

ICT and Firm-Level Performance in Thailand: Findings of the Productivity and Investment Climate Survey

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Abstract

This paper investigates the relationship between ICT and firm performance. While the hype concerning the “New Economy” has largely subsided, the evidence concerning the economic impact of ICT has strengthened, largely through the use of firm-level data that empirically demonstrates a strong relationship between information and communication technology (ICT) and measures of firm performance, including total factor productivity. It draws on the Productivity and Investment Climate Survey (PICS) of 1,385 firms conducted from early 2004 to early 2005 by the Royal Thai Government and World Bank. Based on existing literature, this paper, extracted from the larger Investment Climate Assessment conjectures that ICT Impacts firm performance through three main channels: skills, innovation and networking (1) Telecommunication investments influence the creation of new products and/or processes by making information about market preferences more available to the firm and reducing the time it takes to covert knowledge of consumer preferences to products. (2) ICT enables networking, which reduces search, contracting and coordination costs. (3) ICT can enable firms to participate in regional and global production networks.

PICS data for Thailand suggest that ICT use is strongly correlated with innovation,

even when controlling for firm size, exporters, foreign ownership, and industry. Those firms who used email were far more likely to spend on R&D, introduce new products, markets and technologies. Firms that had a website were far more likely to enter new markets, file patents and introduce new technologies. However, the skills and networking channels have not appeared to increase firm-level performance. The paper explores some of the possible causes and raises some potential recommendations on ways to overcome these barriers.

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¹ This paper is drawn from the upcoming Thailand Investment Climate Assessment, a joint publication of the World Bank and the National Economic and Social Development Board.

International studies in the first half of the 1990s failed to distinguish the impact of ICT on productivity growth at the national level, due to limitations of growth accounting techniques. More recent studies have determined, over a fairly wide range of countries at different levels of development, that ICT diffusion has contributed significantly to GDP growth and productivity growth. In the United States, the evidence suggests that the doubling of labor productivity growth from 1.3 percent from 1973 to 1995 to 2.5 percent in the second half of the decade, while falling over the same period in Europe, was largely attributable to the faster diffusion of ICT in the US relative to Europe.² This holds both for manufacturing and services. Triplett and Bosworth found that ICT contributed to labor productivity growth broadly across most service industries due to capital deepening, but that much of the productivity impact had already been captured before 1995 and was therefore less pronounced during the post-1995 increases.³ Building to an extent on Bosworth, van Ark and Timmer (2003) found that productivity gains are highly sector-specific.

This paper conjectures that ICT Impacts firm performance through three main channels: skills, innovation and networking. To test these relationships, the paper uses data from the Productivity and Investment Climate Survey (PICS) of 1,385 firms conducted 2004 to 2005.

² Timmer, M.P, G. Ypma and B. van Ark "IT in the European Union: Driving Productivity Divergence?" Reserch Memorandum GD-67, "Groningen Growth and Development Center. October 2003.

³ Jack E. Triplett and Barry P. Bosworth, "Productivity Measurement Issues in Services Industries: "Baumol's Disease" Has Been Cured" Federal Reserve Bank of New York Economic Policy Review, September 2003.

Studies have identified a close relationship between ICT use and labor productivity growth in Germany, Netherlands, Canada and Australia.⁴ Countries with a high share of skilled ICT workers in the workforce had higher investment in ICT than other countries. Bechetti, et. al (2003) found that the contribution of ICT to productivity growth is better understood by decomposing it into software and telecommunications. Software investment increases demand for skilled workers thereby altering the skill mix in firms in favor of higher labor productivity (learning gains).

The literature suggests that ICT investments- particularly those that facilitate sharing of information – increase the ability firms to innovate. Telecommunication investments influence the creation of new products and/or processes by making information about market preferences more available to the firm and reducing the time it takes to covert knowledge of consumer preferences to products.¹ Innovation – creating new products, entering new markets, or introducing new technologies – can raise productivity levels by (a) better serving customer's needs, therefore enabling higher prices, which raises the ratio of output to inputs; (b) introducing processes that reduce input costs, such as systems that reduce the cost of quality defects.

ICT enables networking, which reduces search, contracting and coordination costs. Information and communication technology are being increasingly applied to integration and optimization of material, information and financial flows between a particular type of network – a supply chain.⁵

⁴ OECD (2003)

⁵ Supply chains include parts suppliers, manufacturers, distributors, logistics service providers, wholesalers and retailers engaged in the delivery of a particular product or service.

