	84	66	6	14	16	39	25
(g) Development of other IT systems	86	56	8	26	20	28	18
(h) Operation/maintenance of servers	91	50	19	26	13	21	21
(i) Operation/maintenance of a PC environment	93	40	28	28	12	19	13
(j) User support	93	41	29	24	14	19	14
Weighted	**Asnw./relev.**	**Mean**	**0%**	**25%**	**50%**	**75%**	**100%**
(a) Design/development of Internet homepages	86	54	14	19	19	32	16
(b) Maintenance of Internet homepages	86	43	24	31	9	19	17
(c) Internet marketplace for retail customers	17	49	20	26	10	25	19
(d) Internet marketplace for business customers	22	51	16	20	22	30	13
(e) Other business to business commerce appl.	28	64	8	16	15	33	28
(f) Development and maintenance of applications	84	63	6	14	18	42	19
(g) Development of other IT systems	86	51	7	30	25	29	10
(h) Operation/maintenance of servers	91	46	22	29	11	19	19
(i) Operation/maintenance of a PC environment	93	39	31	29	8	18	15
(j) User support	93	37	36	25	10	15	14

The most frequently answered question concerns the outsourcing of user support (see Table 1): 1,705 of the 1,839 firms (93%) consider the question relevant and are able to provide an answer. Given that by construction at least some employees of the sample firms use computers at their work, obviously all should have considered the question relevant if understood as intended. The other questions may be conditional of the specific features of a firm's IT infrastructure. Thus, while it seems that relatively few answers are provided regarding the outsourcing of online (c) retail or (d) business-to-business sales, some eighty per cent of the firms having online sales do provide an answer.

Table 2. Unweighted and weighted correlation coefficients of the IT outsourcing variables.

Unweighted	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
(a) Design/development of Internet homepages	1.00									
	1,587									
(b) Maintenance of Internet homepages	.65 *	1.00								
	1,569	1,581								
(c) Internet marketplace for retail customers	.62 *	.62 *	1.00							
	317	318	320							
(d) Internet marketplace for business customers	.56 *	.58 *	.87 *	1.00						
	383	387	240	396						
(e) Other business to business commerce appl.	.39 *	.34 *	.65 *	.72 *	1.00					
	461	465	158	217	506					
(f) Development and maintenance of applications	.40 *	.36 *	.55 *	.59 *	.62 *	1.00				
	1,399	1,397	304	382	501	1,550				
(g) Development of other IT systems	.39 *	.36 *	.41 *	.48 *	.44 *	.69 *	1.00			
	1,420	1,415	309	384	491	1,484	1,581			
(h) Operation/maintenance of servers	.31 *	.31 *	.31 *	.35 *	.33 *	.46 *	.66 *	1.00		
	1,505	1,504	317	395	503	1,514	1,547	1,674		
(i) Operation/maintenance of a PC environment	0.30 *	0.30 *	0.31 *	0.32 *	0.27 *	0.41 *	.59 *	.82 *	1.00	
	1,516	1,514	313	391	502	1,518	1,552	1,643	1,704	
(j) User support	0.30 *	0.30 *	0.33 *	0.32 *	0.24 *	0.41 *	.59 *	.75 *	.84 *	1.00
	1,518	1,516	315	390	501	1,511	1,549	1,637	1,663	1,705
Weighted	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**
(a) Design/development of Internet homepages	1.00									
	1,587									
(b) Maintenance of Internet homepages	.58 *	1.00								
	1,569	1,581								
(c) Internet marketplace for retail customers	.59 *	.61 *	1.00							
	317	318	320							
(d) Internet marketplace for business customers	.56 *	.51 *	.87 *	1.00						
	383	387	240	396						
(e) Other business to business commerce appl.	.42 *	.40 *	.67 *	.64 *	1.00					
	461	465	158	217	506					
(f) Development and maintenance of applications	.43 *	.38 *	.57 *	.58 *	.67 *	1.00				
	1,399	1,397	304	382	501	1,550				
(g) Development of other IT systems	.41 *	.36 *	.34 *	.42 *	.44 *	.65 *	1.00			
	1,420	1,415	309	384	491	1,484	1,581			
(h) Operation/maintenance of servers	.28 *	.27 *	.17 *	.34 *	.32 *	.39 *	.60 *	1.00		
	1,505	1,504	317	395	503	1,514	1,547	1,674		
(i) Operation/maintenance of a PC environment	0.21 *	0.20 *	0.18 *	0.28 *	0.23 *	0.30 *	.50 *	.79 *	1.00	
	1,516	1,514	313	391	502	1,518	1,552	1,643	1,704	
(j) User support	0.22 *	0.22 *	0.18 *	0.24 *	0.23 *	0.29 *	.50 *	.73 *	.88 *	1.00
	1,518	1,516	315	390	501	1,511	1,549	1,637	1,663	1,705

