Determinants of ICT Usage in the Business Sector in Thailand*

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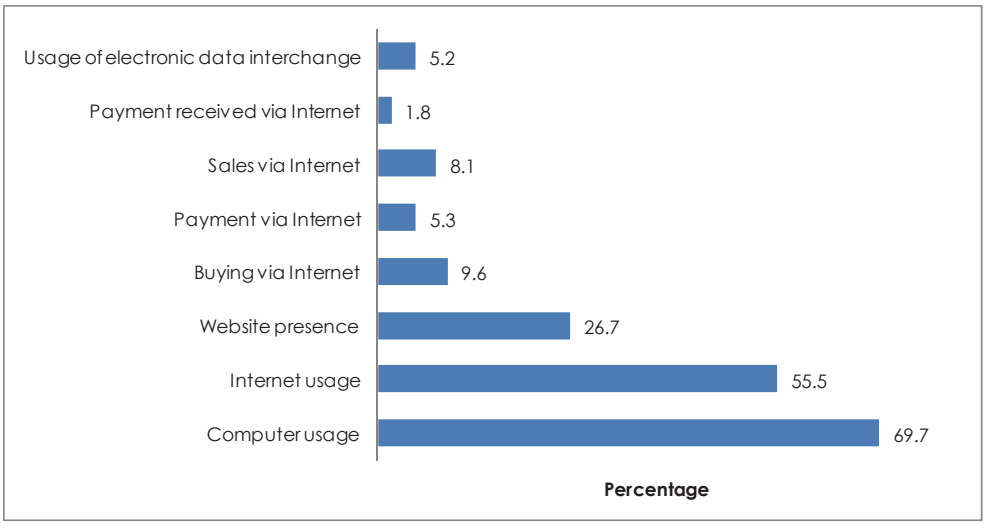
1. INTRODUCTION

Many recent studies have shown that firms which use information and communications technology (ICT) tend to perform better than those that do not. For example, ICT-using firms grow faster, invest more, and are more productive and profitable than firms not using ICT (World Bank, 2006).[1] The contribution of ICT to economic growth and competitiveness leads governments of both developed and developing countries to actively promote the uptake of ICT among firms. Since 2002, Thailand has developed a number of national ICT master plans,[2] as have other countries, in order to promote the development and utilization of ICT.

The adoption of ICT among firms in Thailand, however, is still limited. Figure 1 shows the results of the ICT survey of 188,843 enterprises in Thailand undertaken in 2008 by the National Statistical Office (NSO). In that year, about 70 percent of the firms surveyed used computers; 56 percent, the Internet; and 27 percent had a presence on the Web. With regard to e-commerce, the share of firms buying via the Internet was 10 percent, slightly higher than the share of those selling via the Internet (8%). The share of firms that made online payments was 5 percent, while the share of those receiving online payments was only 2 percent.

Firms were found to have different objectives in using different types of ICT (Figure 2). In particular, their main objective in using computers was for routine tasks, such as AutoCAD (computer-aided design)/design, data processing, and engineering tasks, which accounted for 96 percent of the total. In addition, firms

Figure 1 ICT Usage in Enterprises in Thailand (2008)



Source: Compiled by authors with data from the National Statistical Office.

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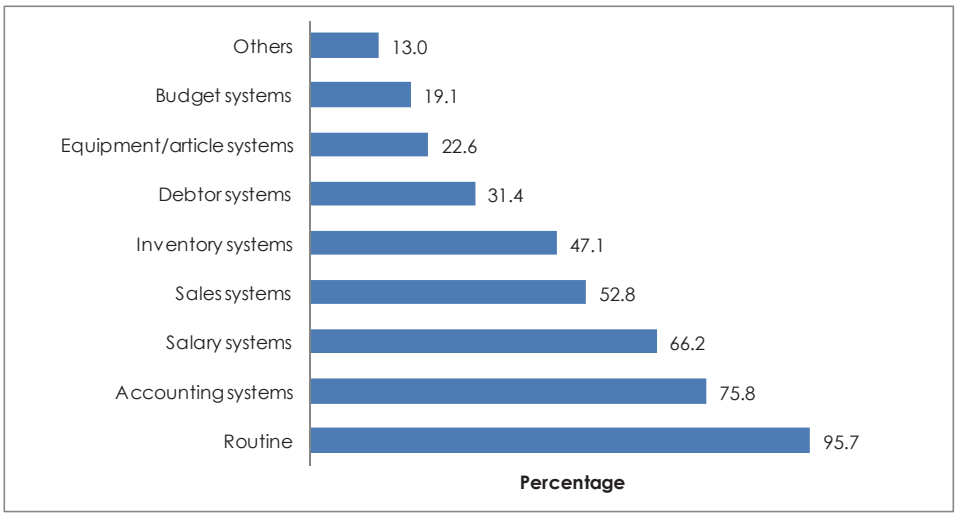
Figure 2 Objectives of Firms in Using Computers (2008)



Source: Compiled by authors with data from the National Statistical Office.

