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ICT and Economic Development: Conclusion from IO Analysis for Selected ASEAN Member States

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Summary: The impact of information and communications technology (ICT) on economic performance has been an interesting issue in economics. There are at least three key points that can be learnt from the previous literatures regarding ICT and country's economic performance. First, more developed countries are expected to benefit greater than less developed countries. Second, the impact of ICT will depend on the intensity of ICT utilization. Third, the size and structure of ICT sector of country's economy does matter. The main contribution of this paper is to evaluate those three points by conducting comparative analysis based on Input-Output (I-O) Table from four ASEAN Member States, namely Indonesia, Singapore, Malaysia and Thailand. ASEAN is used because it is one of the regional associations that have a large income gap among its members. The results suggest that more developed countries (which are measured by income per capita) do not always benefit greater than less developed countries from ICT development. The magnitude of ICT impact on the economy depends on the intensity of ICT utilization and the structure of ICT sector.

Zusammenfassung: Die Auswirkung der Informations- und Kommunikationstechnik (IKT) auf die wirtschaftliche Performance ist ein interessantes Thema in der Wirtschaft. Es können mindestens drei wichtige Aspekte genannt werden, die aus der bisherigen Literatur bezüglich der IKT und der Wirtschaftsperformance des Landes entnommen werden können. Erstens erwartet man, dass höher entwickelte Länder mehr profitieren als weniger entwickelte Länder. Zweitens hängt die Auswirkung der IKT von der Intensität der IKT-Nutzung ab. Drittens sind die Größe und die Struktur des IKT-Sektors der Wirtschaft eines Landes ein weiterer wichtiger Aspekt. Der Hauptbeitrag dieses Papers besteht darin, diese drei Aspekte mit Hilfe einer vergleichenden Analyse auszuwerten, die auf Input-Output-Tabellen der ASEAN-Mitgliedstaaten Indonesien, Singapur, Malaysia und Thailand beruht. Es wird ASEAN verwendet, da dieser Verband eine große Einkommensgefälle/-lücke unter seinen Mitgliedern aufweist. Die Ergebnisse weisen darauf hin, dass höher entwickelte Länder (gemessen am Pro-Kopf-Einkommen) nicht immer einen größeren Profit als weniger entwickelte Länder aus der IKT-Entwicklung ziehen. Das Ausmaß der IKT-Auswirkung auf die Wirtschaft hängt von der Intensität der IKT-Nutzung und der Struktur des IKT-Sektors ab.

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1. Introduction

A large number of studies analyze the role of information and communications technology (ICT) in the economy. Jorgenson and Stiroh (2000) argue that the impressive performance of US economy in the late 1990s was mainly contributed by the rapid increase in capital accumulation, hours worked and total factor productivity. Furthermore, they also found that ICT was the main driver of the rapid growth on US total factor productivity. According to Welfens (2008), the expansion of ICT could affect the productivity growth through some channels, namely: product and process innovation, trade, capital (ICT is also known as "special" form of capital), and the faster diffusion of knowledge.

The positive impact of ICT on productivity growth and economic growth was also supported by many other empirical studies. Colecchia and Schreyer (2002) found that the impact of ICT on output growth was not only positive but also increased over time in eight OECD countries[1]. Venturini (2009) reassessed the impact of ICT on US and EU-15 economy by using long-run perspective and found similar positive result. Seo et.al (2009) also found a positive correlation between ICT investment and economic growth in 29 countries[2]. Moreover, they also found that ICT investment expected to widen economic growth gap between countries. Cortez and Navarro (2011) conducted detail analysis regarding the impact of ICT on economic development by firstly clustering countries based on level of ICT implementation. The results suggest that the level of ICT implementation mattered on countries' economic performance especially on productivity and human development. Some other supporting empirical evidences can also be found in Bakhshi and Larsen (2005); Jalava and Pohjola (2007); Vu (2011); Ahmed and Ridzuan (2012).

Even though many researchers have no doubt about the importance of ICT in the economy, they also noticed that the magnitude of the positive impact of ICT differed across countries. The OECD Report (2004) "ICTs and Economic Growth in Developing Countries" provides a comparative analysis of ICT's role on economic growth in OECD countries, developing countries and LDCs. The results suggest that developing countries and LDCs benefited less than developed countries from the development of ICT due to two main reasons, namely economic structure and policy issues. These two factors were also emphasized as the possible aspects that could explain why the impact of ICT differed across countries in some other studies (Gruber and Verboven, 2001; Daveri, 2002; Bassanini and Scarpetta, 2002; Jalava and Pohjola, 2002).

There are at least three key points that can be learnt from the previous findings regarding ICT and country's economic performance. First, more developed countries are expected to benefit greater than less developed countries. Second, the impact of ICT will depend on the intensity of ICT utilization. Third, the size and structure of ICT sector of country's economy does matter. The main contribution of this paper is to evaluate those three points by conducting comparative analysis based on Input-Output (I-O) Table from four ASEAN[3]

[1] Australia, Canada, Finland, France, Germany, Italy, Japan, and the United Kingdom

[2] Eleven OECD countries plus Argentina, China, Columbia, Egypt, India, Indonesia, Thailand and Venezuela.

[3] Association of Southeast Asia Nations (ASEAN) consists of 10 countries: Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myammar, the Philippines, Singapore, Thailand, and Vietnam.