Traditional inter- and intra-firm manual or semi-automated processes are replaced by partnership networks enabled by sharing of information, processes, decisions and resources. The key to effective supply chain management is transparency, to enable information to substitute for inventory stocking as a hedge against volatility.⁶ By sharing inventory and sales information levels across a supply chain, each participant is able to lower inventories to levels required to fulfil immediate orders, and to have the basis for anticipating demand based on the flow of orders through the supply chain. Anticipating demand enables more efficient production scheduling to minimize switchover costs, and better manage human resources and equipment.

ICT can enable firms to participate in regional and global production networks. Yusuf (2003) claimed that the future of the East Asia region is “linked inexorably with its ability to ensure that ICT is mastered by and readily accessible to the broad mass of the population... For East Asian firms in the highly competitive export industries that supply the bulk of the region’s income, profits are frequently a function of membership in international networks that depend on ICT-based products and use ICT to coordinate production, expedite delivery and embark on collaborative design and research. Firms, regions and economies that lag in their adoption of ICT will certainly find their competitive position eroded.”⁷

The key question, for Thai policy makers, is to make policy choices that maximize the potential gains through these channels.

This requires first an understanding of the extent to which the relationship between ICT and performance has taken place in Thailand. Has ICT investment increased firm performance; and more specifically, through increased skills, innovation or networking? To the extent that patterns observed in more advanced countries are not taking place in Thailand, understanding the likely causes can contribute to policy formulation.

The PICS Results on ICT use and Productivity

The PICS results suggest a positive and significant role of ICT use on firm performance. Controlling only for industry and region, email and website use is strongly correlated with higher TFP (See Column 1). However, when establishment characteristics including size, export status, ownership, industrial estates, technology measures, and establishment age are added to the model, only website use remains statistically significant. (See Column 2) In the full model with controls for establishment characteristics, industry, and region as well as firm-specific technological capabilities, website use remains statistically significant. Website use is associated with a 9.5 percent higher TFP on average. (See Column 3⁸)

⁶ “Information Sharing in a Supply Chain,” Hau L. Lee and Seungjin Whang, *Research Paper Series No. 1549*, Graduate School of Business, Stanford University.

⁷ Shahid Yusuf, *Innovative East Asia: The Future of Growth*. World Bank (2003).

⁸ Percentage increase in wages associated with a dummy variable coefficient is calculated as $\exp(\beta) - 1$.

Table 1 TFP Regressions

	()	()	()
	(7)3)	(7)3)	(7)3)
8 VHF P DQCLQMDIFWRQZLVKFOHQWQGVSSQHLV	. (.) ***	-. (.) ***	-. (.) **
8 VHZ HEVMIQQMIDFWRQZLVKFOHQWQGVSSQHLV	(.)	(.) ***	(.) ***
/ DJH	-	. (.) ***	. (.) ***
(LSRUWFU	-	. (.) ***	. (.) ***
)RUHQ	-	. (.) ***	. (.) ***
QGXVWUQ WVMH	-	. (.) *	. (.) **
,PSRUWGI HZ O DFKIQHV	-	. (.) ***	. (.) **
IURP ' HMYRSHG&RXQW	-	(.)	(.)
&DSLWQ IQWJ H	-	(.) ***	(.) ***
\$ JH	-	. (.) ***	. (.) ***
&RQWQW	. (.) ***	. (.) ***	. (.) ***
7&.	1 R	1 R	<HV
QGXVWU	< HV	< HV	< HV
5 H LRO	< HV	< HV	< HV
2 E V H U D W R Q V	.	.	.
\$ G M V M G 5 - V I X D L H G	.	.	.

IR W :7&, IQFOCH YELIDGMFDNGAVIIP -CHFOFKQRJ IELDSDIOMEV . GH7 DEGI . . IQMHS QQH W&KDSWU .
 SREXVWQEDIGHIRUQSDIFQWFMV .
 * VLIQLHQW % ; ** VLIQLHQW % ; *** VLIQLHQW %
 GRXUFB : 7KLDQDQ3URGNWYLV DQG QYHWV HQMDP DMSXYH . \$ XWRUFDUOXDWRQV

ICT, Skills and Performance

The data strongly suggest that ICT adoption increases demand for higher skills, but does not suggest that this has resulted in productivity gains. First, it is clear that inadequate ICT skills impacts firm performance. 45% of manufacturing firms rated the IT skills of their skilled production workers as “very poor”. “Very poor” IT skills are significantly correlated with lower

TFP; and this negative correlation between “very poor” IT skills and TFP is mainly seen in establishments producing machinery and equipment. Second, it is clear from the PICS that firms perceive the lack of knowledge and availability of trained ICT personnel and the lack of experienced consultants to provide or design ICT based solutions as important or critically important constraints for introducing or expanding ICT use.