Note: * indicates statistical significance at 1% level. The number of observations below the coefficient (in small print).

Various types of IT outsourcing are highly correlated (see Table 2). The correlations among the Internet and e-commerce outsourcing measures (a, b, c, and d) is .56–.87 (weighted: .51–.87). In application (f) and system development (g) the correlation is .69 (weighted: .65). As for the computer network as well as its terminals and users (h, i, and j), the correlation is .75–.84 (weighted: .73–.88). Other business-to-business commerce application (e) is highly correlated with both e-commerce measures (c and d). Internet or extranet marketplace for businesses (d) is correlated with both development measures (f and g).

Table 3. Unweighted and weighted descriptive statistics.

Unweighted	Obs.	Mean	St. dev.	Min.	Max.	IT	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
IT: Share of employees using a computer at work	1,839	.666	.352	.010	1	1										
IT: (a) Design/development of Internet homepages	1,587	.555	.332	0	1	-.17	1									
IT: (b) Maintenance of Internet homepages	1,581	.458	.370	0	1	-.20	.65	1								
IT: (c) Internet marketplace for retail customers	320	.518	.362	0	1	-.11	.62	.62	1							
IT: (d) Internet marketplace for business customers	396	.520	.346	0	1	-.11	.56	.58	.87	1						
IT: (e) Other business to business commerce appl.	506	.664	.317	0	1	-.07	.39	.34	.65	.72	1					
IT: (f) Development and maintenance of applications	1,550	.655	.295	0	1	-.16	.40	.36	.55	.59	.62	1				
IT: (g) Development of other IT systems	1,581	.559	.308	0	1	-.18	.39	.36	.41	.48	.44	.69	1			
IT: (h) Operation/maintenance of servers	1,674	.498	.362	0	1	-.18	.31	.31	.31	.35	.33	.46	.66	1		
IT: (i) Operation/maintenance of a PC environment	1,704	.403	.351	0	1	-.15	.30	.30	.31	.32	.27	.41	.59	.82	1	
IT: (j) User support	1,705	.411	.357	0	1	-.18	.30	.30	.33	.32	.24	.41	.59	.75	.84	1
CD: ln(real value added / labor input)	1,839	10.86	0.57	5.51	14.22	.20	-.03	-.01	-.07	-.04	-.05	-.04	-.06	-.03	.01	-.02
CD: ln(real capital stock / labor input)	1,839	10.10	1.78	-3.35	17.88	.05	.09	.05	.09	.11	.03	.05	.00	-.01	.01	-.02
CD: ln(labor input)	1,839	4.06	1.21	2.30	7.55	.14	-.01	-.05	.06	.03	-.03	-.08	-.16	-.14	-.08	-.19
Firm: Young (established in/after year 2000)	1,839	.147	.355	0	1	.05	.03	.05	.12	.01	.09	.02	.01	.03	.04	.01
Firm: Old (established in/before year 1985)	1,839	.363	.481	0	1	-.04	.03	.01	.01	.07	-.03	.04	.03	.00	-.01	-.01
Fim: Multiple establishments (dummy)	1,839	.468	.499	0	1	.17	-.05	-.06	.07	.06	.02	-.03	-.08	-.08	-.06	-.11
Ed.: Share of employees with bachelor or eq. techn. ed.	1,770	.049	.063	0	.800	.14	-.10	-.07	-.06	-.03	-.09	-.10	-.14	-.08	-.06	-.09
Ed.: Share of employees with Master or eq. techn. ed.	1,770	.058	.096	0	.732	.25	-.12	-.11	-.17	-.15	-.09	-.14	-.17	-.14	-.11	-.14
Ed.: Share of employees with PhD or eq. techn. ed.	1,770	.033	.075	0	.538	.30	-.12	-.09	-.11	-.15	-.12	-.19	-.19	-.13	-.07	-.11
Ed.: Share of employees with bachelor or eq. non-t. ed.	1,770	.108	.105	0	.818	.41	-.05	-.07	.02	-.02	.02	.00	-.01	-.03	-.06	-.05
Ed.: Share of employees with Master or eq. non-t. ed.	1,770	.041	.059	0	.538	.33	-.10	-.09	-.03	-.10	.00	-.06	-.04	-.06	-.03	-.05
Ed.: Share of employees with PhD or eq. non-t. ed.	1,770	.036	.081	0	.755	.31	-.06	-.07	-.06	-.04	-.01	-.10	-.09	-.07	-.04	-.06
Labor: Young (share of those under 35)	1,770	.368	.192	0	1	-.01	.00	-.03	-.02	-.09	-.04	-.09	-.03	.00	-.01	.02
Labor: Old (share of those at least 45)	1,770	.360	.176	0	1	-.09	.07	.09	.07	.16	.08	.13	.08	.06	.06	.04
Labor: Women (share of female employees)	1,770	.341	.262	0	1	.24	-.03	-.06	.05	-.04	.14	.07	.09	.05	.03	.03