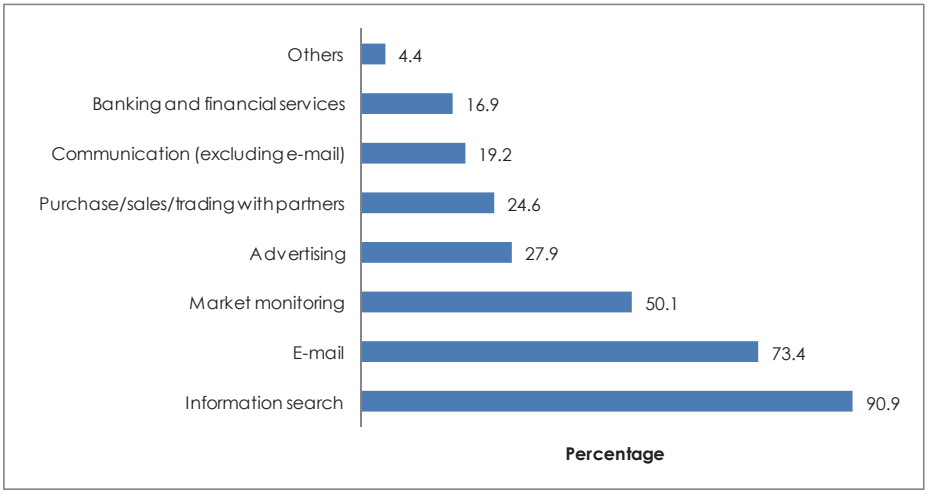
used computers for management information systems in the back office, including accounting systems (76%), salary systems (66%), sales systems (53%), inventory systems (47%), debtor systems (31%), equipment or article systems (23%), and budget systems (19%).

In terms of the purposes of Internet usage, the firms' main objectives in using the Internet were information searching (91%), followed by e-mail usage (73%), market monitoring (50%), advertising of goods and services (28%), purchasing or selling goods and services, and trading with partners (25%), communication channels (excluding e-mail) (19%), and banking and financial services (17%), as shown in Figure 3.

With regard to the limitations to using computers and the Internet, and having a presence on the Web, Figure 4 shows that the main obstacles are quite similar. In particular, the most important obstacle to using computers and the Internet, and having a presence on the Web was that firms believed that it is not necessary for their business, which accounted for more than 70 percent of the total. This may suggest that such ICT use is really inappropriate for their business models, or that firms do not realize how ICT usage could be beneficial to their business. Other major obstacles to using ICT were found to be the lack of employees skilled in information technology (IT) (29-31%) and poor infrastructure, such as the high expenses associated with using ICT and unavailability of network services (26-33%).

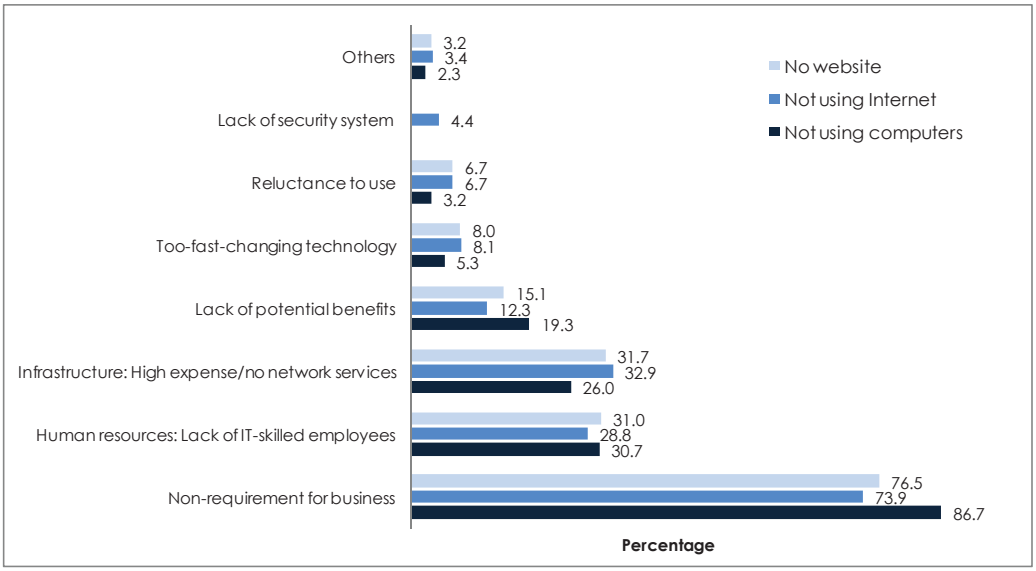
There is a lot of discussion on what factors—both internal and external—could explain ICT usage in the business sector. In particular, Iacovou et al. (1995) and Mehrtens et al. (2001) found that the key factors affecting Internet usage in small enterprises are the expected benefits, including direct benefits, such as cost reduction, and indirect benefits, such as reduction in business procedures; readiness within the organization, such as financial and technological readiness; and external pressures, such as competitors and trade partners. Lefebvre and Lefebvre (1991) also found that the key reasons for adopting technology among firms are

Figure 3 Objectives of Firms in using the Internet (2008)



Source: Compiled by authors with data from the National Statistical Office.

Figure 4 Obstacles that Firms Face in Using ICT (2008)



Source: Compiled by the authors with data from the National Statistical Office.

their characteristics, their competitiveness and business management strategies, internal and external influences, and types of technology adopted. In addition, the personal characteristics of chief executive officers (CEOs) are related to ICT usage in small and medium-sized enterprises (SMEs). Thong and Yap (1995) found that in SMEs the CEOs with vision for ICT in business tended to use ICT in business.

The Organisation for Economic Co-operation and Development (OECD) (2004) also studied the relationships between ICT, e-business and SMEs, and found that large firms adopt ICT earlier than small firms. Factors influencing the usage of ICT are the potential benefit to be gained from ICT usage, and firm- and sector-specific strategies. In contrast, factors militating against the usage of ICT are lack of applicability and lack of incentives when the expected returns from ICT usage are unclear. Other obstacles to ICT usage are concerns about security and the reliability of e-transactions, intellectual property rights, and the challenges that firms face in the management of technology and related capabilities.