Table 2 Constraints to introducing or expanding IT use considered “important” or “very important”

Constraints	Small	Medium	Large
High cost of IT equipment and maintenance	20%	18%	18%
Lack of knowledge and trained IT personnel	42%	35%	33%
Low returns to investments in IT	15%	12%	11%
Lack of consultants on IT-based solution systems	39%	37%	32%
IT-based systems do not improve productivity	20%	13%	13%

Source: Investment Climate Survey (2004), World Bank

ICT and Innovation

The literature suggests that ICT investments- particularly those that facilitate sharing of information – increase the ability of Thai firms to raise their productivity levels through innovation.

Innovation – creating new products, entering new markets, or introducing new technologies – can raise productivity levels by (a) better serving customer's needs, therefore enabling higher prices, which raises the ratio of output to inputs; (b) introducing processes that reduce input costs (such as introduction of systems that reduce the cost of quality defects).

The PICS data suggest that increasing ICT use on the margin increases the probability of innovation, even when controlling for firm characteristics such as size, exporters, foreign ownership, and industry. Those firms who used email were more likely to spend on R&D, introduce new products, markets and technologies. Firms that had a website were more likely to enter new markets, file patents and introduce new technologies.

ICT and Networked Production

The PICS did not appear to suggest a strong correlation between ICT use and participation in such networks. There appears to be no correlation between what we traditionally understand as regional production networks – automotive and electronics – and increased electronic sales. However, these two sectors clearly use email and internet more than other sectors.

The study finds that the Internet is used mostly for basic intra-firm and inter-firm communications. Impact of e-commerce on productivity and sales growth is therefore yet to be seen. If this is the case for Thailand, further studies are necessary to identify the specific constraints firms face in adopting e-commerce, whether domestic or international. PICS data also show that currently, firms only use websites (21% of firms) to advertise their products only as much as they advertise through the media (21% of firms) and exhibitions (23% of firms). The findings of an OECD country survey (2004) confirm that most SMEs do not adopt e-commerce, if the benefits do not outweigh the costs of systems development and maintenance.

Table 3 ICT and Innovation

Regressors	R&D Spending Dummy	New Products Dummy	Entry into New Markets Dummy	Patent Filing Dummy	New Product Line Dummy	Product Line Upgrade Dummy	New Technology Introduction Dummy
Email Dummy	0.089*** (0.025)	0.129*** (0.031)	0.100*** (0.032)	0.004 (0.019)	0.124*** (0.033)	0.103*** (0.029)	0.103*** (0.034)
Website Dummy	0.039 (0.026)	0.055* (0.032)	0.100*** (0.033)	0.041** (0.019)	0.018 (0.035)	0.041 (0.031)	0.072** (0.035)
Current Employment	0.069*** (0.010)	0.032*** (0.012)	0.048*** (0.013)	0.017** (0.007)	0.080*** (0.013)	0.081*** (0.012)	0.123*** (0.014)
Export Intensity	0.039 (0.027)	-0.041 (0.033)	-0.01 (0.034)	0.020 (0.019)	-0.012 (0.035)	-0.009 (0.031)	-0.028 (0.036)
Foreign Ownership Share	-0.04 (0.027)	0.054 (0.036)	0.001 (0.037)	(0.004) (0.019)	0.065* (0.038)	0.015 (0.034)	0.034 (0.038)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1033	1033	1033	1033	1033	1033	1033

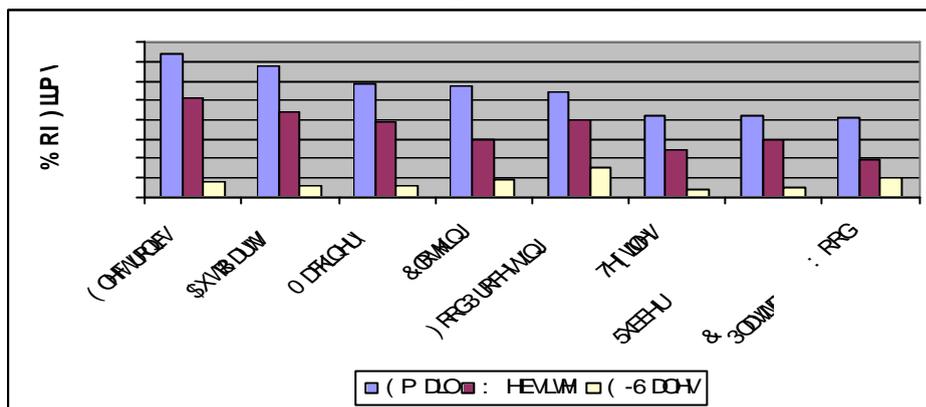
Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

The PICS findings are consistent with other observations of Thailand's performance. Wiboonchutikula (2002) found that SMEs have more subcontracting work than large firms, and that subcontracting represented 3.3, 2.8, and 1.4% of sales for small, medium and large firms respectively.ⁱⁱⁱ

Subcontracted work is most concentrated in clothing, wood, plastic, mineral, automotive and non-electrical machinery. Few SMEs have taken the further step of integrating ICT into their business operations or engaged in e-commerce.