Weighted	Obs.	Mean	St. dev.	Min.	Max.	IT	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
IT: Share of employees using a computer at work	1,839	.734	.305	.010	1	1										
IT: (a) Design/development of Internet homepages	1,587	.541	.325	0	1	-.17	1									
IT: (b) Maintenance of Internet homepages	1,581	.434	.362	0	1	-.22	.58	1								
IT: (c) Internet marketplace for retail customers	320	.492	.360	0	1	-.08	.59	.61	1							
IT: (d) Internet marketplace for business customers	396	.509	.319	0	1	-.04	.56	.51	.87	1						
IT: (e) Other business to business commerce appl.	506	.645	.317	0	1	-.14	.42	.40	.67	.64	1					
IT: (f) Development and maintenance of applications	1,550	.634	.286	0	1	-.18	.43	.38	.57	.58	.67	1				
IT: (g) Development of other IT systems	1,581	.513	.282	0	1	-.18	.41	.36	.34	.42	.44	.65	1			
IT: (h) Operation/maintenance of servers	1,674	.460	.363	0	1	-.12	.28	.27	.17	.34	.32	.39	.60	1		
IT: (i) Operation/maintenance of a PC environment	1,704	.389	.363	0	1	-.09	.21	.20	.18	.28	.23	.30	.50	.79	1	
IT: (j) User support	1,705	.368	.364	0	1	-.07	.22	.22	.18	.24	.23	.29	.50	.73	.88	1
CD: ln(real value added / labor input)	1,839	10.96	0.57	5.51	14.22	.24	-.07	-.05	-.14	-.11	-.10	.01	-.02	.03	.12	.09
CD: ln(real capital stock / labor input)	1,839	10.48	-1.77	3.35	17.88	.12	.03	.00	.10	.11	-.02	.10	-.01	-.01	.04	.02
CD: ln(labor input)	1,839	5.64	1.16	2.30	7.55	.16	-.06	-.05	-.18	-.08	-.07	-.04	-.06	-.02	.03	.01
Firm: Young (established in/after year 2000)	1,839	.180	.384	0	1	.02	.00	.06	.18	.03	.12	.04	.05	.04	.04	.03
Firm: Old (established in/before year 1985)	1,839	.371	.483	0	1	.00	-.01	-.05	-.08	-.06	-.12	-.02	.01	-.03	-.04	-.07
Fim: Multiple establishments (dummy)	1,839	.753	.431	0	1	.15	-.09	-.07	-.07	.00	-.04	-.06	-.05	-.06	-.04	-.01
Ed.: Share of employees with bachelor or eq. techn. ed.	1,770	.056	.058	0	.800	.17	-.16	-.10	.02	-.01	-.12	-.06	-.12	-.07	-.01	-.02
Ed.: Share of employees with Master or eq. techn. ed.	1,770	.065	.087	0	.732	.21	-.16	-.14	-.20	-.10	-.10	-.11	-.13	-.07	.02	.02
Ed.: Share of employees with PhD or eq. techn. ed.	1,770	.040	.071	0	.538	.29	-.18	-.14	-.22	-.17	-.15	-.18	-.20	-.07	.03	.01
Ed.: Share of employees with bachelor or eq. non-t. ed.	1,770	.099	.082	0	.818	.35	-.07	-.12	.03	-.07	-.13	-.11	-.05	-.05	-.12	-.11
Ed.: Share of employees with Master or eq. non-t. ed.	1,770	.039	.047	0	.538	.28	-.13	-.07	-.06	-.18	-.12	-.17	-.08	-.06	-.05	-.06
Ed.: Share of employees with PhD or eq. non-t. ed.	1,770	.033	.072	0	.755	.25	-.09	-.08	-.18	-.08	-.15	-.17	-.14	-.07	-.07	-.09
Labor: Young (share of those under 35)	1,770	.357	.173	0	1	-.06	-.05	.01	-.08	-.17	-.01	-.11	-.04	-.07	-.14	-.09
Labor: Old (share of those at least 45)	1,770	.374	.153	0	1	-.01	.12	.10	.14	.25	.14	.18	.13	.15	.18	.16
Labor: Women (share of female employees)	1,770	.349	.243	0	1	.13	.00	.00	.14	.00	.04	-.01	.04	-.01	-.11	-.09