Member States, namely Indonesia, Singapore, Malaysia and Thailand. Moreover, an analysis of ICT issue in ASEAN countries is rarely found. Thus, this paper will also contribute to fill the gap.

Up to now, I-O analysis has been used by only few studies to analyze ICT issues. Rohman (2012) analyzed the ICT sectors in European countries by comparing multiplier effect of the ICT sector across period. He found the decline in the multiplier effect and output of ICT sectors during the period 2000-2005. However, the decline in the multiplier effect and output of ICT sectors might be subject to the characteristic of price dynamics in ICT sector. Welfens (2011) stated that the relative ICT price tends to decline. Thus, the nominal share of ICT sector in total national output might be undervalued.

This paper compares not only the size of ICT sector but also the structure of input and output of ICT sector. Firstly, aggregation and disaggregation of sectors is conducted in order to introduce ICT manufacturing sector and ICT services sector. Instead of using the detailed ICT sub-sectors, this paper defines only two ICT sectors since each observed IO Table has a different coverage in terms of sectors. Then, some indicators are calculated based on I-O Table; hence output multiplier, income multiplier, forward linkage and backward linkage. Lastly, the paper employs biplot analysis on those four indicators in order to analyze how ICT sector differ from other sectors in each observed country.

Subsequent to this introductory section, Section II presents the theoretical framework on ICT and Economic Performance. In Section III, there is an explanation of the data and methodology. Section IV presents the development of regional cooperation on ICT sector in ASEAN. The results and discussion are provided in Section V. The final section presents concluding remarks.

2. ICT and Economic Performance

Economists had analyzed the correlation between ICT development and economic performance particularly on the impact of ICT on economic growth. Theoretically, the analysis is usually started by using a simple Cobb Douglas production function. In many economic textbook, a Cobb Douglas production function is defined as:

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha} \qquad 0 < \alpha < 1 \qquad \text{(i)}$$

where Y represents the output; A represents the level of technology; L represents labor, and K represents capital. Nonneman and Vanhoudt (1993) expanded the model by introducing several types of capital. Some examples of types of capital are infrastructure, equipment, other physical capital, human capital, technological know-how, etc. The modified Cobb Douglas production functions after introducing m-types of capital, hence:

$$Y_t = A_t L_t^{\left(1-\sum_{i=1}^{m}\alpha_i\right)} K_{1t}^{\alpha_1} \ldots K_{mt}^{\alpha_m} \qquad \text{(ii)}$$

Technological know-how is treated as particular of capital in the production (Nonneman and Vanhoudt, 1993). The model has no presumption of externalities, spillover, imperfect

competition and increasing return in technology. However, it assumes that technological know-how has a well-functioning market. The similar approach is also used by Welfens (2008) and Moradi and Kebryaee (2010). Welfens (2008) used two types of capital, namely ICT capital and non ICT capital. Welfens (2008) argues that the high growth rate of ICT capital per labor will increase output per capita. Moreover, the ratio of ICT capital per labor might have a positive impact on the output elasticity (α). This is also known as the spill-over effect. Moradi and Kebryaee (2010) introduced three types of capital, hence physical capital, human capital and ICT capital. It is basically similar with Nonneman and Vanhoudt (1993) which also defined three types of capital, namely physical capital, human capital and technological know-how.

Aghion and Howitt (1992) used different framework to analyze the impact of innovation on economic growth. They employed a neo-Schumpeterian growth model and treated innovation as one type of inputs in the production process. If we assume ICT is one type of innovation, we should treat ICT as a new intermediate input. A new intermediate input will result more efficient method in the production process. Thus, the utilization of ICT will increase productivity by the factor δ, hence:

$$A_t = A_0 \delta^i \qquad \delta > 1 \qquad \text{(iii)}$$

Where A_0 represents the productivity before the utilization of ICT and A_t represents the productivity after the utilization of ICT.

3. Data and Methodology

Input-Output (I-O) Tables that are used in this study were collected from National Statistical Office[4] in each observed country for the period 2005. Those I-O Tables are produced by using the same concepts and definitions based on the United Nation System of National Accounts (UN SNA). However, each country has different focus in terms of sectors. The most detail published I-O Table for Indonesia consists of 175 sectors. Meanwhile, Singaporean I-O Table consists of 136 sectors, Malaysian I-O Table consists of 120 sectors and 179 sectors are covered in Thailand I-O Table. Table 1 presents the number of sub-sectors in 2005 I-O Table for each country which is grouped into 9 sectors.

The definition of ICT sector in this paper is based on OECD (2002)[5]. In April 2002, OECD revised the OECD's 1998 activity-based definition of ICT. A new definition of ICT introduces two new sub-sectors (ISIC 5151 and ISIC 5152). Those sub-sectors are split from ISIC 5150 (Wholesaling of machinery, equipment and supplies). The detail sub sectors of ICT both in manufacturing and services are: 3000 (Office, accounting and computing machinery); 3130 (Insulated wire and cable); 3210 (Electronic valves and tubes

4 Indonesia (Statistics Indonesia/BPS); Malaysia (Department of Statistics); Thailand (Office oft he National Economic and Social Development Board/NESB); Singapore (Singapore Department of Statistics).