Figure 1 ICT use by Sector



Conclusions and Implications

ICT is associated with increasing firm performance in Thailand. However, the strongest relationship contributing to this impact observed through the PICS is through innovation. The two other expected means for improving firm-level performance – skills and interfirm networking - do not seem to be key means by which ICT contributes to firm-level performance. This suggests a strategy that (a) closes the human capital gap so that skill development can contribute to productivity gains, (b) building on the observed relationship between ICT and innovation; and (c) removing constraints to the use of ICT for networked production.

Closing the human capital gap. Effective ICT is closely related to the quality and quantity of human capital. Both in the Government and outside the government, project manager skills are lacking, as well as programmers in key skill areas. Liberalizing the hiring of foreign ICT professionals is a

useful first step, but in the long run there will need to be a much higher volume of skilled managers. Scale up project manager training involves a combination of technical and managerial capacity building. Digital literacy and technical and management skills are key issues for ICT diffusion. Public and private sector programs are addressing this gap. Software Park Thailand has continuously offered courses and services to develop ICT skilled manpower. CISCO Systems (the leading global provider of routers and other network technology), has an Internet Engineering Support program which trains internet service providers on use of CISCO equipment, and Sun Microsystems and IBM have affiliate programs with Chulalongkorn University. Moreover, with English still the dominant language of the internet, English language and IT skills provision should be fostered in the education system, including vocational training. The role of the private sector in providing IT skills training in countries like India has been critical in supplying relevant skills.

Strengthening Innovation. Since the “innovation channel” appears to be working for firms in Thailand, it would be useful to focus content and human capital development on the use of information to improve products and processes. In pursuing application of ICT, it is important to avoid a technologically deterministic view of what creates innovation. Adding computer-aided design to a firm that lacks the capacity to innovate will not create gains. Innovation is created by high quality human capital and research on the one hand, and intense competition on the other. ICT impacts product innovation by allowing firms to better understand markets. ICT impacts process innovation by supporting organizational improvement efforts aimed at more flexible production, lowering the cost of retooling to achieve the quality and cost requirements of customers. Since many Thai firms are exporters, a dynamic understanding of foreign markets, including evolving trends in customer behavior, must be built on an understanding of market strategy, data mining, and the languages of the customers in target markets – whether they be in China, Italy or the US.

Liberalizing telecommunications markets. The issue of scaling up and mainstreaming technology will ultimately be solved by markets. Markets work best when impediments to competition are removed, when there is regulatory certainty, predictability and flexibility. This is not yet the case for telecommunications markets in Thailand. Poor telecommunications sector performance has resulted in lower quality and higher costs for telecommunication services. Businesses in Thailand, had to wait an average of 22.3 days to obtain a telephone connection, compared to 8.8 days, 13.2 days and 12.5 days in Malaysia, the Philippines and China respectively. Moreover, foreign equity participation limits in the sector capped at 49% have deterred

growth by almost 25% and impacted direct prices by almost 26%⁹. The cost of business telephone connections, monthly subscription costs and broadband are also comparatively higher in Thailand. ICS data analysis¹⁰ shows that the quality and cost of telecommunications infrastructure affects ICT use by firms, with firms more likely to use ICT, when the quality of services is better. Affordable broadband services, provides firms, especially SMEs with the advantage of access to high speed communications and the ability to reach a global marketplace, previously available only to large firms. However, the vast majority of telephone access in Thailand is mobile, and 80% of this is through pre-paid phone cards.