Note: Underlining indicates that the pairwise correlation in question is statistically significance at 1% level.

Table 3 reports the descriptive statistics of the variables used in the analysis (besides the eighteen industry and twenty regional dummies) along with their correlations with the IT measures.

3. MODEL

While the outsourcing questions are of interest in their own right, the key question is their relation to firm performance. In what follows, we will briefly consider the productivity effects of outsourcing in a setting previously employed by Maliranta and Rouvinen (2004;2006).[23]

We wish to study the productivity effects of using a computer at work as well as IT outsourcing at the level of an individual worker. These IT characteristics are, however, only observed at the firm level, that is, the data is grouped in a certain way. Assuming that workers are – after controlling for observable individual qualities – reasonably similar, a firm-level model revealing these effects can nevertheless be devised and estimated.

A Cobb-Douglas production function of firm i can be written as

$$Y_i = A_i K_i^{\beta_K} L_i^{\beta_L} \boldsymbol{Z}_i^{\boldsymbol{\beta}_Z} e^{\varepsilon_i} \tag{1}$$

where Y is net output, A is disembodied technology, K is capital, L is labor, $\boldsymbol{Z}$ is a vector of the other relevant firm and individual qualities and ε is a stochastic error term. Workers may have different marginal productivities depending on whether or not they use a computer at work. Let L_{IT} be the number of workers using a computer at work. Adding this to (1) yields