5 The detailed definition of ICT sectors and ICT products can be found in OECD (2009) „Information Economy Product Definitions Based on the Central Product Classification (Version 2)".

and other electronic components); 3220 (Television and radio transmitters and apparatus for line telephony and line telegraphy); 3230 (Television and radio receivers, sound or video recording or reproducing apparatus and associated goods); 3312 (Instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process equipment); 3313 (Industrial process equipment); 5151 (Wholesale of computers, computer peripheral equipment and software); 5152 (Wholesale of electronic and telecommunication parts and equipment); 7123 (Renting of office machinery and equipment including computers); 6420 (Telecommunications); 72 (Computer and related activities). In this paper, we categorized the first seven sub-sectors as ICT manufacturing, and the rest are categorized as ICT services.

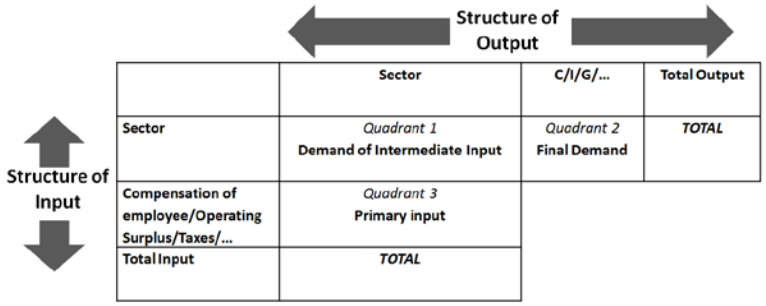
Table 1: Number of sectors in 2005 I-O Table

Sector	Indonesia	Malaysia	Thailand	Singapore
Agriculture	34 (19.4%)	12 (10.0%)	29 (16.2%)	5 (3.7%)
Mining and Quarrying	14 (8.0%)	4 (3.3%)	12 (6.7%)	0 (0%)
Manufacturing	93 (53.1%)	69 (57.5%)	93 (52.0%)	71 (52.2%)
Utilities	2 (1.1%)	2 (1.7%)	3 (1.7%)	3 (2.2%)
Construction	5 (2.9%)	3 (2.5%)	7 (3.9%)	2 (1.4%)
Trade, Hotel and Restaurant	3 (1.7%)	4 (3.3%)	4 (2.2%)	6 (4.4%)
Transportation and Telecommunication	7 (4.0%)	7 (5.8%)	11 (6.1%)	13 (9.6%)
Financial and Intermediary Services	3 (1.7%)	4 (3.3%)	3 (1.7%)	5 (3.7%)
Services	14 (8.0%)	15 (12.5%)	17 (9.5%)	31 (22.8%)
TOTAL	175	120	179	136

We faced a lot of difficulties in order to modify I-O Table with specific ICT sector as formally defined by OECD (2002). The main problem was on ICT services. We still could not find more detail database in order to split ICT services' sub-sectors from its aggregated sector, for instance "Wholesale of computers, computer peripheral equipment and software" - ISIC 5151 and " Wholesale of electronic and telecommunication parts and equipment" - ISIC 5152 from "Wholesale and Retail Trade" sector. Consequently, ICT services sector covers only telecommunications plus post services which could not be separated from "Communication" sector.

I-O Table was firstly developed by Leontief (1936) in order to analyze the relations between input and output in the economic system of United States. It records the flow of transaction across sectors both as a producer of output and a consumer of input. Generally, I-O Table can be divided into three quadrants. The first quadrant presents the transaction flow of intermediary input. It shows total spending of each sector on goods and services that are needed for the production process from other sectors. The second quadrant describes the final demand and the last quadrant presents total spending on primary inputs. The basic idea of I-O Table is total output must be perfectly equal to total input. Figure 1 shows the representation of I-O Table.

Figure 1: Input-Output Table



If we assume that x_{ij} is demand of output from sector *i* by sector *j*, FD_i is final demand of output from sector *i* and PI_j is spending of sector *j* on primary input. Hence, total output (X_i) and total input (X_j) are:

$$X_i = \sum_{j=1}^{n} x_{ij} + FD_i \qquad (1)$$

$$X_j = \sum_{i=1}^{n} x_{ij} + PI_j \qquad (2)$$

Next, we calculated some indicators based on I-O analysis, namely output multiplier, income multiplier, backward linkage and forward linkage. Firstly, we have to calculate technical coefficients (a_{ij}), which are the ratio of the intermediate demand to total output, hence:

$$a_{ij} = \frac{x_{ij}}{X_j} \qquad (3)$$

In the matrix form:

$$A = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix} \qquad (4)$$

After that, we calculated the Inverse Leontief Matrix, $(I - A)^{-1}$. This matrix is also known as multiplier matrix which measures the impact of one unit change in the final demand of sectors on the economy. If we assume that b_{ij} is element of the Inverse Leontief Matrix, then output multiplier (OM_j), backward linkage (BL_j) and forward linkage (FL_i) for each sector are defined as:

$$OM_j = \sum_{i=1}^{n} b_{ij} \qquad (5)$$

$$BL_j = \frac{n\sum_{i=1}^{n} b_{ij}}{\sum_{j=1}^{n}\sum_{i=1}^{n} b_{ij}} \qquad (6)$$

$$FL_i = \frac{n\sum_{j=1}^{n} b_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{n} b_{ij}} \quad (7)$$