In drawing upon the existing literature, this study is aimed at examining the determinants of ICT usage at the firm level in Thailand by applying logistic regression analysis. In our model, the dependent variables are computer usage, Internet usage, website presence, purchasing or selling via the Internet, payment via the Internet, and electronic data interchange (EDI) usage. All dependent variables are dummy variables, which are equal to 1 if there is ICT usage, and 0 otherwise.

The independent variables for explaining ICT usage among firms include main variables, consisting of IT-skilled employees (proxied by the share of IT workers among all employees), foreign partnership (proxied by share of foreign equity-holding), and the use of an "always-on" broadband Internet connection. Other variables comprise the size of firm (proxied by the number of employees), legal form of the organization, economic form of the organization, types of economic activity, and location of the firms.

The organization of this paper is as follows: after the introduction, section 2 furnishes the data summary and statistics. Section 3 focuses on methodology. Section 4 shows the estimation results, and section 5 checks the robustness of those results. The last section summarizes the major empirical results and their policy implications.

2. DATA SUMMARY AND STATISTICS

The firm-level data on ICT usage in Thailand in 2008 were obtained from NSO, which has conducted enterprise surveys on ICT usage annually since 2004. The data include location, economic and legal structure, number of employees, and amount of registered capital. In terms of ICT usage, the data consist of types of ICT usage, such as the use of computers, Internet, website, buying or selling via the Internet, payment via the Internet and EDI, limitations of ICT usage, ICT spending, and IT employees.

The 2008 NSO survey data on ICT usage covered 188,843 firms located in both municipal and non-municipal areas that were involved in all kinds of economic activities. After deleting samples with missing values in the key variables, the final sample covered 20,152 firms in our cross-section estimation.[3]

Table 1 provides a data summary across firms in 2008. We found that the number of sample firms with or without ICT usage varied depending on the different types of ICT usage. For example, the number of sample firms with or without computer usage and EDI was the highest (20,152 firms), while that of sample firms with or without Internet usage was the lowest (13,795 firms).

Table 1 Summary Statistics

Variables	All sizes				
	Obs. (N)	Mean	Std. deviation	Min	Max
Use of computer	20,152	.68	.46	0	1
Use of Internet	13,795	.80	.40	0	1
Website presence	17,330	.30	.46	0	1
Sale via Internet	17,330	.09	.29	0	1
Purchase via Internet	17,330	.11	.32	0	1
Payment via Internet	17,330	.06	.24	0	1
Use of electronic data interchange	20,152	.05	.22	0	1
Share of information technology employees (percent)	20,152	4.38	13.47	0	100
Share of foreign equity (percent)	20,152	.22	.71	0	3
Employees	20,152	102.80	329.32	1	10,524
Variables	Small and medium-sized firms				
	Obs. (N)	Mean	Std. deviation	Min	Max
Use of computer	16,157	.62	.49	0	1
Use of Internet	9,950	.75	.43	0	1
Website presence	13,639	.22	.42	0	1
Sale via Internet	13,639	.07	.26	0	1
Purchase via Internet	13,639	.09	.29	0	1
Payment via Internet	13,639	.05	.21	0	1
Use of electronic data interchange	16,157	.03	.16	0	1
Share of information technology employees (percent)	16,157	4.32	13.84	0	100
Share of foreign equity (percent)	16,157	.14	.57	0	4
Employees	16,157	26.06	32.52	1	200
Variables	Large firms				
	Obs. (N)	Mean	Std. deviation	Min	Max
Use of computer	3,995	.96	.19	0	1
Use of Internet	3,845	.92	.27	0	1
Website presence	3,691	.61	.49	0	1
Sale via Internet	3,691	.17	.37	0	1
Purchase via Internet	3,691	.19	.39	0	1
Payment via Internet	3,691	.11	.32	0	1
Use of electronic data interchange	3,995	.15	.35	0	1
Share of information technology employees (percent)	3,995	4.59	11.78	0	100
Share of foreign equity (percent)	3,995	.53	1.04	0	3
Employees	3,995	413.15	650.19	31	10,524

Source: Compiled by the authors with data from the National Statistical Office.

In terms of firm size, the average number of employees was 103, and its standard deviation 329.3. Owing to the high standard deviation, we ran a robustness check on the effects of the firm size (see section 5 for details). Table 1 also shows that, on average, the SMEs[4] had characteristics different from those of large firms, especially the share of foreign equity.

Naturally, the percentage of firms that simply used computers and the Internet was higher than the percentage of those purchasing or selling via the Internet. In particular, the average shares of firms using computers and the Internet were 68 and 80 percent, respectively, which is higher than the average share of those paying via the Internet (6%), and the average share of those using EDI (5%).

In comparing between SMEs and large firms, the latter were likely to use ICT much more than the former. For example, the average share of large firms using computers was 96 percent, while that of SMEs using computers was 62 percent.

It should be noted that the share of IT-related employees in the business sector in Thailand is quite low, with the mean being 4 percent, that is, on average there were only four IT-related staff members per 100 employees in the firms in our sample.

3. METHODOLOGY

The binary response model, used to predict the probability of occurrence of an event, may be represented as:

$$P(y = 1|X) = G(b_0 + b_1x_1 + \cdots + b_kx_k) = G(b_0 + \text{Xb})$$

where $P(y = 1|X)$ is the probability of occurrence, and G(z) is a function taking on values strictly between 0 and 1 for all real numbers z.