$$Y_i = A_i K_i^{\beta_K} \left(L_i \left(1 + \theta_{IT} \left(\frac{L_{IT,i}}{L_i} \right) \right) \right)^{\beta_L} \boldsymbol{Z}_i^{\boldsymbol{\beta}_Z} e^{\varepsilon_i}, \tag{2}$$

where θ_{IT} is a parameter capturing the possible additional productivity effects associated with computer use. Slight manipulation yields a labor productivity specification

$$\ln\left(\frac{Y_i}{L_i}\right) = \ln A_i + \beta_K \ln\left(\frac{K_i}{L_i}\right) + \beta_L \ln\left(1 + \theta_{IT}\left(\frac{L_{IT,i}}{L_i}\right)\right) + \left(\beta_K + \beta_L - 1\right)\ln L_i + \boldsymbol{\beta_Z} \ln \boldsymbol{Z_i} + \varepsilon_i, \tag{3}$$

where $\left(\beta_K + \beta_L - 1\right)\ln L_i$ accounts for deviations from constant returns to scale. Approximating $\ln\left(1 + \theta_{IT}\left(L_{IT,i}/L_i\right)\right)$ with $\theta_{IT}\left(L_{IT,i}/L_i\right)$ yields

$$\ln\left(\frac{Y_i}{L_i}\right) \approx \ln A_i + \beta_K \ln\left(\frac{K_i}{L_i}\right) + \beta_L \theta_{IT}\left(\frac{L_{IT,i}}{L_i}\right) + \left(\beta_K + \beta_L - 1\right)\ln L_i + \boldsymbol{\beta_Z} \ln \boldsymbol{Z_i} + \varepsilon_i. \tag{4}$$

A worker using a computer is supported either by an in-house IT staff or by an outsider contractor to whom the task has been outsourced. Outsourcing could be incorporated

[23] See also Olsen (2006).

in A suggesting that it makes all factors proportionately more productive. This could be the case for instance if IT outsourcing provides strategic advantages.[24] Alternatively, and in our opinion more appropriately, one could think that IT outsourcing might enhance the computer use of those exposed to it, in which case (4) could be re-written as follows:

$$\begin{aligned}\ln\left(\frac{Y_i}{L_i}\right) \quad &\approx \ln A_i + \beta_K \ln\left(\frac{K_i}{L_i}\right) \\ &+\beta_L \theta_{ITin}\left(\frac{L_{ITin,i}}{L_i}\right) + \beta_L \theta_{ITout}\left(\frac{\left(L_{ITout,i}\right)}{L_i}\right), \\ &+\left(\beta_K + \beta_L - 1\right)\ln L_i + \boldsymbol{\beta_Z} \ln \boldsymbol{Z_i} + \varepsilon_i\end{aligned} \tag{5}$$

where L_{ITin} represent the computer users supported by internal and L_{ITout} by external staff with θ_{ITin} and θ_{ITout} as the respective parameters to be estimated. $L_{ITout} = L_{IT} \times Outsourced$ and $L_{ITin} = L_{IT} \times (1 - Outsourced)$, where $Outsourced$ is the fraction of outsourced user support (derived from the answers to question (j) discussed in the previous section; naturally the subsequent analysis is limited to firms that have provided an answer to this question).[25]

In what follows, we estimate a model incorporating IT outsourcing with the variables discussed in the previous section as well as with a stochastic error term.[26]

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[24] While we do not consider this the most appropriate way to proceed, we nevertheless estimate a model where the term $e^{Outsourced}$ is included in A.

[25] As the discussion in the previous section suggest, the IT outsourcing measures largely convey the same information. Introducing them jointly in a regression setting might cause severe multicollinearity problems. Furthermore, immediate consumption and investment call for rather different modeling approaches; externally purchased IT investment inputs are perhaps best likened to R&D (for discussion on externally purchased R&D inputs see Ulset, 1996). We experimented with combining answers to (h), (i), and (j) using Cronbach's Alpha method. The reliability coefficient of .91, i.e., well above the usually employed cut-off of .70 suggesting that pooling the answers is indeed appropriate. Employing the pooled IT outsourcing measure yields both qualitatively and quantitatively nearly identical results.