Moreover, we also calculated income multiplier by previously multiplying diagonal income matrix by the Inverse Leontief Matrix, $V\left(I-A\right)^{-1}$. If c_{ij} is element of the new matrix, then income multiplier (IM_j) is defined as:

$$IM_j = \frac{n\sum_{i=1}^{n} c_{ij}}{\sum_{j=1}^{n}\sum_{i=1}^{n} c_{ij}} \quad (8)$$

After we had all indicators that are presented above, we employed biplots analysis in order to compare ICT sector with other sectors in the economy. Biplots analysis was firstly introduced by Gabriel (1971) with application to principle component analysis. Kohler and Luniak (2005) stated that biplots show several quantities of a data matrix in one display, namely: the variance-covariance structure; the value of observations; and the Euclidean distance between observations. These analyses are useful to reveal clustering and multivariate outlier. We hypothesize that if ICT sector has a distinguished role in the economy, ICT sector should not be in the same cluster with the majority of sectors.

Kohler and Luniak (2005) presented the mathematical background of biplots analysis. Let assume that Y is an $n \times k$ matrix and it is decomposed into $Y = ULV'$ by using singular value decomposition. L is diagonal matrix which is also known as eigenvalues.

If the coordinates of the observations and the coordinates for the variables are given respectively by:

$$G = UL^c \quad (9)$$

$$H' = L^{1-c}V' \quad (10)$$

Thus,

$$Y = ULV' = UL^cL^{1-c}V' = GH' \quad (11)$$

4. ASEAN and ICT Development

Prior to 2000, ASEAN did not pay specific attention to the development of ICT sector. ICT was only one of many sectors that were usually discussed in ASEAN Economic Ministers Meeting (AEM). In the fourth ASEAN Informal Summit (2000) which was held in Singapore, members of ASEAN signed the first e-ASEAN Framework Agreement. This agreement has four main objectives, namely: (i) promote cooperation to develop, strengthen and enhance the competitiveness of the ICT sector in ASEAN; (ii) promote cooperation to reduce the digital divide within individual ASEAN Member States and amongst ASEAN Member States; (iii) promote cooperation between the public and private

sectors in realizing e-ASEAN; (iv) promote the liberalization of trade in ICT products, ICT services and investments to support the ASEAN initiative. Generally, e-ASEAN agreement was mainly focused on the liberalization of ICT product among ASEAN members, the construction of ICT infrastructure, and the preparation of human resources on ICT sector. Moreover, under the e-ASEAN agreement ASEAN countries was endorsed to implement e-Government.

One year after the execution of e-ASEAN agreement, ASEAN introduced specific bodies that focus on ICT. ICT sector was exclusively discussed in ASEAN Telecommunications and IT Ministers Meeting (TELMIN) and ASEAN Telecommunication Senior Officials Meeting (TELSOM). Furthermore, ASEAN Telecommunications Regulator Council (ATRC) which was previously had no formal link with ASEAN Secretary, was agreed that henceforth act as advisor to TELMIN. In the same year, ASEAN countries agreed to eliminate tariff and non-tariff barriers on intra ASEAN trade in 1,986 ICT products (not including Cambodia) through 3 tranches as a follow up of e-ASEAN agreement. Table 2 shows the number of ICT products that are liberalized in each tranche for each ASEAN Member States. It was based on Joint Press Statement of the Fifteenth Meeting of the AFTA Council. The process of liberalization was fully implemented in 2010 for all ASEAN Member States.

Table 2: Number of ICT Products to be phased in

COUNTRY	1st Tranche	2nd Tranche	3rd Tranche	Total
Brunei Darussalam	61	29	41	131
Indonesia	191	5	19	215
Lao PDR	237	15	39	291
Malaysia	164	0	22	186
Myanmar	-	-	-	42
Philippines	44	0	4	48
Singapore	549	-	-	549
Thailand	218	0	65	283
Viet Nam	-	-	-	241
Total	1,464	49	190	1,986

Source: ASEAN (2001)

In 2005, ASEAN started to build broader cooperation with non-ASEAN countries in order to enhance the ICT sector performance. First, ASEAN signed ICT Cooperative Partnership for Common Development with China. Two years later, both parties agreed on the Plan of Action to Implement ASEAN-China ICT Cooperative Partnership. Under this agreement, China agreed to support ASEAN in terms of ICT infrastructure development and human

capacity building, increase trade an investment in ICT sector, improve network and information security and also supporting the funding by establishing the ASEAN-China Cooperation Fund (ACCF). Still in the same year, ASEAN-Japan ICT Work Plan 2007-2008 was also agreed. Under this agreement, ASEAN is expected to receive additional support from Japan on telecommunication infrastructure, information security, and the formulation of regional policy and regulatory framework. Furthermore, Cooperation on ICT sector has been part of ASEAN-India Partnership for Peace, Progress and Shared Prosperity (2010-2015) especially on the area of software development and ICT capacity building. Besides those three countries, ASEAN already started intensive negotiation with several other countries such as Australia, New Zealand, Republic of Korea and even European Union.