In the logistic (or logit) model, G(z) is the logistic function:

$$G(z) = \frac{\exp(z)}{1+\exp(z)} \text{ or } \frac{1}{1+\exp(-z)}$$

which is between 0 and 1 for all real numbers z.

To interpret the logit estimation results, we may find the partial effect of explanatory variables on the response probability. In the case of roughly continuous variables, such as x_k, the partial effect of x_k is obtained from the partial derivative:

$$\frac{\partial P(y=1|X)}{\partial x_k} = \frac{\partial G(z)}{\partial z}\frac{\partial z}{\partial x_k} = b_k\left\{\frac{\exp(z)}{1+\exp(z)} - \left[\frac{\exp(z)}{1+\exp(z)}\right]^2\right\} = b_k[G(z) - [G(z)]^2] - b_k G(z)[1-G(z)] - b_k P(y=1|X)P(y=0|X)$$

Therefore, the estimates of the marginal effects are dependent on the estimated coefficients ($\widehat{b_k}$) and the scale factor ($P(y=1|X)P(y=0|X)$). The scale factor varies with the observed values of X. There are two popular methods to obtain a scale factor. In the first method, the scale factor is evaluated at the sample means of the explanatory variables. In the second, it is evaluated at every observation, with the average then taken. However, Greene (1997) suggested that in large samples, by applying the Slutsky theorem, the results from both methods would be similar.

Unlike the roughly continuous variables, the marginal effects for dummy variables are calculated by taking the difference between the two probabilities of success when a dummy variable is changed from 0 to 1, that is, the partial effect of x_k, a dummy variable, is obtained from the change in the probability of success resulting from changing x_k from 0 to 1, holding all other variables at some fixed values, $\bar{x}$. Fixed values are set as the related values for dummy variables and sample average for other variables:

$$\text{Marginal effect for } x_k = P(y=1|x_k=1,\bar{x}) - P(y=1|x_k=0,\bar{x})$$

In this study, the logit regression model to estimate the relationship of ICT usage in enterprises is as follows:

$$p(ICT\ usage)_i = \left[\frac{1}{1+e^{-(z)}}\right]$$

in which z =

$$\beta_1 + \beta_{2r} reg_{ri} + \beta_{2s} sec_{si} + \beta_4 emp_i + \beta_{5l} leg_{li} + \beta_{6e} eco_{ei} + \beta_7 for_i + \beta_8 its_i + \beta_9 con_i$$

where

- i represents firm i (1,….,n);
- *ICT usage* represents a proxy for ICT usage (e.g., computer usage, Internet usage, website presence, purchasing or selling via the Internet, payment via the Internet, and EDI usage), which is equal to 1 if there is ICT usage and 0 otherwise;
- reg_{ri} represents a proxy for the firm i's location (with Bangkok as the base location), where reg_1 is equal to 1 if the firm is located in the central region of the country, reg_2 is equal to 1 if the firm is located in the northern region, reg_3 is equal to 1 if the firm is located in the northeastern region, and reg_4 is equal to 1 if the firm is located in the southern region, and 0 otherwise;
- sec_{si} represents a proxy for economic activity of firm i (s = 1,…,11) (with computer use and related activities as the base economic activity), where sec_1 is equal to 1 if its economic activity involves the sale, maintenance and repair of motor vehicles and motorcycles etc., sec_2 is equal to 1 if its economic activity is wholesale trade and commission trade, sec_3 is equal to 1 if its economic activity is retail trade, sec_4 is equal to 1 if its economic activity is hotels and restaurants, including food shops, sec_5 is equal to 1 if its economic activity is real estate, sec_6 is equal to 1 if its economic activity is renting of machinery and equipment without operator, research and development etc., sec_7 is equal to 1 if its economic activity is recreational and other service activities, sec_8 is equal to 1 if its economic activity is manufacturing, sec_9 is equal to 1 if its economic activity is construction, sec_{10} is equal to 1 if its economic activity is other land transport and activities of travel agencies, sec_{11} is equal to 1 if its economic activity is hospital activities, and 0 otherwise;
- emp_i represents the number of employees in firm i;
- leg_{li} represents a proxy for the legal form of firm i (l = 1,…,5) (with the base legal form of individual proprietor) where leg_1 is equal to 1 if the firm is a juristic partnership, leg_2 is equal to 1 if the firm is a limited company, or limited public company, leg_3 is equal to 1 if the firm is a government agency, or state enterprise, leg_4 is equal to 1 if the firm is a cooperative, and leg_5 is equal to 1 if the firm is another legal form, and 0 otherwise;
- eco_{ei} represents a proxy of economic form of firm i (e = 1,2) (with the base economic form of single unit) where eco_1 is equal to 1 if the firm is a head office, eco_2 is equal to 1 if the firm is a branch, and 0 otherwise;
- for_i represents a proxy for foreign equity share of firm i, where for_1 is equal to 1 if the firm has any level of foreign equity share, and 0 otherwise;
- its_i represents the share of IT-related employees in the total number of employees in firm i;
- con_i represents a proxy for Internet connectivity access type, where con_i is equal to 1 if the firm i has an "always-on" broadband Internet connection (via xDSL, cable modem, or leased line), and 0 otherwise.