A policy priority is to improve the quality and availability of critical information and communications infrastructure. A key bottleneck to infrastructure development has been limited telecommunications sector reforms. The November 2004 appointment of Commissioners to the National Telecommunications Commission (NTC) was a first step towards undertaking much needed telecom sector reforms. With the establishment of NTC, it is now important to implement reforms that unleash further competition in the telecommunications sector. Priorities include: (i) resolving the issues that exist between the state owned telecommunication operators, TOT and CAT, and private sector players, by converting the current concession contracts into licenses that allow all operators to operate on a level playing field; (ii) completing the planned privatization of TOT Corporation and CAT Telecom; (iii) implementing a fair pro-competitive interconnection regime; (iv) allowing for

⁹ Cost of Services Trade Restrictions in Thailand, World Bank , 2004

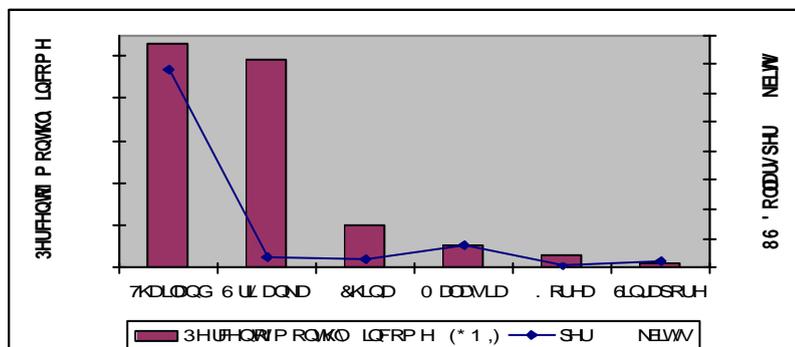
¹⁰ The Role of ICT in Doing Business, (Working Paper - Qiang, Clarke, Halewood and ,Gomez, 2005)

competitive new entry in the international long distance segment and VOIP services; and (v) removing licensing requirements for the entry of new ISPs in the market.

Development of standards and government-wide information architecture. Architecture allows systems serving different functions to exchange information. Standards are critical to Thailand's success in ICT diffusion, as they allow systems serving different purposes or from different vendors to work together, thereby enhancing network effects and reducing risk. The importance of these network effects create a special type of public good – an interoperable architecture. To facilitate e-commerce, standards are being defined in such areas as data interchange, electronic payments, security, and networking. The first step in defining architecture – taking stock of where the Government is today technologically, has been completed. The next step is to leverage industry efforts to categorize electronically-transmitted data over the internet, so that standard web browsers can replace proprietary hardware or software. Second, Extensible Markup Language (XML) standards have been diffused to such an extent that communications platforms are interoperable.

Support services. Networked firms require complementary investments to make networking valuable. Whereas the international community is benefiting from these developments, Thailand has an underdeveloped third-party intermodal logistics industry. Shipments are not traceable through intermodal systems (involving transfers between modes of transport, such as rail-truck-sea) due in part to the relative underinvestment in the public rail system and other transport segments. Third party logistics exists only on a limited basis for export shipments. In addition to logistics, financial settlement systems must adapt to the new environment. In Thailand, there is little available on-line credit, and there are high deposit requirements (Bt 500,000) to initiate on-line account, and there are no electronic settlement mechanisms. Business-to-business e-payments require guaranteed funds, speed, low fees, and effective settlement mechanisms. The recent Ict logistics guidelines produced by Kasetsart University can provide a valuable contribution in this respect.

Figure 2: Broadband prices per month, 2003
Source: ITU (2003)



Applying e-Learning

A focus on human capital. The central focus of e-learning is human capital development. Simply scaling up the number of skilled, English-speaking workers will help alleviate the main constraint identified by firms wishing to use ICT – the lack of appropriately skilled staff. Again, it is important not to confuse technology with pedagogy, which must always remain the primary consideration. However, it is clear that the ability to ICT to create customized, individualized learning programs can enable realization of some of Thailand's education sector strategies.

A focus on innovation content. E-learning can be used as a delivery mechanism effectively to support both product and process innovation. This may include the creation of ICT platforms geared towards new processes and technologies for production chains, logistics management and customer relationship management for SMEs. Development of innovation platforms can be usefully pursued on a collaborative basis with the private sector, through such organizations as the Software Industry Promotion Agency, NECTEC, and the private sector through the Federation of Thai Industry. Many organizations in Thailand focus on productivity improvements at the factory level and could be brought to bear on such an effort.

ⁱⁱⁱ “Small and Medium Sized Firms in Thailand: Recent Trends.” Small Firm Dynamism in East Asia. Iqbal and Urata, Kluwer (2002)

ⁱ Leonardo Becchetti, et.al, “Invest investment, productivity and efficiencies: evidence at firm level using a stochastic frontier approach.” Centre for International Studies on economic Growth. Working Paper No 29,

ⁱⁱ “Small and Medium Sized Firms in Thailand: Recent Trends.” Small Firm Dynamism in East Asia. Iqbal and Urata, Kluwer (2002)