[26] For instance Greenan and Mairesse (2000) have considered a model similar to ours even though without the IT outsourcing extension. Below disturbances are assumed to be uncorrelated across observations but arbitrary differences in their variances (heteroscedasticity) is allowed.

4. RESULTS

Before proceeding, we eliminate outliers by using the standardized or Pearson residuals: a preliminary regression is performed and 14 observations with the standardized residuals over four standard deviations away from the mean are dropped, which with normally distributed errors would be roughly equivalent to eliminating three out of 100,000 observations. Detailed employee characteristics (age, education etc. for each individual) are missing for 69 firms; the missing information is coded as being zero but we also include a separate dummy variable indicating where such replacements have been made.

Table 4. Estimation results (dependent variable: ln(value added/labor input)).

	Unweighted			Employment weighted		
	(1.)	(2.)	(3.)	(4.)	(5.)	**(6.)**
IT: Sh. of employees using a computer at work	.063 *	.076 **		.139 **	.097 *	
IT: Outsourcing sh. (outsourced user support (j.))		.085 ***			.139 ***	
IT: Share of computer users × Outsourcing sh.			.135 ***			**.203** ***
IT: Share of computer users × (1 - Outsourcing sh.)			.024			**.018**
CD: ln(real capital stock / labor input)	.076 ***	.079 ***	.079 ***	.078 ***	.087 ***	**.087** ***
CD: ln(labor input)	.035 ***	.041 ***	.041 ***	.035 ***	.038 ***	**.037** ***
Firm: Young (established in/after year 2000)	.032	.027	.028	.049	.048	**.053**
Firm: Old (established in/before year 1985)	-.005	.001	.001	-.002	.002	**.004**
Fim: Multiple establishments (dummy)	-.058 **	-.067 ***	-.067 ***	-.084 ***	-.079 **	**-.082** **
Ed.: Sh. of employees with Bachelor or eq. techn. ed.	.522 ***	.496 **	.495 **	1.093 ***	1.185 ***	**1.202** ***
Ed.: Sh. of employees with Master or eq. techn. ed.	.766 ***	.782 ***	.787 ***	.532 **	.562 **	**.547** **
Ed.: Sh. of employees with PhD or eq. techn. ed.	.422 **	.410 *	.412 *	.999 ***	.925 ***	**.929** ***
Ed.: Sh. of employees with Bachelor or eq. non-t. ed.	.360 ***	.372 **	.376 **	.320	.405 +	**.417** +
Ed.: Sh. of employees with Master or eq. non-t. ed.	.701 ***	.803 ***	.790 ***	.662 **	.558 *	**.508** *
Ed.: Sh. of employees with PhD or eq. non-t. ed.	1.192 ***	1.193 ***	1.195 ***	1.682 ***	1.763 ***	**1.783** ***
Labor: Young (Sh. of those under 35)	-.370 ***	-.437 ***	-.436 ***	-.235	-.175	**-.187**
Labor: Old (Sh. of those at least 45)	-.135	-.188 +	-.193 +	.064	.032	**.011**
Labor: Women (Sh. of female employees)	-.361 ***	-.415 ***	-.413 ***	-.389 ***	-.359 ***	**-.358** ***
Labor: Missing	-.150	-.208 *	-.210 *	-.006	.022	**.006**
Also including a constant term as well as industry (18 categories) and regional (20 categories) dummies.						
Are the two IT intensity × outsourcing measures equal (= H0)?		F(1, 2207)	6.90 ***		F(1, 2207)	**12.56** ***
Observations:	1,825	1,691	1,691	1,825	1,691	**1,691**
R-squared:	0.37	0.38	0.38	0.50	0.52	**0.52**

Note: Estimated with White (1980) heteroskedasticity consistent ordinary least squares in Stata for Windows version 9.2. ***, **, *, and + respectively indicate significance at 1, 5, 10, and 15 per cent level.