4. EMPIRICAL RESULTS

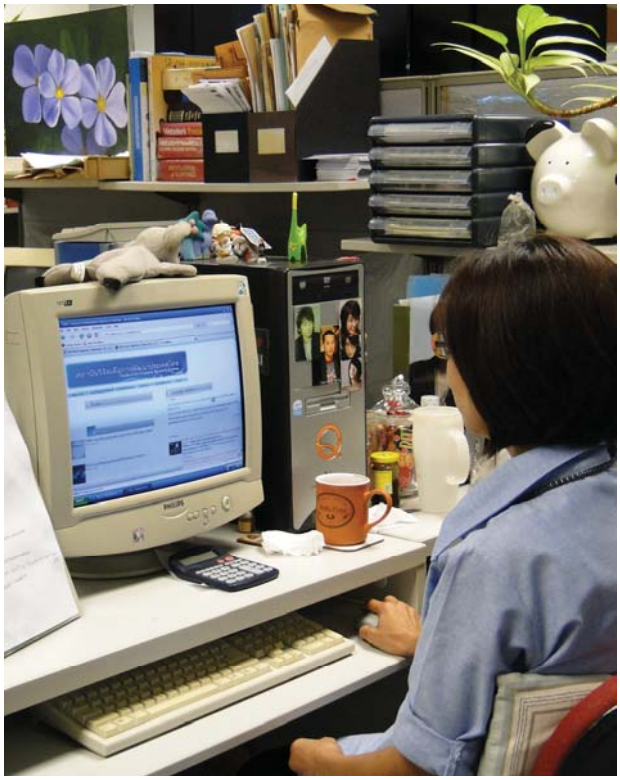
Table 2 shows the marginal effects on the ICT usage probabilities of each dependent variable in the logit model. The key results by which the explanatory variables are evaluated at the sample means are as follows: as expected, firms with a higher share of IT-related employees have higher probabilities of all types of ICT usage. This is because employees with ICT knowledge and skills are likely to facilitate the adoption of ICT among firms.

In respect of the relationship between ICT usage and foreign partnerships, firms with a foreign equity share tended to have higher probabilities of all types of ICT usage than those without. In other words, firms with a foreign equity share have increased probabilities of computer usage, Internet usage, and website presence by 4, 8, and 8 percent, respectively, in comparison with purely domestic firms. Similarly, firms with a foreign equity share showed increased probabilities of using e-commerce (i.e., selling, buying, making payments via the Internet, and using EDI) by 2-4 percent, compared with firms without such shareholders. This may be due to the fact that firms with foreign equity tended to have more international business and because conducting transactions with overseas partners via the Internet is cheaper than using traditional technologies such as telephone or facsimile.

Table 2 Marginal Effects in the Logit Model on Determinants of ICT Usage in All Firms

Variables		Computer usage	Internet usage	Website presence	Selling via Internet	Buying via Internet	Payment via Internet	Electronic data interchange usage
Total number of employees		0.0008***	0.0006***	0.0002***	0.000005*	0.000004	0.000004**	0.000011***
Share of foreign equity holding		0.0394***	0.0755***	0.0801***	0.031***	0.0372***	0.0249***	0.0276***
Share of information technology employees		0.0091***	0.0027***	0.002***	0.0004***	0.0005***	0.0002***	0.0001***
Legal form	Juristic partnership	0.0702***	0.0493***	0.3452***	0.1428***	0.2181***	0.0999***	0.0765***
	Limited company/ limited public company	0.1706***	0.0994***	0.3759***	0.1066***	0.1263***	0.053***	0.0516***
	Public sector/ state enterprise	0.0485***	0.0922***	0.5184***	0.0495	0.091***	0.023	0.2221***
	Cooperative	0.038***	-0.0552*	0.2006***	0.043	0.0076		
	Others	-0.0946***	0.0138	0.0817***	-0.0063	-0.0447***	-0.027***	0.0159
Economic form	Head office (headquarters)	0.0385***	0.0672***	0.1493***	0.0214***	0.0288***	0.0236***	0.0157***
	Branch	-0.0104**	0.0025	0.0872***	-0.0056	-0.0134***	-0.0057**	0.0102***
Location	Municipal area	0.029***	0.0313***	0.0078	0.0047	-0.0012	-0.0034	0.0002
Region	Central	-0.0044	-0.0211**	-0.0411***	-0.0024	0.0146***	0.0062	-0.006***
	North	-0.0067	0.0021	-0.0474***	0.0071	0.0522***	0.0386***	-0.0033
	Northeast	-0.0217***	-0.0428***	-0.0751***	-0.0059	0.0336***	0.0265***	-0.0023
	South	-0.0089	-0.025**	-0.0687***	0.0064	0.036***	0.0328***	-0.0013
Economic activity	Sale, maintenance and repair of motor vehicles and motorcycles	-0.3173**	-0.3598***	-0.129***	-0.0405***	0.0062	-0.0191***	0.0129
	Wholesale trade	-0.4345**	-0.3837***	-0.1299***	-0.0212***	-0.017*	-0.0222***	-0.0017
	Retail trade	-0.408**	-0.461***	-0.14***	-0.0336***	-0.0156*	-0.0165***	-0.0014
	Hotel and restaurant, food shop	-0.3871**	-0.515***	0.0889**	0.0521***	-0.022**	-0.0226***	-0.0022
	Real estate	-0.2099	-0.4825***	-0.0752**	-0.0324***	-0.0547***	-0.0269***	-0.0077
	Renting of machinery and equipment	-0.2166	-0.427***	-0.1081***	-0.0365***	-0.053***	-0.0222***	-0.008**
	Recreational and other service activities	-0.5103***	-0.5872***	-0.1025***	-0.0345***	-0.0532***	-0.0337***	-0.0093**
	Manufacturing	-0.2607***	-0.2822***	-0.156***	-0.0185*	-0.0501***	-0.0472***	-0.0023
	Construction	-0.4926***	-0.3347***	-0.167***	-0.0516***	-0.0507***	-0.0267***	-0.0122***
	Land transport and travel agency	-0.5766***	-0.4161***	-0.1123***	-0.0190**	-0.0472***	-0.0255***	0.0068
	Hospital	0.0051	-0.2279*	-0.0005	-0.0438***	-0.0391***	-0.0216***	-0.0019
"Always-on" Internet connection				0.1556***	0.0290***	0.0407***	0.0278***	0.0250***
Sample size		20,152	13,795	17,330	17,330	17,330	17,181	19,939
Mean predicted probability		.6845	.7954	.3043	.0916	.1122	.0614	.0517