Table 3: Detail Actions for each foundation of ASEAN ICT Master Plan

Strategic Thrusts	Initiatives	Actions
Infrastructure Development	Improve Broadband Connectivity	Establish ASEAN Broadband Corridor
		Establish an ASEAN Internet Exchange Network
	Promote network integrity and information security, data protection, and Computer Emergency Response Team (CERT) cooperation	Develop common framework for network security
		Develop common network for information security
Human Capital Development	Build Capacity	Develop a registry of experts and innovators
		Create ASEAN ICT scholarship programme
	Develop skills upgrading and certification	Establish Mutual Recognition Arrangement (MRA) for skills certification
		Develop ICT certification and skills upgrading programme
Bridging the Digital Divide	Review of Universal Service Obligation (USO) or similar policies	Review of Universal Service Obligation (USO) or similar policies
	Connect schools and advocate early ICT education	Prioritise roll-out to schools
		Collaborate between ICT and education sectors within ASEAN
		Promote ASEAN integration through exposure to different cultures within ASEAN at an early age
	Improve access and relevance of information	Collaborate with relevant ministries
	Bridge the digital divide within ASEAN	Bridge the digital divide within ASEAN

Source: ASEAN ICT Master Plan 2015

The next phase of ASEAN cooperation on ICT development was the introduction of ASEAN ICT Master Plan 2015 in 2011. This five year plan was formulated based on five visions, hence: empowering, transformational, inclusive, vibrant, and integrated. ASEAN agreed on six strategic thrusts (which also known as three pillars supported by three foundations) in order to achieve four key outcomes. The first three strategic thrusts which covered infrastructure development, human capital development and bridging the digital divide, were the top priority of the Plan. ASEAN consists of ten countries which have

significantly different level of economic development and also ICT utilization, for instance between Singapore and Vietnam or even Cambodia. Regional cooperation on the development of ICT infrastructure and human resources is important in order to reduce the gap between those relatively more developed and less developed member states. Moreover, the readiness of ICT infrastructure and human resources will ensure the ability of all ASEAN Member States to benefit from regional cooperation on ICT development. In other words, three foundations of ASEAN ICT Master Plan are the necessary condition for ASEAN to develop and receive the benefit of ICT. The detail actions for each foundation of ASEAN ICT Master Plan can be seen in Table 3.

The next focuses are three main pillars of ASEAN ICT Master Plan. These are covering economic transformation, people engagement and empowerment, and innovation. Based on the first pillar, ASEAN is expected to create a conducive business environment that will increase investment, trade and entrepreneurship in ICT sector. Moreover, public sector will work together with the private sector to leverage the utilization of ICT in businesses. Private sector has a role to identify their ICT needs and requirements. These are expected to help public sector in providing the necessary infrastructure and policies that help to create better business environment for ICT sector.

In the second pillar, ASEAN focuses on the society empowerment and engagement. ASEAN society is expected to be familiar with e-services and willing to use e-services and its contents. The most important factor that must be firstly ensured is the cyber security. People will be attracted to use e-services if they sure all transactions are safe. Furthermore, e-services that are available should be relevant and has affordable price in order to attract more people engagement in ICT sector. Finally, the last pillar is innovation. ASEAN wanted to develop a creative, innovative and green ICT sector. ASEAN will establish networks of Centre of Excellent (COEs) across ASEAN Member States in order to facilitate the exchange of ideas and greater collaboration that will accelerate innovation.

5. Results and Discussions

ASEAN is one of the regional associations that have a large income gap among its members. Table 4 shows several economic indicators for four ASEAN Member States in 2005. In terms of total output, which is measured by Gross Domestic Product (GDP), Indonesia was the biggest country in ASEAN. However, Indonesia had the lowest per capita income compare to other three observed countries. Per capita income of Singapore was about 23 times larger than per capita income of Indonesian. Structure of the economy of all four countries were mainly dominated by the services sector and followed by the manufacturing sector. Contribution of the agriculture sector in GDP was relatively not significant, it was 13.13 percent in Indonesia, 10.27 percent in Thailand, 8.26 percent in Malaysia and only 0.05 percent in Singapore. By considering 5 economic indicators in Table 4, four countries that are analyzed in this study represent countries with different stage of development.

Table 4: Key Economic Indicators for 4 ASEAN Member States, 2005

Indicator	Indonesia	Malaysia	Singapore	Thailand
GDP (billion US$, current US$)	285.87	143.53	123.51	176.35
GDP per capita (current US$)	1257.65	5499.29	28952.81	2644.02
Agriculture, value added (% of GDP)	13.13	8.26	0.05	10.27
Manufacturing, value added (% of GDP)	27.41	27.55	26.83	34.70
Services, etc., value added (% of GDP)	40.33	45.37	68.35	45.77

Source: World Development Indicators, 2012

The size of the ICT manufacturing sector in 4 ASEAN Member States was positively correlated with its per capita income. Table 5 shows that the size of the ICT manufacturing sector as a percentage of GDP in Singapore was relatively higher than Malaysia, Thailand and Indonesia. Moreover, we also found the same results if we use the size of the ICT manufacturing as a percentage of total manufacturing output. The ICT manufacturing sectors in Singapore and Malaysia have a high contribution to total manufacturing output. It was accounted approximately 37.15 percent in Malaysia and 38.66 percent in Singapore. Those empirical evidences were precisely in line with the level of per capita income in four observed countries. Unfortunately, we do not find the same figure in the ICT services sector. Indeed, the share of the Singaporean ICT services output in total national output was relatively higher than other three countries, but the contribution of the ICT services sector to Malaysian economy was relatively lower than Thailand.