Table 4 provides both unweighted (Columns 1–3) and employment weighted (Columns 4–6) heteroskedasticity-consistent (robust) ordinary least squares production function estimates with the share of computer using employees (IT intensity) as the only IT measure

(Columns 1 and 4), the share of computer users and the IT outsourcing intensity as the measures (Columns 2 and 5), as well as the estimates, where the IT intensity is split into two by interacting it with the share of outsourcing as well was one minus the share of outsourcing (Columns 3 and 6). As the effect of outsourcing should in our opinion be a function of the firm's IT intensity and we wish to make interpretations regarding an individual worker, the rightmost Column 6 in Table 4 provides our preferred estimates.[27]

Before proceeding, a word of caution: The results in Table 4 do not take into account the output elasticity of labor, that is, $\beta_L \theta_{IT}$ (.203 for the *Share of Computer users* × *Outsourcing share* in Column 6) rather than θ_{IT} (correspondingly .214) is reported. Furthermore, Table 4 does not report output elasticities of ICT, which are more common in this literature (correspondingly the IT output elasticity for the computer users with outsourced support is about five per cent). Maliranta and Rouvinen (2006) discuss these issues in some detail.

After controlling for industry and regional effects as well as labor and other firm-level characteristics, the "excess" productivity associated with using a computer at work is little over ten per cent (Column 3), which is inline with our earlier results (Maliranta and Rouvinen, 2004). Regardless of how IT outsourcing is introduced to the model, it seems to have a considerable impact: If it is assumed to enhance all factors proportionally, a completely IT outsourcing firm, as opposed to one with completely internal IT support, seem to have some ten per cent higher labor productivity (Column 2). If assumed to enhance the labor input associated with using a computer at work, the difference between internally and externally supported labor is qualitatively large and statistically significant (Column 6): in fact it seems that a computer is enhancing a worker's productivity only if s/he is externally supported. A worker using an externally supported computer at work is about twenty per cent more productive than a similar worker without a computer.

[27] In one wishes to make interpretations at the level of a firm, Column 3 is preferred.

5. Discussion

In section 3 we neither explicitly model firms' motives and behavior nor identify the actual channels of influence when it comes to IT outsourcing. The results in section 4 are partial correlations. They nevertheless suggest IT outsourcing might have considerable effects. Earlier literature suggests that its effects might be conditional on timing (first-term vs. subsequent contracts; associated re-organization and coordination costs). Outsourcing might also have unintended long-run effects (forgone learning associated with internal provision of IT services; "hollowing out" of the firm etc.). One might also want to take into account unobserved firm heterogeneity as well as (self-)selection into IT outsourcing before drawing definite conclusions about its effects.

Even though we control for a number of firm characteristics, in this paper we have not considered how the estimated effects might vary by firm characteristics. For example, to the extent that our findings reflect economies of scale, it might be that smaller firms have more to gain from IT outsourcing.[28]

Most likely outsourcing will move at least some IT investment outside the firm, in which case outsourcing studies using IT capital to measure intensity of use might be biased, as the benefits of the IT-related productivity gains might captured by the outsourcing measure (Knittel and Stango, 2008). This is not, however, an issue in our case as we directly measure IT use.

[28] We thank Tony Clayton for pointing this out.

6. Conclusion

Our findings suggest that – despite being little studied and understood – IT outsourcing has potentially considerable economic consequences. IT outsourcing seems to enhance the involved organization's IT use and thus also boost its labor productivity.[29] In the longer run a firm has to consider, from its own point of view, whether IT is just a support department/function, or is it in fact the clue that binds together everything else?

[29] Some caveats of this finding are discussed in Section 5.

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