Notes: ***, ** and * indicate statistical significance at the 1, 5 and 10 percent levels, respectively.



In terms of Internet connection types, firms with an "always-on" broadband connection had 16 and 3-4 percent higher probabilities of a website presence and using e-commerce than those without. The results are not surprising because the "always-on" broadband Internet connection is a key element to doing business online.

In considering the size of firms, those with more employees tended to use ICT more than firms with fewer employees. In terms of location, firms located in different places were likely to use ICT differently. Firms in municipal areas had about a 3 percent higher probability of using computers and the Internet than those in non-municipal areas. Similarly, firms in Bangkok were found more likely to have a higher probability of Internet usage, and website presence, but slightly lower probabilities of online buying and online payment than firms in provincial areas. This is probably a result of the differences in infrastructure, and their opportunities to access the market.

Our results also show that firms with different legal forms were likely to have different probabilities of ICT usage. In other words, firms set up under legal forms of juristic partnership and limited partnership, limited company, government agency or state enterprise, and cooperative had higher probabilities of computer usage than individual proprietors in a range between 4 and 17 percent.

With regard to economic forms, the headquarters of firms had higher probabilities of having a website presence (15%), using computers and the Internet (4% and 7%, respectively), and doing online business (about 2-3%) than single unit firms.

In terms of economic activities, firms in the computer and related sectors were likely to use ICT relatively more than firms in other sectors. In particular, the former had about a 23-59 percent higher probability of Internet usage than others. The former were also more likely to have had a website presence by 8-17 percent compared with other sectors, except for hotels and restaurants.

5. CHECKING ROBUSTNESS

Owing to the high variation in firm size, we needed to check the robustness of the results, particularly the effects of firm size on ICT usage. In order to check whether the results are sensitive to the size of a firm, the original sample was divided into two categories: SMEs and large firms.[5]

The estimation results of the marginal effects on the ICT usage probabilities of each dependent variable in the logistic model for SMEs and large firms are shown in Tables 3 and 4, respectively. The results for SMEs are quite consistent with those for large firms, in terms of the sign, but not the magnitude of the marginal effects. The main different results are as follows:

- The probability of SMEs using ICT increases significantly with their size, measured by the number of their employees. For example, an increase of 10 employees in an SME is likely to increase the probabilities of computer usage, Internet usage, and website presence by 5, 2, and 1 percent, respectively. Unlike SMEs, when large firms increase in size, their probability of using ICT increases only slightly. For example, an increase of 10 employees in large firms tends to increase Internet usage and website presence by a mere 0.1 percent;
- SMEs in a foreign partnership are more likely to use ICT than those without such a partnership. For example, SMEs with foreign partners have higher probabilities of computer usage, Internet usage, website presence, and e-commerce than SMEs without such partners by 11, 13, 8, and 1-2 percent, respectively. With regard to large firms, those in a foreign partnership tend to use the Internet and e-commerce 1 and 5-11 percent, respectively, more than those without such partners;
- SMEs established under the legal forms of juristic partnership and limited company/limited public company tend to use all types of ICT more than SMEs set up as an individual proprietorship, whereas large firms established under the legal forms of juristic partnership and limited company/limited public company are more likely to use computers and the Internet, and have a website presence than are large firms set up as an individual proprietorship;