Table 5: The Size of ICT sector, 2005

Indicator	Indonesia	Malaysia	Singapore	Thailand
ICT Manufacturing				
% of total output	2.30	11.07	14.23	10.18
% of manufacturing output	6.14	37.15	38.66	17.60
ICT Services				
% of total output	1.67	1.06	4.62	1.38
% of services output	4.71	4.78	8.69	5.38

Source: IO Table of Indonesia, Malaysia, Singapore and Thailand, 2005

The ICT manufacturing sector has a different role in each observed country. The ICT manufacturing sector has an important role as an exported commodity in Singapore and Malaysia. Table 6 suggests that about 94.3 percent of the Singaporean ICT manufacturing products were exported abroad, 5.7 percent were consumed by other sectors as intermediate input and nearly zero percent were consumed as final demand. However, it does not mean that people in Singapore did not consume ICT manufacturing products. There was private consumption on ICT manufacturing products, but this demand was satisfied by using its inventory. In Malaysia, more than two third of ICT manufacturing products were exported abroad. Twenty percent others were consumed by other sectors as intermediate input, and only less than 4 percent were consumed as final demand. The ICT manufacturing sector in Thailand also had an almost similar figure with Malaysia. Thailand exported approximately 69.2 percent of its total manufacturing products and 20.7

percent were consumed domestically as intermediate input. Oppositely, the ICT manufacturing products in Indonesia were mostly produced to satisfy the domestic final demand as much as 51 percent of total ICT manufacturing output and about 37 percent others were exported abroad. In Thailand, the ICT manufacturing sector was important both as exported commodity and intermediate input. We found that about 43 percent of ICT manufacturing outputs were exported and almost 40 percent others were domestically consumed by other sectors.

Table 6: Output Structure of ICT manufacturing sector

	Indonesia	Malaysia	Singapore	Thailand
Intermediate input	11.1%	20.9%	5.7%	20.7%
Domestic demand	51.3%	3.5%	0.0%	10.1%
Export	37.6%	75.6%	94.3%	69.2%

Source: IO Table of Indonesia, Malaysia, Singapore and Thailand, 2005

The structure of ICT services output were almost the same across observed countries except for Singapore. Most of the ICT services outputs in three observed countries were mainly consumed domestically both as intermediate input and final demand. Meanwhile, only few others were exported abroad. It was only Singapore who exported about 36.5 percent of their ICT services, whereas Thailand, Malaysia and Indonesia exported only 13.1 percent, 4 percent and 0 percent respectively.

Table 7: Output Structure of ICT services sector

	Indonesia	Malaysia	Singapore	Thailand
Intermediate input	47.7%	64.5%	50.6%	56.4%
Domestic demand	52.3%	31.5%	12.9%	30.5%
Export	0.0%	4.0%	36.5%	13.1%

Source: IO Table of Indonesia, Malaysia, Singapore and Thailand, 2005

In terms of intermediate input, high percentage of ICT manufacturing products were used by the manufacturing sector. Table 8 shows that two biggest users of ICT manufacturing products as intermediate input in Indonesia were manufacturing sector and transportation, communication and services sector. Each of these consumed as much as 67 percent and 24.7 %[6] respectively. If we considered more disaggregated sector, we found that more than half of ICT manufacturing products (which were consumed as intermediate input) in Indonesia were used as intermediate input by the ICT manufacturing sector itself. The proportion was even bigger for Thailand, Singapore and Malaysia as much as 79.8 percent, 83.6 percent, and 99.7 percent respectively. These imply that the linkages between the ICT manufacturing sectors are relatively strong in the observed countries.

6 In this paragraph, the percentages are measured as sectoral expenditure on ICT products divided by total ICT products as intermediate input.

Table 8: ICT manufacturing products as intermediate input

	Indonesia	Malaysia	Singapore	Thailand
Agriculture and Mining	0.5%	0.1%	0.0%	0.2%
Manufacturing	67.0%	99.7%	83.6%	79.8%
Utilities and Construction	7.0%	0.0%	1.1%	7.1%
Trade, Restaurant and Hotel	0.7%	0.0%	8.1%	2.4%
Transportation, Communication and Services	24.7%	0.2%	7.3%	10.5%

Source: IO Table of Indonesia, Malaysia, Singapore and Thailand, 2005

As intermediate input, ICT services products were mainly used by transportation, communication and services sector in the four observed countries. Two other sectors that also intensively used ICT services products were manufacturing sector and trade, restaurant and hotel sector (except for Malaysia). Interestingly, the utilization of ICT services products by trade, restaurant and hotel sector in Malaysia was relatively low compare to other countries. However, we should underline that there are some weaknesses in the construction of the ICT services sector database. In more detailed disaggregation, we found that the ICT services sector was an essential intermediate input for the ICT services sector itself, trade sector and financial institution.

Table 9: ICT services products as intermediate input

	Indonesia	Malaysia	Singapore	Thailand
Agriculture and Mining	1.6%	1.7%	0.0%	1.4%
Manufacturing	16.7%	19.0%	16.4%	20.2%
Utilities and Construction	6.9%	5.1%	1.7%	1.6%
Trade, Restaurant and Hotel	26.6%	8.8%	28.6%	20.5%
Transportation, Communication and Services	48.1%	65.4%	53.3%	56.3%

Source: IO Table of Indonesia, Malaysia, Singapore and Thailand, 2005

In terms of the input structure, Indonesia had a relatively higher value added relative to Singapore, Malaysia and Thailand. Total value added that was created in the Indonesian ICT manufacturing sector was 27 percent, which is almost two times larger than value added in Thailand. Malaysia had the lowest value added compare to other three observed countries. Table 10 shows that the ICT manufacturing sector had a relatively higher percentage of intermediate input in Malaysia, Singapore, and Thailand than Indonesia. It was accounted more than 80 percent in Malaysia and Thailand, whereas only 64 percent in Indonesia. Interestingly, the Indonesian ICT manufacturing sector had high local content. It was accounted about 64.9 percent of total intermediate input. In contrast, the Singaporean ICT manufacturing sector had high dependency on imported intermediate input as much as 78.7 percent of total intermediate input.