Table 3 Marginal Effects in the Logit Model on Determinants of ICT Usage in SMEs

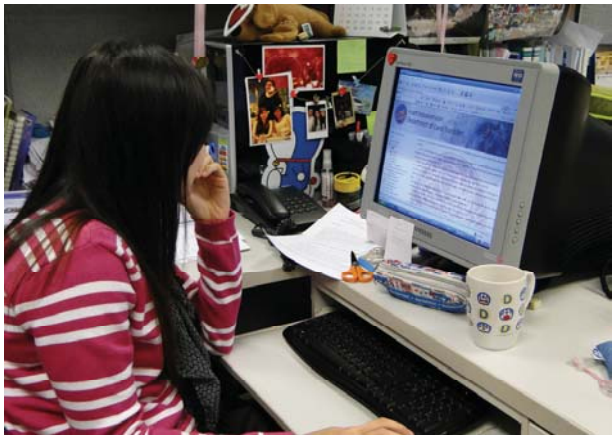
Variables		Computer usage	Internet usage	Website presence	Selling via Internet	Buying via Internet	Payment via Internet	Electronic data interchange usage
Total number of employees		0.0045***	0.0022***	0.001***	0.0002***	0.0002***	0.0001***	0.0001***
Share of foreign equity holding		0.1144***	0.1291***	0.0791***	0.0249***	0.0239***	0.0145***	0.0128***
Share of information technology employees		0.0233***	0.004***	0.0017***	0.0003***	0.0003***	0.0002***	0.0001***
Legal form	Juristic partnership	0.2108***	0.0672***	0.2489***	0.0937***	0.1525***	0.0634***	0.0335***
	Limited company/ limited public company	0.3462***	0.1247***	0.2691***	0.0842***	0.1042***	0.0368***	0.0245***
	Public sector/state enterprise	0.148***	0.1544***	0.4555***	-0.0115	0.0068	-0.003	0.148***
	Cooperative	0.134***	-0.0913**	0.1507**	0.0242	-0.0063		
	Others	-0.2443***	0.0186	0.0472**	-0.0035	-0.032***	-0.0218***	0.0024
Economic form	Head office (headquarters)	0.0984***	0.0848***	0.1024***	0.0125**	0.0197***	0.0137***	0.008***
	Branch	-0.0372***	0.0059	0.0579***	-0.0066**	-0.0113***	-0.0045**	0.0083***
Location	Municipal area	0.0849***	0.0641***	0.0109*	0.0082***	0.0018	-0.0018	0.0015
Region	Central	-0.012702	-0.029695**	-0.027912***	0.002904	0.01355**	0.002301	-0.002434
	North	-0.0223	0.0148	-0.0238**	0.0172***	0.049***	0.0242***	-0.0002
	Northeast	-0.0529***	-0.0516***	-0.0464***	0.0002	0.0281***	0.0159***	-0.0001
	South	-0.0211	-0.0338*	-0.0345***	0.0132**	0.0341***	0.0192***	0.0008
Economic activity	Sale, maintenance and repair of motor vehicles and motorcycles	-0.526***	-0.5276***	-0.0882***	-0.0308***	0.0013	-0.0145***	0.0017
	Wholesale trade	-0.621***	-0.5142***	-0.0937***	-0.0196***	-0.014**	-0.0162***	-0.0036
	Retail trade	-0.6132***	-0.5937***	-0.1031***	-0.029***	-0.0148**	-0.0138***	-0.0039*
	Hotel and restaurant, food shop	-0.6017***	-0.66***	-0.0033	-0.0033	-0.021***	-0.0199***	-0.0072***
	Real estate	-0.4077**	-0.6091***	-0.063***	-0.0284***	-0.0429***	-0.021***	-0.0065***
	Renting of machinery and equipment	-0.4075**	-0.5364***	-0.07***	-0.0295***	-0.0382***	-0.0153***	-0.0052***
	Recreational and other service activities	-0.6779***	-0.6766***	-0.0856***	-0.0305***	-0.041***	-0.0237***	-0.006***
	Manufacturing	-0.5581***	-0.4727***	-0.1502***	-0.0281***	-0.0504***	-0.0418***	-0.0095***
	Construction	-0.6569***	-0.4968***	-0.119***	-0.0394***	-0.0378***	-0.0195***	-0.0069***
	Land transport and travel agency	-0.684***	-0.5156***	-0.0782***	-0.0169***	-0.0337***	-0.0177***	0.0012
	Hospital	-0.0594	-0.5627***	-0.042	-0.0349***	-0.0296***	-0.0154***	-0.0057**
"Always-on" Internet connection				0.1135***	0.022***	0.0345***	0.0211***	0.0125***
Sample size		16,157	9,950	13,639	13,639	13,639	13,516	15,974
Mean predicted probability		.6158	.7469	.2214	.0710	.0917	.0467	.0278

Notes: ***, ** and * indicate statistical significance at the 1, 5 and 10 percent levels, respectively.

Table 4 Marginal Effects in the Logit Model on Determinants of ICT Usage in Large Firms

Variables		Computer usage	Internet usage	Website presence	Selling via Internet	Buying via Internet	Payment via Internet	Electronic data interchange usage
Total number of employees		-0.000005	0.000058***	0.000077***	-0.000002	-0.000001	0.000002	0.000032***
Share of foreign equity holding		0.009692	0.014208***	0.004202	0.046732***	0.073125***	0.06048***	0.105369***
Share of information technology employees			0.001765***	0.004591***	0.001858***	0.001647***	0.000996***	0.000867**
Legal form	Juristic partnership	0.044105***	0.018035***	0.184746***	0.064785	0.102449	0.098023	0.173003
	Limited company/ limited public company	0.103817***	0.028998*	0.349741***	0.02542	0.009859	0.042717	0.102154**
	Public sector/state enterprise	0.005791	0.005949	0.276593***	-0.023449	-0.028834	-0.006158	0.271173
	Cooperative	-0.050708	-0.006156	-0.058395	-0.05472	-0.100246**		
	Others	-0.122503**	0.001574	0.010368	-0.103277***	-0.150995***	-0.065023**	0.131585
Economic form	Head office (headquarters)	0.032831***	0.02806***	0.137455***	0.036996**	0.049143***	0.052003***	0.040702***
	Branch	0.01282	-0.000199	0.117461***	-0.005063	-0.028506*	-0.013653	0.018359
Location	Municipal area	0.006915	-0.00361	0.025042	-0.001774	-0.007187	-0.009541	-0.00502
Region	Central	-0.039916	-0.013077*	-0.100226***	-0.040288**	0.004157	0.022558	-0.059261***
	North	-0.068847	-0.020676*	-0.137109***	-0.037218**	0.055706*	0.11825***	-0.038667**
	Northeast	-0.131037	-0.047593**	-0.188851***	-0.040252**	0.04431	0.078139**	-0.035482**
	South	-0.16397	-0.018468	-0.217958***	-0.029144	0.03482	0.110381***	-0.027401
Economic activity	Sale, maintenance and repair of motor vehicles and motorcycles	-0.990162***	0.024152**	-0.280116*	-0.066525	0.081206	-0.017682	0.400405**
	Wholesale trade	-0.99066***	-0.007043	-0.21934	0.041936	0.00278	-0.035195	0.238909
	Retail trade	-0.999179***	-0.00916	-0.248942	0.0004	0.02425	0.000272	0.199473
	Hotel, restaurant, food shop	-0.986768***	0.017007	0.242107**	0.423932***	0.009049	-0.01933	0.264875
	Real estate		0.020504	-0.05379	0.023029	-0.07015	-0.018863	0.182481
	Renting of machinery and equipment	-0.992811***	-0.018514	-0.275718*	-0.028508	-0.11726***	-0.049676	0.088887
	Recreational and other services	-0.991614***	-0.019375	-0.112108	0.000323	-0.092722**	-0.089243***	0.023445
	Manufacturing	-0.997379***	0.021594	-0.137151	0.085644	-0.021779	-0.055039	0.204279*
	Construction		0.016727	-0.33122**	-0.106781***	-0.102346**	-0.054429*	0.013328
	Land transport and travel agency	-0.98884***	-0.014058	-0.222383	0.038725	-0.1046***	-0.060417**	0.257578
	Hospital		0.046782***	0.003869	-0.083091*	-0.081064	-0.047317	0.215214
"Always-on" Internet connection				0.151091***	0.029978**	0.0328**	0.039617***	0.074818***
Sample size		1,327	3,845	3,691	3,691	3,691	3,665	3,965
Mean predicted probability		.8870	.9209	.6104	.1674	.1878	.1157	.1480

Notes: *** Statistical significance at 1 percent, ** statistical significance at 5 percent, * statistical significance at 10 percent.



- Location does matter with regard to the adoption of ICT among SMEs. In particular, SMEs located in municipal areas are more likely to use computers and the Internet than those in non-municipal areas. In contrast, for large firms, their location is not related to their ICT usage;
- SMEs in the computer and related sector have about a 41-68 percent higher probability of computer usage than those in other sectors, such as wholesale trade, retail trade, hotel business, manufacturing, construction, land transport, and travel agency work. For large firms, the probability of computer usage among those in the computer and related sector is more than 99 percent, compared with firms in other sectors;
- Large firms have higher mean predicted probabilities of ICT usage than SMEs. For example, the mean predicted probabilities of computer usage and Internet usage of large firms are 0.89 and 0.92, respectively, while those of SMEs are 0.62 and 0.75.

6. SUMMARY AND POLICY IMPLICATIONS

Our analysis shows that the probability of a firm using ICT increases with its size, measured by the number of its employees. We also found that firms in municipal areas were more likely to use ICT than those outside the municipal areas, and that those in Bangkok were more likely to use ICT than those in provincial areas.

Based on the analysis, we recommend that the government encourage local firms, especially SMEs and those located in provincial and rural areas, to make greater use of ICT in order to increase their productivity.

In addition, our results showed that firms with a higher share of IT employees among their total staff were more likely to use ICT. Accordingly, the government should promote the acquisition among the Thai labor forces of IT skills through formal and informal education and training. Possible promotional measures include increasing the availability of loans to IT students and encouraging firms to train their employees by granting them tax incentives.

Our analysis also suggests that firms with an "always-on" broadband Internet connection were 3-16 percent more likely to conduct online business than those without such a connection. Thus, the government should promote broadband Internet usage by ensuring free and fair competition in the broadband Internet market. It is advisable that the telecommunications market should be liberalized and properly regulated.

In addition, the government should support the linkage between domestic firms and their foreign partners. Our analysis shows that firms with the participation of foreign capital tended to have a higher probability of using ICT, especially the Internet.

There are other obstacles to ICT usage that need to be addressed. We found that more than 70 percent of firms that did not use ICT believe that ICT is unnecessary for their business. This may suggest that ICT usage is really unsuitable to their business models or that they underestimate the potential of ICT owing to a lack of knowledge. If the latter is true, campaigns to raise awareness of the potential of ICT are likely to be a good policy measure.

Finally, it should be mentioned that some firms are worried about the problem of security in conducting Internet transactions. Thus, a policy to set up the necessary legal framework for secured electronic transactions is needed in order to boost the confidence of firms and consumers.

ENDNOTES

[1] For more examples of studies on positive impacts of ICT at the firm level, see Doms et al. (1997), Stolarick (1999), and Milana and Zeli (2001). Early empirical studies on ICT, productivity and firm performance found mostly negative or no effects of ICT on productivity. This is the so-called "productivity paradox." However, since the late 1990s, there has been much more evidence to support the impacts of ICT on productivity, which suggests that the productivity paradox has been solved.

[2] The Thailand ICT Master Plans consist of the first ICT Master Plan (2002-2006) and the second ICT Master Plan (2009-2013).

[3] Although NSO has conducted its enterprise survey annually since 2004, only cross-section, not panel, data are available. If panel data were available, firm dynamics could be analyzed. Then, the data sets would be more useful.

[4] Following the definition of Thai SMEs by the Ministry of Industry introduced on September 11,

2002, in terms of the number of salaried workers, SMEs refer to a firm with fewer than or equal to 200 employees in the manufacturing sector, fewer than or equal to 50 employees in the service sector and the wholesale trade sector, and fewer than or equal to 30 employees in the retail trade sector.

[5] Firms are defined as small and medium-sized if the number of employees is fewer than or equal to 200, 50, and 30 in the manufacturing sector, the service and the wholesale sectors, and the retail sector, respectively.

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