Table 10: Input Structure of ICT Manufacturing

	Indonesia	Malaysia	Singapore	Thailand
Intermediate input	**64.7%**	**87.2%**	**77.2%**	**81.3%**
- Domestic intermediate input	*64.9%*	*44.8%*	*21.3%*	*31.6%*
- Imported intermediate input	*35.1%*	*55.2%*	*78.7%*	*68.4%*
Value Added	**27%**	**12.7%**	**22.7%**	**14.7%**
- Compensation Of Employee	*26.8%*	*26.2%*	*23.3%*	*30.8%*
- Operating Surplus	*73.2%*	*73.8%*	*76.7%*	*69.2%*
Taxes + Depreciation	**8.3%**	**0.1%**	**0.1%**	**4.0%**

Source: IO Table of Indonesia, Malaysia, Singapore and Thailand, 2005

The ICT services sector had a relatively higher value added in the four observed countries relative to the ICT manufacturing sector. Again, the Indonesian ICT services sector had a relatively higher value added than the Thailand, Singaporean, and Malaysian ICT services sector. Total value added that was created in the Indonesian ICT services sector was 59.5 percent. It was slightly higher than the Malaysian, Thailand and Singaporean ICT services sector which had value added as much as 49.9 percent, 44.6 percent, and 41.2 percent respectively.

Table 11: Input Structure of ICT Services

	Indonesia	Malaysia	Singapore	Thailand
Intermediate input	**21.9%**	**50.1%**	**58.3%**	**39.0%**
- Domestic intermediate input	*82.1%*	*89.2%*	*39.0%*	*99.6%*
- Imported intermediate input	*17.9%*	*10.8%*	*61.0%*	*0.4%*
Value Added	**59.5%**	**49.9%**	**41.2%**	**44.6%**
- Compensation Of Employee	*26.4%*	*17.4%*	*43.9%*	*39.6%*
- Operating Surplus	*73.6%*	*82.6%*	*56.1%*	*60.4%*
Taxes + Depreciation	**18.6%**	**0.0%**	**0.5%**	**16.4%**

Source: IO Table of Indonesia, Malaysia, Singapore and Thailand, 2005

Table 12 summarizes some indicators (Output Multiplier, Forward Linkage, Backward Linkage and Income Multiplier) that are calculated from I-O Table for each observed country. Those indicators provide valuable information on the importance of the ICT sector in the economy. An Output Multiplier of 1.2 means that an 1 unit/value increase in demand for the ICT products is expected to increase national output by 1.2 unit/value. A Forward Linkage of 1.2 means that an increase in final demand for ICT products by 1 unit/value is expected to result in an increase of 1.2 unit/value of final demand for all sectors that used ICT products as intermediate input. A Backward Linkage of 1.2 means that an increase in final demand for ICT products by 1 unit/value will result as much 1.2 unit/value increase in other sector's production. Income multiplier has no unique economic interpretation since it is represented in the index. An income index that is higher than 1 means that each additional unit of production in the sector will lead to an increase of income generating activities in other sectors above the typical increase due to the extra unit of production.

Table 12: Output Multiplier, Income Multiplier, Backward Linkage and Forward Linkage

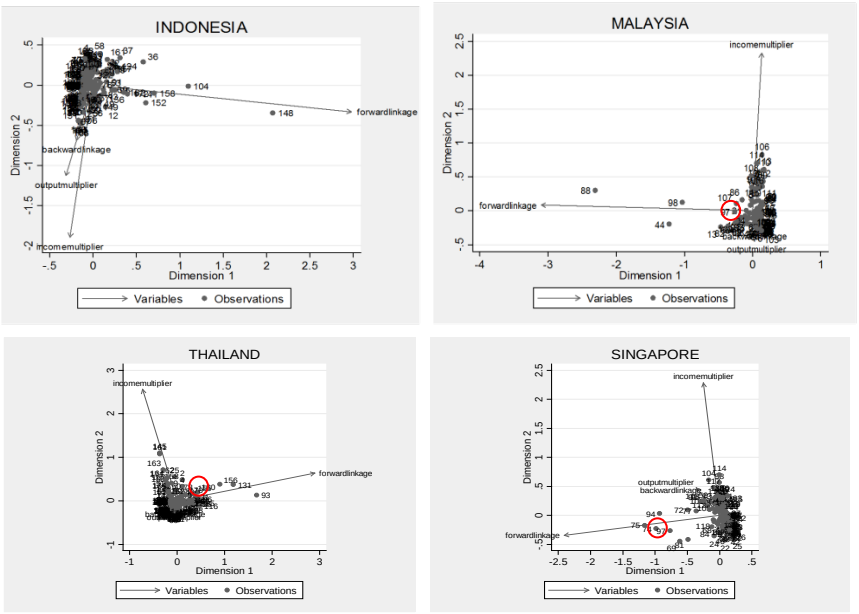
Indicators	Indonesia		Malaysia		Singapore		Thailand	
	ICT Manufacturing	ICT Services	ICT Manufacturing	ICT Services	ICT Manufacturing	ICT Services	ICT Manufacturing	ICT Services
Output Multiplier	1.68	1.27	1.64	1.81	1.23	1.33	1.38	1.64
Backward Linkage	1.03	0.78	0.88	0.98	0.84	0.91	0.82	0.97
Forward Linkage	0.92	1.60	1.35	1.80	1.10	3.51	2.30	2.14
Income Multiplier	0.67	0.81	0.49	0.92	0.34	0.85	0.33	1.19

Source: IO Table of Indonesia, Malaysia, Singapore and Thailand, 2005

In general, all the ICT sectors both the ICT manufacturing sector and the ICT services sector in all observed countries had output multiplier greater than one. The Indonesian ICT manufacturing sector had the highest output multiplier compare to other three countries. Oppositely, Singapore had the lowest output multiplier compare to others. If we consider backward and forward linkages in order to generate sectoral cluster (Loviscek, 1982), the ICT Manufacturing sectors can be grouped into different cluster in four observed countries, whereas the ICT services sectors were in the same cluster. The ICT services sectors in all three observed countries had weak backward linkage and strong forward linkage. The Indonesian ICT Manufacturing sector had strong backward linkage and weak forward linkage. Oppositely, The Malaysian and Singaporean ICT Manufacturing sector had weak backward linkage and strong forward linkage. The ICT Manufacturing sector in Thailand had both strong backward and forward linkages. The argument behind these can be explained by the structure of output and input that was previously discussed. The Indonesian ICT Manufacturing had weak forward linkage because the Indonesian ICT manufacturing products were mostly consumed as domestic final demand. Meanwhile, the Indonesian ICT Manufacturing had strong backward linkage because it had a relatively high local content. These imply that the impact of the ICT manufacturing sector on the national economy is not solely depend on the size of the country but mainly on the structure of the ICT sector within economy.

Next, we employed Biplots analysis to determine whether the ICT manufacturing sector and the ICT services sector are unique compare to other sectors in each observed country. Figure 2 shows that both the ICT Manufacturing sector (sector 127) and the ICT Services sector (sector 157) in Indonesia were in the same cluster with other sectors (majority). These mean that up to 2005 both the Indonesian manufacturing and services ICT sectors did not have a distinguished role in the economy. Both sectors could not be categorized as one of key sectors even though the local contents of ICT products were relatively higher than other countries. In Malaysia, only the ICT Manufacturing sector (sector 69) was in the same cluster with other sectors, whereas the Malaysian ICT services sector (sector 97) lies outside the cluster. The Malaysian ICT services sector had a relatively higher forward linkage relative to other sectors in the Malaysian economy. These imply the importance of the ICT services sector to support the production growth of other sectors.

Figure 2: Biplot analysis of ICT Manufacturing and ICT Services sector



The Thailand ICT services sector (sector 155) had a slightly different role relative to other sectors as it lies just outside the cluster (majority). Furthermore, the Thailand ICT Manufacturing (sector 116) was completely outside the "majority" cluster. It lies in the same cluster with iron and steel sector and secondary steel products sector. Those sectors had a substantially large output multiplier and forward linkage. The Singaporean ICT services sector (sector 74) had a distinguished role in the economy. It lies far outside the cluster due to its substantially high forward linkage.

6. Conclusion

Southeast Asian countries (ASEAN) have been seriously working together in order to improve their ICT sector since 2000. The combination between country's individual actions and regional actions is considered to be the best strategy. There are at least six aspects that have been implemented regionally by ASEAN. First, ASEAN increased intra-regional trade in ICT products by removing trade barriers among ASEAN Member States. Second, ASEAN improved the quality of human capital in order to catch up with the development of ICT products. Third, ASEAN prepared infrastructures that are necessary to support the development of ICT sector. Fourth, ASEAN optimized extra-region power by strengthening their cooperation particularly on ICT with relatively more developed countries. ASEAN would gain advantages from technological spillovers and knowledge spillovers through direct training and Foreign Direct Investment (FDI). Fifth, ASEAN increased awareness of its society to receive and use ICT on their daily lives, for instance

E-Government. Sixth, ASEAN reduced the technology gap between ASEAN Member States.

Based on three key points that we emphasized in this study, we found that all those three key points are not always true. More developed countries are not always benefit greater than less developed countries from ICT development. When per capita income is used as the indicator of country's development, we found that Singapore had smaller output multiplier than other three countries. Meanwhile, Indonesia which had the lowest per capita income in the observation had even the highest output multiplier compare to others. The paper also suggests that per capita income is positively correlated with the size of the ICT sector. Thus, the size of the ICT sector is not always the main factor that determines the magnitude of ICT development on the economic performance. Regarding the other two key points, the paper provides empirical evidences that the impact of ICT on the economy will depend on the structure and the intensity of the ICT sector in the economy. Moreover, the paper suggests that ICT services sector in Singapore, Thailand and also Malaysia had a distinguished role compare to other sectors in the economy. However, we should notice the problem with the definition of the ICT services sector in this paper which also covers post services.

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